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Comparison of internal cognitive training versus external cognitive training on mild cognitive impairment among elderly population

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Abstract

Background: Mild cognitive impairment (MCI) is a common condition in the elderly population. It is characterized by confusion, disorientation, memory complaints, as well as restricted attention, learning, and language abilities.

Objectives: The objective of this study was to compare the effect of internal and external cognitive training in patients with mild cognitive impairment.

Methods: Twenty-six patients with mild cognitive impairment participated in this study. An equal number of participants ($n=13$) were allocated into two groups, i.e., the internal cognitive training group (group A) and external cognitive training (group B). Cognitive training session was administered 40 min per day, at a frequency of 2 sessions per week, for a period of 4 weeks for both groups, and aerobic exercise was also performed for 15 min per day, for a period of 4 weeks. Outcome measures were undertaken at baseline and at the end of the 4th week.

Results: The result shows a significant improvement on MoCA components in the internal cognitive training group than the external cognitive training group ($P<0.05$).

Conclusion: It was concluded that the internal cognitive training (ICT) shows significant improvement on mild cognitive impairment in elderly as compared to external cognitive training (ECT).

Keywords: Aging, Mild cognition impairment, Cognitive therapy, ICT, ECT

Introduction

Population aging is a worldwide process of growing older at the cellular, organ, or whole body level [1]. The elderly population is increasing dramatically worldwide, with many social, economic, and health implications. "Elderly" has been defined as a chronological age of 65 years old or older [2]. The United Nations (UN) proposed a cut-off at 60+ years to refer to the older population. The number of older persons in the world is projected to reach 1.4 billion by 2030 and 2.1 billion by 2050 and could rise to 3.2 billion in 2100 [3]. The growing number of older individuals will lead to an increase in the incidence of age-related disorders such as mild cognitive impairment (MCI). A significant risk factor for alterations in motor function and body balance is cognitive impairment [4]. It is the intermediate state between normal cognition and dementia and is characterized by confusion, disorientation, memory complaints, as well as restricted attention, learning, and language abilities. Such intellectual deterioration is feared and often broadly affects the quality of life because of limitations on functioning in daily life and increased disability [5]. The prevalence rate of MCI is estimated at 3–42% in the older adult population, and the conversion rate between MCI and dementia is estimated at 2–31% [6–8]. MCI is a risk factor for dementia and is associated with a 6-fold increased risk of Alzheimer's disease (AD) [6].

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Findings from numerous epidemiological and clinical studies suggest that multiple neurobiological, behavioral, social, and environmental factors may increase the risk of cognitive decline. Neurobiological factor leads to a decrease in brain size in old age; role of diet and lifestyle changes are also responsible for brain aging; decrease in blood flow to the brain can also impair memory and lead to changes in cognitive skills, smoking, and alcohol consumption; and many other genetic and environmental factors also affect the cognitive function during aging. It has been suggested that improving the diet help to delay age-associated cognitive decline; vitamin B is essential for maintaining normal brain function and memory. The physical activity and active lifestyle improve age-associated cognitive decline [9, 10].

The mild cognitive impairment (MCI) diagnosis is based mainly on the patient's history and cognitive examination [11]. The Mini-Mental Status Examination (MMSE) and Montreal Cognitive Assessment (MoCA) scales are useful instruments to detect cognitive function and both scales are used to diagnose both MCI and dementia; MoCA scale has better psychometric characteristics than MMSE [12, 13]. Currently, pharmacological intervention is not intended for the treatment of mild cognitive impairment (MCI) by the food and drug administration (FDA) [14]. The non-pharmacological interventions include physical activities, healthy diet, and cognitive training. This helps in the maintenance of synaptic function and synaptic protein loss may be prevented. In addition, physical activities can contribute to the increase of vascularization, energy metabolism, and resistance against oxidative stress, which has a positive effect on cognitive functions [15]. In the literature, multiple terms have been used for cognitive intervention, including cognitive rehabilitation, cognitive stimulation, and cognitive training [16].

