Asia-Pacific Journal of Science and Technology :Volume :26 .Issue :02 .Article ID :.APST-26-02-08. Research Article

APST

Asia-Pacific Journal of Science and Technology

https//:www.tci-thaijo.org/index.php/APST/index

Published by the Research and Graduate Studies,
Khon Kaen University, Thailand

Impact of a brain exercise program on cognitive functions among rural Thai older adults: a quasi-experimental study

Mayuree Leethong-In[1,*], Sirimart Piyawattanapong[1], Sawitree Sommongkol[1], Supavadee Thiengtham[1], Suttinan Subindee[1], Nutda Komniyom[1], Patchara Chotchaisthit[1] and Chanokruethai Chuen-arom[2]

[1]Gerontological Nursing Department, Faculty of Nursing, Khon Kaen University, Khon Kaen, Thailand
[2]Psychiatric and Mental Health Nursing Department, Faculty of Nursing, Khon Kaen University, Khon Kaen, Thailand
[*]Corresponding author: mayuree@kku.ac.th

Received 4 July 2020
Revised 13 November 2020
Accepted 29 December 2020

Abstract

Brain exercise is important to maintain and improve cognitive functions in older adults. Most Thai brain training programs have been developed for higher socio-economic status groups in urban areas rather than older rural adults. Therefore the development of an effective brain-training program for older rural people was indicated. This quasi-experimental study aimed to examine the effects of a combination multi-component stimulation program on rural Northeast Thai elders. Fifty older adults in Northeastern Thailand were divided into a control group and intervention group equally. The study instruments were the general information sheet, Montreal Cognitive Assessment (MoCA) Thai version with inter-rater reliability of 0.86, and the Brain Exercise program with content validity of 0.90. The average age of the participants in the intervention group was 68.08 years (standard deviation (SD) = 5.70) and the control group was 69.14 years SD= 5.64. The study results showed that post-intervention cognitive scores of the intervention group were significantly higher than at baseline (p =0.000**). Also, the post-intervention cognitive scores of older adults in the intervention group were significantly higher than those in the control group (p = 0.042*). The results indicated that the Brain Exercise program could be applied to improve cognition, especially in healthy young-old age groups.

Keywords: Brain exercise, Cognition, Older person, Rural

1. Introduction

Thailand’s elderly reached 16.5% of the population in 2016, with further projection that the country would achieve complete aged society status in 2021 [1]. Age is the most common risk factor for dementia, with the probability of dementia increasing from 1 in 1000 for people younger than 65 years, to 1% for people aged over 60 and closer to 25% for people over 85 years [2]. Deary et al. (2009) [3] and Miller et al. (2013) [4] report that a particular concern among older adults is increasing dementia risk due to increasing age and progression of age- related memory impairments. Dementia presents as degeneration in cognitive and memory function, and behavior and is the major cause of dependency among older people [5]. Consequently, it is increasingly difficult for affected older adults to continue their routines and to communicate or interact with others. They are liable to get confused even in familiar environments, and show emotional and behavioral changes [6]. Dementia impacts not just elders, but also their families, caregivers, economy, and communities [5]. Alzheimer’s Disease International estimated globally that there were around 46.8 million persons with dementia in 2015, and due to increasing longevity this number would double every 20 years, or new patients would be diagnosed every 3.2 seconds [7]. The number of older people with dementia in Asian countries are around 22.9 million [7]. Thailand, is expected to have 1.12 million patients in 2030 and 2.08 million by 2050 [2]. Dementia can significantly effect older people’s quality of life [7], and significantly increase health care costs [8]. This rapidly growing elder demographic calls for public health service systems to gear up prevention efforts for early screening and follow-up planning to handle this emerging challenge.

Previous research has found cognitive stimulation activities effective for resisting cognitive decline, reducing the occurrence of dementia, or retarding its severity [9]. Cognitive stimulation activities can prevent or slow cognitive regression resulting from nervous system denervation, and stimulate cognition and brain reserve [10,11]. Cognitive stimulation activities include various fun activities, such as playing Sudoku, chess, and cards. Even though some activities can be done by individuals, previous studies support group activities as better than individual activities [12,13].

