The effects of Baduanjin exercise on the subjective memory complaint of older adults
A randomized controlled trial
Hong Su, MD, Haina Wang, MD, Lina Meng, MD

Abstract
This study aimed to explore the efficacy of Baduanjin exercise on promoting memory function, executive function and general self-efficacy, decreasing the level of subjective memory complaints of older adults.

In this randomized controlled trial, 80 patients were randomly allocated in a 1:1 ratio to 12-week Baduanjin exercise group or 12-week control group. Subjective memory complaint questionnaire, Auditory verbal learning test, Trail Making Test and General Self-Efficacy Scale was used to assess the subjective memory complaint level, memory function, executive function and general self-efficacy level at three times (baseline, after intervention and follow up at 3 months). One-way repeated measures analysis of variance was used to compare the outcome variables of the two groups.

There were no significant differences between the Baduanjin exercise and the control group at baseline in demographic, SMCQ, MoCA, and GDS-15. Compared to participants in the control group, participants in the Baduanjin group had a significantly improvement in memory function ($F = 46.93, P < .00$), executive function ($F = 317.83, P < .00$) and general self-efficacy ($F = 38.72, P < .00$) at the end of 12-week intervention period and after 3 months follow-up period ($P < .01$). At the same time, participants in the Baduanjin group had a significantly greater decrease in subjective memory complaint scores at the end of 12-week intervention period and after 3 months follow-up period ($F = 24.53, P < 0.00$).

Baduanjin exercise appears to be a feasible and acceptable intervention to improve subjective memory complaint among older adults.

Abbreviations: $\eta^2$ = Partial Eta Squared, AD = Alzheimer disease, MCI = mild cognitive impairment, SMC = subjective memory complaints.

Keywords: a randomized controlled trial, Baduanjin exercise, cognitive decline, subjective memory complaints

1. Introduction
According to the World Health Organization, 47.5 million people worldwide have dementia with an annual incidence of 7.7 million new cases every year. This number is projected to increase to 75.6 million people by 2030 and to 135.5 million people by 2050. There were 178 million Chinese aged 60 years or older constituting 13.26% of the total population, dementia from Alzheimer disease, mild cognitive impairment (MCI) and Alzheimer’s disease. Population-based studies suggest that between 50%
and 80% of older individuals (aged 70 years and older) who perform within normal ranges on cognitive tests, report some form of perceived decline in cognitive functioning when asked.

The problem of subjective memory complaint is common in the elderly and has a risk of transformation to MCI and AD. Therefore, there is a need to develop an efficient and cost-effective therapeutic method for subjective memory complaints (SMC) in older adults.

Older adults with subjective memory complaints experience a decline in memory functioning, without evidence for objective cognitive impairments or an underlying neurodegenerative disease or psychological disorder. The absence of objective cognitive impairment distinguishes SMC from MCI. In principle, MCI was developed as a diagnostic entity, whereby the absence or presence of cognitive impairment is decided on the basis of clinical judgment. Cognitive test performance of the patient can support this diagnostic judgment. There is accumulating evidence that older individuals with SMC have an increased likelihood of biomarker abnormalities consistent with Alzheimer disease pathology and an increased risk for future pathologic cognitive decline and dementia. Although the experienced decline lies within the normal limits of cognitive ageing, it will have a negative impact on daily life and quality of life. Therefore, in the stage of subjective memory decline, when the performance of the elderly in the objective cognitive test has not decreased significantly, targeted intervention is an effective starting point to prevent and delay the occurrence of dementia.

Previous studies have shown that physical exercise is beneficial to improve the cognitive function of the elderly. Some studies have shown that the physical activity (especially aerobic exercise) was negatively correlated with risk of cognitive decline in older adults with or without cognitive impairment. The mechanism is still uncertain, but aerobic exercise may increase neurogenesis in the dentate gyrus of the hippocampus. Further, animal research suggests that exercise promotes the growth of new brain cells in the hippocampus and it is beneficial to the regeneration of neurons. Although diversified sports or the common aerobic exercise such as running, gymnastics has also been shown to improve mental health and cognitive function in older adults, because of their hard exercise and need to consume more energy, so it is likely to lead to poor adherence in the elderly.

