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Exploring the impact of aerobic exercise on sleep quality in older adults: A systematic review

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ABSTRACT

Problem: Sleep disturbances are common and impact health, yet the most effective exercise modalities for improving sleep quality remain unclear. This study aims to evaluate the effectiveness of aerobic and resistance training in enhancing sleep quality and related health outcomes. **Purpose:** The purpose of this study is to examine the effectiveness of various exercise modalities, including aerobic and resistance training, in improving sleep quality and related health indices, and to determine the most helpful techniques for managing sleep disruptions in old. **Methods:** This study utilized a systematic literature review approach, gathering and analyzing scientific articles on the effects of exercise on sleep quality of elderly. Articles were sourced from Scopus using search terms such as "aerobic exercise" OR "aerobic training" OR "cardiovascular exercise" OR "endurance exercise" AND "sleep quality" OR "sleep disturbance" OR "sleep improvement" OR "sleep duration" OR "sleep patterns" OR "insomnia" AND "elderly" OR "older adults" OR "aging population" OR "senior citizens" OR "aged" AND "effect" OR "impact" OR "outcome" OR "influence" with a focus on studies published within the past five years. After collecting relevant articles, descriptive analysis was conducted to identify consistent patterns and findings. **Results:** Aerobic exercise was consistently the most effective intervention for improving overall sleep quality, including sleep efficiency, duration, and deep sleep, along with cognitive function and inflammation markers. Resistance and combined training also demonstrated significant benefits, with resistance training enhancing sleep onset latency and duration. These findings highlight exercise as a versatile, non-pharmacological approach to improving sleep health in diverse populations. Aerobic exercise was consistently the most effective intervention for improving overall sleep quality, including sleep efficiency, duration, and deep sleep, along with cognitive function and inflammation markers. Resistance and combined training also demonstrated significant benefits, with resistance training enhancing sleep onset latency and duration. These findings highlight exercise as a versatile, non-pharmacological approach to improving sleep health in diverse populations. **Conclusion:** This systematic study suggests that aerobic exercise improves sleep quality in older persons. Sleep disturbances decreased and sleep efficiency, total sleep time, and sleep start latency improved in multiple studies.

Keywords: aerobic exercise, sleep quality, resistance training, cognitive function, non-pharmacological intervention.

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Introduction

As the world population ages, enhancing sleep quality is crucial to older persons' health and well-being. Nearly half of older persons have sleep problems, according to studies. (Li et al., 2022). Sleep difficulties include insomnia, fragmentation, short sleep duration, and poor quality. Such problems impact older persons' physical, mental, and emotional health. Low-quality sleep is linked to cognitive decline, depression, and chronic diseases like cardiovascular disease, diabetes, and obesity. (Mukherjee et al., 2024). Therefore, improving sleep quality in older persons is essential to improve their health and quality of life.

Several interventions have been explored to address sleep issues in older adults, ranging from pharmacological treatments to behavioral therapies. However, non-pharmacological approaches, especially physical activity, have gained attention for their potential to improve sleep without the side effects often

associated with medications. Among various types of physical activity, aerobic exercise has emerged as a particularly promising intervention. Aerobic exercise, which includes activities such as walking, swimming, and cycling, has been shown to improve various aspects of health, including cardiovascular function, mental health, and sleep quality (Kashyap, 2023). Aerobic exercise may improve sleep by regulating circadian cycles, lowering anxiety and sadness, and boosting physical health. (Kramer, 2020).

Aerobic exercise may benefit older persons, according to accumulating data. Most exercise and sleep research has focused on younger populations. Age-related changes in circadian rhythms, hormone imbalances, and sleep architecture can impair sleep. (Garbarino et al., 2020). Older persons may have particular sleep issues, therefore specialized therapy like aerobic exercise may improve sleep quality. Regular aerobic exercise improves sleep latency, total sleep time, efficiency, and disruptions in older persons, according to studies. (Taillard et al., 2021).

Despite these promising findings, the exact mechanisms by which aerobic exercise affects sleep quality in older adults remain unclear. Some researchers suggest that aerobic exercise may promote better sleep through the regulation of body temperature and cortisol levels, the reduction of stress and anxiety, and the improvement of sleep-related neural functioning(Panagiotou et al., 2021). Many studies show that aerobic exercise improves sleep quality, but results vary depending on exercise intensity and duration, baseline sleep health, and individual factors like age and health status (Mahalakshmi et al., 2020).