Cognitive stimulation programs or brain exercise programs vary by length of program, kinds and numbers of activities, and program formats. Program lengths may last 10-12 h over a couple days, 30 to 90 min weekly, and up to 375 h over 2 years [13]. Different programs have integrated diverse activities, such as physical exercise and social activities, examples include; Tai Chi exercise 3 times a week [14], Reality Orientation Therapy [13], computerized brain exercise programs [4], combined physical activity with cognitive practice with a one-year follow-up [15]. However, most programs integrate cognitive stimulation with physical exercise with a length of 5-30 weeks [15,16]. One interesting result is that a social activity and cognitive stimulation program for 1 h, 3 times a week or 20-25 min a day at least 5 days a week, was related to a statistically significant increase in brain volumes [4,16].

Thai cognitive stimulation research with healthy older people and those with mild cognitive impairment (MCI) have taken different forms and durations, including computer use, home-based practice, facilities-based practice, and video game exercises. For example, a study conducted by Pratoomtan among 11 older people with MCI in Northern Thailand, using a home-base cognitive training kit found increased cognitive ability over pre-program baseline [17]. This home-based practice program focused on memory, attention, and executive management, for 18 sessions over 6 weeks [17]. Other programs addressed cognitive practice, attention, memory, and executive management [18]; memory enhancement with 1 to 1.5 h sessions spread over 7 weeks [19]; and aerobics [20]. In 2016, the Thai Institute of Geriatric Medicine provided a set of manuals for cognitive stimulation programs for people with mild cognitive impairment, i.e., twice a month, for a 3 month duration with 6 activities [21]. Later, a computer-based cognitive training program was developed by Chaikham et al. (2016) [22] that included six categories (visuospatial skill, working memory, abstraction, sequencing, categorization, and orientation). Leethong-in and colleages [23] extended these activities to include physical fitness and brain exercise, with home-based continual practice review with equipment for 5 weeks (once a week, 3 h per a time). The study was conducted among 23 healthy older people living in urban areas in Northeastern Thailand. The promotion of communication channels and practice stimulation among elders and caregivers was also introduced through the telephone application, LINE. The results showed higher Montreal Cognitive Assessment (MoCA) scores at weeks 10, 14, and 18 (follow-up) than at pre-program baseline. Most brain training programs for Thai elders have been designed for higher socio-economic, educated groups in urban areas with easier affordability and higher accessibility to electronic technologies than elders in rural areas [23]. Only one research study with rural Thai elders was found. Pratoomtan studied 11 elders MCI living in northern Thailand. Using a home-base cognitive training kit they found higher cognitive ability scores post-intervention than at pre-program baseline [17].

Given limited research with rural Thai elders this study was designed to evaluate the effects of a modified integrated brain exercise program on cognitive function among this rural demographic. The multi-component program incorporated activities from prior research studies including elements of the Baddeley and Hitch model [24], Reality Orientation Therapy (ROT) [25], neurobic exercise, physical activity, and interactions with others via social participation.

2. Materials and methods

2.1 Research design

This study used a quasi-experimental group comparison design. Forty-five persons over 60 years of age living in two rural provinces of northeast Thailand participated; treatment group (24), control group (21). Data was collected between April and August 2017.

2.2 Participant selection

The required sample size was calculated using Schlesselman’s formula (1973); test power was set at 95%, with reliability at 0.05, standard deviation (SD), and mean difference between the intervention and control groups, according to previous research articles [26]. To cope with possible participant attrition, 20% allowance was then added to obtain a sample estimate of 25 persons each group [27]. The participants were drawn from 2 provinces following inclusion and exclusion criteria as follows.

Inclusion criteria were: 1) being 60 years old or greater; 2) not getting a positive result from the Mini-Mental State Examination Thai 2002 (MMSE-Thai 2002) [28]; 3) being literate in Thai; 4) being able to engage in physical exercise; 5) not being at risk of falling, based on Timed Up and Go Test (TUGT) [29] criteria; and, 6) being willing to cooperate in the research.

Exclusion criteria included: 1) missing 2 consecutive program sessions; 2) having an illness or diseases affecting body movement or cognition, including uncontrollable cardiovascular diseases, ataxia, uneven gait, knee pain, disorientation, dizziness, auditory hallucination, and illusions, and 3) medical history of using nervous system agents, including tranquilizers, at least 1 week before and during the research.

Simple random sampling was conducted by drawing lots without replacement. The draw was based on lists of dependent older adults from sub-districts out of municipalities to prevent bias. The first sampling from an Isan province became the control group. The second sampling from another Isan province became the intervention group. Thirty potential participants were obtained for each group. Then, all eligible participants were screened by the research assistants using the screening evaluation instruments. There were ten persons excluded due to Thai illiteracy (2 persons), at-risk for falls (2 persons), dementia risk (2 persons), and unwilling to cooperate in this study (4 persons). Therefore, 25 participants met the criteria to join each group.