Compared with TaiChi, Baduanjin exercise is easier to learn because it consists of only eight movements. Baduanjin exercise is one of the most common forms of Qigong that has been practiced in China more than 1000 years. Baduanjin belongs to a mind-body aerobic exercise. In the process of exercise, it pays attention to the unity of spirit, seeks both static and static in movement, attaches importance to the realization of entering stillness, and strengthens the connection between physiology and psychology through the regulation of mind to the brain. The effect is better than simple limb movement. According to Sun’s study Baduanjin exercise has shown promising results on movement reaction among elderly after three months of practice. Another study showed that Baduanjin exercise can significantly improve the overall cognitive function in patients with MCI. However, there is a lack of high-quality evidence for the effectiveness of Baduanjin exercise for patients with subjective memory complaint. Consequently, the purpose of this study was to verify the effect of Baduanjin exercise on cognitive function and mental health in the elderly with subjective memory complaint.

2. Methods

2.1. Design and setting

This study is a randomized controlled trial. The participants were recruited from the community and randomly allocated to either a Baduanjin training group or usual physical activity group at a 1:1 ratio using the Random Number Seed procedure of the statistical software SPSS22.0. The aim, procedures, and possible side effects of the exercise will be explained in detail to the patients; all patients will be asked to sign a written informed consent form before randomization. This study was approved by the ethics committee of Harbin medical university, which was completed in accordance with the Declaration of Helsinki.

2.2. Participants

All participants were aged between 60 and 75 years. The inclusive criteria: (1) SMCs were confirmed by an affirmative answer to both of the following questions: “Are you complaining about your memory;” and “Is it a regular complaint which lasts more than 6 months?.” (2) ≥60 years of age; (3) Willingness to participate in the study; (4) No movement disorder; (5) Have not practiced Baduanjin exercise before, and have not engaged in regular exercise in the past half a year (at least 2 times a week, at least 20 minutes each time). Criteria for exclusion are the following: (1) Patient’s condition was too severe to exercise, or activity was restrained by other diseases; (2) psychiatric disorders diagnosed according to the DSM-5 (e.g., depression, general anxiety disorder); (3) vascular risk factors; (4) participating in another clinical study.

A priori sample size calculation was based on a preliminary experiment in MoCA scores among participants undergoing the 12-week Baduanjin training compared to those in the control group. Through preliminary experiment of Baduanjin exercise intervention, the biggest test efficiency of Baduanjin intervention on cognitive function was 0.301 (Cohen’s effect size = 0.301), sample size of 58 participants was calculated to ensure the same effect size with 80% power by G*POWER version 3.1 program. Considering a 15% attrition rate, it is calculated that a total of 66 participants are needed in this study, 33 people are needed in the intervention group and the control group respectively. In the final sample of this study, there were 35 subjects in the Baduanjin group and 35 subjects in the control group, which met the basic needs of the subjects.

2.3. Intervention

2.3.1. Baduanjin exercise group.

The participants in the intervention group practiced one hour Baduanjin exercise every day, and five days a week, including 15 min warm up, 40 min Baduanjin training and 5 min cool down. Baduanjin exercise was guided by two qualified coaches who have been in the Baduanjin sport for at least five years. To ensure intervention fidelity, two coaches who provided the intervention underwent training provided by the investigators. The training scheme of Baduanjin exercise was in accordance with the Health Qigong—Baduanjin published by the General Administration of Sport of China, which is mainly divided into eight steps: two hands support Tianli Sanjiao, left and right bow like shooting sculpture, recuperating spleen and stomach should lift alone, five labor and seven injuries look back, shake head and tail to remove heart fire, two hands climb feet to take care of the kidney and waist, save fist to increase
In this study, SPSS22.0 was used for statistical analysis, a two-sided \( p \) value of less than 0.05 was considered significantly
different. In this study, t-test and chi-square test were used to compare the baseline demographic and clinical measures data between the two groups. One-way repeated measures analysis of variance (ANOVA) was used to analysis the outcomes between two groups at different time. The within-subject factor between time points was denoted by “Time,” and the between-subject factor, that is, Baduanjin exercise vs. control group was denoted by “Group.” A significant “Time × Group interaction” thus indicated a difference in response between the two groups. Partial Eta Squared ($\eta^2$) was used to assess effect size in ANOVA model.

