REVIEW ARTICLE

The Impact of Cognitive Intervention on the Cognition of Adults Over 50 with Mild Cognitive Impairment (MCI) in Asia: A Systematic Review

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ABSTRACT

The cognitive intervention for the ageing population is growing rapidly. This review aimed to explore the impact of cognitive intervention on the cognitive abilities among adults over 50 with mild cognitive impairment (MCI) in Asia. Articles on randomised controlled trials (RCT) studies published between 2010 and December 2020 in PubMed, Science Direct, Web of Science, and Scopus databases were searched. A total of 13 studies were included in this review for further analysis. The results showed that cognitive training can be effective in improving the cognitive function in adults with MCI in various aspects, including memory, attention, executive functioning, reducing subjective memory complaints, and improving daily living skills. The findings indicated that different modalities of cognitive intervention, namely single-domain, multi-domain, and multimodal modalities could be a promising intervention in improving the overall cognitive abilities of adults with MCI in Asia. The single-domain cognitive intervention was influenced by the far transfer effect that improved other untrained cognitive areas. Both multi-domain and multimodal cognitive interventions showed improvement in the global cognitive function and transfer effect on the non-cognitive areas such as daily activities and mood. Future review could explore the impact of intervention duration on cognitive abilities and the transfer effect for each modality to understand the ideal intervention package for adults over 50 with MCI in Asia.

Keywords
cognitive intervention, transfer effect, mild cognitive impairment, older adults

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INTRODUCTION

There is an increase in the prevalence of mild cognitive impairment (MCI) among older Asian adults, which is linked to the increase in dementia, comorbid diseases, mortality, and hospitalisation.[1,2] The ageing population in Asian countries is expected to increase drastically for the next 50 years,[3] hence requiring a better healthcare system. Older adults with MCI may progress towards dementia. However, this condition may be reversed to normal cognitive function.[4] The risk of older adults with MCI developing dementia is 10-40% per year[5] compared to healthy older adults with a lesser rate of 1-2% per year. Studies suggested that cognitive intervention could help restore cognitive ability and delay cognitive decline among older adults with MCI.[6,7]

Several studies attempted to observe the effectiveness of cognitive training on the transfer effect, which refers to the ability of an individual to use the knowledge and skills on similar or different tasks.[8] Transfer effect can be divided into two types: 'near transfer effects' (improvement in similar tasks or trained areas) and 'far transfer effects' (improvement in dissimilar tasks or untrained areas).[9] The transfer effect can determine whether training could improve the cognitive ability of older adults with MCI. Previous reviews suggested that cognitive training could improve the trained areas (near transfer) and untrained cognitive areas, intelligence, and daily living skills among healthy older adults (far transfer).[10,11] Several reviews have been conducted to

understand the effectiveness of cognitive training on healthy older adults and MCI populations.[12] Studies within the Western populations showed that cognitive intervention was effective in restoring cognitive function among older adults with MCI. Besides that, cognitive training showed an immediate effect in the trained area of the related task in healthy older adults.[13] The question arises whether the different modalities of cognitive training among adults with MCI could promote near and far transfer effect.

Despite its effectiveness, there are limited works of literature on the impact of cognitive intervention amongst the older adults in Asia with MCI and how it is related to the transfer effect of the training. Previous reviews[10,14] included the combination of healthy older adults and MCI populations in the same study which limited the discussion on the effectiveness of the intervention. The review from Chandler et al.[15] compared the cognitive intervention for people with MCI with the control group on daily living activities, mood and quality of life rather than cognitive outcomes – which are the main aim of the present review. Chandler et al.[15] focused on the global population and did not discuss the effectiveness of the interventions' modalities in detail. Hence, the current review focused on the impact of heterogeneous cognitive intervention on people with MCI in Asia.

METHODS

Duration of the Data Collection

The duration of the data collection was from year 2010 to December 2020.

Selection Strategy

PubMed, Web of Science, Science Direct, and Scopus databases were used to search for randomized control trial (RCT) studies on the cognitive intervention for people with MCI in Asia. These databases were widely and commonly used databases in previous systematic reviews. The keywords used were 'cognitive training' or 'cognitive intervention' or 'cognitive stimulation' and 'older adults' and 'mild cognitive impairment'. The main keyword of 'cognitive training' was used to refer to exercises that improved cognitive abilities. The abstracts were screened to identify the articles that focused on the Asian population.

Selection Criteria

The following inclusion criteria were applied: (1) articles published in English; (2) RCT studies; (3) participants aged 50 and above; (4) the population with MCI; (5) any types of cognitive intervention; (6) allowing multimodal cognitive intervention; and (7) Asian based study. The following criteria were excluded from the review: (1) non-Asia population; (2) review, guideline, and protocol papers; and (3) non-community setting. The non-community setting was excluded as the majority of individuals with MCI are living in the community setting and independent in their daily life.

Data Extraction and Collection

Figure 1 illustrates the data extraction. PubMed, Scopus, Web of Science, Science Direct, and searches had identified 2124, 12, 29, and 8 articles, respectively. In addition, five articles were identified from the references of the selected articles. After removing duplicates, there were 2165 articles remaining. A total of 2123 articles were excluded as they did not include MCI participants. The remaining 55 studies were screened and 42 articles were excluded as follows: 15 articles without cognitive intervention, 10 articles did not include the Asian population, and 17 articles did not employ RCT methodology. Thus, the remaining 13 articles were included in this review.

