Improvement in Cognitive Function Through Brain Gymnastics For Nursing Home Residents: A Quasi Experimental Study from Indonesia

Siska Evi Martina[1], Rumondang Gultom[2], Janno Sinaga[3], Agustina Hia[4]
[1,2,3]Faculty of Pharmacy and Health Sciences, Universitas Sari Mutiara Indonesia, 20123, North Sumatera, Indonesia
[4]Bachelor Nursing Student, Faculty of Pharmacy and Health Sciences, Universitas Sari Mutiara Indonesia, 20123, North Sumatera, Indonesia.

*Email Correspondence: simanjuntaksiska26@gmail.com

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Abstract

Cognitive function in older adults is influenced by various factors, including age, gender, education, and physical activity, all of which can contribute to cognitive decline. This decline poses a growing challenge, particularly among institutionalized elderly populations. Brain gymnastics, a simple, low-cost, non-pharmacological intervention, has shown potential for improving cognitive function, yet evidence among nursing home residents remains limited and inconsistent. This study aimed to evaluate the effect of brain gymnastics on cognitive function among older adults residing in nursing homes in North Sumatera. A quasi-experimental design was employed, involving 56 participants aged 60 to 80 years, divided into intervention (n = 28) and control (n = 28) groups through purposive sampling. The intervention group engaged in a four-week brain gymnastics program, while the control group received a self-guided exercise leaflet. The study was conducted from January to March 2025. Cognitive function was assessed using the MoCA-INA at baseline and post-intervention. Descriptive statistics, Chi-square tests, paired t-tests, and independent t-tests were used for data analysis. At baseline, both groups exhibited moderate cognitive function (62.5% and 67.9%, respectively). Post-intervention, the intervention group showed a significant improvement in mean cognitive scores from 17.64 ± 4.09 to 22.00 ± 4.46 ($p < 0.001$, Cohen's $d = 1.52$), whereas the control group demonstrated a smaller increase. An independent t-test revealed a significant difference in post-intervention scores between the intervention (22.00 ± 4.46) and control (17.00 ± 3.23) groups ($p < 0.001$, Cohen's $d = 3.89$), indicating a strong effect of the intervention. These findings underscore the potential of brain gymnastics as a practical, scalable, and cost-effective strategy to enhance cognitive health. Its integration into routine elderly care may help delay cognitive decline and promote healthier aging, particularly in low-resource settings.

Keywords: *Brain Gymnastic, Older People, Cognitive Function, Nursing Home*

INTRODUCTION

Globally, the number of individuals affected by dementia has steadily increased over the past several decades, with more than two-thirds residing in developing countries, including Indonesia (Mattap et al., 2022). In 2024, the global population aged 65 and older reached approximately 830 million, accounting for 10.3% of the total population. This figure is projected to rise to 1.4 billion by 2030 (World Health Organization, 2024). Indonesia has officially entered the "population ageing era," with an estimated 29–32 million older adults, equivalent to around 12% of the national population, according to the Population Census by Statistics Indonesia (Badan Pusat Statistik, 2023). In North Sumatra, the proportion of older adults was reported to be 17.12% in 2023(Badan Pusat Statistik, 2024).

However, cognitive impairment among older adults remains a significant concern. In North Sumatra, the prevalence of cognitive impairment is estimated at 34%, with an additional 16.34% classified as pre-elderly (Badan Pusat Statistik, 2024), indicating that the province has an ageing population structure. Research consistently shows that the risk of cognitive impairment increases with age. For example, 5–8% of individuals aged 60–64 experience mild cognitive decline, rising to 15–20% among those aged 70–74, and exceeding 30% in individuals aged 80 and above (World Population Review, 2023). Globally, more than 40% of people aged 90 and older are affected by some form of dementia (Gauthier S, 2021). In Indonesia, the national prevalence of cognitive impairment among older adults is estimated at 34%, with a substantial proportion categorized as mild cognitive impairment(Pragholapati et al., 2021). This trend aligns with findings that cognitive function begins to decline significantly from the age of 65, particularly among individuals with low educational attainment, poor nutrition, physical inactivity, and chronic conditions such as hypertension and diabetes (Farina et al., 2023; Feng et al., 2021).

