

Effects of a 4-movement Qigong exercise on cognitive function and physical performance in elderly women

SUPHANNIKA LADAWAN¹, SUDARAT SUNKAMANEE², SINTHUPORN MAHARAN³,
PATCHAREEYA AMPUT⁴, ARUNRAT SRITHAWONG⁵, MARTIN BURTSCHER⁶

^{1,2,3,4,5}Department of Physical Therapy, School of Allied Health Sciences, University of Phayao, Phayao,
THAILAND

⁶Department of Sport Science, Medical Section, Faculty of Psychology and Sport Science, University of
Innsbruck, Innsbruck, AUSTRIA

Published online: February 28, 2022

(Accepted for publication February 15, 2022)

DOI:10.7752/jpes.2022.02062

Abstract:

Four-movement Qigong is a new and easy-to-perform type of exercise which is becoming increasingly popular among elderly individuals. Although beneficial health effects might be expected, data on such effects of this type of exercise, derived from controlled studies, are lacking. Therefore, the purpose of the present study was to assess effects of 4-movement Qigong on cognitive function and physical performance. A total of 26 healthy older female participants (60 to 76 years) were randomly assigned to the Qigong or the control group. Participants of the Qigong group were asked to perform 4-movement Qigong 3 days per week for 8 weeks while those of the control group maintained their usual activities of daily living throughout the study period. Cognitive function ((Trail Making Tests part A (TMT-A), Trail Making Tests part B (TMT-B), Digit Span Forward (DSF), and Digit Span Backward (DSB)), and physical performance, assessed by the 6-min walk test (6MWT), were determined at baseline and after the end of the 8-week exercise program. Eight weeks of 4-movement Qigong training resulted in a significant improvement of TMT-A, TMT-B and 6MWT distance compared to controls ($P=0.035$, 0.040 , and 0.029 , respectively). In addition, the deltas of TMT-B and 6MWT results were significantly correlated ($P=0.029$, $r=-0.537$). In conclusion, 8 weeks of 4-movement Qigong exercise has the potential to improve both cognitive function (in particular the executive domain) and physical performance in elderly females. As this is the first study evaluating effects of 4-movement Qigong, further large scaled studies are needed to confirm beneficial effects of 4-movement Qigong.

Key Words: Physical activity; Health; Sex; Aging; Intervention

Introduction

Cognitive function is defined as a variety of mental processes including perception, attention, memory, decision making, and language comprehension (Nouchi & Kawashima, 2014). It plays an important role in both basic and instrumental activities of daily living (ADL) such as grooming, feeding, taking medication, and using the telephone. Changes in structure and function of the aging brain such as loss of synapses and structural alterations in neurons lead to a decline in cognitive performance, which affects both physical and mental health, finally contributing to a decrease in quality of life in the elderly (Murman, 2015; Shen et al., 2021).

Previous studies have demonstrated that several types of physical activities and exercises such as aerobic, resistance and mind-body exercise elicit beneficial effects on cognitive function. For instance, brisk walking, performed 5 days per week for 12 weeks, improved cognitive function, particularly in executive function and attention speed (Roig-Coll et al., 2020). Resistance exercises were also shown to effectively improve processing speed and executive function in older adults with cognitive frailty (Yoon et al. 2018). Moreover, 12 weeks of active video game-based physical activity resulted in cognitive benefits of executive function and memory in older adults (Guimaraes, 2018). Tai Chi Chuan and Baduanjin were also shown to prevent memory decline with aging (Trapero & Cauli, 2016).

Qigong is a mind-body exercise defined as meditative movement (MM) including movement with focus on breathing and a meditative state of mind and relaxation (Larkey et al., 2009; Payne & Crane-Godreau, 2013). Practicing Qigong has been shown to prevent the progression of cognitive decline, to improve cognitive function (Jin et al., 2020), to increase back and leg strength, to reduce oxidative stress, to increase total antioxidant capacity (Klarod et al., 2020), to improve lung function, but also quality of life and exercise capacity (Tong et al., 2019). Moreover, Qigong training resulted in increased hippocampal gray matter volume and reduced peripheral interleukin-6 (IL-6) levels in older people (Qi et al., 2021). Conversely, elevated IL-6 levels might be associated with pathogenesis of cognitive dysfunction (Trapero et al., 2014).