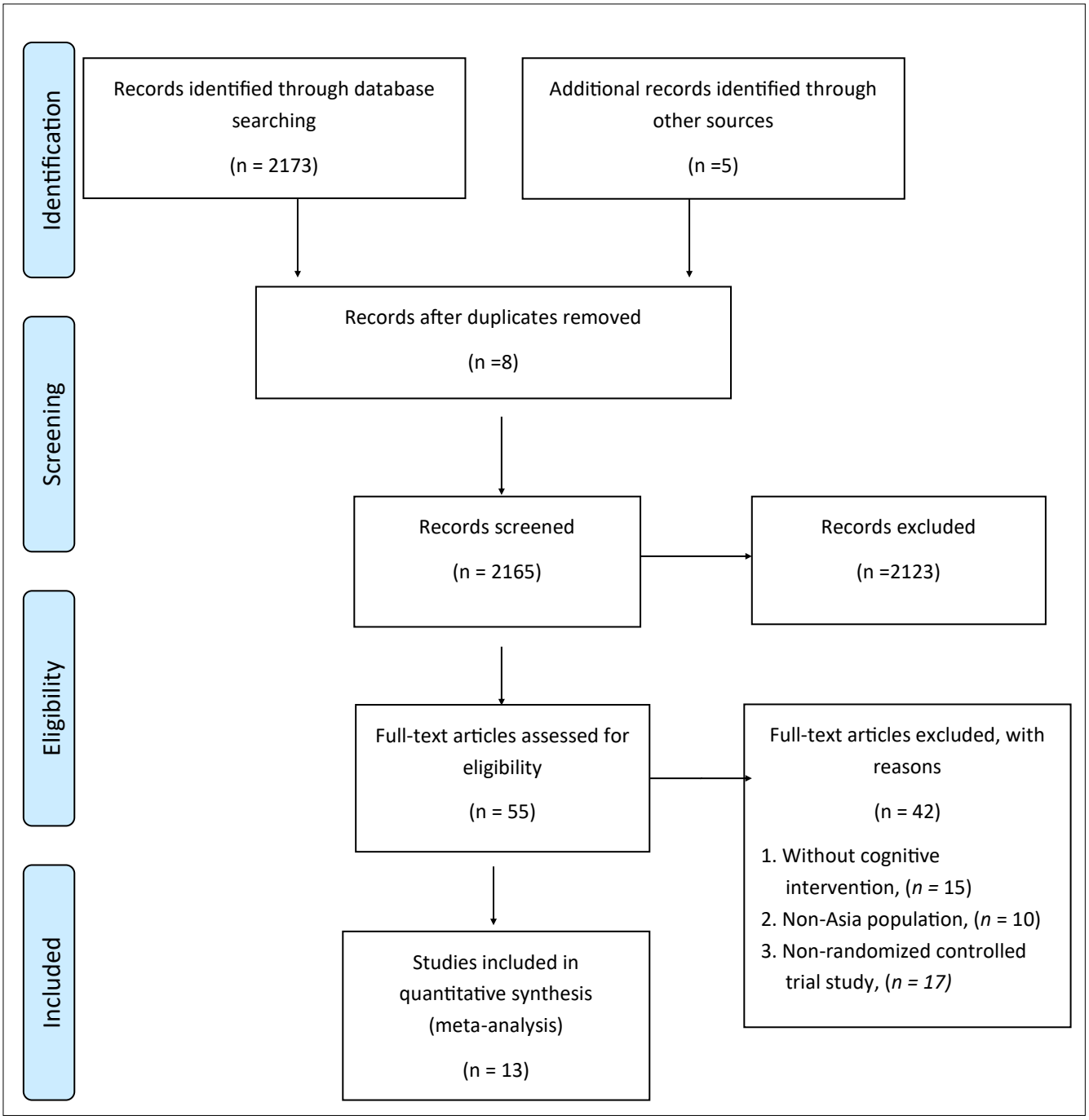

Figure 1. Preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagram for cognitive training on adults with Mild Cognitive Impairment

Table I: Study characteristics of cognitive intervention in Asian MCI population

No	Author	Aim	Age	n/condition	Design	No. of session/ duration/format	Measures	Outcome
1	Yang et al[16]	To analyse the effects of multidomain attention training on alertness sustained attention and visual-spatial attention in older adults with mild cognitive impairment (MCI).	Mean: 79.5 years	39/experimental and 39/control group	Two –arm, parallel-group, double-blind Pretest, posttest and 3 and 6 months after training.	45 minutes three times per week for six weeks (18 sessions in total)	Trail Making Test, MMSE, MoCA	The experimental group displayed a significant improvement in attention, memory, and the orientation of MMSE and MoCA subscales over 6 months.
2	Youn et al[17]	To assess the efficacy of a novel cognitive training approach—named multi-strategic metamemory training—in older adults with amnestic mild cognitive impairment.	60-85 years old	113/ training group (N-66) and control group (N-47).	Pre and post -training	10 sessions, with 1-week intervals, each session 90 minutes. Each session is divided into three parts and 30n minutes each.	MMSE, the Subjective Memory Complaints Questionnaire (SMCQ) and Early Memory Disorder Scale (EMS)	The training programs improve verbal memory (i.e., delayed free recall), language processing (i.e., categorical fluency) and limit complaints in everyday instrumental memory activities of mildly impaired older adults.
3	Weng et al[8]	To explore the transfer effects of cognitive training on working memory among older Chinese adults with mild cognitive impairment (MCI).	>60 years old	62/ (33 for cognitive training and 29 for mental leisure activities (MLA) control)	Baseline, post-training and 3 months after training)	8 weeks of intervention, 2 times/ week for 40-60 minutes.	MoCA, Forward and Backward Digit Span, Digital Symbol Conversion, VFT, Reasoning based on similarity and ADL	The cognitive training group showed significant effects in both the trained (working memory) and untrained (execution function and ability of daily living) domains. The effects maintained for at least 3 months, even without the cognitive training.
4	Liu et al[18]	To investigate the feasibility and efficacy of cognitive training for older adults in rural settings and with low education levels, who have mild cognitive impairment (MCI).	>65 years old	45 participants with a ratio of 2:1 for training and waitlist group.	Pre-training, metaphase and post-training	2 months of duration, 2 hours/day.	MMSE, MoCA, Loewenstein Occupational Therapy Cognitive Assessment (LOTCA), and Hamilton Depression Scale (HAM-D).	Cognitive training has beneficial effects on attention, language, orientation, visual perception, organization of visual movement, and logical questioning in patients with MCI.
5	Sugano et al[19]	To study the effectiveness of the cognitive intervention programs for mild cognitive impairment.	74.1 (range 64–87)	67 participants/ three groups; cognitive function program, physical program, non -intervention group	Pre-intervention assessment and post-intervention assessment (within 2 weeks after completion).	Once per week, approximately 1 hour at each session for 2 months or 8 weeks.	Finger Movement, A set of dependent activity, cued recall, clock drawing, verbal fluency, similarity.	The participants in both intervention groups showed a significant improvement in their memory function compared with the non-intervention group.