This systematic review seeks to consolidate and critically analyze the existing body of literature on the effects of aerobic exercise on sleep quality in older adults. By examining a wide range of studies that explore both subjective and objective measures of sleep, this review aims to provide a comprehensive understanding of how aerobic exercise influences various dimensions of sleep, including sleep onset latency, sleep duration, sleep efficiency, and overall sleep quality. Ultimately, the findings from this review will help inform future research and practical recommendations for the use of aerobic exercise as a non-pharmacological approach to improving sleep and promoting the health of older adults.

Method

The method used in this study is a systematic literature study that collects and analyzes various scientific sources. The data collection process is carried out by searching for articles from Scopus, the search string used were ("aerobic exercise" OR "aerobic training" OR "cardiovascular exercise" OR "endurance exercise") AND ("sleep quality" OR "sleep disturbance" OR "sleep improvement" OR "sleep duration" OR "sleep patterns" OR "insomnia") AND ("elderly" OR "older adults" OR "aging population" OR "senior citizens" OR "aged") AND ("effect" OR "impact" OR "outcome" OR "influence") which includes original article published in the last five years, studies evaluating the effects of exercise on sleep quality of elderly. After collection, articles that met those criteria were analyzed descriptively to identify consistent patterns and findings regarding the effects of exercise on sleep quality of elderly. Figure 1 illustrates the article selection process employed in this study.

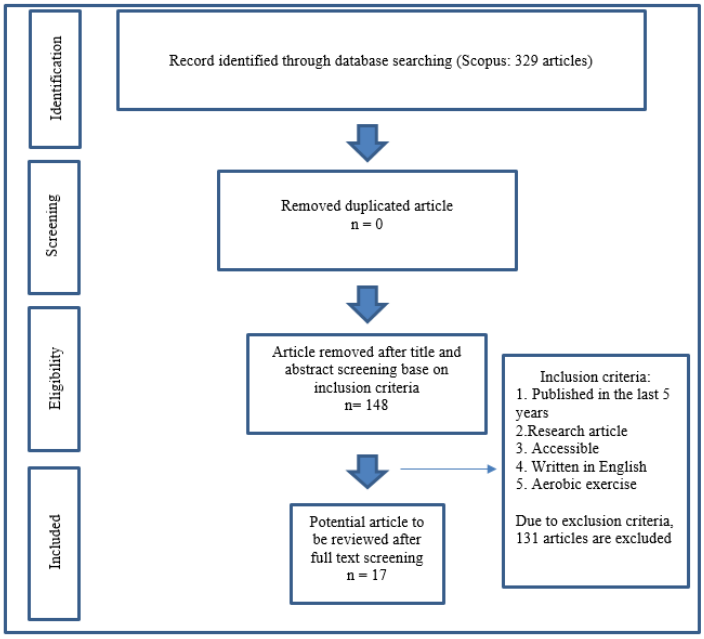

Figure 1. PRISMA flowchart of the study selection process

Results

Table 1 presents a critical appraisal analysis of sixteen selected journals.

