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Enhancing Cognitive Function in Elderly through Brain Gym: A Community Implementation in Petoran Hamlet, Surakarta

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Abstract

Background: The elderly often struggle to accept the changes and setbacks they encounter. The changes that occur are not only physical, but also cognitive, sexual, and social in nature. Decreased brain function can lead to diseases such as delirium, dementia, psychological disorders, and neurological disorders. Nonpharmacological therapy to prevent cognitive decline in the elderly is an intervention that includes Cognitive Rehabilitation Therapy (CRT), one of which is activity therapy, namely, brain exercises. **Objective:** This study aimed to evaluate the effectiveness of brain gymnastics application on improving cognitive function in the elderly in Petoran RT 01 RW 07 Jebres Village, Jebres District, Surakarta City. **Method:** This type of research employs a case study approach, utilizing descriptive methods and administering pre-test and post-test MMSE sheets. **Results:** Based on the application's results, there is an improvement in cognitive function. **Conclusion:** There are differences in the final results of cognitive function scores before and after participants were given brain gymnastics, with both groups showing an increase.

Keywords: Elderly, Cognitive Function, Brain Gymnastics

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1. BACKGROUND

Aging is a natural and inevitable biological process that follows the sequential life stages of childhood, adolescence, and adulthood, culminating in later life (Kartolo & Rantung, 2020). According to the World Health Organization (WHO, 2022), individuals aged 60 years and older are classified as older adults, a demographic entering the final phase of the human life course (Raudhoh & Pramudiani, 2021). Globally, the older adult population is expanding at an unprecedented rate. WHO estimates that the number of people aged 60 and above will nearly double from 1 billion in 2020 to approximately 2.1 billion by 2050, posing significant challenges and opportunities for public health systems worldwide.

In Indonesia, this demographic shift is equally pronounced. Statistics Indonesia (BPS, 2021) reported that among the elderly population, 65.56% are classified as "elderly" (60–69 years), 26.76% as "old" (70–79 years), and 7.69% as "very old" (80 years and above). In Central Java Province, the older adult population grew to 4.65 million in 2021, with a further 0.43% increase recorded in 2022 (BPS Central Java, 2023). Specifically, Surakarta City reported 71,487 older adults in 2022 (BPS Surakarta, 2021), underscoring the need for targeted health interventions in this urban setting.

Aging is associated with progressive declines in multiple physiological systems, including renal, cardiovascular, sensory, and cognitive functions (Salsabila, 2024). Cognitive decline is one of the most concerning consequences of aging, affecting memory, executive function, attention, and emotional regulation. Globally, over 55 million people live with dementia, a severe form of cognitive impairment, with projections indicating a rise to 152 million by 2050 (WHO, 2022). While the cited figure of "121 million elderly with cognitive impairment in Indonesia" appears inconsistent with global estimates and may reflect a misinterpretation or typographical error, national studies confirm a substantial and growing burden of mild cognitive impairment (MCI) among Indonesian older adults, with prevalence rates ranging from 15% to 30% depending on the region and assessment methods (Muyassaroh, 2021; Kementerian Kesehatan RI, 2022).

Cognitive impairment not only diminishes the quality of life and autonomy of older adults but also places increasing strain on families, caregivers, and healthcare systems (Muyassaroh, 2021). Consequently, early prevention and non-pharmacological interventions have gained prominence in geriatric care. Evidence supports the use of multimodal approaches, including physical activity, cognitive stimulation, and social engagement, as practical strategies to delay or mitigate cognitive decline (Siska & Royani, 2024). Among these, cognitive rehabilitation therapies (CRT), particularly structured brain exercises such as Brain Gym, have demonstrated promising results.

Brain Gym, a set of simple, integrative physical movements designed to enhance neural coordination between the brain's hemispheres, has been proposed as a low-cost, accessible, and non-invasive intervention for older adults (Pratidina et al., 2023). Empirical studies in Indonesia

have indicated its potential. Widari et al. (2022) observed a marked reduction in severe cognitive impairment among elderly participants following a Brain Gym program, while Augusta et al. (2021) reported statistically significant improvements in cognitive scores among intervention groups compared to control groups.

Preliminary field assessments conducted in early 2025 at the Ngoresan Community Health Center (Puskesmas) in Jebres Subdistrict, Surakarta, identified 4,211 older adults (1,881 males; 2,330 females), including 1,304 aged 70 and above. Within Petoran Hamlet, RW 07, RT 01, a representative urban community, 36 older adults were registered, of whom 30 exhibited normal cognitive function (Mini-Mental State Examination [MMSE] ≥20), while 6 scored below 20, indicating possible cognitive impairment. Notably, none of the six individuals with cognitive impairments reported prior engagement in Brain Gym or similar cognitive exercises.