Cognitive training may be strategy-based and act as a preventive technique incorporating both internal and external strategies. Acting as primary prevention helps to reduce the incidence of disease by delaying the cognitive decline process. ICT implicit training is a mental technique or self- abilities to facilitate cognitive processes, e.g., "chunking" pieces of information to assist encoding. ECT explicit training uses practical aides to compensate for weaker cognitive processes, e.g., writing information down to reduce the burden on memory processes. Both internal (e.g., categorizing, visualizing, or paraphrasing information during learning), and external (e.g., using calendars or environmental cues) techniques encourage to strengthen intact cognitive function and adapt to areas of weakness or decline [17]. In literature, there is a lack of evidence that compares the effect of ICT and ECT on mild cognitive impairment in the elderly. The aim of the present study is to compare the effect of ICT and ECT on mild cognitive impairment in the elderly.

Materials and methods

This is an experimental study conducted at the SGT Medical College Hospital & Research Institute, Gurugram Haryana, India. After receiving Institutional Ethical Clearance the study was initiated. Thirty subjects who have mild cognitive impairment having MoCA scores between 22 and 26 [13] of either gender ranging from 60 to 70 years of age group [18] with a minimum education of 12th class who can understand simple English words and follow verbal instruction were included in the study. Those who were having any neurological disorders in the brain and spinal cord such as Alzheimer's disease (AD), Lewy body disease, stroke (CVA), Huntington's disease, MS, ALS, frontotemporal dementia, and vascular dementia; use of medication known to have a negative impact on cognition (benzodiazepines); use of antipsychotics and cholinesterase inhibitors (CHEIs); current or recent (past 6 months) alcohol or substance use disorder; any behavioral changes like depression, anxiety, stress, other systemic diseases likely to impair cognition, such as hypothyroidism, deficiency of folic acid or vitamin B12, or viral infection (syphilis, HIV); vision and speech impairment (aphasia); any sort of musculoskeletal pain; lack of sleep less than 8 h; and nutritional deficiency likethiamine were excluded [19, 20]. The sample size was calculated using the G- power software with a 10% power and 95% confidence interval.

The samples of 42 subjects were selected from the population on the basis of inclusion and exclusion criteria. Twelve subjects were excluded (not meeting the inclusion criteria) and 4 subjects lost follow-up out of 30 subjects. Twenty-six subjects fulfilled the protocol and were equally divided into two groups (Fig. 1). Pre readings of Montreal Cognitive Assessment (MoCA) were taken for both the groups at baseline, i.e., before starting the intervention. Both the groups received different cognitive strategies and aerobic exercise. Cognitive treatment protocol of 40 min per day, at a frequency of 2 sessions per week, for a period of 4 weeks [21], was given by the researcher in her supervision for both groups, and aerobic exercise was also performed for 15 min per day, for a period of 4 weeks. At the end of the 4th week, post readings were taken through Montreal Cognitive Assessment (MoCA).

Outcome measures

Montreal Cognitive Assessment (MoCA). This scale has been used in the population of normal individuals, mild cognitive impairment, stroke, multiple sclerosis, Parkinson's disease, traumatic brain injury, and