Qigong 18-movements or Taiji Qigong also known as Shibashi Qigong, covers a set of 18 individual Qigong exercises (Robinson, 2017). It represents one of the most popular forms of Qigong practiced today. A

previous study demonstrated that Qigong 18-movements improved attention, and brain processing speed domain of cognition (Ladawan., 2017). Although this Qigong style is not very challenging, for many elderly people it is not easy to follow all steps of the movements.

Nowadays, a new Qigong practice has been introduced, encompassing only 4 out of 18 movements, including lift hands, opening the chest, flying wild goose, and balancing the Chi (Detkong, 2004). This mode of Qigong is easier to practice, suitable for all ages, and in particular for the elderly. Although this type of exercise is becoming increasingly popular, to the best of our knowledge, no studies have evaluated the effects of 4-movement Qigong in older individuals. Therefore, the present study was aimed at investigating the effects of 4-movement Qigong on cognitive function and physical performance in females aged 60 years or older. We hypothesized that cognitive function and physical performance would improve to a similar extent as known from 18-movement Qigong.

Material & methods

Participants

Sedentary but healthy females aged over 59 years were eligible to participate in this study. The sample size needed ($n=12$) was calculated based on our previous study (Ladawan et al., 2017); the alpha level and statistical power were set to 0.05 and 0.80, respectively. As a drop-out rate of about 5% was expected, 13 participants per group were recruited. A total of 26 healthy female between 60 and 76 years were randomly assigned to the Qigong group and the control group. Exclusion criteria were any medical condition including cardiovascular diseases, respiratory diseases, orthopedic problems, neurological disorders, acute or chronic infections, which would not be compatible with performing Qigong exercise safely. All participants did not engage in any regular exercise and did not take part in physical training at an athletic level for at least three months before enrolling in the study. Before signing the consent form, each subject has been informed verbally and in written form on the experimental protocol and possible risks involved. The present study was approved by the Ethical Committee of the University of Phayao, reference number 2/067/61 and Thai Clinical Trials Registry (TCTR20210701003).

Qigong exercise

Participants in the Qigong group were required to attend outdoor group exercise of 4-movement Qigong three days a week for eight weeks, while the control group was asked to maintain their usual activities of daily living throughout the study period (Fig. 1). The exercise program started with a 10-min general stretching as a warm up, followed by two 15-min parts of Qigong exercise, interspersed by a 2-min rest interval. Then, participants were asked to cool down by stretching for 10 minutes.

The following four Qigong movements which were adapted from 18-movements Taiji Qigong by Detkong (Detkong, 2004), Robinson (Robinson, 2017), and Ladawan et al (Ladawan et al., 2017), were performed:

Movement 1: Lift hands

Movement 2: Opening the chest

Movement 3: Flying wild goose

Movement 4: Balancing the Chi

To avoid overloading of the knee joints, participants were asked to move the upper body with knees slightly bent during movement 1 and 3, while during movement 2 and 4 they performed Qigong stand naturally upright.

Outcome measurements

Cognitive Function

Cognitive function included executive function and memory domains, evaluated before the first Qigong session, and after the end of the 8-week training period.

Executive function was assessed by the Trail Making Test (Shibuya-Tayoshi et al., 2007), which consists of two parts, Trail Making Test, part A (TMT-A) and part B (TMT-B). TMT-A requires participants to connect numbers from 1 to 25 that are distributed on a paper sheet. The TMT-B is similar to the TMT-A except participants connect alternately between numbers and letters. Participants were asked to complete the tests as quickly and accurately as possible. The score on each part is the total time to complete the task (Tombaugh, 2004)

Memory function was evaluated by the Digit Span Test, consisting of two subsections, the Digit Span Forward test (DSF) and Digit Span Backward test (DSB). The DSF, measuring short-term memory, requires participants to memorize and repeat the numbers in the same order as they were shown on a computer screen. The DSB, measuring working memory, participants have to repeat the numbers in reverse order. The score of each test is the number of correctly repeated sequences until participants cannot reproduce two sequences of equal length (Nouchi et al., 2012).