The rising prevalence of cognitive impairment not only diminishes individuals' ability to carry out daily activities but also places considerable strain on caregivers and healthcare systems particularly in nursing homes, where a substantial proportion of older adults with moderate to severe impairment reside. Current treatment options are limited; pharmacological approaches can be expensive and often carry adverse side effects, making them unsuitable for widespread use. Consequently, there is an urgent need for safe, cost-effective, and easily implementable non-pharmacological interventions that can be seamlessly integrated into long-term care settings. Another consequence of cognitive decline in older adults is the reduced ability to acquire new information and retrieve stored memories (Pamungkas, 2021). Simultaneously, the number of older individuals living in nursing homes with dementia continues to rise (Mitchell, 2017). Age-related physical changes include alterations in the neurological and nervous systems, leading to weakened sensory and motor perception within the central nervous system. These changes can contribute to a decline in cognitive function. Previous studies have shown that 10% to 15% of individuals over the age of 65 experience changes in cognitive function(Pragholapati et al., 2021). Cognitive impairment and memory deterioration in older adults can significantly affect their ability to carry out daily routines (Manungkalit et al., 2021).

Despite its prevalence, cognitive decline is not an inevitable outcome of aging and can be mitigated through preventive strategies. One promising approach is brain gymnastics, a form of structured, light physical exercise that integrates body movements with cognitive

stimulation. Brain gymnastics involves simple movements, such as crossing the midline, coordinating hand and foot movements, and rhythmic breathing, that are designed to activate both brain hemispheres and enhance neural connectivity (Noyumala & Musaidah, 2023). This phenomenon highlights that cognitive decline in older adults has not yet received adequate treatment. Techniques to improve cognitive function in older people must be made simpler and more efficient. Several studies have shown that brain gymnastics can improve concentration, memory, attention span, and emotional regulation by increasing blood flow and oxygen to the brain, reducing stress, and stimulating neuroplasticity (Cano-Estrada et al., 2022; Lina & Kurniawan, 2022). Its low-impact, adaptable format makes it especially suitable for older adults, including those residing in nursing homes who may have limited mobility or energy. Moreover, it is a non-pharmacological, cost-effective intervention that can be easily integrated into daily routines without requiring specialized equipment or intensive supervision.

Brain gymnastics is a light physical activity involving movements such as hand and foot coordination that stimulate brain function. These movements generate neural stimulation that can help improve cognitive performance and delay the onset of premature dementia. Brain gymnastics is considered a natural alternative for promoting brain health, relieving tension, and inducing relaxation (Dennison, P.E., & Dennison, 2006). Brain Gym exercises are simple yet effective techniques that enhance brain function, helping individuals become sharper, more focused, and more confident. These exercises consist of basic physical motions that encourage synchronization between the brain's two hemispheres (Cano-Estrada et al., 2022). Brain gymnastics has been shown to promote self-confidence, strengthen learning motivation, stimulate both the left and right hemispheres, calm the mind, and improve cognitive performance. A previous study found that brain gymnastics performed at light intensity for ten minutes per session, three times per week, was more effective in improving cognitive function in older adults than medium-intensity exercises performed for 15 minutes per session, twice per week (Parellangi et al., 2018; Pazare et al., 2023). Furthermore, brain and mind-body exercises have been shown to enhance global cognitive function in older adults with Mild Cognitive Impairment (MCI) (Han et al., 2023).

In contrast, a study by Varela et al. (2023) found that brain gymnastics did not lead to improvements in cognitive function among individuals with or without cognitive impairment, with evidence ranging from low to high quality. The urgency of the present study stems from inconsistencies in previous findings and the limited research conducted among older adults living in nursing homes. Cognitive decline among nursing home residents in North Sumatera is on the rise, yet effective non-pharmacological interventions remain scarce. Existing studies

on brain gymnastics have yielded mixed results and have primarily focused on community-dwelling older adults.

This research seeks to address that gap by providing evidence for a simple, low-cost, and structured brain gymnastics program specifically tailored to institutionalized older individuals. By targeting this population, the study offers practical solutions that can be integrated into routine elderly care. Therefore, the objective of this study was to examine the effect of brain exercise therapy on cognitive function in older adults residing in nursing homes.

METHODS

This study employed a quasi-experimental design with repeated measures across two groups. A quasi-experimental approach was chosen because it enables outcome comparisons in naturalistic settings, such as nursing homes, where full randomization is often impractical. This design is particularly suitable for evaluating non-pharmacological interventions like brain gymnastics, where ethical and logistical constraints may limit experimental control.

