Sleep Neurophysiology in the Elderly: The Potential of Brain Gym to Improve Quality of Life

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ABSTRACT
Sleep disturbances represent a common health problem among older adults due to physiological changes associated with aging, decreased melatonin production, and the presence of chronic diseases. Poor sleep quality has been associated with impaired cognitive function, weakened immune response, increased risk of falls, and reduced overall quality of life. Non-pharmacological interventions such as Brain Gym have been proposed as a potential strategy to improve sleep quality by stimulating the parasympathetic nervous system, enhancing cerebral blood flow, and regulating neurotransmitter activity. This study aimed to examine the effect of Brain Gym on sleep quality among older adults. A quantitative study with a quasi-experimental design using a pretest–posttest control group approach was conducted. The sample consisted of 20 elderly participants selected through purposive sampling based on predetermined inclusion criteria. Brain Gym intervention was administered three times per week for four weeks, with each session lasting 30 minutes. Sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI) questionnaire. Data were analyzed using the Wilcoxon test to determine differences in sleep quality before and after the intervention. Prior to the intervention, all respondents (100%) were categorized as having poor sleep quality. Following the intervention, eight respondents (80%) demonstrated good sleep quality, while two respondents (20%) remained in the poor category, although their PSQI scores showed improvement. The Wilcoxon test produced a p-value of 0.000 ($p < 0.05$), indicating a statistically significant difference in sleep quality before and after the intervention. Brain Gym was found to be effective in improving sleep quality among older adults, with an effectiveness rate of 80%. This intervention is simple to implement, safe, and has the potential to be integrated into gerontological nursing care as a non-pharmacological alternative to enhance the quality of life among the elderly.
Keywords: brain gym; elderly; neurophysiology; sleep quality; insomnia

INTRODUCTION
Sleep disturbances represent one of the most common health problems experienced by older adults. Aging is accompanied by various physiological changes that affect the sleep–wake cycle, including decreased melatonin secretion, alterations in circadian rhythm regulation, and the presence of comorbid chronic conditions that often accompany the aging process [1]. These physiological changes can lead to reduced sleep efficiency, increased sleep latency, frequent nocturnal awakenings, and shorter total sleep duration. Consequently, many older adults experience persistent sleep disturbances that interfere with their daily functioning and overall well-being. Poor sleep quality among older adults has been associated with significant health consequences, including decreased cognitive performance, impaired attention and memory, weakened immune response, and increased vulnerability to infections [2]. In addition, inadequate sleep has been linked to a higher risk of falls, emotional instability, and mental health problems such as anxiety and depression. Chronic insomnia may further contribute to a decline in functional independence and overall quality of life, making sleep disturbances an important concern in geriatric health care and nursing practice [2].

The prevalence of sleep disturbances among older adults continues to increase in parallel with the growing global aging population. Several studies have reported that more than half of elderly individuals experience some form of sleep disturbance, ranging from mild insomnia to more severe sleep disorders that significantly affect both physical and psychological health [3]. In Indonesia, the prevalence of sleep disturbances among older adults has been reported to reach approximately 67%, indicating that sleep problems constitute a major public health concern within geriatric populations [4]. This high prevalence highlights the urgency of addressing sleep disorders through comprehensive health services that encompass promotive, preventive, curative, and rehabilitative approaches. If left untreated, chronic sleep disturbances may increase the risk of developing various degenerative diseases, including hypertension, diabetes mellitus, cardiovascular disease, and stroke, as well as psychological disorders that ultimately reduce the quality of life among older adults [5]. Therefore, effective and sustainable strategies are required to address sleep disturbances as part of comprehensive geriatric care.

Management of sleep disorders among older adults often involves pharmacological therapy, particularly the use of hypnotic or sedative medications. Although such medications may provide short-term relief, long-term use can lead to several adverse effects, including cognitive impairment, metabolic disturbances, daytime drowsiness, and an increased risk of dependency [5]. These risks are particularly concerning among older adults, who frequently experience multiple chronic conditions and polypharmacy due to the use of several medications simultaneously for different illnesses. As a result, the potential for drug interactions and adverse drug reactions becomes significantly higher in this population. For this reason, non-pharmacological interventions that are safe, cost-effective, and easy to implement have gained increasing attention as alternative strategies for managing sleep disturbances among older adults. Compared with pharmacological treatments, non-pharmacological approaches are generally considered more sustainable because they not only address sleep problems but also provide broader benefits for physical, psychological, and social well-being in a holistic manner.