Physical Performance

Physical performance was assessed by the 6-min walk test (6MWT), where participants have to walk as far as possible in 6 minutes at their normal walking pace. On the signal “go” participant had to walk around the

outdoor course with a 50-yard rectangular area (20 yards by 5 yards) (Rikli R & Jones CJ, 2013). The score of the test was based on the total distance walked (Bean et al., 2002). 6MWT were assessed before, and after the end of the 8-week intervention.

Statistical Analysis

Shapiro-Wilk test was used to assess the normality of each parameter. The differences within groups were compared using paired t-tests for parametric or Wilcoxon tests for non-parametric data. Differences between groups were evaluated by the use of unpaired t-tests for parametric or Mann-Whitney U tests for non-parametric data. The Pearson correlation coefficient was used to evaluate associations between outcome variables. Data are presented as means $\pm$ standard deviation (SD). A *P*-value of ≤ 0.05 was considered statistically significant. Data analyses were conducted with SPSS version 17.

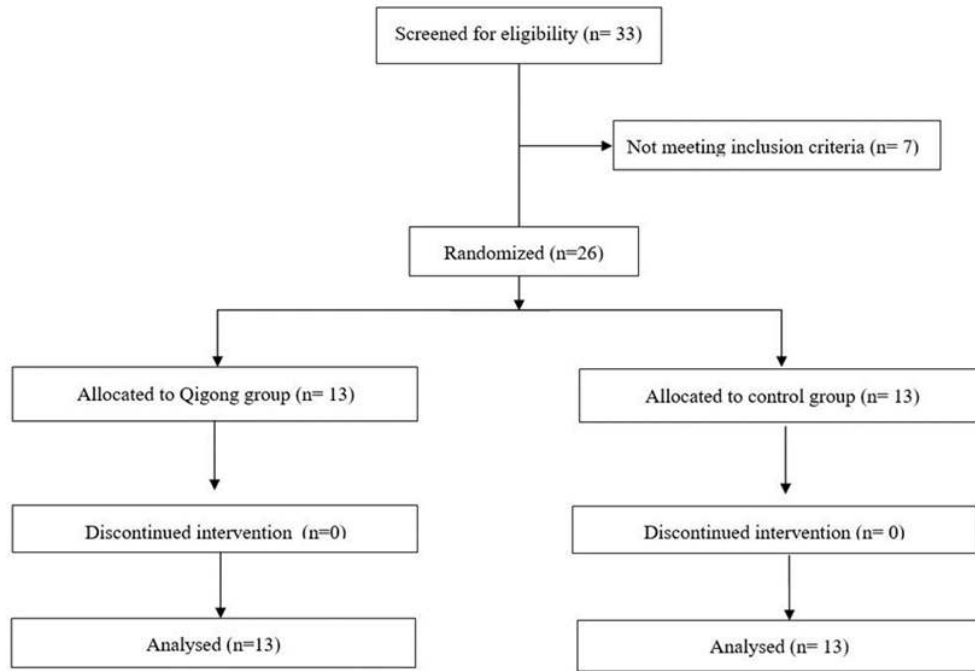


Fig. 1 Flow chart of study progress

Results

4-movement Qigong exercises have been well tolerated by all patients without any adverse effects reported. Baseline characteristics of both groups are shown in Table 1. Except age, characteristics were not significantly different between groups.