3. Results

3.1. Adherence to the intervention

The remaining 80 eligible subjects were enrolled and randomly assigned to either the Baduanjin group (n=40) or the control group (n=40). Of the 40 participants, 38 (95%) completed the entire Baduanjin exercise intervention.1 participant dropped out at 4 weeks, and 1 at 8 weeks. Attrition was due to personal reasons unrelated to the study. Another 3 participants did not complete the follow-up assessment (Lost to follow-up). In the control group,1 discontinued prior to postintervention assessment and 4 were lost to follow-up. Eventually, data from 35 participants in the Baduanjin group and 35 participants in the control group were included in the final analyses (Fig. 1).

3.2. Clinical and demographic characteristics

Demographic characteristics and baseline results for both groups are showed in Table 2. The mean age of the Baduanjin exercise group was 64.4 ± 6.57 years; the mean age of the control group was 65.37 ± 6.31 years (mean ± standard). The majority of the two group participants were married, and had an secondary school level education and monthly income was mostly 1000~3000 rmb. There were no significant differences between the Baduanjin exercise and the control group at baseline in demographic, SMCQ, MoCA, and GDS-15.

3.3. Training effects on outcome measures

In order to investigate the intervention effect of Baduanjin, firstly, we took the measurement time (baseline, post-intervention, follow up 3 months) as the internal variables and the groups (Baduanjin group, control group) as the inter-test variables. Gender, age, marital status, education level and family annual income were used as covariates to do the repeated measures analysis of variance.

3.3.1. Memory complaints. The Baduanjin group had a significant reduction in SMCQ score at the end of 12-week intervention period (5.09 ± 1.82) ($t = 2.695, P = .009$) and after 3 months follow-up period (4.97 ± 1.62). However, the reduction of SMCQ score in control group is modest at the end of 12-week
Table 2
Baseline characteristics of subjects.

| Characteristics | Intervention (n = 32) | Control (n = 33) | t or χ² | P |
|-----------------|----------------------|-----------------|---------|---|
| Age (Mean±SD)   | 64.40±6.57           | 65.37±6.31      | -0.631  | .530 |
| Gender n (%)    |                      |                 | 0.514   | .473 |
| Men             | 16 (45.71)           | 18 (51.43)      |         |    |
| Women           | 19 (54.29)           | 17 (48.57)      |         |    |
| Education n (%) |                      |                 | 0.683   | .877 |
| Primary education or lower | 6 (17.14) | 8 (22.86) |         |    |
| Secondary school | 16 (45.71)      | 15 (42.86)      |         |    |
| High school     | 10 (28.57)           | 8 (22.86)       |         |    |
| University      | 3 (8.6)              | 4 (11.4)        |         |    |
| Marital status n (%) |             |                 | 1.120   | .290 |
| Married (remarried) | 27 (77.14)   | 23 (63.64)      |         |    |
| Single (never married, widowed or divorced) | 8 (22.86) | 12 (34.29) |         |    |
| Household monthly income n (%) |             |                 | 0.521   | .771 |
| Low (<1000rmb)  | 7 (2)                | 8 (22.86)       |         |    |
| Middle (1000~3000rmb) | 18 (51.43) | 15 (42.86) |         |    |
| High (>3000rmb) | 10 (28.57)           | 12 (34.29)      |         |    |
| SMQO            | 6.37±2.16            | 6.54±2.42       | -0.313  | .755 |
| MOCA (Mean±SD)  | 28.97±1.15           | 27.23±1.14      | -0.940  | .351 |
| GDS-15 (Mean±SD)| 2.69±1.02            | 2.83±0.98       | -0.595  | .554 |