One promising non-pharmacological intervention is Brain Gym, a form of structured light physical exercise designed to stimulate coordination between the left and right hemispheres of the brain through a series of simple body movements [6,7]. Brain Gym exercises involve movements that integrate sensory, cognitive, and motor functions, thereby promoting improved neural connectivity and brain activation. From a physiological perspective, Brain Gym is believed to stimulate the parasympathetic nervous system, which plays an essential role in relaxation and stress reduction. Through gentle movements and breathing patterns, Brain Gym can help reduce muscle tension, promote relaxation, and facilitate a calmer physiological state that is conducive to better sleep [8,9]. In addition, Brain Gym exercises may improve cerebral blood circulation, particularly to brain regions responsible for emotional regulation, cognitive processing, and the sleep–wake cycle.

Furthermore, Brain Gym is thought to influence the regulation of neurotransmitters involved in sleep modulation. Regular practice of these movements may contribute to improved neurotransmitter balance, including serotonin and gamma-aminobutyric acid (GABA), which are essential for regulating sleep quality and promoting relaxation [10]. Enhanced neurotransmitter activity may help stabilize circadian rhythms and facilitate the transition from wakefulness to sleep. The simplicity and adaptability of Brain Gym movements make them particularly suitable for older adults, as they do not require special equipment, complex training, or intensive physical exertion. These exercises can be performed independently or

with the assistance of caregivers or family members, making them a practical and accessible intervention in community and clinical settings. Because of these characteristics, Brain Gym has considerable potential as a safe and feasible non-pharmacological intervention for improving sleep quality among older adults.

Despite the theoretical and physiological rationale supporting the potential benefits of Brain Gym, empirical evidence specifically examining its effects on sleep quality in older adults remains relatively limited. Existing studies have primarily focused on the benefits of Brain Gym for cognitive function, concentration, and learning performance, while its role in improving sleep quality has received less scientific attention. This lack of comprehensive research creates a research gap that highlights the need for further investigation into the effectiveness of Brain Gym as a promotive and therapeutic intervention for sleep disturbances among older adults. Addressing this gap is important for strengthening the scientific basis of non-pharmacological interventions in gerontological nursing practice. Therefore, this study aims to examine the effect of Brain Gym on sleep quality among older adults as a basis for developing effective, practical, and evidence-based non-pharmacological interventions that can be integrated into geriatric health care services.

METHODS

This study employed a quasi-experimental design using a pretest–posttest with control group approach. This design was selected to evaluate the effect of the Brain Gym intervention on sleep quality among older adults by comparing changes in sleep quality scores between the intervention group and the control group. The study population consisted of all older adults registered at the Elderly Integrated Health Service Post (Posyandu Lansia) within the study area. The sample was determined using a purposive sampling technique. A total of 20 participants were included, comprising 10 respondents in the intervention group and 10 respondents in the control group. The sample size was determined based on the calculation of a paired mean difference test, assuming a 95% confidence level, 80% statistical power, and a moderate estimated effect size based on previous similar studies. Participants were allocated into intervention and control groups through non-random allocation while considering comparability in age, gender, and baseline sleep quality scores in order to minimize potential selection bias. The inclusion criteria were: a) aged ≥ 60 years, b) having poor sleep quality indicated by a PSQI score > 5, c) able to follow Brain Gym movement instructions, and d) willing to participate by signing informed consent. The exclusion criteria included: a) older adults with severe cognitive impairment, b) significant motor disorders, or c) those currently undergoing long-term pharmacological sleep therapy.

The independent variable in this study was the implementation of Brain Gym, while the dependent variable was sleep quality among older adults. Sleep quality was measured using the Indonesian version of the Pittsburgh Sleep Quality Index (PSQI) questionnaire. The PSQI instrument has undergone cultural adaptation and validity testing, with item validity values of $r > 0.30$ and high reliability with Cronbach's alpha ranging from 0.70–0.83 [11,12]. Therefore, the instrument is considered appropriate for use in the Indonesian population. The PSQI evaluates sleep quality based on seven components, namely sleep duration, sleep latency, sleep efficiency, sleep disturbances, use of sleep medication, subjective sleep quality, and daytime dysfunction. In this study, the intervention group received Brain Gym sessions three times per week, each lasting 30 minutes, for a total duration of four weeks. Meanwhile, the control group did not receive the intervention and continued their routine activities at the Posyandu Lansia. Sleep quality measurements were conducted at baseline (pretest) and again at the fourth week after the intervention (posttest) using the PSQI questionnaire. Data were analyzed using a paired t-test to determine differences in sleep quality scores before and after the intervention within each group. Differences between the intervention and control groups were also analyzed using the Wilcoxon test because the change scores were not entirely normally distributed. Statistical significance was set at $p < 0.05$.