The intervention group participated in a four-week brain gymnastics program, conducted twice weekly for 20 minutes per session, with exercises specifically designed to stimulate cognitive function. In contrast, the control group received a self-guided exercise leaflet for the same duration. Cognitive assessments were conducted at baseline and post-intervention, with the study period spanning January to March 2025

Purposive sampling was employed to select participants who met specific inclusion criteria: older adults who were cooperative, not bedbound, and free from degenerative diseases that could interfere with participation. This approach ensured the intervention could be delivered safely and effectively while reflecting real-world conditions in nursing homes.

The sample size was calculated using the G*Power program, based on an effect size of 0.84(Liangruenrom et al., 2023), an alpha level of 0.05, a power of 0.95, and an allocation ratio (N2/N1) of 1. A power level of 0.95 was chosen to increase the likelihood of detecting a statistically significant effect. The calculation indicated that 23 participants were required for each group. To enhance the robustness of the study, the sample size was increased by 15%, resulting in 28 participants per group. This adjustment accounted for potential dropouts, non-compliance, or missing data during the intervention period, thereby preserving adequate statistical power.

Participants in the intervention group were residents of Binjai Nursing Home, while the control group consisted of residents from Bodhi Asri Nursing Home, both large facilities located in North Sumatera. Cognitive function was assessed using the Montreal Cognitive

Assessment (MoCA), with permission from the original authors. The MoCA is an English-language tool that has been translated into Indonesian (MoCA INA) (Husein, 2010), and has demonstrated strong psychometric properties across studies. The MoCA INA assesses seven cognitive domains: Visuospatial Function, Naming, Attention, Language, Abstraction, Delayed Recall, and Orientation. The maximum score is 30 points; a score of 26 or higher is considered normal. One additional point is added for individuals with fewer than 12 years of formal education. The intervention was implemented using a brain gymnastics program based on the framework developed by Dennison(Dennison, 2002).

Older adults who were selected and agreed to participate in the intervention group followed the brain gymnastics sessions according to a predetermined schedule. The program consisted of four core components: midline movements, lengthening activities, energy exercises, and deepening attitudes. Participants were allowed to take breaks between each component to accommodate potential fatigue, which is common among older adults.

Cognitive function was assessed in both groups before and after the intervention using the MoCA INA (Husein, 2010). In contrast, participants in the control group received a self-guided exercise leaflet. The leaflet included text and illustrations providing information about dementia, its symptoms, associated impacts, and recommended activities to help prevent cognitive decline.

Data were analyzed using SPSS version 25. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to summarize participant characteristics. All dependent variables were tested for normality using the Shapiro-Wilk test ($N < 50$), and were found to follow a normal distribution. A paired t-test was used to examine differences within groups, while an independent t-test was employed to compare outcomes between groups.

This study was approved by the Human Research Ethics Committee of Universitas Sari Mutiara Indonesia (Approval No. 3235/KEPK/USM/I/2025). In accordance with the Declaration of Helsinki, informed consent was obtained from all participants. No personally identifiable information was collected during the study.

RESULTS

A total of 56 participants were recruited for the study, and all were assessed following the intervention. The mean age of participants in the intervention group was 68.50 years (SD = 5.83), while the control group had a mean age of 72.61 years (SD = 4.64), with no significant difference in age between the groups. The majority of participants were female, comprising 78.6% of the intervention group and 67.9% of the control group.

In terms of educational background, most participants in the intervention group had completed junior high school (35.7%), whereas the largest proportion in the control group had no formal education (35.7%). Regarding cognitive function, 82.1% of respondents in the intervention group were classified as having mild cognitive impairment, while 67.9% of those in the control group were classified as having moderate cognitive impairment. Detailed demographic and cognitive characteristics are presented in Table 1

Table 1. Characteristic of older people in nursing homes (n=56)