GDS-15 = geriatric depression scale-15, MOCA = montreal cognitive assessment, SMQO = subjective memory complaint questionnaire.

intervention period (6.29±1.86) (t=0.384, P=.702) and after 12-week follow-up period (6.34±2.10). Table 3 shows the results of the within-group effects and between-group over time from baseline to the 3 months for each group using repeated measures ANOVA. A significant effect of “Group” (F=4.032, P=.049) and “Time” (F=24.528, P=.000) was detected in the SMQO scores, the results also revealed a significant time-by-group interaction on the SMQO scores (F=37.09, P<.01, η²=0.17). And the total decreased SMQO score of the two groups at the three time intervals are shown in Figure 2.

3.3.2. Verbal learning and memory. Both groups had comparable AVLT score at baseline (33.46±5.80 vs 33.89±4.56, P=.732). After 12-week intervention, the AVLT score in the intervention group increased from 33.46±5.80 to 40.83±5.39 (t=12.25, P=.000) while the SMQO control group score control less increased from 33.89±4.56 to 36.26±5.53 (t=-1.858, P=.064). A significant “Time × Group interaction” effect was found in the AVLT total score (F=7.36, P=.008, η²=.098), as shown in Table 3. There was only a time effect on the subscale of immediate recall (F=10.36, P=.000, η²=.132) and no group effect (F=2.32, P=.132, η²=.003) and time-by-group interaction (F=2.639, P=.083, η²=.037); there was a significant time and a time-by-group interaction of the subscale of short-term delayed recall and long-term delayed recognition. Learning and memory ability can be improved by Baduanjin exercise, and total AVLT score between 2 groups at three time points are shown in Figure 2.

3.3.3. Executive function. The results indicated that the outcomes on executive function abilities were not different between groups at baseline (t=-.263, P=.794). The intervention group had a significant reduction in TMT total score at the end of 12-week intervention period, the TMT score in the intervention group decreased from 154.97±26.7 to 134.54±25.7 (t=3.261, P=.002), while the TMT score control group decreased from 153.37±24.2 to 152.54±24.7 (t=1.142, P=.888). For repeated measures ANOVA, there was a time effect on the subscale of TMT A (F=249.39, P=.000, η²=.78) and TMTB (F=317.83, P=.00, η²=.824); no group effect on TMTA (F=2.84, P=0.097, η²=0.04) and TMTB (F=2.163, P=0.146, η²=0.003); the subscale of TMTA (F=112.68, P=0.000, η²=0.62), and TMTB ((F=327.486, P=0.000, η²=0.828) showed significant time-by-group interaction. The participants in both groups showed an increase in the TMT total score, and there was a significant time-by-group interaction of the TMT total score (F=408.37, P=0.000, η²=0.86), as shown in Table 3. Baduanjin exercise can significantly improve the executive ability of SMC, and the total TMT score between two groups at three time points are shown in Figure 2.

3.3.4. General self-efficacy. There were no significant differences in the GSES score between the 2 groups at baseline (t=-2.862, P=.412). After intervention, the total score of GSES in the Baduanjin group (3.03±0.75) was significantly higher than that in the control group (2.60±0.78) (P<.05), the effect was maintained after 12-week follow-up period (t=10.50, P=.002), it shows that Baduanjin exercise has an influence on the general self-efficacy of the subjects. For repeated measures ANOVA, a significant effect of “Time” was detected in the GSES score (F=38.72, P<.001, F=0.148), and a significant effect of “Time × Group interaction” effect was found in the GSES score (F=12.72, P=.000, η²=.16), as shown in Table 3 and Figure 2.