Given the rising prevalence of cognitive vulnerability among older adults in urban Indonesia and the demonstrated feasibility of non-pharmacological interventions, this study aims to evaluate the implementation and impact of a structured Brain Gym program designed to enhance cognitive function among older adults in Petoran Hamlet, RT 01/RW 07, Jebres Subdistrict, Surakarta City.

2. METHODS

This study employed a quantitative, quasi-experimental design with a pretest–posttest structure to evaluate the implementation and preliminary effects of a Brain Gym intervention on cognitive function among older adults with cognitive impairment. The research was conducted within the service area of Ngoresan Community Health Center (Puskesmas Ngoresan), located in Jebres Subdistrict, Surakarta City, Indonesia. Cognitive function was assessed using the Mini-Mental State Examination (MMSE), a widely validated screening tool with established reliability and clinical utility in geriatric populations. Participants were selected through purposive sampling based on predefined inclusion and exclusion criteria. Inclusion criteria required participants to be aged 60 years or older, have an MMSE score below 21 (indicative of at least mild cognitive impairment), possess the physical and cognitive capacity to engage in structured Brain Gym exercises, be free from severe psychiatric disorders unrelated to cognitive decline, and provide voluntary informed consent.

Exclusion criteria comprised the absence of cognitive impairment, severe physical limitations impeding participation, significant sensory impairments (e.g., uncorrected hearing or vision loss), inability to follow verbal instructions, or the presence of acute or severe mental health conditions that could confound assessment or intervention adherence.

The intervention was implemented with two older adult residents of RT 01/RW 07, Petoran Hamlet, both of whom met all inclusion criteria. Participant 1 was a 66-year-old male with primary school education, employed as a private sector worker, and an initial MMSE score of 19 (moderate cognitive impairment). Participant 2 was a 71-year-old female with no formal education, a homemaker, and an initial MMSE score of 17 (also indicating moderate cognitive impairment). In this context, cognitive function was operationally defined as the capacity to comprehend, process, and execute mental tasks, as measured by the MMSE. The Brain Gym intervention consisted of a standardized set of simple, bilateral physical movements designed to enhance interhemispheric communication and stimulate neural activity associated with attention, memory, and executive function. MMSE scores were interpreted using established clinical thresholds: 27–30 (normal cognition), 21–26 (mild cognitive impairment), 11–20 (moderate impairment), and 0–10 (severe impairment).

Data collection occurred between April 21 and May 3, 2025, and involved primary data gathered through direct face-to-face interviews (autoanamnesis) and structured observation. Interviews were used to administer the MMSE before and after the intervention, while observations documented participants' engagement, responsiveness, and behavioral changes throughout the sessions. Data processing and analysis were conducted concurrently with data collection and continued until fieldwork completion. Given the exploratory and case-based nature of this study intended as a pilot implementation rather than a powered efficacy trial statistical inference was not performed. Instead, findings were analyzed descriptively and interpreted through thematic comparison of pre- and post-intervention cognitive scores, behavioral observations, and alignment with existing theoretical frameworks on non-pharmacological cognitive interventions. Results are presented narratively with supporting tabular summaries to illustrate individual trajectories. Ethical principles were rigorously upheld in accordance with the Declaration of Helsinki: all participants

received comprehensive information about the study's purpose, procedures, potential benefits, and their right to withdraw at any time without penalty. Written informed consent was obtained prior to participation. To ensure privacy and confidentiality, participants were assigned anonymized codes in all research records, and data were stored securely. The research team adhered to principles of beneficence, non-maleficence, justice, and integrity throughout the study's design, implementation, and reporting.

3. RESULTS

This study was conducted in Kampung Petoran, RT 01/RW 07, Jebres Subdistrict, Surakarta City, a densely populated urban hamlet comprising approximately 74 households. Jl borders the area. Kp. Petoran to the north, the PJKA railway wall to the south, RT 02/RW 07 to the west, and Jl. Asem Kembar to the east. Residents primarily access primary healthcare through Ngoresan Community Health Center (Puskesmas Ngoresan) and participate in monthly elderly posyandu (community health posts) for routine monitoring and health promotion activities. The two participating older adults resided in adjacent, well-ventilated homes located near a main road and active railway tracks.

A two-week Brain Gym intervention was delivered to two older adults with moderate cognitive impairment, both of whom had no prior exposure to brain exercise programs and provided informed consent. The intervention consisted of six supervised 20-minute sessions, conducted over 12 days (April 21–May 3, 2025), with consistent researcher accompaniment to ensure fidelity and safety.