Table 1. Baseline characteristics of both groups

Characteristics	Qigong (n=13)	Control (n=13)
Age (yrs)	62.46 $\pm$ 2.56	69.46 $\pm$ 5.08*
Height (cm)	152.70 $\pm$ 4.55	149.08 $\pm$ 5.95
Body mass (kg)	52.35 $\pm$ 5.03	51.32 $\pm$ 9.28
BMI (kg/m ²)	22.51 $\pm$ 2.61	22.99 $\pm$ 3.35
Systolic blood pressure (mmHg)	120.27 $\pm$ 13.04	124.00 $\pm$ 19.02
Diastolic blood pressure (mmHg)	73.08 $\pm$ 8.88	69.00 $\pm$ 8.74
Mean arterial pressure (mmHg)	88.78 $\pm$ 9.10	86.14 $\pm$ 8.19

Values are mean $\pm$ SD.

BMI= Body mass index

*Significant difference between groups

Cognitive Function

After eight weeks of 4-movement Qigong training, TMT-A and TMT-B were significantly improved from baseline (*P*=0.005 and 0.046) while DSF tended to improve but failed to reach statistical significance (*P*=0.053). In contrast, participants of the control group showed a significant increase (impairment) in time to

complete TMT-B compared to the baseline ($P=0.038$) (Table 2). Importantly, TMT-A, TMT-B, DSF, and DSB were all significantly improved in the Qigong group compared to the control group ($P= 0.035, 0.040, 0.007$ and 0.024).

Table 2. Cognitive function

Variables	Qigong (n=13)		Control (n=13)	
	Pre	Post	Pre	Post
DSF (score)	5.85±3.11	7.46±1.76 [†]	4.92±1.71	5.62±1.76
DSB (score)	3.77±2.31	4.15±1.34 [†]	3.15±1.52	3.15±1.06
TMT-A (sec)	83.52±39.99	62.89±32.47* [†]	90.13±43.69	115.67±91.57
TMT-B (sec)	183.86±84.26	158.03±112.25* [†]	180.79±84.56	266.48±179.35*

Values are mean± SD.

*Significant difference from baseline

[†]Significant difference between groups

DSF = Digit Span Forward test, DFB = Digit Span Backward test, TMT-A = Trail Making Tests, part A, TMT-B = Trail Making Tests, part B

Physical Performance

At the end of the 8-week intervention period, Qigong participants also showed significant pre-to-post-training improvements in the 6MWT ($P=0.036$), while the control group did not. Differences were also significant between groups ($P=0.029$) (Table 3). Significant correlation was observed between the improvement in the 6MWT distance and the improvement in TMT-B (Fig. 2).

Table 3 Physical performance

Variables	Qigong (n=13)		Control (n=13)	
	Pre	Post	Pre	Post
6MWT (m)	252.88±37.87	264.71±46.44* [†]	228.47±38.85	228.89±45.20

Values are mean± SD.

6MWT = 6-minute walk test

*Significant difference from baseline

[†]Significant difference between groups

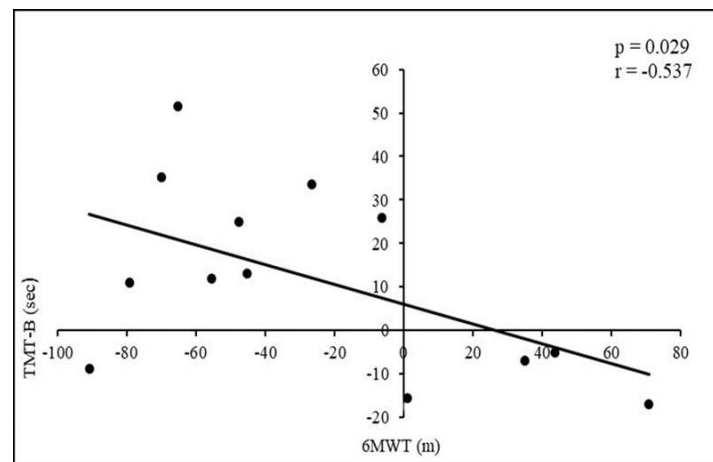


Fig. 2 Correlation between the improvement in the 6-min walking test (6MWT) distance and the improvement in the Trail Making Test, part B (TMT-B)

Discussion

The present study set out to evaluate the effects of an 8-week 4-movement Qigong exercise program on cognitive function and physical performance in elderly women. The findings confirm the hypothesis that 4-movement Qigong exercise is similar effective as known from 18-movement Qigong (Klarod et al., 2021; Ladawan et al., 2017).