During the implementation phase, four participants withdrew from the control group; two did not engage in activities in the second session, and the other two became unwilling. The intervention group lost a participant since the participant joined the program sessions less than two times. Finally, 21 persons participated in the control group and 24 in the intervention group as illustrated in Figure1.

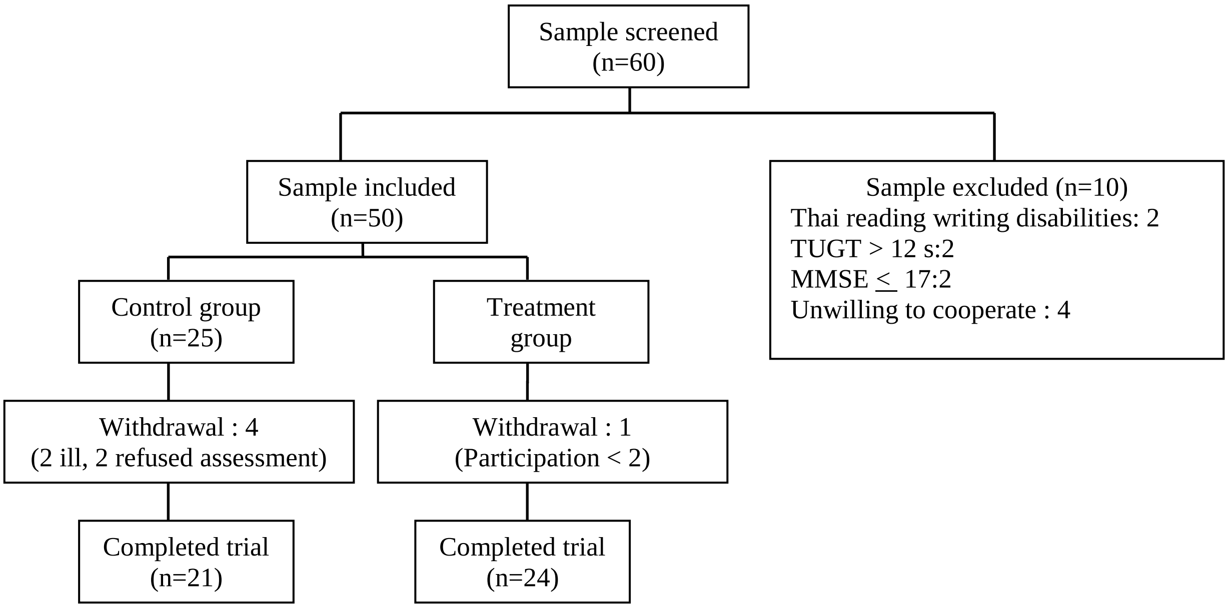

Figure 1 Participant selection process.

2.3 Intervention

All participants in the intervention group received the brain exercise program. The program was based on the multi-component Baddeley and Hitch model [24] that focuseed on many aspects including perception, attention, calculation, language, recall, visuospatial and executive management through to memory development. The program was also included Reality Orientation Therapy (ROT) [25] which focused on cognitively stimulating activities. The program was carried out as group activities, 3 h a week for 5 weeks. Weekly program details were as follows;

Week 1: Prevention of Dementia (Knowledge of dementia)

The activities included group introduction, information about causes of dementia, treatments and prevention, and games to aid the memory of older people such as Knowing Each Others game.

Week 2: Here and now (Attention, memory, calculation and language practice)

The activities included orientation (to date, time and place), physical exercises including Tai Chi, streching exercise, paring card games. The card paring game helps to stimulate memory. The participants were asked to practice this week's actitives at home and record those practiced activities in a homework book given by the researchers.

Week 3: Come back home (Visuospatial practice)

The activities consisted of orientation to date, time and place, Tai Chi, neurobic exercises and mathematic related games. The participants were asked to continue practicing Week 3 activities at home and record in the workbook given.

Week 4: Management (Executive practice)

The activities included orientation, Tai Chi, and games such as Dominoes, and Mazes. The purpose of these activities were to help improve older adults' planning and management skills.