Con't

No	Author	Aim	Age	n/condition	Design	No. of session/ duration/format	Measures	Outcome
6	Li et al[20]	To assess the effectiveness of the first Chinese version of computer-based multi-modal cognitive training for MCI patients.	Mean: 70.4	78 patients in the training group and 63 patients in the control group	Baseline and at 6 months	3-4 times per week for six months	Chinese version of Addenbrooke's cognitive examination-revised (ACER), the auditory -verbal learning test (AVLT)- the shape trail test (STT, including Part A and B), Rey-Osterrieth complex figure test (CFT), Symbol Digit Substitution test (SDS), and the Stroop Color-Word Test (SCWT).	Multi-modal cognitive training help MCI patients to gained cognition benefit, especially in memory, attention and executive function.
7	Jeong et al[21]	To examine the efficacy of group-based cognitive intervention (GCI) and home-based cognitive intervention (HCI) in amnestic mild cognitive impairment (aMCI)	50 – 85 years old only	Randomized and the blinded trial, 293 patients with aMCI from 18 nationwide hospitals were randomized: 96 to the GCI group, 98 to the HCI group and 99 to the control group.	Baseline, post-intervention and at the six-month follow-up after the intervention	For 12 weeks, subjects received GCI participated twice per week in group sessions led by trained instructors, and those receiving HCI completed homework materials 5 days per week.	Alzheimer's Disease Assessment Scale cognitive subscale (ADAS-Cog).	The GCI and HCI resulted in cognitive improvements in aMCI.
8	Kwok et al[22]	To examine the short-term and long-term effects of a cognitive training (CT) program in enhancing cognitive function of older people with subjective memory complaints.	>65 years old	A single-blind randomized placebo-controlled trial 223 older adults aged 65 years or above (intervention group, N= 111) or attend health-related educational lectures only (control group, N= 112).	Baseline, after training, at 9 months follow up.	12 weeks training program	Chinese Memory Symptoms Scale, Chinese version of Mini-mental state examination, Chinese version of Mattis Dementia Rating Scale.	Cognitive training was effective in enhancing the overall cognitive functioning of less-educated older adults with subjective memory complaints. The positive effect was durable for at least nine months in two cognitive areas (conceptualization and memory)
9	Peng et al[23]	To evaluate the efficacy of the intervention after three and six months of cognitive training.	≥60 years old	140/ 70 for each intervention and control group	Baseline and after six months follow up	Every two weeks for six months – 90 minutes for each training	MoCA-BJ	The cognitive training intervention is effective and may help to decrease the deterioration of cognitive function in patients with MCI
10	Shimada et al[24]	To compare the cognitive and mobility effects of a 40 weeks program of combined cognitive and physical activity with those of a health education program	>65 years old	308 (154/154)	Pre and post - intervention	Weekly 90-minute sessions for 40 weeks	MMSE, Wechsler Memory Scaled Revised, Rey Auditory Verbal Learning Test (RAVLT)	Combined physical and cognitive activity improves and maintains cognitive and physical performance in older adults with mild cognitive impairment.

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No	Author	Aim	Age	n/condition	Design	No. of session/ duration/format	Measures	Outcome
11	Park and Park[25]	To investigate differences between non-specific computer training (NCT) and cognition specific computer training (CCT)	N/A	78 39/39)	Pre-intervention and post-intervention	30-minute intervention, three times a week, for 10 weeks	WAIS digit span subtests, Rey Auditory Verbal Learning Test (RAVLT) Trail Making Test-Part B	NCT was superior to CCT for improving cognitive function and quality of life of elderly adults with MCI.
12	Han et al[26]	To evaluate the effectiveness of Multimodal Cognitive Enhancement Therapy (MCET).	N/A	32/23	Baseline, week 9 and week 21	Two eight weeks treatment phases	MMSE ADAS-Cog Revised Memory and Behaviour Problem Checklist (RMBPC)) GDS Disability Assessment for Dementia (DAD) QoL –AD	MCET improved cognition, behavior, and quality of life in people with MCI or mild dementia more effectively than conventional cognitive-enhancing activities did.
13	Sukotonpol et al[27]	To assess the effectiveness of a cognitive training program on global cognition among people with mild cognitive impairment	≥50 years	60 participants (30/30)	Baseline, week 13, month 6 and 9	6 sessions, 2 sessions per months for 3 months	Montreal Cognitive Assessment (MoCA), Thai Geriatric Depression Scale (TGDS-15).	The cognitive training program helped to improve global cognition and reduce depressive symptoms.

RESULTS

Table 1 presents the study characteristics, which include study participants, design, measures, intervention sessions, duration, intervention format, and main outcomes. The sample size ranged from 45 to 293 participants aged 50 years old and above. For the research design, 11 studies conducted a randomised control trial (RCT) design with two arms and two studies with a three-arm design.[19,21] The interventions were conducted about 30 min-2 hour over 6 -20 weeks. Most studies conducted individual sessions and five studies[19,21,23,24,26] used the group intervention. The meta-analysis was not performed in this review as it focused on exploring the impact of the cognitive intervention instead of the effectiveness of the cognitive intervention.

Types of interventions

One study separately investigated the effects of the multimodal cognitive intervention and physical exercise on people with MCI,[24] and another study combined cognitive stimulation with various psychosocial interventions such as reality orientation, physical therapy, reminiscence therapy, and music therapy.[26] One single study reported the combined cognitive training with physical exercises.[19] Three studies focused on the effectiveness of single-domain cognitive training that included attention training[16] and memory training[8,17] among adults with MCI. Six studies[18,20-23,27] included multi -domain cognitive training such as the combination of attention and memory training in one package. One study[25] focused on the comparison between specific and non-specific cognitive computer training among participants with MCI. Table 2 presents the specific elements of interventions.