Table 1. MMSE Scores Before and After the Brain Gym Intervention

Participant	Pre-Intervention (Apr 21, 2025)	Post-Intervention (May 3, 2025)	Change	Final Classification*
Mr. S	19	27	+8	Normal cognition
Mrs. S	17	24	+7	Mild cognitive impairment

**MMSE classification: 27–30 = normal; 21–26 = mild impairment; 11–20 = moderate impairment; 0–10 = severe impairment.*

Following the intervention, both participants demonstrated clinically meaningful improvements in cognitive performance. Participant 1's MMSE score increased by 8 points to 27, moving from moderate impairment to the normal cognitive range. Participant 2's score improved by 7 points to 24, reflecting a

shift from moderate to mild cognitive impairment. These gains were observed across multiple MMSE domains, including orientation, attention, and recall, as noted during structured observation.

No adverse events were reported during the intervention period. Both participants actively engaged in all sessions and expressed willingness to continue the exercises independently. The proximity of their residences facilitated consistent participation and allowed for direct monitoring of adherence and behavioral responses.

4. DISCUSSION

Cognitive Function of the Elderly Before Brain Gymnastics Intervention

Prior to the intervention, both participants exhibited moderate cognitive impairment, as indicated by MMSE scores of 19 and 17. These findings align with the well-documented trajectory of age-related cognitive decline, characterized by reductions in brain volume, particularly in the prefrontal cortex and hippocampus, decreased synaptic density, and diminished cerebral blood flow (Widyaningsih et al., 2024; Muyassaroh, 2021). Such neurobiological changes typically manifest as impairments in memory, attention, executive function, orientation, and language processing, all of which were observed during baseline assessments.

Several sociodemographic and biological factors likely contributed to the participants' baseline cognitive status. Age remains the strongest non-modifiable risk factor for cognitive decline (Glans et al., 2024), and both participants were over 65 years old. Gender may also play a role: epidemiological studies suggest women are at higher risk for certain types of cognitive impairment, potentially due to postmenopausal declines in estradiol, which modulates hippocampal plasticity and verbal memory (Margareth et al., 2024). Mrs. S, the female participant, scored lower at baseline, consistent with this pattern.

Educational attainment further influences cognitive trajectories through the concept of cognitive reserve, which refers to the brain's capacity to compensate for neuropathological damage via efficient neural networks built through lifelong intellectual engagement (Sari et al., 2024; Maisyatana, 2023). Mr. S, who completed elementary education, may have benefited from a marginally greater cognitive reserve compared to Mrs. S, who did not graduate, potentially explaining their initial score difference. Indeed, formal education enhances exposure to complex cognitive tasks, literacy, and social interaction, all of

which support neural resilience (Riskiana & Mandagi, 2021).

Occupational history also matters. Mr. S's continued engagement in employment, likely involving decision-making and social coordination, may have provided ongoing cognitive stimulation. In contrast, Mrs. S's role as a homemaker, while valuable, may have offered fewer opportunities for novel mental challenges (Istiqomah, 2025). Collectively, these factors illustrate how cognitive function in late life reflects the cumulative interplay of biological aging, gender, education, and lifelong cognitive engagement.

Cognitive Function of the Elderly After Brain Gymnastics Intervention

Following six 20-minute sessions of Brain Gym over two weeks, both participants demonstrated clinically meaningful improvements: Mr. S's score rose to 27 (normal cognition), and Mrs. S's to 24 (mild impairment). These gains spanned domains including orientation, attention, calculation, and recall, core components of everyday cognitive functioning.

The observed improvements support the hypothesis that sensorimotor-based interventions can enhance neurocognitive performance in older adults. Brain Gym, though simple in design, integrates bilateral cross-lateral movements that are theorized to promote interhemispheric communication and stimulate neural pathways involved in attention and memory (Pratidina et al., 2023). Such exercises may enhance cerebral perfusion, increase brain-derived neurotrophic factor (BDNF) levels, and support synaptic plasticity, particularly in the hippocampus, a region critical for learning and memory (Suciana, 2023; Puspasari et al., 2023). Improved blood flow and oxygenation during physical activity further facilitate neuronal metabolism and neuroprotection (Al-Finatunni'mah & Nurhidayati, 2020).