Week 5: Wrap up (Attention, memory, calculation, language, visuospatial and executive practice)

This week's activities included homework review, orientation, Tai Chi and games such as card matching. Participants were also asked to close their eyes and use their hand to feel an object in a bag and guess a name of the object.

The content of the brain exercise program manual and activities were validated by three experts: one psychiatrist and two geriatric nurses, giving a content validity index of 0.90. Then, the program was pilot tested with 3 older adults who met the participant inclusion criteria. After ascertaining that these older adults understood the program and could perform all activities, the program was applied with the experimental group for the research.

The intervention was carried out in the central display place of a village of a rural province in northeastern Thailand. Participants of the intervention group were divided into small subgroups (5-7 persons per each). Each subgroup was led by a primary trainer who is a researcher from the research team and a 1 to 2 co-trainers.

For the control group, a 1-day program was held including activities like the 5-week program but shorter. Control group participants also received a manual for home activities and equipment for brain training at homes.

2.4 Data collection

The cognitive function of the participants in the intervention group were assessed individually by research assistants using MoCA [30] on the first week before program begins, and again after finishing all activities on week 5 of the program in a private meeting room at the village center. MoCA has an established reliability of 0.86 in this research.

Participants in the control group were pretested for cognitive function individually by research assistants using MoCA and assessed again after 5 weeks without being exposed to the brain stimulation program.

2.5 Data analysis

Descriptive statistics were used to analyze demographic data. Pretest and the posttest cognitive scores for each group were compared by paired t-test analysis. The independent t-test was used to examine the mean difference between the intervention and the control groups with the significance level set at 0.05. All analyses were completed using SPSS (v 19.0, IBM SPSS Inc, Chicago, IL).

3. Results and discussion

The average ages of participants in the intervention and the control group were 68.08 years (S.D. = 5.70) and 69.14 years (S.D. = 5.64), respectively. Almost all (98%) had completed primary education, just over half were married (55%), and most (87%) had never joined a brain exercise program before. No significant difference was found at baseline between the groups on the MMSE-Thai 2002, MoCA and TUGT tests ($p > 0.05$). Demographic data of participants are presented in Table 1.

3.1 Outcomes: score differences between pre-and post- tests within control and intervention group

As shown in Table 2, there was a significant difference in overall MoCA scores from baseline to post-test for the intervention group, [$t = 5.517$, $p < 0.05$, $M = 15.42$, $SD = 3.84$ and $M = 18.17$, SD 4.07, respectively). However, only 3 of 7 subtests: visuospatial/executive, attention, and orientation were significantly different. Other subtests: naming, language, abstraction, and delayed recall were not significantly different pre to post-test ($p > 0.05$).

The intervention group had a significantly higher mean MoCA score than that of the control group at post-test ($t = 2.095$, $p < 0.05$), with an effect size at 0.68. However, only the visuospatial/executive subtest score was significantly higher than the control group ($t = 5.816$, $p < 0.001$). There was no difference between the groups on naming, attention, language, abstraction, delayed recall, or orientation sub-tests. See Table 3.

Table 1 Baseline between-group comparisons of sociodemographic and clinical data (n=45).

Characteristics	Interventions (n=24)	Controls (n=21)	*P*-value
Mean age (years, SD)	68.08 (5.70)	69.14 (5.64)	0.535[a]
Gender: Male: Female	0:24	3:18	0.094[c]
Education 4 years: higher	24: 0	20:1	0.467 [c]
Marital status: Married: Windowed	14:10	11:10	0.688[b]
Member's senior club: not member	14:10	9:12	0.300 [b]
Exercise : not exercise	17:7	18:3	0.231 [b]
Prior brain program: never	4:20	2:19	0.400 [c]
Risk of falling (TUGT)	11.16 (0.99)	11.47 (0.65)	0.237 [a]
MMSE score	21.96 (3.47)	21.76 (2.76)	0.834 [a]
Baseline cognition (MoCA)	15.42 (3.84)	14.76 (3.60)	0.560 [a]
▪ Visuospatial/Executive	0.92 (1.02)	0.86 (0.73)	0.825 [a]
▪ Naming	2.38 (0.88)	2.00 (0.95)	0.175 [a]
▪ Attention	3.13 (1.57)	3.43 (1.47)	0.508 [a]
▪ Language	0.29 (0.69)	0.33 (0.58)	0.829 [a]
▪ Abstraction	0.21 (0.41)	0.19 (0.40)	0.885 [a]
▪ Delayed recall	2.04 (1.90)	1.52 (1.54)	0.325 [a]
▪ Orientation	5.46 (0.78)	5.43 (0.68)	0.893 [a]

Note. TUGT=Time Up and Go Test, MMSE-Thai 2002= Mini-Mental State Examination Thai 2002, MoCA= Montreal Cognitive Assessment. [a] : Independent t-test, [b]: Chi-square test, [c]: Fisher's exact probability test.