Single domain cognitive intervention

The single-domain cognitive intervention can improve the cognitive ability among adults with MCI. Three studies[8,16,17] revealed that single-domain cognitive intervention could significantly improve the cognitive function of targeted domains. The training on working memory reduced daily complaints of memory activities[17] and improved the untrained cognitive function[8] in adults with MCI.

Table 2: Specific elements of cognitive intervention for MCI in Asia

Author (Year)	Country	Participants based	Domains of intervention	Intervention content/ programme	Mode of delivery	Training/ monitoring/ support/fidelity	Homework	Cultural Component/ elements	Remarks
Yang et al[16]	Taiwan	Retirement centres and community housing	Single domain: Attention	Multi-domain attention training Computer training: alertness training, sustained attention training, and visual-spatial attention training	Computer training CogniPlus software	The training was divided into three stages: instruction, practice, and training.	No	No	The executive attention training significantly improved selective attention and divided attention performance.
Youn et al[17]	Korea	Recruited from a Seoul National University Boramae Medical Center and a community centre	Single domain: Multi-strategic metamemory training (MMT)	The first part addresses the storage of knowledge as memory according to the metamemory model; the second part addresses the training of memory methods based on metamemory; the third part covers memory training in practical circumstances.	Pen and paper-based intervention	10 sessions of intervention monitored by the trained researchers. Instructors give an overview about the MMT and teach participants how to use memory strategic and cognitive training in their everyday lives. 10 sessions (covers memory, attention, structure and function of brain, environment and perception)	No	No	Multi-strategic metamemory training help to improve verbal memory (delayed free recall, language processing (categorical fluency) and limit daily complaints for memory activities
Weng et al[8]	China	Recruited via holding recruitment sessions at older adult communities.	Single-domain cognitive training (working memory)	The graphic/ image delay matching task, the information delay matching task, the object of tracking task, memory/ attention composite task	Computer cognitive training	The games were developed by Zhejiang University and Nanjing Zhihui Education Technology Company, Limited.	No	No	The training effects of working memory could transfer to other untrained areas (such as an executive function).
Liu et al[18]	China	Cluster sampling from the rural area.	Multi-domain cognitive training (attention, memory, cognition, language and task performance)	Five aspects of training including attention, memory, cognitive, language and task performance training.	At-home training No homework assigned	Cognitive Training modules were developed	No	No	The cognitive training improves the cognitive abilities of patients with MCI that reside in rural areas and how low education levels.
Sugano et al[8]	Japan	Local community-dwelling	Two separate interventions: (1) Executive function training and (2) group aerobic training	Executive function training group: creating a travel plan, conduct a couch tour and revised the travel plan. Physical function group: exercises program such as stretching, muscle strengthen exercises and walking.	Group training	Executive training – participants were divided into a group of 5-6 and need to drew up a travel plan. Physical function program – group aerobic with a lot of activities were implemented.	No	No	Both intervention groups showed significant improvement in memory function compared to the non-intervention group.

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Author (Year)	Country	Participants based	Domains of intervention	Intervention content/ programme	Mode of delivery	Training/ monitoring/ support/fidelity	Homework	Cultural Component /elements	Remarks
Li et al[20]	China	N/A	Multi-domain cognitive training (working memory, speed of processing, attention, visuospatial)	Visual working memory task; 30-second memory task; episodic memory task, speed calculation task, visual search task, alertness task, mental rotation task, image re-engagement task.	At patient's home online computerized training	The login information was checked weekly and a telephone interview was used to ensure all participants got an equal amount of training.	No	Chinese version computer training	The effect was only observed immediately after training and confined to trained domains.
Jeong et al[21]	Korea	N/A	Multi-domain intervention (memory, attention, executive function, language, orientation and visuospatial functions)	The cognitive intervention was a comprehensive multimodal intervention, including multicomponent restorative cognitive training targeted largely at memory training and compensatory cognitive rehabilitation.	Group-based (GCI) and home-based (HCI) cognitive intervention	Participants in the HCI completed daily homework materials consisting of seven pages, 5 days per week, for 12 weeks. Six pages consisted of tasks for memory and other cognitive domain. The guidebook of homework materials was given to the informant to help participants complete it.	Yes	No	Both participants from GCI and HCI showed significant improvement in cognitive function. The benefits of cognitive intervention also persisted for at least another 6 months after it had been discontinued.
Kwok et al[22]	Hong Kong	Selected from six community centres from the three districts	Multi-domain intervention (attention, memory and reasoning)	Attention (search for difference, cancelation, and substitution) • Memory (mnemonic strategies) • Reasoning (reasoning skills)	Training-based program	Includes a variety of games to improve attention and speed of processing. Memory training focuses on helping participants memorize things. Participants were involved with reasoning and problem-solving skills.	No	No	Cognitive training beneficial to the overall cognitive function of less-educated older adults. Durable for at least 9 months. Support the presence of cognitive plasticity in older adults.
Peng et al[23]	China	community-dwelling elderly people	Multi-domain cognitive intervention (memory, attention, and calculation)	Memory training included seven-piece board recovery training, picture-reading memory, reading aloud, and reciting phrases; attention training included colour reaction training and Schulte Grid training; and calculation training included two simple calculations questions and one simple application question for calculation in each intervention process.	Group training base (Classroom-based intervention)	The training was conducted by the designer and used the classroom-based where all participants gathered. Intervention was conducted every two weeks for 6 months.	No	No	The cognitive training intervention is effective and may help to decrease the deterioration of cognitive function in patients with MCI, and the interaction between intervention time and cognitive training significantly improves cognitive function.