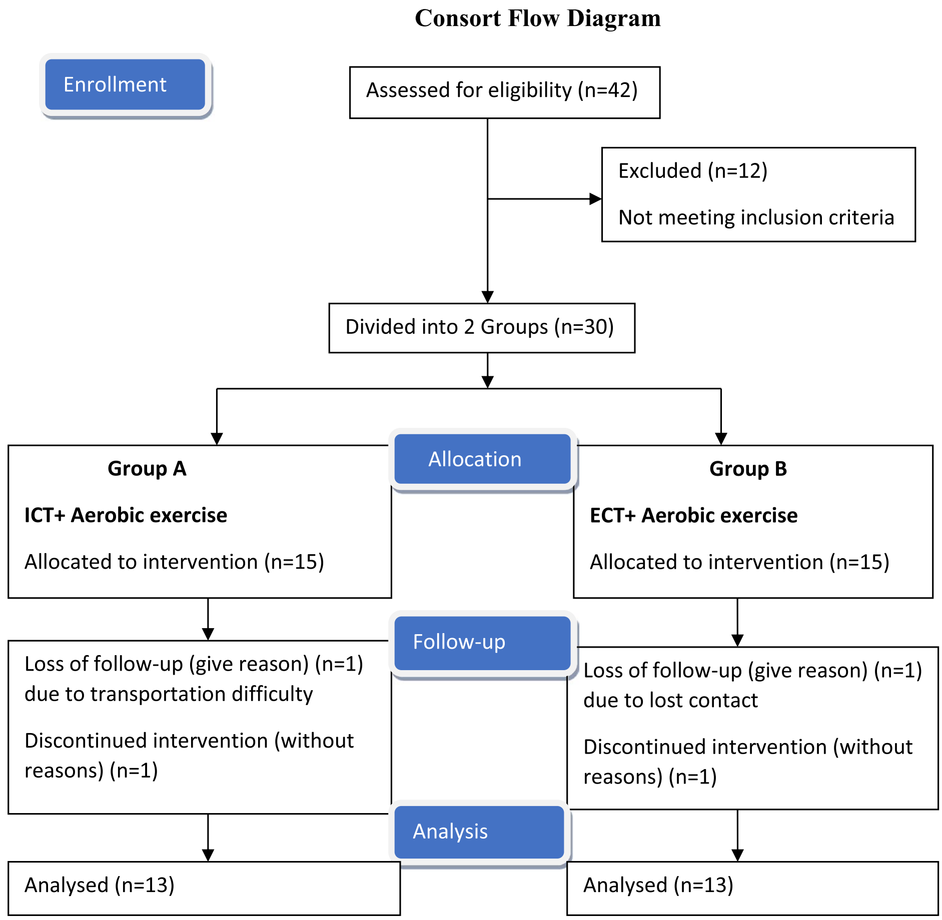

Fig. 1 Flowchart demonstrates the experimental design of the study

those who have cognitive decline. The scale consists of 8 items that are scores range between 0 and 30. A score of 26 or over is considered to be normal. MoCA scale is a valid scale in detecting cognitive impairment. It has high sensitivity and specificity, i.e., 100% and 87% respectively [21].

Interventions

Group A (internal cognitive training+ aerobic exercise)

The internal cognitive training (ICT) included mnemonics, chunking, method of loci, story recall, and list/object recall. In mnemonics, participants are asked to recognize the photo and remember the name of that person by self-generating mnemonics; chunking is a process of taking individual pieces of information (chunks) and grouping them into large units; method of memory enhancement uses visualizations with the use of spatial memory; story recall is when reading or listening to a story; it might be helpful to focus on only the key points of the story, this way irrelevant information can be forgotten and the story may simplify and be easier to recall and in last recall the list of things or list of items needed for cooking or shopping, etc. It combines with chunking and method of loci.

Group B (external cognitive training+ aerobic exercise)

The external cognitive training (ECT) included cueing, spaced retrieval, face-name recall, and number recall. Cueing by providing relevant cues at recall can aid retrieval and can be useful when teaching information particularly face-name recall or number recall. Two types of cueing are vanishing cues (cueing with decreasing assistance) or forward cues (cueing with increasing assistance); spaced retrieval helps to aid increase retention of information. This strategy is beneficial for face-name associations, object naming, and memory of object location, face-name recall, present a photograph of the to-be-remembered person. Discuss the photograph and name. Generate mnemonics (or association) that can be used to assist recall. It combines with cueing and spaced retrieval, number recall, and present the to-be-remembered numbers in verbal and written formats. Discuss

Table 1 Baseline demographic data of participants: mean ± SD

Characteristics	Group A (n=13)	Group B (n=13)	*p* value
Sample size (n)	13	13	
Age (years)	64.00 ±3.12	63.85±3.24	$p > 0.05$
Women/men (n)	6/7	5/8	

the number, what it is for, how often it is used, etc., and generate mnemonics (or associations) that can be used to assist recall. It also combines with cueing and spaced retrieval [22, 23].