Table 1. Literature Review Summary of Results

Researchers	Article Title	Research Results
(Gao et al., 2024)	Effects of different types of exercise on sleep quality based on Pittsburgh Sleep Quality Index in middle-aged and older adults: a network meta-analysis	Based on the results from the surface under the cumulative ranking (SUCRA) curve, aerobic exercise was the most effective in improving overall PSQI score (SUCRA = 93.2%), sleep onset (SUCRA = 96.8%), and use of sleep medication (SUCRA = 77.1%). Yoga, on the other hand, was the most effective for improving sleep disorders (SUCRA = 90.4%), sleep efficiency (SUCRA = 95.9%), sleep duration (SUCRA = 93.8%), and daytime dysfunction (SUCRA = 98.3%). In conclusion, aerobic exercise is the most effective type of exercise for improving the overall PSQI score in middle-aged and older adults.
(Gupta et al., 2022)	A clinical trial to compare the effects of aerobic training and resistance training on sleep quality and quality of life in older adults with sleep disturbance	The study found that both resistance and aerobic training significantly improved sleep quality (PSQI scores) and quality of life (QoL), but there was no significant difference between the two groups. Resistance training showed better improvement in sleep efficiency, sleep onset latency, and sleep duration, while the aerobic training group had better outcomes in social relationships. Both types of training are beneficial for sleep quality and QoL, and the choice of training can be based on an individual's functional and medical status.
(Alfini et al., 2020)	Impact of exercise on older adults' mood is moderated by sleep and mediated by altered brain connectivity	The study showed that 30 minutes of moderate-intensity aerobic exercise improved mood and reduced brain connectivity between areas involved in emotion regulation, especially in older adults with sleep problems. The changes in brain connectivity helped explain how sleep disturbances influenced the positive effects of exercise on mood. Overall, the research highlights the benefits of moderate-intensity exercise for improving mood, particularly in older adults with poor sleep quality.
(Tseng et al., 2020)	Effects of exercise training on sleep quality and heart rate variability in middle-aged and older adults with poor sleep quality: A randomized controlled trial	The exercise group showed significant improvements in overall sleep quality and heart rate variability compared to the control group. Multiple regression analysis revealed that exercise participation was linked to better sleep quality and certain heart rate variability measures, but the effect on heart rate variability was no longer significant after accounting for sleep quality. The findings suggest that moderate-intensity exercise improves both sleep quality and cardiac autonomic function, and middle-aged and older adults with poor sleep quality should be encouraged to participate in this type of exercise.

(Song et al., 2024)	Effect of an aerobic dancing program on sleep quality for older adults with mild cognitive impairment and poor sleep: a randomized controlled trial	The study found that a 16-week aerobic dancing program was feasible and effective in improving sleep quality and cognitive function in older adults with mild cognitive impairment (MCI) and poor sleep. Participants in the exercise group showed significant improvements in general sleep quality, sleep latency, sleep duration, sleep efficiency, and cognitive function compared to the control group. The results suggest that aerobic dancing could be a valuable intervention to address sleep and cognitive decline in older adults with MCI.
(Seol, Fujii, et al., 2021)	Effects of Morning Versus Evening Home-Based Exercise on Subjective and Objective Sleep Parameters in Older Adults: A Randomized Controlled Trial	The evening exercise group showed significant improvements in both subjective and objective measures of sleep latency throughout the intervention. Additionally, subjective sleep satisfaction was significantly higher in the evening group compared to the morning group. The evening exercise also had larger effect sizes on sleep-related variables. The study concludes that low-intensity stepping exercises in the evening could be an effective nonpharmacological approach to improving sleep quality in older adults.
(Seol, Park, et al., 2021)	Distinct effects of low-intensity physical activity in the evening on sleep quality in older women: A comparison of exercise and housework	The study found that core body temperature was significantly higher after both housework and aerobic exercise compared to the control group. Sleep latency was shortest after aerobic exercise, and delta power density, a measure of deep sleep, was higher after aerobic exercise than after the control trial. Aerobic exercise also significantly improved both polysomnographic and self-reported sleep quality. While housework also increased core body temperature, it did not lead to the same improvement in sleep quality as aerobic exercise. The results suggest that low-intensity aerobic exercise in the evening can enhance sleep quality more effectively than housework
(Cassim et al., 2022)	Effects of exercise on the sleep microarchitecture in the aging brain: A study on a sedentary sample	The results showed that aerobic exercise led to more deep sleep and an increase in total EEG power during both light (N1 and L1) and deep sleep (N2 and N3). These changes in sleep microarchitecture suggest that non-pharmacological approaches, like exercise, may help counteract age-related changes in EEG patterns, potentially benefiting neurocognitive health.
(El Refaey et al., 2020)	Effect of aerobic exercises on sleep and hormonal levels in elderly with chronic primary insomnia: A randomized controlled trial	The study found significant improvements in sleep quality and serotonin levels in the exercise group, with a notable difference between the groups ($p < 0.05$). However, there were no significant changes in epinephrine or norepinephrine levels. The control group showed no significant changes in any measured variables ($p > 0.05$). The conclusion suggests that moderate-intensity aerobic exercise can improve