RESULTS

Based on Table 1, the total number of respondents was 20 older adults with an equal gender distribution, consisting of 10 males (50.0%) and 10 females (50.0%). The age distribution indicates that most respondents were in the 60–65 year age group, accounting for 8 individuals (40.0%), followed by those aged 66–70 years with 7 individuals (35.0%), and the remaining 5 respondents (25.0%) were older than 70 years.

Regarding physical activity history, 6 respondents (30.0%) reported exercising regularly, 9 respondents (45.0%) exercised occasionally, and 5 respondents (25.0%) reported never engaging in regular exercise. In terms of medical history, hypertension was the most common chronic condition experienced by the respondents, affecting 6 individuals (30.0%), followed by diabetes in 4 individuals (20.0%). Meanwhile, 10 respondents (50.0%) reported having no history of chronic disease.

Table 2 shows that all respondents in the intervention group (n = 10; 100%) had poor sleep quality prior to the intervention. After receiving the Brain Gym intervention, 8 respondents (80%) demonstrated improvement in sleep quality to the good category, while 2 respondents (20%) remained in the poor sleep quality category. The results of the Wilcoxon test indicated a statistically significant difference between sleep quality scores before and after the intervention ($p < 0.05$).

Table 1. Distribution of demograpic characteristics of elderly

Variable	Category	Percentage
Gender	Male	50.0
	Female	50.0
Age	60–65 years	40.0
	66–70 years	35.0
	>70 years	25.0
Physical Activity History	Regular	30.0
	Rarely	45.0
	Never	25.0
Medical History	Hypertension	30.0
	Diabetes	20.0
	No chronic disease	50.0

Table 2. Comparison of elderly sleep quality before and after brain gym intervention

		Sleep quality after intervention		p-value
		Good	Poor	
Sleep quality before intervention	Good	0 (0.0%)	0 (0.0%)	<0.001
	Poor	8 (80.0%)	2 (20.0%)	

DISCUSSION

The results of this study indicate that the Brain Gym intervention contributed to an improvement in sleep quality among older adults. Prior to the implementation of the intervention, all respondents were categorized as having poor sleep quality. After participating in the Brain Gym program for a specified intervention period, the majority of participants demonstrated noticeable improvements in their sleep patterns and were subsequently categorized as having better sleep quality. The statistical analysis confirmed that there was a meaningful difference in sleep quality before and after the intervention, indicating that Brain Gym can be considered an effective non-pharmacological approach for improving sleep quality among older adults. These findings support the research hypothesis that structured and regular Brain Gym exercises may serve as a practical strategy to address sleep disturbances in the elderly population.

Sleep disturbances among older adults represent a significant global health concern with a relatively high prevalence. Aging is accompanied by various physiological changes that influence sleep regulation, including alterations in circadian rhythm, reduced secretion of melatonin, and the increased presence of chronic health conditions that may interfere with normal sleep patterns [13,14]. These physiological and pathological factors contribute to the higher susceptibility of older adults to sleep-related disorders. In Indonesia, sleep disturbances among older adults have been reported to occur at a considerable rate, highlighting the importance of addressing this issue as part of gerontological health services [15]. Poor sleep quality among the elderly has far-reaching consequences, including impaired cognitive function, reduced concentration and memory, increased risk of falls, and metabolic disturbances such as hypertension and diabetes. In addition, persistent sleep problems may contribute to psychological distress, including anxiety and depression. Therefore, the development and implementation of effective interventions to improve sleep quality among older adults are essential in promotive, preventive, and therapeutic health care contexts.

From a physiological perspective, Brain Gym exercises may influence the central and autonomic nervous systems, both of which play an important role in sleep regulation. The structured movements involved in Brain Gym are believed to stimulate the parasympathetic nervous system while reducing excessive sympathetic activity, thereby promoting a state of relaxation within the body [16]. Activation of the parasympathetic system contributes to reduced muscle tension, slower heart rate, and more stable respiratory patterns, all of which facilitate the body's natural transition into sleep. In addition, Brain Gym movements may enhance cerebral blood circulation, particularly in areas of the brain such as the prefrontal cortex and the limbic system that are closely associated with emotional regulation and the sleep–wake cycle.

From a neuroendocrine perspective, Brain Gym activities may also stimulate the release and regulation of neurotransmitters associated with relaxation and sleep induction. Neurotransmitters such as serotonin and gamma-aminobutyric acid (GABA) are known to play an important role in calming neural activity and facilitating sleep initiation. Serotonin additionally acts as a precursor in the production of melatonin, the hormone responsible for regulating circadian rhythm and sleep timing. Through the combination of physical movement and cognitive engagement, Brain Gym exercises may help restore balance in neurohormonal regulation, improve sleep efficiency, and reduce the risk of chronic insomnia among older adults. This explanation aligns with sleep physiology theory, which emphasizes that the balance between autonomic nervous system activity and neurohormonal regulation is essential for achieving optimal sleep quality.