Characteristics	Intervention (n=28)		Control (n=28)	
	F	%	F	%
Age (Years), Mean ± SD	68.50 ± 5.83		72.61 ± 4.64	
Gender	22	78.6	19	67.9
Female				
Male	6	21.4	9	32.1
Level of education				
Not formally educated	4	14.3	10	35.7
Elementary	6	21.4	8	28.6
Junior High School	10	35.7	7	25.0
Senior High School	6	21.4	3	10.7
College	2	7.1	0	0
Cognitive Function				
Mild Cognitive Impairment	23	82.1	9	32.1
Moderate Cognitive Impairment	9	17.9	19	67.9

Table 2. Differences in cognitive function among older people before and after intervention (n=28)

Variable		Mean	SD	T	*p-Value*	Cohen's d
Cognitive Function of Older People	Post	22.00	4.456	15.163	0.000	1.52
	Pre	17.64	4.093			

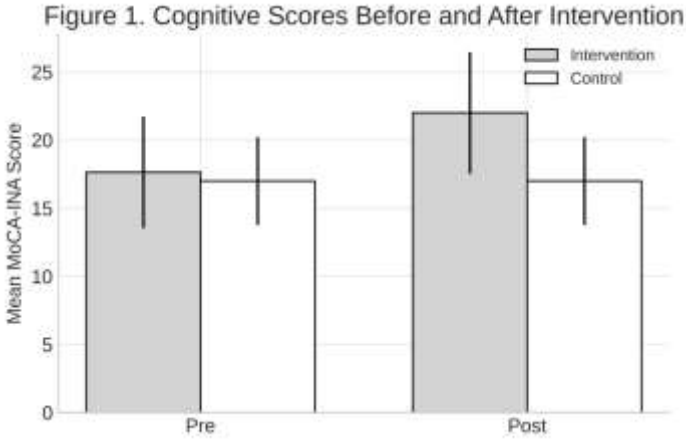
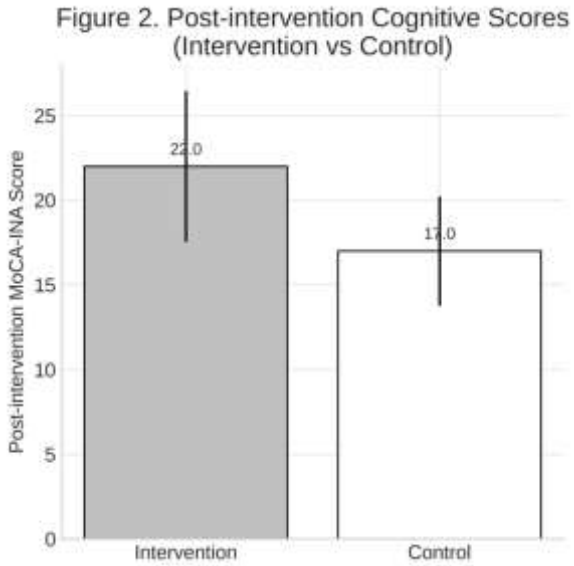


Table 2 and Figure 1 show the means comparison for paired samples within the intervention group before and after 4 4-week intervention on cognitive function with Paired t-tests. The participants in the intervention group had a significantly higher mean of cognitive function ($p < 0.001$). The standardised effect sizes based on Cohen's d were large.

Table 3. Comparison of means of cognitive function between the intervention and control group using an independent *t*-test

Variable	Intervention (n=28)		Control (n=28)		t	*p-Value*	Cohen's d
	Mean	SD	Mean	SD			
Cognitive Function of Older People	22.00	4.456	17.00	3.232	4.807	0.000	3.89



The comparison of mean cognitive scores between the intervention and control groups following the brain gymnastics program is presented in Table 3 and illustrated in Figure 2. Post-intervention, cognitive function in the intervention group was significantly higher than in

the control group, which received usual care ($p < 0.001$). The effect size for cognitive function, measured using Cohen's d, indicated a moderate impact of the intervention. In conclusion, there was a statistically significant difference in cognitive function between the intervention and control groups following the intervention period.

DISCUSSION

The study found that participants in the intervention group had an average age of 68.50 years, while those in the control group averaged 72.61 years. Additionally, the age distribution in the intervention group was more varied, as indicated by a higher standard deviation (SD = 5.83) compared to the control group (SD = 4.64). Age disparities are often linked to differences in physical and psychological health among older adults (Gunardi Pome et al., 2025; Maringka et al., 2023). Cognitive function in older adults is closely associated with the development of dementia, likely due to age-related cognitive decline that increases the risk of mild cognitive impairment—a transitional stage between normal aging and Alzheimer's disease (Kim & Kim, 2024). Advancing age is a major risk factor for dementia. Although dementia primarily affects older individuals, there is growing recognition of cases that begin before the age of 65. The global trend of population aging plays a significant role in the emergence and escalation of the dementia epidemic.