Both cognitive function and the 6MWT were significantly improved after 4-movement Qigong compared to the control group. To the best of our knowledge, this is the first study investigating the effects of the 4-movement Qigong on cognitive function and physical performance in the elderly.

Cognitive function

These findings are consistent with previous studies evaluating more complex movement exercise programs. For instance, Ladawan et al. reported significantly improved TMT-A after 8 weeks of 18-movement Qigong training (Ladawan et al., 2017), and Sungkarat et al. found that 6 months of 10-form Tai Chi training improved the mental switching component of executive function which was evaluated by TMT- B minus TMT-A in older adults with mild cognitive impairment (Sungkarat et al., 2018). Moreover, Siu demonstrated significantly improved global cognitive function measured by the Chinese version of mini-mental state examination (CMMSE) in participants who practiced 16 weeks of Yang Tai Chi which consists of 24 unique movements (Siu & Lee, 2018). Participants who practiced a 4-week combination exercise training (aerobic, strength, and stretching) showed significantly improved executive functions, episodic memory, and processing speed when compared to those of the waiting list control group (Nouchi et al., 2014).

Previous studies suggest the following potential mechanisms contributing to improved cognitive function, i.e., the elevation of brain-derived neurotrophic factor (BDNF) (Nouchi et al., 2014; Sungkarat et al., 2018), insulin-like growth factor (IGF-1) (Nouchi et al., 2014), and vascular endothelial growth factor (VEGF) level (Nouchi et al., 2014). All these factors play important roles in neurogenesis and angiogenesis, which may contribute to beneficial changes in brain structure, brain function, and brain connectivity (Nouchi et al., 2014). Additionally, a previous study also showed that aerobic exercise training increases hippocampus size. Those authors found a positive association between hippocampal volume and BDNF level (Erickson et al., 2011). Tao et al. reported significantly increased grey matter volume in the insula, medial temporal lobe, and putamen following a 12-week exercise program using Tai Chi Chuan and Baduanjin (Tao et al., 2017).

While some studies suggested that moderate to high intensity aerobic exercise improves BDNF (Azevedo et al., 2020; Jeon & Ha, 2017), others found that mind-body practice (e.g., Qigong and Tai Chi) increases BDNF concentrations (Lu et al., 2020; Sungkarat et al., 2018), and IGF-1 (Ryu et al., 2000). Qigong, which combines aerobic, isometric, isotonic muscle contractions with meditation and relaxation (Sakata et al., 2008), has been characterized as a low to moderate intensity exercise (Chao et al., 2002; Kjos & Etnier, 2006). Thus, beneficial effects of 4-movement Qigong may be related to all of the above-mentioned mechanisms. However, in order to precisely evaluate underlying effects of 4-movement Qigong, further, more specific studies are needed.

Interestingly, the control group also showed significantly improved TMT-B after 8 weeks. This finding is similar to that reported by Volders et al., who demonstrated that participants of both the intervention and the waiting list control groups significantly improved memory outcomes (Volders et al., 2021). One potentially explanatory mechanism may be related to a learning effect. The score improvement after training may also be caused by reduced anxiety, and increased familiarity with the testing environment (Hausknecht et al., 2007; Volders et al., 2021).