Con't

Author (Year)	Country	Participants based	Domains of intervention	Intervention content/ programme	Mode of delivery	Training/ monitoring/ support/fidelity	Homework	Cultural Component/ elements	Remarks
Shimada et al[24]	Japan	Recruited from the residential suburb Assigned into amnestic MCI (aMCI) and non-amnestic MCI (naMCI)	Multi-modal intervention	The program included aerobic exercise, muscle strength training, postural balance retraining, and dual-task training. The exercises combined physical and cognitive tasks.	The combined program was conducted at the fitness facility.	The combined activity program significantly improved the MMSE and WMS-LM II scores in participants with aMCI, suggesting significant Improvements in their cognitive abilities and logical memory.	No	No	Combined physical and cognitive activity improves or maintains cognitive and physical performance in older adults with mild cognitive impairment, especially the amnestic type.
Park and Park[25]	Korea	Local community welfare centre	Multi-domain: Cognitive Computer Training (CCT) and Nonspecific Computer Training (NCT)	CCT contained programs including attention, memory, and visual-spatial abilities. NCT consists of three-sport games (table tennis, swordplay and archery). Participants played games for 10 minutes for each session.	CCT is using the CoTras program (Netblue, Korea)	NCT group produced more significant improvements in cognitive function and health-related quality of life than did CCT NCT appears to be an entertaining alternative to CCT.	No	No	NCT was superior to CCT for improving cognitive function and health-related quality of life of elderly adults with MCI.
Han et al[26]	Korea	Recruited from dementia clinics	Multi-modal: Combination of physical exercises, cognitive training and music therapy	MCET: Consisting of cognitive training, cognitive stimulations, reality orientation, physical therapy, reminiscence therapy and music therapy. Mock Therapy (MT) also consisted of three 3- hour sessions per week for eight weeks.	Combination of activities, Group therapy, 3-hour per session.	The training was provided to the occupational therapist before the intervention started.	No	No	MCET improved cognition, behaviour, and quality of life in people with MCI or mild dementia more effectively than conventional cognitive-enhancing activities did.
Sukotonpol et al[27]	Thailand	Recruited from the southern region of Thailand.	Multi-domain cognitive intervention	Cognitive Training Program (4 aspects of cognitions, Executive Function, Attention, Memory and Visuospatial Perception)	Group session Each session involved training of different domains of cognition.	Follow up activities after each session for participants to practice skills at home (e.g. writing one's own biosketch, diary, and drawing a family tree)	No	No	There were significant effects in enhancing global cognitions; increased MoCA score and decreased depressive score. The Improvement of cognitions sustained for 6 months after the 3-month intervention.

Multi-domain Cognitive Intervention

Most studies on the multi-domain cognitive intervention included the area of training on executive function, memory, attention, visual-spatial, and perception. Six studies[18,20–23,27] included the following cognitive domains: executive functioning, memory, and attention. Three studies included training on visuospatial perception.[21,25,27] The training on visual-spatial focused on the activities of drawing and sketching. Overall, the multi-domain cognitive intervention improved the general cognitive abilities, which influenced better brain plasticity among adults with MCI.22 However, the intervention only lasted between six to nine months.[21,22]

One study compared the multi-domain in which the specific cognitive intervention of memory, attention, and visual-spatial abilities used computer and non-specific computer training such as playing three-sport games (table tennis, swordplay, and archery).[25] The results showed that non-specific computer training produced more significant results than specific-cognitive computer training. Besides, there was only one study that focused on multi-domain cognitive computer training that covered the memory and attention domains.[16] Although there was improvement in the cognitive functioning of older adults with MCI, the impact could only be observed immediately after training and confined to the trained area.

Multimodal Combined Intervention

Two studies focused on multi-modal combined intervention[24,26] showed that the intervention could improve cognition and other areas such as physical health, blood circulation, and reduced risk of complicated diseases. A study by Shimada et al.[24] combined aerobic exercises, muscle strength training, postural balance training, and dual-task training with cognitive elements like crossword puzzle while doing stepping exercise showed an improvement in cognitive abilities and logical memory. Han et al.[26] combined the multimodal intervention for older adults with MCI that contained physical exercises, reality orientation, cognitive training, reminiscence therapy, cognitive stimulation, and music therapy. The intervention could improve cognition, behaviour, and quality of life. This study suggested that the combined multi-domain intervention was more effective than conventional cognitive training.

DISCUSSION

This systematic review explored the impact of cognitive intervention for adults over 50 with mild cognitive impairment (MCI) in Asia. The review showed that cognitive intervention improved cognitive abilities, including memory, attention and executive functioning; reduced subjective complaints; and improved daily living skills. There were three variations in the cognitive intervention in Asia for MCI, namely single-domain, multi -domain and multimodal interventions. Computerised cognitive training could provide detailed comparison on the effectiveness of different types of interventions.

The Impact of Single-domain Cognitive Intervention

The single-domain cognitive intervention had one cognitive domain such as memory training or attention training. The transfer effect of cognitive training could identify the impact of cognitive intervention. In this review, two studies of single-domain cognitive training on memory and attention had proven that far transfer effect of cognitive improvement in untrained areas such as executive functions.[8,16] This finding was consistent with the findings by Cheng et al.[28] whereby single-domain cognitive training outperformed multi-domain cognitive training in many cognitive areas, which supported the notion of generalisation of training. Besides that, the finding was further supported by studies on single-domain cognitive training of speed processing and forward word recognition that improved the global auditory memory skills and memory cognitive abilities.[29,30] Similarly, Anderson et al.[31] suggested that specific hearing processing training in older adults with MCI could increase the cognitive abilities in auditory signal detection test and memory enhancement. These studies suggested that single-domain cognitive training promoted near transfer (trained areas) and far transfer (non-trained areas) effects in the cognitive abilities of adults with MCI. A

possible explanation for the significant transfer effect observed in single-domain cognitive intervention may be due to neural brain plasticity that was preserved until late adulthood.[32] The single-domain intervention enhanced cognitive functioning and induced neural changes, where it modified the specialised regions involved in the task and activated alternative brain regions.[33] This statement was further explained by Belleville et al.[34], suggesting that strategic memory training increased the brain activation involved in memory encoding before training and also in the new activation brain regions that were not active before the training. Consistent with a study by Belleville et al.,33 the current review suggested that single-domain cognitive intervention facilitates the improvement in the trained areas and the restorative effect which suggested the new activation of untrained areas, allowing the transfer effect.