4. Discussion
Baduanjin is a traditional Chinese health preservation movement. Through the soothing and stretching of the limbs and dredging the meridians and collaterals, Qi and blood can enter the Zang-fu organs through the meridians and collaterals, Qi and blood can enter the Zang-fu organs, so as to achieve the effect of regulating and improving Zang-fu organs, Qi and blood, Yin and Yang.[32] It has been considered as a popular community exercise to promote health in China.[33] Our study is the first randomized controlled trial to examine the effect of Baduanjin exercise on subjective memory complaints in China. Compared with the control group, the intervention group showed a significant improvement in memory, executive function abilities and general...
self-efficacy after 12-week Baduanjin exercise. Furthermore, most of those significant effects were sustained in the additional 12-week follow-up. More and more studies have shown that exercise helps to improve the cognitive function of the elderly with or without cognitive impairment. Based on the results of this study, we found that 12 weeks of a Baduanjin training was sufficient to improve subjective memory/objective memory functioning, which is consistent with a previous study. Baduanjin exercise is a traditional Chinese fitness sport, simple and easy to learn, widely circulated in the folk. It consists of 8 steps. Practicing Baduanjin requires body-mind coordination by combining body posture, movement and breathing with meditation. We believe that long-term regular exercise may increase neurogenesis in the dentate gyrus of the Hippocampus and supports proliferation and division of neuronal precursor cells in the dentate gyrus (expansion phase).

Regarding the effects of the intervention on executive functioning we found that the Baduanjin group, showed significant improvements, previous studies have shown that regular physical exercise can significantly improve executive function and processing speed. Baduanjin exercises the nervous system with internal motion, static movement and the combination of the two. Static movement refers to the self-static state under the control of the self-thinking dimension information machine system, to ensure the brain cells in the self-brain into a static state. In order to ensure the smart action of the information machine system, to ensure the brain cells in the self-conscious nerve function, mainly by brain training, which is regulation of the nervous system, especially the information and neurogenesis in the dentate gyrus (expansion phase).

Table 3
Comparisons between the groups on outcome measures (Mean ± SD).

|                      | Baduanjin (n = 30) (Mean ± SD) | Control (n = 29) (Mean ± SD) | F    | P     | n2   |
|----------------------|-------------------------------|-------------------------------|------|-------|------|
| Primary outcome      |                               |                               |      |       |      |
| SMCQ                | 6.37 ± 2.16 5.09 ± 1.82 4.97 ± 1.62 | 6.54 ± 2.41 6.29 ± 1.86 6.34 ± 2.10 | 24.528 | .00 | 0.27 |
| Time effect          |                               |                               |      |       |      |
| Time × group effect  |                               |                               |      |       |      |
| Group effect         |                               |                               |      |       |      |
| AVLT                | 33.46 ± 5.80 40.83 ± 5.39 40.91 ± 5.16 | 33.89 ± 4.56 36.26 ± 5.53 35.49 ± 5.24 | 46.926 | .00 | 0.408 |
| Total score          | 7.31 ± 2.10 8.79 ± 2.06 8.63 ± 1.90 | 7.46 ± 1.99 7.77 ± 2.79 7.69 ± 2.54 | 10.364 | .00 | 0.132 |
| Time effect          | 7.49 ± 2.00 9.43 ± 2.10 9.74 ± 1.93 | 7.80 ± 1.84 8.46 ± 1.80 8.66 ± 1.83 | 147.86 | .00 | 0.685 |
| Time × group effect  | 10.37 ± 1.83 11.74 ± 1.85 11.60 ± 1.65 | 10.43 ± 2.00 10.71 ± 1.96 10.49 ± 1.99 | 8.31 | .00 | 0.125 |
| Group effect         | 2.85 ± 0.96 |                           | 536.61 | .00 | 0.888 |
| TMT                  | 154.97 ± 26.70 134.54 ± 25.71 130.31 ± 25.61 | 153.37 ± 24.22 152.54 ± 24.71 151.37 ± 24.01 | 408.37 | .00 | 0.857 |
| Time effect          | 50.86 ± 13.63 43.49 ± 12.56 41.57 ± 11.84 | 51.46 ± 13.21 50.20 ± 12.64 49.54 ± 12.32 | 4.333 | .04 | 0.600 |
| Time × group effect  | 104.11 ± 22.29 91.06 ± 21.51 88.74 ± 21.68 | 101.91 ± 20.37 102.34 ± 20.42 101.83 ± 20.13 | 249.39 | .00 | 0.78 |
| Group effect         | 2.84 |                           | 112.68 | .00 | 0.62  |
| GSES                 | 2.29 ± 0.86 3.03 ± 0.75 3.20 ± 0.58 | 2.43 ± 0.88 2.60 ± 0.78 2.71 ± 0.67 | 317.83 | .00 | 0.824 |
| Time effect          | 38.72 |                           | 12.72 | .00 | 0.158 |
| Time × group effect  | 2.609 |                           | 2.060 | .11 | 0.037 |