Aerobic exercise

It includes brisk walking, cycling, jogging, and running for 15 min per day for 4 weeks which is not done under supervision [24].

Statistical analysis

Statistical Analysis was done using the software package SPSS 20.00 for Windows 7 version. The mean and standard deviation of all the variables was calculated. Wilcoxon test was used to compare the mean of data of pre and post-intervention within the group. Mann-Whitney test was used to compare the mean of data of pre and post-intervention between groups A and B. The p-value<0.05 was considered to be statistically significant.

Result

In the present study, a total of 26 subjects were selected of age 61–68 years who met the inclusion criteria and completed the treatment protocol for a period of 4 weeks. The subjects include 18 males and 8 females out of 26 subjects who were divided into two groups i.e., ICT (N=13) and ECT (N=13). The treatment protocol of 4 weeks was given to both groups. In the result analysis of demographic data, comparisons within the group and in between the group have been done. The mean age of group A and group B was 64±3.12 and 63.85±3.24 respectively. There were 7 men and 6 women in group A, whereas there were 8 men and 5 women in group B. (Table 1). An equal variance t-test reveals a significant difference in the Montreal Cognitive Assessment score of both groups (p-value < 0.05) (Table 2). An equal variance t-test reveals a statistical difference between the mean values of the MoCA component (visuospatial/executive, attention, and delayed recall) pre-intervention and post-intervention among subjects of group A (Table 3). Similarly, an equal variance t-test reveals a statistical difference between the mean values of the MoCA component (visuospatial/executive and delayed recall) pre-intervention and post-intervention among subjects of group B (Table 4). There was a significant difference in MoCA score (p-value < 0.05) and u value between group A and group B post-intervention (end of 4th week) (Table 5).

Table 2 Comparison of mean and standard deviation (SD) of MoCA score of pre (baseline) and post-intervention (end of 4th week) among groups A and B

Total MoCA score	Pre-intervention (baseline)	Post-intervention (end of 4th week)	*z*-value	*p*-value
Group A (mean±SD)	22.38±1.044	27.38±0.768	**-3.24**	**$P < 0.05$***
Group B (mean±SD)	22.46±0.967	25.62±0.650	**-3.22**	**$P < 0.05$***

*Significant p-value ($p \leq 0.05$)

Table 3 Comparison of mean and standard deviation (SD) of various components of the MoCA score at pre- (baseline) and post-intervention (end of 4th week) in group A

Variables (MoCA components)	Group A		*z* value	*p*-value
	Pre-intervention (baseline) (mean±SD)	Post-interventaion (end of 4th Week) (mean±SD)		
Visuospatial/executive	2.38±0.506	4.62±0.506	**− 11.23**	**0.001 ***
Naming	2.77±0.599	2.84±0.376	− 0.39	0.698
Attention	4.38±0.506	5.46±0.660	**− 4.66**	**0.001 ***
Language	2.85±0.376	2.92±0.277	− 0.59	0.558
Abstraction	1.77±0.439	1.92±0.277	− 1.06	0.296
Delayed recall	2.38±0.506	3.69±0.480	**− 6.75**	**0.001 ***
Orientation	5.85±3.76	5.92±2.77	− 0.59	0.558

Table 4 Comparison of mean and standard deviation (SD) of various components of the MoCA score at pre- (baseline) and post-intervention (end of 4th week) in group B