The Impact of Multi-domain Cognitive Training

The multi-domain cognitive intervention has more than one targeted cognitive domain such as the combination of memory, attention and executive functioning domains. This review revealed that multi-domain cognitive intervention influenced the global cognitive improvement in people with MCI in Asia.[18,20,22,27] The multi-domain cognitive intervention showed improvement in trained areas compared to baseline performance, indicating the near transfer effect in improving the cognitive function. This finding was consistent with the previous studies in MCI which found multi-domain cognitive training could improve memory abilities,[35,36] executive function,[37] processing speed,[37] and naming and semantic fluency.[38] In contrast to the single domain, the far transfer effect of multi-domain intervention in this review had fewer reviews compared to the single-domain intervention. Besides, multi-domain cognitive studies also suggested that cognitive intervention improved the global cognitive functioning of adults in rural areas with low education level[18,22,] which was consistent with other studies on older adults with MCI. [39,40]

The impact of multi-domain computer cognitive training
The current review revealed non-specific computer training influenced more improvement in the cognitive functioning of older adults with MCI compared to specific cognitive computer training in Asia.[25] The finding was inconsistent with previous studies, suggesting that computer-based cognitive training improved the various domains of cognitive functioning of individuals with MCI.[41,42] The differences in the effect of computer training may contribute to the content of the intervention and also the intrinsic motivation of participants. We hypothesised that entertaining participants would lead them to be motivated in performing the task. Previous research found participants who were intrinsically motivated performed better in cognitive training than those with paid studies.[43,44] The multi-domain computerised training improved the general cognitive functioning of adults with MCI in Asia[20] and supported the near transfer effect on the trained areas of memory, attention, executive function, and visuospatial tests. However, the transfer effect did not extend to other non-trained cognitive areas (far transfer effect).[20] This finding was inconsistent with Gajewski et al.[45] who found that the computerised multi-domain cognitive training improved non-explicitly trained function. This suggested the occurrence of far transfer effect to untrained cognitive areas which was observed by the improvement in the attention and executive function. The differences in the findings may due to differences in objective measurement and the content of the multi-domain intervention.

The Impact of Multimodal Cognitive Intervention

The multimodal cognitive intervention involved the combination of any cognitive domains such as memory, attention, processing speed, or executive functioning training, and other activities such as aerobic exercises, physical training, music therapy, reality orientation, and reminiscence therapy. The current review revealed that the combination of cognitive training with other activities such as aerobic, physical training, exercises, and music therapy[14,15] had significant improvement in restoring the cognitive abilities of older adults with MCI.[24,26] This finding was consistent with a meta-analysis report on healthy ageing by Zhu et al.[46] whereby combined physical

exercises with cognitive activities were more effective than physical exercises alone. A study by Sugano et al.[19] in the present review revealed that aerobic training alone can improve the cognitive function of participants with MCI compared to the control group. This finding is parallel with Sperling et al.[47], suggesting that behavioural intervention such as physical exercises could be effective in improving cognitive function at the pre-clinical stages of Alzheimer's disease (AD). Similarly, Heyn et al.[48] also found a significant effect on the overall cognition from a single component of physical fitness among people with MCI and dementia.

In addition, the current review found that the combination of behavioural intervention and cognitive training were effective in promoting transfer effect on the trained or untrained areas. For instance, the improvement of the training was observed on specific trained cognitive domains such as memory function,[24,26] reducing the behavioural problem,[26] and increasing the quality of life.26 A previous review suggested the transfer effect of the combined multimodal intervention for people with MCI could improve the daily living activities,[15,49] memory function[15,49] and mood.[49] Past studies showed that combined physical and cognitive training increased the number of physical, motor, and cognitive outcomes compared to a single component training without the combination of cognitive training.[46,50] Moreover, cognitive-physical training can improve psychomotor speed, processing speed, attention and multitasking skills.[50] However, the limited studies in Asia suggested that the combination of cognitive training and behavioural activation could elevate the improvement of cognitive function of adults with MCI; hence, further research should be conducted in Asia.

Overall, this review included studies with different modalities of a single domain, multi-domain, and multimodal interventions for adults with MCI in Asia. Each modality showed significant improvement in cognitive function. However, there is still limited evidence to assess the transfer effect between each modality. There were differences in the objective measurement in each study, where single-domain intervention utilised specific objective measurement, whereas the majority of studies from multi-domain and multimodal interventions utilised general cognitive measurement. Therefore, it is difficult to assess the impact of intervention objectively. It is important to highlight that multimodal intervention only incorporates a small amount of cognitive training and no specific cognitive domain was measured in adults with MCI in Asia. The effectiveness of multimodal intervention in this review was limited to global cognitive function. The transfer effect of the multimodal intervention was only observed in other non-cognitive domains such as the improvement in daily living activities and mood. Therefore, the information about whether multimodal intervention was more effective than traditional cognitive training that utilised single and multi-domain cognitive interventions could not be derived in Asia.

The strength of this current review is that it is the first review attempted to systematically synthesise the studies of cognitive intervention of adults with MCI in the Asian population. By focusing on the Asian population, this review presented the overall impact of cognitive training that is suitable to be adapted for the Asian population. Besides that, it also eliminated other possible biases such as the culture and language biases from the Western population. Secondly, this review highlighted the different modalities of intervention and focused on the implementation of cognitive training for adults with MCI in Asia. Thirdly, this review discussed the transfer effect of cognitive training in Asia to understand how cognitive training can benefit specific cognitive areas, other untrained areas, or global daily functioning. The outcome of the transfer effect could provide a better understanding of how the cognitive intervention impacted trained areas, non-trained areas, and global daily functioning. Overall, this review could determine the availability of the different modalities of cognitive intervention in Asia and the benefits received by the participants. Then, the finding could be adapted for cognitive training among older adults in the Asian population, including Malaysia.

The main limitation of the present review is the differences in outcome measures employed among

studies which may influence the overall summary of reviews. The differences must be considered when interpreting the impact of cognitive intervention. Besides that, the inferences of transfer effect can only be associated with the format of intervention, and there were limited papers on the transfer effect. Moreover, the duration of intervention can also influence the transfer effect of cognitive training, which were not discussed in this review. Therefore, future reviews need to explore the format of training and duration of intervention to understand factors that contributed to the impact of the cognitive intervention for older adults with MCI in Asia.