AVLT = auditory verbal learning test, GDS-15 = geriatric depression scale-15, GSES = the general self-efficacy scale, SMCQ = subjective memory complaint questionnaire, TMT = trail making test.
give elderly achievement of persistent feeling. Moreover, Netz’s meta-analysis provided supporting evidence that the elderly like to practice physical activity and apply physical activity to daily life. This supporting evidence may yield positive mental health effects, which promotes the self-efficacy level of SMC elderly.

The results of this study show that regular Baduanjin exercise is beneficial to improve the cognitive function of the SMC elderly. Baduanjin exercise can be described as a combination of Confucianism, Buddhism, Taoism and traditional Chinese medicine. So Chinese elderly more easily accept this intervention methods, which enhance compliance. The participants reported that the time went faster during the Baduanjin sessions, and after the intervention, they will continue to practice the Baduanjin exercise.

5. Conclusion

In summary, this study found that 12-week Baduanjin exercise could improve the memory function and general self-efficacy of the older adults with SMC. We recommend the application of this free, simple, and safe technique to elderly with SMCQ as an intervention to help deal with their memory deficits.

5.1. Clinical implication and future direction

Subjective memory complaint is highly prevalent in the elderly, and the decline of cognitive function will have a negative effect on the daily life of the elderly. Our results have demonstrated that Baduanjin exercise is a feasible and effective intervention program for improving subjective memory complaint in community-dwelling older adults. Application of this simple, traditional Baduanjin exercise is recommended for SMC elderly to manage their subjective memory decline and improve their quality of life. A Baduanjin exercise program for community SMC elderly should consist of a well-developed Baduanjin exercise program with guidance and instructions from a Baduanjin exercise demonstration video, an educational brochure, and regular follow-up.

There are several limitations in the present study. First, 12 weeks of exercise is a relatively short duration. Therefore, the long-term effects of Baduanjin need to be studied further. In
addition, the effectiveness of Baduanjin intervention in non-Chinese population needs to be further studied. This intervention should be tested within a larger, more general population. Third, our study did not compare Baduanjin exercise to other forms of exercise. Therefore, it is still unclear whether Baduanjin exercise is more effective than other forms of exercise.

**Author contributions**

Hong Su and Lina Meng: formal analysis. Hong Su, and Haina

**References**

[1] World Health Organization. Dementia. Fact Sheets 2016; Available at: http://www.who.int/mediacentre/factsheets/fs362/en/. Accessed July 3, 2017.

[2] Yin SF, Li T, Zhu XY. Subjective memory loss of episodic memory in the elderly behavior and brain mechanisms. Psycho sci progress 2019;27: 51–9.

[3] Sperling RA, Aisen PS, Beckett LA, 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. Alzheimers Dement 2011;7:280–92.

[4] van Harten AC, Mielke MM, Swenson-Dravis DM, et al. Subjective cognitive decline and risk of MCI. Neurology 2018;91:e300–12.

[5] Ardila A, Ostrosky SF, Rosselli M, omez C. Age-related cognitive decline during normal aging: the complex effect of education. Arch Neuropsychol 2000;15:495–513.

[6] Luck T, Luppia M, Matschinger H, et al. Incident subjective memory complaints and the risk of subsequent dementia. Acta Psychiatr Scand 2015;131:290–6.

[7] Jungwirth S, Fischer P, Weissgram S, et al. Subjective memory complaints and objective memory impairment in the Vienna-Transdanube aging community. J Am Geriatr Soc 2004;52:263–8.