This study demonstrates the effectiveness of brain gymnastics in enhancing cognitive function among older adults residing in nursing homes. The intervention led to significant improvements in cognitive performance, with a large effect size (Cohen's d = 1.52), indicating that participation in the brain gymnastics program had a substantial impact. These findings are consistent with those of Pazare et al. (Pazare et al., 2023),

who reported that brain gym exercises significantly improved cognitive functions, including memory, attention, and processing speed, among geriatric populations. Their study emphasized that light, rhythmic movements in brain gymnastics enhance cerebral oxygenation and neurostimulation, thereby improving mental clarity and concentration.

Similarly, our findings confirm that even short sessions (20 minutes, twice weekly for four weeks) are sufficient to produce meaningful cognitive benefits. Brain gymnastics helps relax the central nervous system, increase energy levels, and improve reading and speaking abilities. It also enhances concentration, attention, and comprehension, allowing individuals to engage more fully in daily activities. The exercises are designed to activate multiple regions of the brain, promoting overall cognitive health.

Moreover, our results align with those of Cano-Estrada et al. (Cano-Estrada et al., 2022; Han et al., 2023) who found that brain gym interventions improved global cognitive function in institutionalized older adults. Their randomized controlled trial demonstrated that participants who engaged in structured brain gymnastics experienced improvements across several cognitive domains, including attention and visuospatial ability. The consistency between their RCT and our quasi-experimental findings strengthens the validity of brain gymnastics as a generalizable intervention for older populations. The lateral dimension of brain gymnastics promotes synchronization between the left and right hemispheres of the brain, contributing to improved respiration, stamina, stress reduction, and decreased fatigue. The focusing dimension helps remove cognitive barriers, enhancing attention and concentration

The neurophysiological mechanisms activated during brain gymnastics may help explain the observed cognitive benefits. Brain gym exercises incorporate cross-lateral, midline, and coordination movements that are believed to stimulate both hemispheres of the brain simultaneously, thereby enhancing interhemispheric communication. This synchronization facilitates integration between cognitive processes, primarily associated with the left hemisphere and emotional or creative functions, typically linked to the right hemisphere. Such integration is essential for maintaining optimal cognitive function in older adults (Cancela et al., 2021; Lina & Kurniawan, 2022).

Declines in mental function may be partially attributed to underutilization of the brain. Therefore, preserving cognitive potential throughout the aging process is crucial. Older adults should be encouraged to continue learning and participating in activities that stimulate brain function and nurture intellectual engagement well into their 80s and 90s.

In addition to promoting neural synchronization, brain gymnastics is associated with enhanced cerebral oxygenation. The light, rhythmic movements and deep breathing patterns embedded in brain gym routines help improve blood circulation and oxygen delivery to the brain—both of which are critical for sustaining cognitive functions such as memory, attention, and executive processing.

The repetition and coordination involved in brain gymnastics may also promote neuroplasticity the brain’s capacity to reorganize itself by forming new neural connections. This is especially important in aging populations, where synaptic density and neuronal efficiency typically decline. By engaging multiple sensory and motor pathways, brain gymnastics may help preserve or even enhance neural connectivity in critical regions such as the prefrontal cortex and hippocampus, which play key roles in attention regulation and memory consolidation (Cancela et al., 2021; Lina & Kurniawan, 2022; Parellangi et al., 2018).

In addition, this study analyzed the differences between the intervention and control groups and found significant disparities in the mean scores of the MoCA-INA. These results indicate that brain gymnastics has a substantial impact on cognitive function among older adults, as evidenced by statistical testing ($p < .001$) and a medium-level effect size (Cohen's $d = 3.89$). Participants in the intervention group who received brain gymnastics demonstrated significant improvements in cognitive function compared to those in the control group.