CONCLUSION

This systematic review synthesized types of cognitive training available for adults with MCI in Asia and their transfer effect. This review also explored the psychosocial impact of the training based on the different modalities of the cognitive intervention. It is worth noting that the transfer effect significantly occurred in the single-domain intervention compared to multi-domain and multimodal interventions. In general, all types of cognitive interventions can produce positive impacts after the training. However, the impact of cognitive training could only be observed for a limited period and did not sustain for a longer duration. Future review can consider the impact of the intervention by the group and individual format in Asia to explore the most beneficial approach. This systematic review provides a good understanding to plan ideal cognitive intervention packages that could benefit adults with MCI in Asia.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this manuscript.

REFERENCES

1. Barnes DE, Yaffe K, Satariano WA, Tager IB. A longitudinal study of cardiorespiratory fitness and cognitive function in healthy older adults. J Am Geriatr Soc. 2003;51(4):459–65.
2. Ho SC, Woo J, Sham A, Chan SG, Yu ALM. A 3-year follow-up study of social, lifestyle and health predictors of cognitive impairment in a Chinese older cohort. Int J Epidemiol. 2001;30(6):1389–96.
3. Smith JP. Preparing for population aging in Asia: Strengthening the infrastructure for science and policy. In: Aging in Asia: Findings from New and Emerging Data Initiatives. National Academies Press (US); 2012.
4. De Rotrou J, Wenisch E, Chausson C, Dray F, Faucounau V, Rigaud A. Accidental MCI in healthy subjects: a prospective longitudinal study. Eur J Neurol. 2005;12(11):879–85.
5. Petersen RC, Parisi JE, Dickson DW, Johnson KA, Knopman DS, Boeve BF, et al. Neuropathologic features of amnestic mild cognitive impairment. Arch Neurol. 2006;63(5):665–72.
6. Hyer L, Scott C, Atkinson MM, Mullen CM, Lee A, Johnson A, et al. Cognitive training program to improve working memory in older adults with MCI. Clin Gerontol. 2016;39(5):410–27.
7. Jean L, Bergeron M-È, Thivierge S, Simard M. Cognitive intervention programs for individuals with mild cognitive impairment: systematic review of the literature. Am J Geriatr Psychiatry. 2010;18(4):281–96.
8. Weng W, Liang J, Xue J, Zhu T, Jiang Y, Wang J, et al. The transfer effects of cognitive training on working memory among Chinese older adults with mild cognitive impairment: a randomized controlled trial. Front Aging Neurosci. 2019;11:212.
9. Barnett SM, Ceci SJ. When and where do we apply what we learn?: A taxonomy for far transfer. Psychol Bull. 2002;128(4):612.
10. Chiu H-L, Chu H, Tsai J-C, Liu D, Chen Y-R, Yang H-L, et al. The effect of cognitive-based training for the healthy older people: A meta-analysis of randomized controlled trials. PLoS One. 2017;12 (5):e0176742.

11. Karbach J, Verhaeghen P. Making working memory work: a meta-analysis of executive-control and working memory training in older adults. Psychol Sci. 2014;25(11):2027–37.
12. Tardif S, Simard M. Cognitive stimulation programs in healthy elderly: a review. Int J Alzheimer's Dis. 2011;2011.
13. Papp K V, Walsh SJ, Snyder PJ. Immediate and delayed effects of cognitive interventions in healthy elderly: a review of current literature and future directions. Alzheimer's Dement. 2009;5(1):50–60.
14. Reijnders J, van Heugten C, van Boxtel M. Cognitive interventions in healthy older adults and people with mild cognitive impairment: a systematic review. Ageing Res Rev. 2013;12(1):263–75.
15. Chandler MJ, Parks AC, Marsiske M, Rotblatt LJ, Smith GE. Everyday impact of cognitive interventions in mild cognitive impairment: a systematic review and meta-analysis. Neuropsychol Rev. 2016;26(3):225–51.
16. Yang H, Chu H, Kao C, Miao N, Chang P, Tseng P, et al. Construction and evaluation of multidomain attention training to improve alertness attention, sustained attention, and visual-spatial attention in older adults with mild cognitive impairment: A randomized controlled trial. Int J Geriatr Psychiatry. 2020;35(5):537–46.
17. Youn J-H, Park S, Lee J-Y, Cho S-J, Kim J, Ryu S-H. Cognitive Improvement in Older Adults with Mild Cognitive Impairment: Evidence from a Multi-Strategic Metamemory Training. J Clin Med. 2020;9 (2):362.
18. Liu XY, Li LI, Xiao JQ, HE CZ, Lyu XL, Lei GAO, et al. Cognitive training in older adults with mild cognitive impairment. Biomed Environ Sci. 2016;29 (5):356–64.
19. Sugano K, Yokogawa M, Yuki S, Dohmoto C, Yoshita M, Hamaguchi T, et al. Effect of cognitive and aerobic training intervention on older adults with mild or no cognitive impairment: a derivative study of the nakajima project. Dement Geriatr Cogn Dis Extra. 2012;2(1):69–80.
20. Li B-Y, He N-Y, Qiao Y, Xu H-M, Lu Y-Z, Cui P-J, et al. Computerized cognitive training for Chinese mild cognitive impairment patients: a neuropsychological and fMRI study. NeuroImage Clin. 2019;22:101691.
21. Jeong JH, Na HR, Choi SH, Kim J, Na DL, Seo SW, et al. Group-and home-based cognitive intervention for patients with mild cognitive impairment: a randomized controlled trial. Psychother Psychosom. 2016;85(4):198–207.
22. Kwok T, Bai X, Li J, Ho F, Lee TMC. Effectiveness of cognitive training on improving cognitive abilities of Chinese older people with memory complaint: A randomized placebo-controlled trial. Int J Geriatr Psychiatry. 2013;
23. 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;2019.
24. Shimada H, Makizako H, Doi T, Park H, Tsutsumimoto K, Verghese J, et al. Effects of combined physical and cognitive exercises on cognition and mobility in patients with mild cognitive impairment: a randomized clinical trial. J Am Med Dir Assoc. 2018;19(7):584–91.
25. Park J-H, Park J-H. Does Cognition-specific computer training have better clinical outcomes than non-specific computer training? A single-blind, randomized controlled trial. Clin Rehabil. 2018;32 (2):213–22.
26. Han JW, Lee H, Hong JW, Kim K, Kim T, Byun HJ, et al. Multimodal cognitive enhancement therapy for patients with mild cognitive impairment and mild dementia: a multi-center, randomized, controlled, double-blind, crossover trial. J Alzheimer's Dis. 2017;55(2):787–96.
27. Sukontapol C, Kemsen S, Chansirikarn S, Nakawiro D, Kuha O, Taemeeyapradit U. The effectiveness of a cognitive training program in people with mild cognitive impairment: A study in urban community. Asian J Psychiatr. 2018;35:18–23.
28. Cheng Y, Wu W, Feng W, Wang J, Chen Y, Shen Y, et al. The effects of multi-domain versus single-domain cognitive training in non-demented older people: a randomized controlled trial. BMC Med. 2012;10(1):1–13.