[8] Petersen RC. Mild cognitive impairment as a diagnostic entity. J Interm Med 2004;256:183–94.

[9] Jessen F. Subjective and objective cognitive decline at the pre-dementia stage of Alzheimer’s disease. Eur Arch Psychiatry Clin Neurosci 2014;264(Suppl. 1):S3–7.

[10] Montejo P, Montenegro M, Fernandez MA, et al. Subjective memory complaints in the elderly: prevalence and influence of temporal orientation, depression and quality of life in a population-based study in the city of Madrid. Aging Ment Health 2011;15:85–96.

[11] Ahlskog JE, Geda YE, Graff-Radford NR, et al. Physical exercise as a preventive or disease-modifying treatment of dementia and brain aging. Mayo Clin Proc 2011;86:876–84.

[12] Baker LD, Frank LL, Foster-Schubert K, et al. Effects of aerobic exercise on mild cognitive impairment: a control trial. Arch Neurol 2010;67: 71–9.

[13] Clark PJ, Brzezinska WJ, Thomas MW, et al. Intact neurogenesis is more effective than other forms of exercise. Therefore, it is still unclear whether Baduanjin exercise is more effective than other forms of exercise.

[14] Koh TC. Baduanjin – an ancient Chinese exercise. Am J Chin Med 1982;10:14–21.

[15] Chang YK, Nien YH, Tsai CL, et al. Physical activity and cognition in older adults: the potential of Tai Chi Chuan. J Aging Phys Act 2010;18:451–72.

[16] Sun G. Health qigong Baduanjin for male elderly intelligence physiological and the influence of some physiological indexes[Di]. Beijing: Beijing sports university; 2004.

[17] Liu T, Bai S, Huang R. Exericise intervention in patients with mild cognitive impairment cognitive level and the influence of related parameters of cerebrospinal fluid. Shaxiu medical med 2015;44:1388–90.

[18] Health Qigong Management Center of General Administration of Sport of China; Health qigong—Baduanjin. Beijing: Peop Sport Pub Chin; 2003.

[19] Nasreddine ZS, Phillips NA, Bedirian V, et al. The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. J Am Geriat Soc 2005;53:695–9.

[20] Gong-wei , Qi S, Ying Y, et al. A preliminary study of application of montréal cognitive assessment in Chongqing city. Neural Injury Funt Reconstruction 2008;3:41–2.

[21] Youn JC, Youn JC, Lee DY, et al. Development of the Subjective Memory Complaints Questionnaire. Dement Geriatr Cogn Disord 2009; 27:6–17.

[22] Meng LD, Feng X, Liu K. Subjective memory impairment scale in evaluation of reliability and validity of the community elderly. Chinese modern medicine J 2017;27:120–4.

[23] Guo QH, Sun YM, Pei-Min YU, et al. Norm of auditory verbal learning test in the normal aged in china community. Chinese Clinical Psych J 2007;15:132–4.

[24] Xie DD, Cheng HD, Yin CL, et al. Neuropsychological study of false memory in patients with amnesia mild cognitive impairment. Zhonghua Yi Xue Za Zhi 2011;91:155–9.

[25] Guo QH, Lv CZ, Hong Z. Auditory words memory test trial analysis of the elderly in China. Chin J Men health 2001;15:13–5.

[26] Arbuthnott K, Frank J. Trail making test, part B as a measure of executive control: validation using a set-switching paradigm. J Clin Exp Neuro- psyholog 2000;22:518–28.

[27] Sheikh JL, Yesavage YA. Brink TL. Geriatric DepressionScale (GDS): recent evidence and development of a shorter version. Clinical gerontology: A guide to assessment and intervention, New York, NY: Hawthor Press; 1986;165–73.

[28] Tang D. Jane's version of the geriatric depression scale (GDS-15) the use of the elderly in China. Chinese clinical psycho J 2013;21:402–5.