Variables (MoCA components)	Group B		z value	p-value
	Pre-intervention (baseline) (mean±SD)	Post-intervention (end of 4th week) (mean±SD)		
Visuospatial/executive	2.62±0.506	3.77±0.439	**− 6.21**	**0.001 ***
Naming	2.85±0.376	2.92±0.277	− 0.59	0.558
Attention	4.15±0.689	4.54±0.519	− 1.60	0.121
Language	2.92±0.277	3.00±0.0	− 1.00	0.327
Abstraction	1.85±0.376	1.92±0.277	− 0.59	0.558
Delayed recall	2.23±0.439	3.54±0.519	**− 6.94**	**0.001 ***
Orientation	5.85±3.76	5.92±2.77	− 0.59	0.558

Table 5 Comparison of (MoCA) at pre-intervention and post-intervention, i.e., baseline and end of 4th week of subjects between group A and group B

MoCA components	Group a vs group b	
	u-value	p-value
Pre-intervention (baseline)	− 0.27	$P > 0.05$
Post-intervention (end of 4th week)	**− 4.08**	**$P < 0.05^{*}$**

*Significant p-value ($p \leq 0.05$)

Discussion

Many studies have concluded that age is an important factor affecting cognitive functioning in older adults. The participants in the present study were 60–70 years of age. The one-month intervention study proved to show significant improvement in both group A and group B. This indicates that both interventions are valuable in the rehabilitation of individuals with mild cognitive impairment. However, the result of the present study provides evidence supporting the hypothesis that internal cognitive training (ICT) would lead to greater improvement in cognitive function when compared to external cognitive training (ECT). Nevertheless, the difference between the results of the two distinguished groups could be attributed to their different training protocol. Internal cognitive training (ICT) is a mental technique or self-abilities to facilitate cognitive processes-e.g. 'chunking' pieces of information to assist encoding. In internal cognitive training (ICT), participants think internally through thier own self mental ability and learn the tasks by using different methods like mnemonics, chunking, and story recall that aid information retention. The training offered numerous opportunities of practice with mental attention; it helps the participant to learn or remember things by self-generating mnemonics and make the story to recall for a longer period. Therefore, it improves the cognitive status of all participants and enhances the MoCA score. These findings again suggest intervention effectiveness in cognitive tests which are similar to the activities trained, but also suggest possibly a higher degree of plasticity in executive functions.

A study conducted by Liu et al. (2016) on cognitive training in older adults with mild cognitive impairment concluded that age is an important factor affecting cognitive functioning in older adults and also demonstrated that level of education may affect cognitive abilities, with an association between fewer years of education and faster declines in cognitive ability with age, which is consistent with our study [7]. The effect of training on older adults with MCI participated in this training. Training may stimulate brain activity and promote cognitive ability by using cognition to complete all tasks independently and the mean MoCA score was increased, which still represents improvements in cognitive functioning which is consistent with our study.

Mowszowski et al. (2010) reviewed that early intervention through selective prevention programs directed "at-risk" groups to reduce the cognitive decline and ultimately reduce the incidence of dementia. Such programs should target the prevention of cognitive decline and promote neuroplasticity. They showed that cognitive activity contributes to dendritic arborization, increased synaptogenesis, and brain plasticity. At a cellular level, cognitive activity likely influences spine density, synaptogenesis, and vascular supply to the brain. It likely promotes glial and metabolic activity and hippocampal neurogenesis. Indeed, in older people, higher mental activity levels have been associated with lower rates of hippocampal atrophy [17]. The processes that strengthen brain function can be conceptualized as being "positive" plasticity which is consistent with our study.