29. Mahncke HW, Connor BB, Appelman J, Ahsanuddin ON, Hardy JL, Wood RA, et al. Memory enhancement in healthy older adults using a brain plasticity-based training program: a randomized, controlled study. Proc Natl Acad Sci. 2006;103(33):12523–8.
30. Zanetti O, Binetti G, Magni E, Rozzini L, Bianchetti A, Trabucchi M. Procedural memory stimulation in Alzheimer's disease: impact of a training programme. Acta Neurol Scand. 1997;95(3):152–7.
31. Anderson S, White-Schwoch T, Parbery-Clark A, Kraus N. Reversal of age-related neural timing delays with training. Proc Natl Acad Sci. 2013;110(11):4357–62.
32. Erickson KI, Colcombe SJ, Wadhwa R, Bherer L, Peterson MS, Scalf PE, et al. Training-induced plasticity in older adults: effects of training on hemispheric asymmetry. Neurobiol Aging. 2007;28(2):272–83.
33. Belleville S, Boller B, del Val LP. Cognitive training in mild cognitive impairment. In: Cognitive Training. Springer; 2016. p. 187–97.
34. Belleville S, Clement F, Mellah S, Gilbert B, Fontaine F, Gauthier S. Training-related brain plasticity in subjects at risk of developing Alzheimer's disease. Brain. 2011;134(6):1623–34.
35. Hwang HR, Choi SH, Yoon DH, Yoon B-N, Suh YJ, Lee D, et al. The effect of cognitive training in patients with mild cognitive impairment and early Alzheimer's disease: a preliminary study. J Clin Neurol. 2012;8(3):190.
36. Savulich G, Piercy T, Fox C, Suckling J, Rowe JB, O'Brien JT, et al. Cognitive training using a novel memory game on an iPad in patients with amnestic mild cognitive impairment (aMCI). Int J Neuropsychopharmacol. 2017;20(8):624–33.
37. Greenaway MC, Duncan NL, Smith GE. The memory support system for mild cognitive impairment: randomized trial of a cognitive rehabilitation intervention. Int J Geriatr Psychiatry. 2013;28(4):402–9.
38. Gooding AL, Choi J, Fiszdon JM, Wilkins K, Kirwin PD, van Dyck CH, et al. Comparing three methods of computerised cognitive training for older adults with subclinical cognitive decline. Neuropsychol Rehabil. 2016;26(5–6):810–21.
39. Draganski B, Gaser C, Busch V, Schuierer G, Bogdahn U, May A. Changes in grey matter induced by training. Nature. 2004;427(6972):311–2.
40. Vidovich MR, Lautenschlager NT, Flicker L, Clare L, McCaul K, Almeida OP. The PACE Study: A Randomized Clinical Trial of Cognitive Activity Strategy Training for Older People with Mild Cognitive Impairment. Am J Geriatr Psychiatry. 2015;23(4):360–72.
41. Ge S, Zhu Z, Wu B, McConnell ES. Technology-based cognitive training and rehabilitation interventions for individuals with mild cognitive impairment: a systematic review. BMC Geriatr. 2018;18(1):1–19.
42. Nousia A, Martzoukou M, Siokas V, Aretouli E, Aloizou A-M, Folia V, et al. Beneficial effect of computer-based multidomain cognitive training in patients with mild cognitive impairment. Appl Neuropsychol Adult. 2019;1–10.
43. Jaeggi SM, Buschkuehl M, Shah P, Jonides J. The role of individual differences in cognitive training and transfer. Mem Cognit. 2014;42(3):464–80.
44. Von Bastian CC, Oberauer K. Effects and mechanisms of working memory training: a review. Psychol Res. 2014;78(6):803–20.
45. Gajewski PD, Thönes S, Falkenstein M, Wascher E, Getzmann S. Multidomain cognitive training transfers to attentional and executive functions in healthy older adults. Front Hum Neurosci. 2020;14.
46. Zhu X, Yin S, Lang M, He R, Li J. The more the better? A meta-analysis on effects of combined cognitive and physical intervention on cognition in healthy older adults. Ageing Res Rev. 2016;31:67–79.
47. Sperling RA, Aisen PS, Beckett LA, Bennett DA, Craft S, Fagan AM, et al. Toward defining the preclinical stages of Alzheimer's disease: recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. Alzheimer's Dement. 2011;7(3):280–92.
48. Heyn P, Abreu BC, Ottenbacher KJ. The effects of exercise training on elderly persons with cognitive

impairment and dementia: a meta-analysis. Arch Phys Med Rehabil. 2004;85(10):1694–704.
49. Kurz A, Pohl C, Ramsenthaler M, Sorg C. Cognitive rehabilitation in patients with mild cognitive impairment. Int J Geriatr Psychiatry A J psychiatry late life allied Sci. 2009;24(2):163–8.
50. Levin O, Netz Y, Ziv G. The beneficial effects of different types of exercise interventions on motor and cognitive functions in older age: a systematic review. Eur Rev Aging Phys Act. 2017;14(1):1–23.