Symptoms of mild cognitive decline commonly observed in older adults include slowed thought processes, ineffective memory strategies, difficulty maintaining attention, frequent distraction, and prolonged learning times. These symptoms can impair daily functioning and are often associated with age-related cognitive decline (Lestari et al., 2020; Martina, 2020) One of the earliest and most prevalent signs of cognitive impairment is forgetfulness. It is estimated that 39% of individuals aged 50–59 experience some degree of forgetfulness, with prevalence increasing to over 85% among those aged 80 and above. Several factors contribute to this decline, including aging, reduced neuroregeneration, inadequate nutrition, and decreased physical and mental activity (Fitri et al., 2023; Iso-Markku et al., 2022; Mataqi & Aslanpour, 2020). However, conflicting evidence exists. A meta-analysis by Varela et al.Varela et al. (2023)

concluded that brain gymnastics may not significantly improve cognition across all populations. This discrepancy may be attributed to variations in intervention duration, frequency, and participant characteristics. While Varela et al.'s review included shorter or less frequent programs and populations with diverse cognitive baselines, our study employed a structured and consistent four-week protocol targeting individuals with mild to moderate cognitive impairment. These design differences may help explain the divergent findings.

Thus, brain gymnastics can be considered a physical practice aimed at enhancing cognitive function, particularly when implemented with appropriate structure and frequency.

Several limitations should be acknowledged. First, the quasi-experimental design employed purposive sampling rather than randomization, which may introduce selection bias. Participants were not randomly assigned and may differ in unmeasured characteristics that influence cognitive function. Second, blinding was not implemented for either participants or assessors. The absence of blinding increases the risk of a Hawthorne effect, whereby participants may have performed better simply because they were aware of being observed.

Third, the study was conducted in only two nursing homes in North Sumatera, limiting the generalizability of the findings to other settings or to community-dwelling older adults. Fourth, the relatively short intervention period (four weeks) and the lack of long-term follow-

up restrict the ability to determine whether the observed benefits are sustained over time. Finally, potential confounding factors, such as nutritional status, social engagement, and comorbid health conditions, were not fully controlled and may have influenced the outcomesThese limitations suggest that future research should employ randomized controlled trials with larger and more diverse populations, incorporate blinding of outcome assessors, and include long-term follow-up to confirm the sustainability of the observed effects. Despite these limitations, the findings carry important policy implications. Brain gymnastics is a low-cost, adaptable intervention that can be easily integrated into daily routines within long-term care settings. We recommend training nursing staff and caregivers to deliver brain gymnastics effectively, adapting exercises for residents with limited mobility, including those who use wheelchairs, and incorporating brain gym sessions into routine elderly care programs to promote mental stimulation and delay cognitive decline.

CONCLUSIONS

This study demonstrated that brain gymnastics significantly improved cognitive function among older adults residing in nursing homes. Participants in the intervention group exhibited a substantial increase in their MoCA-INA scores compared to the control group, indicating that structured brain gymnastics exercises can serve as a powerful, non-pharmacological intervention to support cognitive health in aging populations. The large effect size further reinforces the clinical relevance and potential utility of this approach.

The implications of this study are both practical and strategic. Brain gymnastics offers a low-cost, scalable, and adaptable intervention that can be readily implemented in institutional care settings, even where resources are limited. It requires no sophisticated equipment or clinical supervision, making it especially feasible in developing countries with large aging populations, such as Indonesia. Integrating brain gymnastics into routine elderly care has the potential to enhance quality of life, promote mental engagement, and delay the onset of dementia-related symptoms.

There is an urgent need to translate evidence into action. Policymakers and health service administrators should prioritize training nursing staff and caregivers to deliver brain gymnastics effectively and consistently. Standardized protocols and modules should be developed and adapted for various settings, including nursing homes, community centers, and day-care programs for older adults. Brain gymnastics should be incorporated into national geriatric care guidelines and programs to ensure systematic implementation. Additionally, partnerships with local communities should be facilitated to extend these interventions to independent older adults.

Future studies should consider employing randomized controlled trials (RCTs) with larger and more diverse populations to strengthen the evidence base. Longer follow-up periods are also necessary to assess the sustainability of cognitive improvements over time. Additionally, investigating the integration of brain gymnastics with other cognitive and social interventions may yield synergistic benefits.

In conclusion, brain gymnastics represents a promising, evidence-based strategy for enhancing cognitive function among older adults in nursing homes. Incorporating this intervention into elderly care programs may help address the growing burden of cognitive impairment in aging societies.

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