Table 2 Pre to post-test comparison of the Montreal Cognitive Assessment (MoCA) scores for the intervention group. Pair t-test (n=24).

Outcomes	Baseline		Post-intervention		*t*	*P-value*
	x̄	SD	x̄	SD		
Total MoCA score	15.42	3.84	18.17	4.07	5.571	<0.001**
Visuospatial/Executive	0.92	1.02	1.88	0.95	4.337	<0.001**
Naming	2.38	0.88	2.54	0.72	1.446	0.162
Attention	3.13	1.57	3.79	1.47	2.436	0.023*
Language	0.29	0.69	0.42	0.58	1.000	0.328
Abstraction	0.21	0.41	0.25	0.61	0.440	0.664
Delay recall	2.04	1.90	2.50	1.89	1.123	0.273
Orientation	5.46	0.78	5.79	0.51	1.881	0.073

Statistically significant at **p* <0.05, ** *p*<0.001.

Table 3 Comparison of post-test intervention and control group MoCA scores T-test (n=45).

Variable	Intervention (n=24)		Control (n=21)		t	*P-value*	Mean of differences (95% C.I.)	S.E
	x̄	SD	x̄	SD				
Total MoCA score	18.17	4.07	15.71	3.73	2.095	0.042*	2.45 (0.09, 4.81)	1.17
Visuospatial/ Executive	1.88	0.95	0.48	0.60	5.816	<0.001*	1.40 (0.91, 1.88)	0.24
Naming	2.54	0.72	2.43	0.75	0.516	0.608	0.11 (-0.33, 0.55)	0.22
Attention	3.79	1.47	3.48	1.25	0.768	0.446	0.32 (-0.51, 1.14)	0.41
Language	0.42	0.58	0.38	0.80	0.172	0.864	0.04 (-0.38, 0.45)	0.21
Abstraction	0.25	0.61	0.29	0.46	-0.219	0.828	-0.04 (-0.36, 0.29)	0.16
Delay recall	2.50	1.89	1.90	1.48	1.165	0.251	0.60 (-0.44, 1.63)	0.51
Orientation	5.79	0.51	5.76	0.54	0.190	0.850	0.03 (-0.29, 0.35)	0.16

Statistically significant at **p*<0.05, ** *p*<0.001.

This study is the first to investigate the effect of the brain exercise program in older rural Thai adults in Northeastern Thailand. The results revealed that the mean cognitive scores of the intervention group were significantly higher than those of the control group after the 5 week study period. There were improvements in diverse aspects of their brain functions including learning skills, memory, and thinking process. The high cognitive scores could be explained by the fact that intervention group participants had continually practiced the exercise activities as instructed every week. Persistent engagement with the activity log over the 5 weeks could also have led to their increased perceived self-efficacy, reflected in their feedback when they had completed activities and shared achievements with their fellows , they felt confident and enjoyment [31]. In discussion with the group leader, participants reflected how much they enjoyed the activities saying that "I just want to see if I can master the task.", "I carry them wherever I go", and "They are fun and joyful."

The self-regulation of continuing practice facilitated thinking repetition until memory consolidation process takes place [32]. Regular mental and instrumental support from participants' families was also crucial. It was also found that breaking participants into small groups to establish close relationship better facilitated their engagement in the exercises and their eagerness for participation. This finding is similar to previous research studies which found that older adults in a nursing home who attended 14 sessions of cognitive stimulating program (7 weeks) had higher cognition scores than those who did not attend the program [33]. Also, the results of the current study were consistent with those of prior studies examining the effectiveness of cognitive training program among Thai older adults both those with dementia risk and those with normal health [18,23].