		sleep and increase serotonin levels in patients with chronic primary insomnia.
(Al-Jiffri & Abd El-Kader, 2021)	Aerobic versus resistance exercises on systemic inflammation and sleep parameters in obese subjects with chronic insomnia syndrome	After 6 months of aerobic and resistance exercise training, both groups showed significant improvements in total sleep duration, sleep efficiency, sleep onset latency, and IL-10 levels, along with a reduction in awake time after sleep onset, REM latency, IL-6, and TNF-α. However, there were significant differences between the two groups, with aerobic exercise proving more effective in improving sleep quality and modulating inflammation in individuals with chronic primary insomnia.
(Baron et al., 2023)	Effect of aerobic exercise training on sleep and core temperature in middle-aged women with chronic insomnia: a randomized controlled trial	The exercise group showed a significant decrease in the Insomnia Severity Index (ISI) and improvements in various objective sleep parameters. Core body temperature changes included a lower batyphase value and a larger amplitude, with a strong correlation between insomnia improvement and changes in core temperature. The study concludes that a moderate to vigorous aerobic exercise program is an effective non-drug therapy for improving sleep in women with insomnia, and such programs should aim to increase core body temperature during exercise to enhance sleep-promoting adaptations.
(Miyazaki et al., 2021)	Effects of light-to-moderate intensity aerobic exercise on objectively measured sleep parameters among community-dwelling older people	The exercise group showed significant improvements in total sleep time, sleep efficiency, and a reduction in waking episodes after sleep onset (WE≥10 min) compared to the control group. Subgroup analysis within the exercise group showed no differences in sleep quality changes based on baseline sleep conditions. The study concludes that three months of light aerobic exercise can improve sleep quality in community-dwelling older adults, regardless of their initial sleep status, although the effect may be modest.
(Sarıtoy & Usgu, 2023)	The effect of aerobic exercises of different intensities on anxiety, cigarette addiction, sleep quality, and quality of life in former smokers	The MoIA group showed a greater decline in the SCS score compared to the MIA and CON groups, while the MIA group had a lower sleep disturbance score than the other groups after assessing the influence of exercise training over time. Aerobic exercise had no impact on SF-36 or BAS scores. The study concludes that both mild and moderate-intensity aerobic exercise offer similar benefits for quality of life and anxiety, but mild-intensity exercises may be more suitable for addressing sleep difficulties, while moderate-intensity exercises may be more effective for reducing smoking addiction
(Atef et al., 2020)	Effect of different types of exercise on sleep deprivation and functional capacity in middle aged patients after coronary artery bypass grafting	Both aerobic exercise alone and combined aerobic and resistance exercises significantly improved sleep quality and functional capacity. However, the improvements were more pronounced in the aerobic exercise group, with significant increases in total sleep duration, deep sleep, sleep efficiency, and functional capacity.

		The study concludes that while both exercise modes offer benefits, aerobic exercise alone has a more significant impact on sleep quality and functional capacity.
(Zhou et al., 2022)	Benefits of different combinations of aerobic and resistance exercise for improving plasma glucose and lipid metabolism and sleep quality among elderly patients with metabolic syndrome: a randomized controlled trial	All intervention groups showed significant improvements in blood pressure, handgrip strength, plasma glucose, and Pittsburgh Sleep Quality Index (PSQI) scores compared to baseline. The HRLAT and HALRT groups also saw improvements in lipid levels, with the HALRT group showing the greatest overall improvements. The study concluded that combined exercise prescriptions were more effective than aerobic or resistance training alone in improving plasma glucose, lipid metabolism, and sleep quality in elderly patients with metabolic syndrome.
(Atef & Abdeen, 2021)	Effect of exercise on sleep and cardiopulmonary parameters in patients with pulmonary artery hypertension	The study found that aerobic training significantly improved sleep quality, exercise capacity (VO2max), and reduced right ventricular systolic pressure (RVSP) in patients with pulmonary arterial hypertension (PAH). These results suggest that aerobic exercise positively impacts three key risk factors for mortality in PAH patients: sleep quality, exercise capacity, and right ventricular remodeling.
(Amalia et al., 2021)	The effect of aerobic exercises on estradiol plasma, quality of sleep, and cognitive function in menopausal women	The study found that aerobic exercise improved sleep quality and cognitive function in menopausal women compared to the control group. The authors suggest that future research should include a larger sample size and longer duration to observe a significant increase in plasma estradiol levels.