Many studies have concluded that cognitive training is an effective method to promote improvements in the cognitive abilities of patients with MCI, and may decrease the rate at which MCI progresses to dementia or AD. More than 50.00% of people with MCI subsequently develop dementia [25–29]. Currently, cognitive training is frequently used in patients with MCI, and it generally includes physical activity training and mental training. In our study, significantly higher improvements to normal levels were observed after internal cognitive training (ICT) group A than in the external cognitive training (ECT) group B. Therefore, although a substantial proportion of individuals with MCI in the external cognitive training (ECT) group B improved to normal levels, we still recommend cognitive training as the best and most effective method for improving the cognitive functions of patients with MCI. According to some studies, cognitive training exerts beneficial effects on visuospatial/executive function, attention, language, delayed recall, and orientation in individuals with MCI [6, 7].

Our study has few limitations: we include small sample size and duration of treatment was too short to test the efficacy of cognitive training. Structural and functional MRI was not used to investigate the underlying mechanism. The subjects were not ruled out for any community activity, housework, or reading (times/weeks) during the study which may affect the outcome of the results.

Conclusion

The present study concluded that internal cognitive training is more effective than external cognitive training. It shows significant improvement on mild cognitive impairment in elderly as compared to external cognitive training.

Abbreviations

ICT: Internal cognitive training; ECT: External cognitive training; MCI: Mild cognitive impairment; MoCA: Montreal Cognitive Assessment; CT: Cognitive training; SR: Spaced retrieval; MMSE : Mini-Mental Status Examination; FDA: Food And Drug Administration (FDA).

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Authors' contributions

Asha: conceptualization, data curation, investigation, methodology, roles/writing - original draft, writing - review and editing. Saurabh Kumar: project administration, supervision, visualization, writing - review editing, software, supervision, validation, visualization, writing - review and editing. Raghuveer Raghumahanti: conceptualization, formal analysis, investigation, methodology, resources. Anushree Rai: project administration, writing - review and editing. All authors read and approved the final manuscript.

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Availability of data and materials

Availability of data and materials. The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the Institutional Ethical Clearance of SGT university Faculty of Physiotherapy prior to the study (Ethical Number: SGTU/FOP/2020/36).

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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References

1. Kapoor A, Jayaraman G, Kumar S. Incidence of musculoskeletal pain and its relatedfunctional disability in geriatric urban and rural population of Patiala district. Intern J Phys Educ Sports Health. 2016;3(6):212–6.
2. Orimo H, Ito H, Suzuki T, Araki A, Hosoi T, Sawabe M. Reviewing the definition of"elderly". Geriatr Gerontol Int. 2006;6(3):149–58.
3. Naja S, Makhlouf MMM, Chehab MAH. An ageing world of the 21stcentury: a literature review. Int J Commun Med Public Health. 2017;4(12):4363–9.
4. Monika, Kumar S, Gupta A. Relationship between cognitive impairment and postural stability in the elderly population. Sport Sci Health. 2–9. https://doi.org/10.1007/s11332-022-00913-4
5. Plassman BL, Williams JW Jr, Burke JR, Holsinger T, Benjamin S. Systematic review: factors associated with risk for and possible prevention of cognitive decline in later life. Ann Int Med. 2010;153(3):182–93.
6. Peng Z, Jiang H, Wang X, Huang K, Zuo Y, Wu X, et al. The Efficacy of Cognitive Training for Elderly Chinese Individuals with Mild Cognitive Impairment. Biomed Res Int. 2019;30:1–10. https://doi.org/10.1155/2019/4347281.
7. Liu XY, Li L, Xiao JQ, He CZ, Lyu XL, Gao L, et al. Cognitive Training in Older Adults with Mild Cognitive Impairment. Biomed Environ Sci. 2016;29(5):356–64.
8. Jongsiriyanyong S, Limpawattana P. Mild cognitive impairment in clinical practice: a review article. Am J Alzheimers Dis Other Demen. 2018;33(8):500–7.
9. Deary IJ, Corley J, Gow AJ, Harris SE, Houlihan LM, Marioni RE, et al. Age-associated cognitive decline. Bri Med Bull. 2009;92(1):135–52.
10. Baghel MS, Singh P, Srivas S, Thakur MK. Cognitive changes with aging. Proc Natl Acad Sci India Section B. 2019;89(3):765–773.7.
11. Knopman DS, Petersen RC. Mild cognitive impairment and mild dementia: a clinical perspective. In Mayo Clin Proc. 2014;89(10):1452–9.
12. Cecato JF, Martinelli JE, Izbicki R, Yassuda MS, Aprahamian I. A subtest analysis of the Montreal cognitive assessment (MoCA): which subtests can best discriminate between healthy controls, mild cognitive impairment and Alzheimer disease? Int Psychogeriatr. 2016;28(5):825–832.8.
13. Segal-Gidan FI. More on Cognitive Screening Tools Response to an Interested Reader. Clin Rev. 2013;23(5):28–30.