[29] Schwarzer R, Babler J, Kwiecik P, et al. The assessment of optimistic self-beliefs: Comparison of the german, Spanish, and Chinese version of the general self-efficacy scale. Applied Psycho 1997;46:69–88.

[30] Zhang ZJ. Behavioral medicine inventory manual. Chin J Beha Medi science 2001;10:185–8.

[31] Wang CK, Zhu ZF, Liu Y. General self-efficacy scale reliability and validity of the research. Applied Psycho 2001;7:37–40.

[32] Zhou XQ, Zeng YQ, Yang BL, Wang AL. Effects of health Qigong and Baduanjin on the middle and old aged people’s blood lipid. J Beijing Sport Univ 2007;30:795–7.

[33] Lin Q. Baduanjin and Chinese Medical Health Preservation. J Fujian Univ Tradit Chin Med 2010;20:55–6.

[34] Hillman CH, Erickson KI, Kramer AF. Be smart, exercise your heart: exercise effects on brain and cognition. Nat Rev Neurosci 2008;9: 58–65.

[35] Smith PJ, Blumenthal JA, Hoffman BM, et al. Aerobic exercise and neurocognitive performance: a meta-analytic review of randomized controlled trials. Psychosom Med 2010;72:239–52.

[36] Wang ST. Effect of Baduanjin on physiological age of intelligence for old people. Neural Regeneration Research 2007;11:7910–3.

[37] Guo QH, Li X. The influence of education and different exercise forms on the subjective memory complaints and the risk of subsequent dementia. Acta Psychiatr Scand 2015;131:290–6.

[38] Navarro-Delgado F, Mancera-Aguado C, et al. The influence of exercise on subjective memory complaints and objective memory impairment in the Vienna-Transdanube aging community. J Am Geriatr Soc 2004;52:263–8.

[39] Petersen RC. Mild cognitive impairment as a diagnostic entity. J Interm Med 2004;256:183–94.

[40] Jessen F. Subjective and objective cognitive decline at the pre-dementia stage of Alzheimer’s disease. Eur Arch Psychiatry Clin Neurosci 2014;264(Suppl. 1):S3–7.

[41] Montepol M, Montenegro M, Fernandez MA, et al. Subjective memory complaints in the elderly: prevalence and influence of temporal orientation, depression and quality of life in a population-based study in the city of Madrid. Aging Ment Health 2011;15:85–96.

[42] Ahlskog JE, Geda YE, Graff-Radford NR, et al. Physical exercise as a preventative or disease-modifying treatment of dementia and brain aging. Mayo Clin Proc 2011;86:876–84.

[43] Fabel K, Wolf SA, Ehninger D, Babu H, Leal-Galicia P, Kempermann G. Additive effects of physical exercise and environmental enrichment on adult hippocampal neurogenesis in mice. Front Neurosci 2009;3:50.

[44] Kronenberg G, Reuter K, Steiner B, et al. Subpopulations of proliferating cells of the adult hippocampus respond differently to physiologic neurogenic stimuli. J Comp Neurol 2003;467:453–63.

[45] Sun XN, Wang S, Xia YN, et al. Predictive-trend-aware composition of web services with time-varying quality-of-service. IEEE Access 2020; 8:1910–21.

[46] Feng FK. Effects of Baduanjin on mental health: a comprehensive review. J Bodyw Mov Ther 2015;19:138–49.

[47] Wu YM, Lin KL, Chen RF. Research the intervention with Baduanjin exercise and healthy education to the 175 plasma glucose of diabetes mellitus sub-healthy state. Chin Primary Health Care 2008;22:80–2.

[48] White SM, Wójcicki TR, McAuley E. Physical activity and quality of life in community dwelling older adults. Health Qual Life Outcomes 2009;7:10.

[49] Fox KR. The influence of physical activity on mental well-being. Public Health Nutrition 1999;2:411–8.

[50] Naas rz, Wu MJ, Becan-BJ, Tenenbaum G. Physical activity and psychological well -being in advanced age: a meta -analysis of intervention studies. Psychol Aging 2005;20:272–84.