Discussion

This systematic review aimed to explore the impact of aerobic exercise on sleep quality in older adults. The results of the studies included in this review consistently show that aerobic exercise has a positive effect on various aspects of sleep, such as sleep onset latency, total sleep time, sleep efficiency, and sleep disturbances. These findings are consistent with previous research that suggests physical activity, especially aerobic exercise, may be an effective non-pharmacological intervention for improving sleep quality among older adults(Brown & Gervais, 2020). This review shows that aerobic exercise improves sleep quality, which is reassuring considering the rising prevalence of sleep disorders in the elderly.

Aerobic exercise increases sleep efficiency and reduces sleep onset latency, according to this review. Sleep efficiency-the ratio of time asleep to time in bed-is a key measure of sleep quality. Exercise has been demonstrated to assist older folks fall asleep faster and remain asleep. (Mahalakshmi et al., 2020). Multiple studies in this review found that regular aerobic exercise reduces sleep onset latency by adjusting the body's circadian rhythm. Aerobic exercise may regulate circadian rhythms by releasing sleep-inducing hormones like melatonin. Multiple studies in this review found that regular aerobic exercise reduces sleep onset latency by adjusting the body's circadian rhythm. Aerobic exercise may regulate circadian rhythms by releasing sleep-inducing hormones like melatonin. (El Refaey et al., 2020). Moreover, aerobic exercise may also improve sleep by reducing symptoms of anxiety and depression, which are often prevalent in older adults and are known to contribute to sleep disturbances (Sarıtoy & Usgu, 2023).

Aerobic exercise increased sleep time and decreased sleep disruptions while improving sleep efficiency. Older persons' sleep quality declines with age, resulting in fragmented sleep and insufficient rest (Panagiotou et al., 2021). The findings in this review suggest that aerobic exercise can help older persons sleep longer and more restfully, which is crucial for health. Aerobic exercise also improved objective sleep measurements like actigraphy data, supporting self-reported sleep improvements.

Aerobic exercise's effect on sleep quality is still being studied. Aerobic exercise may improve sleep in

older persons through numerous pathways, according to this analysis. Possible mechanism: body temperature regulation. Studies have indicated that aerobic exercise raises core body temperature, which may help cool the body after exercise and induce sleep. (Amalia et al., 2021). This cooling process helps signal to the body that it is time to sleep, potentially leading to quicker sleep onset. Furthermore, exercise-induced increases in heart rate and circulation could contribute to overall improvements in cardiovascular health, which in turn may positively impact sleep quality (Baron et al., 2023).

Another potential mechanism is the modulation of the autonomic nervous system. Regular aerobic exercise has been shown to enhance parasympathetic activity (the "rest and digest" system), which could lead to a reduction in the physiological arousal that often disrupts sleep. Aerobic exercise may also help alleviate symptoms of stress and anxiety, both of which are common contributors to sleep disturbances in older adults (Szuhany et al., 2024). Regular exercise improves mood and mental health, which affects sleep quality.

The limitation of the studies included in this review is the lack of uniformity in sleep measurement techniques. While many studies relied on self-reported sleep questionnaires, such as the Pittsburgh Sleep Quality Index (PSQI), some studies used objective measures, such as actigraphy or polysomnography. The discrepancy between subjective and objective measures of sleep makes it difficult to compare results across studies and draw definitive conclusions regarding the impact of aerobic exercise on sleep. Future research should aim to incorporate both subjective and objective measures of sleep to provide a more comprehensive understanding of how aerobic exercise influences sleep in older adults.

Conclusion

Aerobic exercise is the best non-pharmacological treatment for sleep quality, including efficiency, length, and depth, cognitive function, and inflammation. Exercise is adaptable for treating sleep disorders in varied individuals since resistance and combination training are beneficial. Future studies should examine how different exercise methods affect sleep quality over time and across age groups and health problems. To optimize exercise prescriptions for specific populations, greater sample sizes and studies on the processes linking exercise to sleep improvements are necessary.

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