14. Petersen RC. Mild cognitive impairment. New Engl J Med. 2011;364(23):2227–34.
15. Klimova B, Valis M, Kuca K. Cognitive decline in normal aging and its prevention: areview on non-pharmacological lifestyle strategies. Clin Intervent Aging. 2017;12:903.
16. Coyle H, Traynor V, Solowij N. Computerized and virtual reality cognitive training forindividuals at high risk of cognitive decline: systematic review of the literature. Am J Geriatr Psychiatry. 2015;23(4):335–59.
17. Mowszowski L, Batchelor J, Naismith SL. Early intervention for cognitive decline: can cognitive training be used as a selective prevention technique? Int. Psychogeriatr. 2010;22(4):537.
18. Salthouse TA. When does age-related cognitive decline begin? Neurobiol Aging. 2009;30(4):507–14.
19. Eleni P, Fotini K, Christina A, Evaggelia B, Aikaterini S, Stavros Z, et al. Use it more and keep it alive: a Longitudinal Randomized Controlled Trial in people with Mild Cognitive Impairment. Hellenic J Nucl Med. 2017;20(2):218–32.
20. Zhang K, Wang J, Peng G, Liu P, He F, Zhu Z, et al. Effect of cognitive training on episodic memory retrieval in amnestic mild cognitive impairment patients: study protocol for a clinical randomized controlled trial. Trials. 2019;20(1):1–8.
21. Brum PS, Forlenza OV, Yassuda MS. Cognitive training in older adults with mildcognitive impairment: Impact on cognitive and functional performance. Dementia Neuropsychol. 2009;3(2):124–31.
22. Kelly ME, Sullivan M. Strategies and techniques for cognitive rehabilitation; manual for healthcare professionals working with people with cognitive impairment; 2015.
23. Jang JS, Lee JS, Yoo DH. Effects of spaced retrieval training with errorless learningin the rehabilitation of patients with dementia. J Phys Therapy Sci. 2015;27(9):2735–8.
24. Klimova B, Valis M, Kuca K. Cognitive decline in normal aging and its prevention: a review on non-pharmacological lifestyle strategies. Clin Intervent Aging. 2017;12:903.
25. Kurz A, Pohl C, Ramsenthaler M, Sorg C. Cognitive rehabilitation in patients with mild cognitive impairment. Int J Geriatr Psychiatry. 2009;24(2):163–8.
26. Okamura H, Otani M, Shimoyama N, Fujii T. Combined exercise and cognitive training system for dementia patients: a randomized controlled trial. Dementia Geriatr Cogn Disord. 2018;45(5-6):318–25.
27. Langa KM, Levine DA. The diagnosis and management of mild cognitive impairment: a clinical review. Jama. 2014;312(23):2551–61.
28. Kirova AM, Bays RB, Lagalwar S. Working memory and executive function decline across normal aging, mild cognitive impairment, and Alzheimer's disease. BioMed Res Int. 2015.
29. Behrman S, Valkanova V, Allan CL. Diagnosing and managing mild cognitive impairment. Practitioner. 1804;2017(261):17–20.

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