These findings resonate with prior studies in Indonesian and global contexts. Kustianah and Waliyanti (2023) reported reduced cognitive decline after brief Brain Gym sessions, while Hasanah et al. (2021) documented MMSE improvements following similar interventions. Importantly, Brain Gym represents a low-cost, scalable, non-pharmacological strategy within the broader framework of Cognitive Rehabilitation Therapy (CRT), which includes music, puzzles, and group stimulation (Rahmi et al., 2025). Its accessibility makes it especially suitable for community-based settings, such as urban posyandu in low-resource environments.

Notably, the intervention's brevity (12 days) and modest time commitment

(20 minutes/session) suggest that even short-term, structured physical-cognitive stimulation can yield rapid benefits, an encouraging insight for public health programming targeting older adults with emerging cognitive concerns.

Comparison of Final Cognitive Function Scores

The differential outcomes between participants, Mr. S achieving normal cognition while Mrs. S remained in the mild impairment range, highlight the role of individual variability in response to cognitive interventions. This divergence may be attributed to a confluence of factors, including baseline cognitive reserve, gender-related neurocognitive profiles, and psychosocial context.

Cognitive reserve theory posits that individuals with greater educational or occupational enrichment can better withstand neural decline (Stern, 2009). Mr. S's formal education and active employment likely conferred a neuroprotective advantage, enabling more robust recovery. In contrast, Mrs. S's limited formal schooling may have constrained her neural adaptability, despite comparable engagement in the intervention.

Gender differences in cognitive processing may also contribute to these differences. Research indicates that men often outperform women in visuospatial tasks, while women excel in verbal episodic memory (Margareth et al., 2024). The MMSE includes both domains, and Mr. S's stronger performance may reflect this pattern. Additionally, emotional state and motivation significantly impact the efficacy of interventions. Positive affect enhances attention, compliance, and neuroplastic responsiveness (Mandolesi et al., 2018). Both participants were cooperative, but subtle differences in mood, self-efficacy, or social support, which were not measured in this study, could have moderated the outcomes.

From a physiological perspective, repeated Brain Gym sessions likely improve systemic circulation, facilitating the delivery of nutrients and oxygen to the brain and upregulating neurotrophic factors such as BDNF and nerve growth factor (NGF) (Puspasari et al., 2023). These mechanisms support neuronal survival and synaptic efficiency, particularly in aging brains. Furthermore, culturally relevant cognitive stimuli such as Qur'anic recitation, which combines rhythmic auditory input, semantic processing, and emotional regulation, may synergize with physical interventions to enhance cognitive outcomes in religious

communities (Basuki, 2022; Karauwan & Kerangan, 2024).

In summary, the observed improvements underscore the potential of multimodal, non-pharmacological approaches to mitigate cognitive decline. While this case series cannot establish causality, the magnitude and consistency of change coupled with biological plausibility support further investigation through controlled trials with larger, diverse samples.

5. CONCLUSION

This case study provides preliminary evidence that Brain Gym exercises may be an effective non-pharmacological intervention for improving cognitive function in older adults with moderate cognitive impairment. Prior to the intervention, both participants scored within the 11–20 range on the Mini-Mental State Examination (MMSE), consistent with moderate cognitive impairment. Following six supervised 20-minute Brain Gym sessions over two weeks, both individuals demonstrated clinically meaningful improvements: Participant 1 (Mr. S) increased from 19 to 27 (indicating a return to normal cognitive function), while Participant 2 (Mrs. S) improved from 17 to 24 (reflecting a shift to mild cognitive impairment). These gains, representing 7–8 point increases on the MMSE, suggest rapid and substantial cognitive enhancement, particularly in domains such as orientation, attention, and memory.

Although limited by its small sample size and lack of a control group, this study underscores the potential of Brain Gym as a low-cost, accessible, and scalable cognitive stimulation strategy suitable for community-based settings. Given its simplicity and minimal resource requirements, Brain Gym can be readily integrated into daily routines or community health programs, such as elderly posyandu activities, as a preventive and rehabilitative approach to cognitive aging.

For older adults, regular practice of Brain Gym may serve as a practical self-care strategy to maintain or even restore cognitive function during leisure time. Families and caregivers are encouraged to actively support and facilitate engagement in such non-pharmacological interventions, as social encouragement and consistent participation significantly influence adherence and outcomes. Future research should validate these findings through larger, controlled trials to establish efficacy, optimal dosing, and long-term sustainability of Brain Gym in diverse elderly populations.

AUTHOR CONTRIBUTIONS

The author contributes in conceptualization, data collection and analysis Hesti Janatunnisa, Didik Iman Margatot, Nur Haryani. Writing and manuscript revisions: Hesti Janatunnisa.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest in this research.

DATA AVAILABILITY STATEMENT

The data are available from the corresponding author upon reasonable request.

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