Brain exercise program have consistently proven to be beneficial for older adults. In this study, we found that participants in the intervention group had significant increases in executive management function and attention compared to baseline. The result could be explained by the arrangement of the exercise activities ordered from easy to harder tasks, i.e., ordering numbers, domino, molding figures, puzzles, pairing cards, calculating from leaflets, and neurobics exercise. Also, the nature of the activities were designed to be congruent with the parcicipants' life context. This finding is consistent with a previous study which found that older adults with normal health had higher cognition in the aspect of executive management [23]. This result , however, is not consistent with a similar study examining the effects of cognitive stimulation in older people with mild cognitive impairment where there were no significant differences between pre and post-intervention cognitive scores [21].

For the rest of the cognitive function outcomes, there was no significant difference between groups for naming, attention, abstraction, delayed recall, and orientations, though adjusted percentages of initial values showed higher percentage score for the intervention group than the controls in all those aspects, except abstract concepts. This findings might be explained by the numbers of practice and activity forms, whether the activities were implemented continually and in what order. MoCA was the only the cognitive evaluation instrument used in this study, and its focus mostly on activity repetition might not adequately assess cognitive function in northeastern Thai contexts. In fact, according to the literature review, most studies in this area have typically relied on more than one cognitive evaluation instrument [11].

4. Conclusion

Our results indicate that a brain exercise program can provide cognitive benefits for older adults in Northeastern Thailand. This combination brain exercise program is not complicated and can be incorporated into daily living activities in rural life contexts. Itcould also be used in aging preparedness programs and other health promotion activities for promoting sustainable well-being in communities. Longitudinal studies would also be useful to examine continuing brain exercise practice effects, alongside the role of good nutrition., proper rest, reducing negative emotions, in promoting quality of life for elders.

Possible research limitations include short duration for data collection might assist participants' memory for assessment questions and might even engender celling effects. External cognitive stimulation possibly occurred in daily situations and environments beyond the researchers' control.

5. Acknowledgments

This research was supported by Faculty of Nursing, Khon Kaen University, Thailand. The manuscript was English edited by Professor John F. Smith via the Khon Kaen University Publication Clinic.

6. Ethic approval

The research proposal was reviewed and approved by the Human Research Ethics Committee of Khon Kaen University (No. HE592408).

7. References

[1] Foundation of Thai Gerontology Research and Development Institute. Situation of the Thai Elderly 2016. Nakorn Pathom: Printery; 2017.