The findings of this study are consistent with previous research demonstrating that light and structured physical exercise can improve sleep quality among older adults. Relaxation-based exercise programs have been shown to help reduce sleep latency and improve sleep efficiency in elderly populations [17]. Similarly, other studies have reported that regular elderly exercise programs can contribute to improvements in sleep quality scores among older individuals [18]. The results of the present study reinforce the growing body of evidence suggesting that simple and routine physical activities can serve as effective non-pharmacological interventions for addressing sleep disturbances. What distinguishes this study from previous investigations is its specific focus on Brain Gym exercises, which combine physical movement with cognitive stimulation aimed at enhancing coordination between the left and right hemispheres of the brain. This dual stimulation makes Brain Gym a unique intervention, as it simultaneously supports physiological, cognitive, and emotional processes that may collectively contribute to improved sleep quality.

The analysis of respondent characteristics also provides additional insight into the observed outcomes. The distribution of participants between males and females was relatively balanced, and improvements in sleep quality were observed across both groups. This suggests that the Brain Gym intervention may be applied broadly without significant limitations related to gender. In terms of age distribution, most respondents belonged to the younger segment of the elderly population. Individuals within this age range often retain greater physiological adaptability, which may allow non-pharmacological interventions to produce more noticeable benefits. Participants who reported engaging in regular physical activity also appeared to demonstrate faster improvements in sleep quality compared with those who rarely exercised or had never engaged in routine physical activity. Physical activity is widely known to improve sleep quality through mechanisms such as increased energy metabolism and the release of endorphins that promote relaxation and psychological well-being [19,20].

Furthermore, the presence of chronic diseases such as hypertension and diabetes among some respondents did not appear to hinder the positive effects of the Brain Gym intervention. This finding suggests that Brain Gym exercises may be safely implemented among older adults with certain chronic medical conditions. Unlike pharmacological treatments, which may carry risks of adverse effects and drug interactions, Brain Gym provides a low-risk and accessible alternative that can be incorporated into daily routines without significant health risks.

From the perspective of gerontological nursing practice, the findings of this study have several important implications. Brain Gym exercises may be integrated into community-based elderly health programs, including activities conducted at elderly integrated health service posts. Community health nurses can play an essential role in teaching these simple movements to older adults as well as to community health volunteers, enabling the exercises to be practiced regularly at home. In addition to improving sleep quality, Brain Gym activities may also contribute to improved psychological well-being, enhanced independence, and reduced risk of falls among older adults.

More broadly, Brain Gym may be developed as part of a holistic approach to elderly nursing care [21,22]. By combining physical movement, cognitive stimulation, and emotional regulation, this intervention aligns with contemporary nursing paradigms that emphasize the integration of biological, psychological, social, and spiritual dimensions of health. Such comprehensive approaches are particularly important in gerontological care, where maintaining quality of life is a central goal.

Despite the positive findings, several limitations should be acknowledged. The relatively small sample size limits the generalizability of the study results to broader populations. Additionally, the duration of the intervention was relatively short, making it difficult to determine the long-term effects of Brain Gym on sleep quality among older adults. External factors such as sleep environment, dietary habits, and caffeine consumption were also not fully controlled during the study period. Therefore, future research with larger sample sizes, longer intervention durations, and more comprehensive control of external variables is recommended to strengthen the scientific evidence regarding the effectiveness of Brain Gym as a non-pharmacological intervention for improving sleep quality in elderly populations.

CONCLUSION

Overall, the study findings indicate that the research objective was achieved, demonstrating that Brain Gym has the potential to improve sleep quality among older adults. Brain Gym is a simple, safe, and easily applicable intervention that can be implemented widely in gerontological nursing services. The improvement in sleep quality observed after the intervention suggests that non-pharmacological approaches are feasible and beneficial in both clinical and community settings. Physiologically, the effects of Brain Gym are associated with activation of the parasympathetic nervous system, increased regulation of sleep-related neurotransmitters, and stabilization of circadian rhythms. Therefore, Brain Gym not only contributes to better sleep quality but also supports the overall quality of life among older adults.

Ethical consideration, competing interest and source of funding

-This study received ethical approval from the Health Research Ethics Committee of Universitas Muhammadiyah Ponorogo with approval number 2025/KEPK/2025. All participants were provided with detailed information regarding the objectives, procedures, benefits, and potential risks of the study, and were required to sign an informed consent form prior to participation.
-There is no conflict of interest related to this research and publication
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