Although DSF and DSB did not significantly improve in the Qigong group, changes between groups were significant because the control group showed some impairment. In another study, DSB increased after an 8-week Qigong training but did not reach a significant difference between the groups (Klarod et al., 2021). Participants in the study by Klarod (Klarod et al., 2021) were young sedentary females who performed 18 movements of Qigong exercise, whereas the present study included sedentary females aged 60 years and older. Additionally, the study from Tao et al. showed that 12 weeks of Tai Chi Chuan based on Yang-style 24-form can improve comprehensive memory performance in elderly adults (Tao et al., 2016). As participants who practiced 4-movement Qigong exercise showed a better score of DSF and DSB than the control group, 4-movement Qigong could play a critical role in the prevention and delay of age-related cognitive decline in the elderly.

Physical performance

Another important finding from the present study confirms improved physical performance after 4-movement Qigong, indicated by the 6MWT results. The 6MWT is a useful test to evaluate functional capacity in patients suffering from various diseases, e.g., cardiovascular and pulmonary diseases. This test is designed to evaluate the global and integrated responses of pulmonary and cardiovascular systems, systemic circulation, peripheral circulation, blood, neuromuscular units, and muscle metabolism (Laboratories, 2002). Several studies demonstrated that mind-body exercise increased the ability to walk for longer distances. For instance, Kantatong and coworker reported significantly improved 6MWT results in patients suffering from chronic obstructive pulmonary disease after 12 weeks of Tai Chi Qigong training (Kantatong et al., 2020). Dziubek et al. reported such improvements after Tai Chi training in patients with end-stage renal disease (Dziubek et al., 2016). On the other hand, Yeh et al. did not find any significant difference in the change of the 6 MWT distance in elderly persons suffering from chronic heart failure who participated in the 12-week Tai Chi exercise program compared to the time-matched education group (Yeh et al., 2011). However, these authors found greater improvements in quality of life measured by Minnesota Living With Heart Failure Questionnaire (MLHFQ) for the Tai Chi group.

Qigong involves sequences of movements, controlled breathing, mental focus and relaxation. In addition to improve back and leg strength by Qigong (Klarod et al., 2020), Chan reported that practicing Tai chi

Qigong can also improve respiratory function and activity tolerance (Chan et al., 2011). Improved leg muscle strength and respiratory function may both contribute to the improved 6MWT results after Qigong training.

The negative correlation between the improvement in 6MWT distance and that of TMT-B is in accordance with findings of Baldasseroni et al., who reported a positive association between the 6MWT and the Mini Mental State Examination (MMSE) score in older patients suffering from chronic heart failure (Baldasseroni et al., 2010). Freudenberger et al. also demonstrated a positive association between cardiorespiratory fitness (evaluated by VO_{2max}) and the global and executive function (Freudenberger et al., 2016). The correlations between the 6MWT and cognition may indicate that the 6MWT is not only an effective tool to evaluate functional capacity but may also provide information on cognitive function as well.

One of the limitations of this study is the lacking knowledge on the intensity of 4-movement Qigong exercise, which would be important to determine physiological training responses. Moreover, the sample size of the present study may be considered low, but the results confirm significant improvements in cognitive function and physical performance. Another limitation may be related to the fact that all participants in this study were women. Previous literature mentions that sex could represent an important moderator of the relationship between physical activity and cognition (Barha & Liu-Ambrose, 2018). On the other hand, Jancke suggested that cognition is modulated by environment, culture, and practice, but sex is not much important in term of sexual dimorphism in cognition (Jancke, 2018).

Conclusions

4-movement Qigong exercise is a new type of Qigong practice derived from 18-movement Qigong. It is easier to practice, suitable for all ages, and in particular for the elderly. Practicing of 4-movement Qigong exercise for 8 weeks elicits similar effects as other forms of Qigong with regard to improvements of cognitive function, in particular the executive domain, and physical performance in elderly females. Furthermore, the correlation between 6MWT and TMT-B results suggests that the 6MWT may also provide some information on cognitive function. As this is the first study evaluating effects of 4-movement Qigong, further large scaled studies are needed to confirm beneficial effects of 4-movement Qigong

Conflicts of interest

The authors declare no conflict of interest.

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