[2] Alzheimer's Disease International and Alzheimer's Australia. Dementia in the Asia-Pacific region. London: Alzheimer's Disease Internaional; 2014.
[3] Deary IJ, Corley J, Gow AJ, Harris SE, Houlihan LM, Marioni RE, et al. Age-associated cognitive decline. Br Med Bull. 2009;92(1):135-152.
[4] Miller KJ, Dye RV, Kim J, Jennings JL, Toole EO, Wong J, et al. Effect of a computerized brain exercise program on cognitive performance in older adults. Am J Geriatr Psychiatry. 2013;21(7):655-663.
[5] World Health Organization. Global action plan on the public health response to dementia 2017-2025 [Internet]. 2017 [cited 2018 Jan 30]. Available from: https://www.who.int/mental_health/neurology/deme Tia/action_plan_2017_2025/en/.
[6] World Health Organization. Dementia [Internet]. 2015 [cited 2016 Jan 20]. Available from: http://www.who.int/topics/dementia/en/.
[7] Prince M, Wimo A, Guerchet M, Ali GC, Wu YT, Prina M. World Alzheimer Report 2015- the global impact of dementia an analysis of prevalence, incidence, cost and trends. London: Alzheimer's Disease International; 2015.
[8] Harding S, Byles J, Peng D, Umranikar J, Mizuta K. Dementia in the Asia-Pacific region. Innov Aging. 2017;1 Supple 1:1303.
[9] Mewborn CM, Lindbergh CA, Miller LS. Cognitive interventions for cognitively healthy, mildly impaired, and mixed samples of older adults: a systematic review and meta-analysis of randomized-controlled trials. Neuropsychol Rev. 2017;27(3):403-439.
[10] Reijnders J, Heugten CV, Boxtel MV. Cognitive interventions in healthy older adults and people with mild cognitive impairment: a systematic review. Ageing Res Rev. 2013;12(1):263-275.
[11] Tardif S, Simard M. Cognitive stimulation programs in healthy elderly: a review. Int J Alzheimers Dis. 2011;3:378934.
[12] Kueider A, Krystal B, Rebok G. Cognitive training for older adults: what is it and does it work [Internet]. Virginia: American Institutes for Research; 1946 [cited 2016 Jan 20]. Available from: https://www.air.or g/sites/default/files/downloads/report/Cognitive%20Training%20for%20Older%20Adults_Nov%2014.pd f.
[13] Woods B, Aguirre E, Spector AE, Orrell M. Cognitive stimulation to improve cognitive functioning in people with dementia. Cochrane Database Syst Rev. 2012;15;(2):CD005562.
[14] Wayne PM, Walsh JN, Piliae RT, Wells Re, Papp KV, Donovan NJ, et al. Effect of tai chi on cognitive performance in older adults: systematic review and meta-analysis. J Am Geriatr Soc. 2014;62(1):25-39.
[15] Rahe J, Petrelli A, Kaesberg S, Fink GR, Kessler J, Kalbe E. Effects of cognitive training with additional physical activity compared to pure cognitive training in healthy older adults. Clin Interv Aging. 2015;10:297-310.
[16] Mortimer JA, Ding D, Borenstein AR, DeCarli C, Guo Q Wu Y, et al. Changes in brain volume and cognition in a randomized trial of exercise and social interaction in a community-based sample of non-demented Chinese elders. J Alzheimer's Dis. 2012;30(4):757-766.
[17] Pratoomtan D, Rattakorn P, Mumkhetvit P. Effect of home-based cognitive training kit and satisfaction of elderly with mild cognitive impairment. J Occup Ther Assoc Thail. 2013;18:35-46.
[18] Chaiwong PP, Rattakorn P, Mumkhetvit P. Effects of cognitive training program on cognitive abilities and quality of life in elderly with suspected dementia. J Assoc Med Sci. 2015;48(3):182-191.
[19] Chattrawongwiwat T, Kong-in W, Thaniwattananon P. Impacts of a memory-enhancing programme on perceived memory self-efficacy amongst elderly people. Thai J Nurs Counc. 2013;28:98-108.
[20] Choombuathong A, Chaitiamwong R, Sanguansit P, Tothonglor A. Effect of aerobic exercise on reaction time and memory in the elderly. J Heal Sci. 2015;24(2):283-295.
[21] Institute of Geriatric Medicine (Thailand). Cognitive stimulation in people with mild cognitve impairment. Bangkok: CyberPrint Group; 2016.
[22] Chaikham A, Putthinoi S, Lersilp S, Bunpun A, Chakpitak N. Cognitive training program for Thai older people with mild cognitive impairment. Procedia Environ Sci. 2016;36:42-45.
[23] Leethong-in M, Piyawattanapong S, Sommongkol S, Thhiengthaimi S, Kumniyom N. Effects of a physical activity and brain exercise program on cognitive ability of healthy Thai elders. Walailak J Sci Technol. 2019;16(2):1-8.
[24] Baddeley A, Hitch GJ. Working memory. Scholarpedia. 2010;5(2):3015.
[25] Spector A, Davies S, Woods B, Orrell M. Reality orientation for dementia: a systematic review of the evidence of effectiveness from randomized controlled trials. Gerontologist. 2000;40(2):206-212.
[26] Hongtong R, Sasat S. The effect of reminiscence program on cognitive function of older people with dementia. J Nurs Educ. 2015;8:99-112.
[27] Gray JR, Grove SK, Sutherland SZ. Burns and Grove's the practice of nursing research : appraisal, synthesis, and generation of evidence. 8th ed. St.Louis: Elsevier; 2017. p. 329-364.

[28] Department of Medical Service (Thailand). Mini Mental State Examination; Thai version, MMSE-Thai 2002. Bangkok: The goverment. 2002.

[29] Podsiadlo D, Richardson S. The timed “Up & Go”: a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc. 1991;39:142-148.

[30] Hemrungrojn S. Montreal Cognitive Assessment MoCA Thai version [Internet]. 2011 [cited 2015 Sep 22]. Available from: http://www.mocatest.org/wp-content/uploads/2015/tests-instructions/MoCA-Instruct Ions-Thai.pdf.

[31] Bandura A. Social foundations of thought and action: a social cognitive theory. Englewood Cliffs, NJ: Prentice-Hall; 1986.

[32] Atkinson RC, Shiffrin RM. Human memory: a proposed system and its control processes. Psychol Learn Motiv. 1968;2:89-195.

[33] Apóstolo JLA, Cardoso DFB, Rosa AI, Paúl C. The effect of cognitive stimulation on nursing home elders: a randomized controlled trial. J Nurs Scholarsh. 2014;46(3):157-166.