

Tai chi improves cognitive and physical function in the elderly: a randomized controlled trial

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Abstract. [Purpose] To investigate the effect of Tai Chi on cognitive and physical function in the elderly. [Subjects and Methods] A randomized trial design was used. A total 150 subjects were enrolled and were divided into Tai Chi and control groups. Subjects in the Tai Chi group participated Tai Chi for 6 months, and subjects in the control group participated in other non-athletic activities. [Results] There were no differences between the groups in the one leg standing time with eyes open, left grip strength, or the Frontal Assessment Battery at bedside after 3 and 6 months of intervention. The Mini-Mental State Examination scores after 3 and 6 months were higher in the Tai Chi group than in the control group. The right grip strength after 3 months increased more in the Tai Chi group than in the control group. Both the 5-m high walking speed and 10-m normal walking speed were significantly lower after 3 and 6 months of Tai Chi practice. [Conclusion] These results suggest that regular Tai Chi practice may improve cognitive and physical function in the elderly.

Key words: Tai Chi, Mobility, Cognition

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INTRODUCTION

Dementia is closely associated with aging, and cognitive decline is common in the elderly. In 2010, the number of people diagnosed with dementia was 35 million, and the population is projected to increase to 115 million by 2050¹⁾. At present, 8.87% of people in China are older than 65 years of age, and the population is expected to rapidly increase to 22.6% by 2050. In China, 1–2% of dementia patients are 60–69 years old, 4–8% are 70–79 years old, and 15–20% are more than 85 years old. The population of elderly people with dementia in China is expected to total 20 million by 2025²⁾.

In recent years, interventions to reduce cognitive dysfunction have been investigated, including memory therapy³⁾, music therapy⁴⁾, and exercise therapy⁵⁾. In China, therapeutic exercise has been used as a community nursing intervention, but it is limited to simple exercises such as walking⁶⁾. Tai Chi is a traditional Chinese martial art and is widely practiced by Chinese people. Many studies have shown that Tai Chi has beneficial effects on balance, falls, and non-vertebral fractures^{7–9)}. Tai Chi also reportedly improves renal function

in patients with chronic renal disease and cardiac function in cardiovascular disease patients via regulation of lipid metabolism¹⁰⁾. Many studies have investigated methods to prevent dementia symptoms, but few have investigated the effect of Tai Chi on dementia^{11, 12)}. This study aims to investigate whether Tai Chi can improve physical and cognitive function in elderly Chinese subjects.

SUBJECTS AND METHODS

This study was completed at a senior activity center in Jilin, China. A total 150 elderly people residing in the local communities were recruited by public announcement. Subjects did not have previous experience with Tai Chi and did not exercise regularly. The inclusion criteria were as follows: (1) >60 years of age; (2) Mini-Mental State Examination (MMSE) score > 24, indicating no cognitive impairment; (3) sufficient upper limb mobility to perform requisite finger-pointing tasks, such as flexing and extending the shoulder, elbow, wrist, and fingers; and (4) no neurologic or musculoskeletal disease such as stroke or visual and auditory impairments. Subjects meeting the inclusion criteria were randomly allocated to the Tai Chi group or the control group using a random number table (n = 75 per group, Fig. 1). An independent researcher blinded to the number allocation enrolled and assigned subjects to each group. The research ethics committee of Jilin University approved the study.

The study was conducted from September 2012 to February 2013. Subjects in the Tai Chi group practiced 24-

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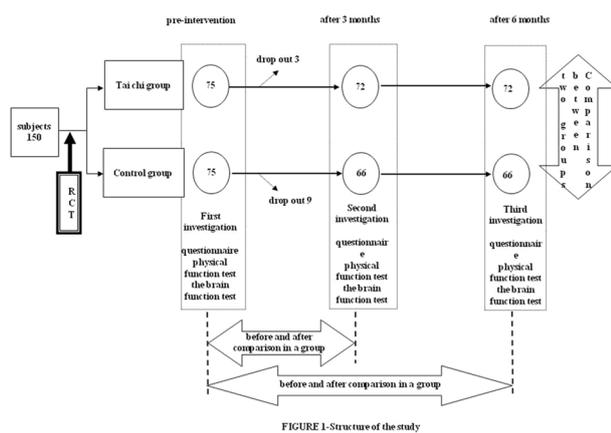


FIGURE 1-Structure of the study

Fig. 1. Study protocol and subject recruitment

A total 150 subjects >60 years old were randomly divided into a Tai Chi intervention group and a control group. All participants were investigated at baseline and at 3 and 6 months after beginning intervention.

form Yang style Tai Chi for 60 minutes twice weekly for 6 months. The control group participated in other activities such as playing cards or singing at the activity center. However, due to a variety of factors such as hospitalization, the intervention group included 72 people after 3 months and the control group 66 people after 6 months. The total capture rate was 92% (138/150). After completing the study, the control group was provided a similar intervention program.

Before the study, all subjects were given 10 min to read a document on dementia prevention, and a researcher answered any questions concerning the document. Each subject completed a questionnaire concerning gender, age, education, disease status, and the Functional Capacity Tokyo Metropolitan Institute of Gerontology Index of Competence (TMIG, 0–13 points). The TMIG is used to measure the functional capacity in daily life; higher scores indicate greater functional ability¹³. Physical function was assessed using the eyes open/leg standing time, 5-m high walk speed, 10-m normal walk speed, left grip strength, and right grip strength¹⁴. The subjects were asked to stand on either leg as long as possible while keeping their eyes open to assess their static balance. The time from when the subject raised a leg until the raised leg touched the ground was measured twice, and the longer time of the two trials was analyzed. Grip strength was measured twice in both hands using an adjustable handheld dynamometer to assess muscular strength, and the highest measure for each hand was used. Participants were asked to walk 10 m at normal speed or 5 m at maximal speed, and the mean time was measured using a stopwatch. Cognitive function was measured using the MMSE (0–30 points) and Frontal Assessment Battery (FAB) at bedside (0–18 points)^{15, 16}. For the MMSE, 23–24 points indicates mild dementia, while higher scores indicate better cognitive function. For the FAB at bedside, higher scores indicate higher cognitive function.

Data were analyzed using the χ^2 test before and after intervention in the Tai Chi group and control group. Differences between the groups were analyzed by two-way ANOVA.

Statistical analysis was performed using SPSS 13.0, and $p < 0.05$ was considered statistically significant.

RESULTS

The study design is outlined in Fig. 1. A total 150 individuals were eligible to participate. Of these, 138 subjects completed the 6-month study program, and 12 subjects (Tai Chi group $n = 3$, control group $n = 9$) were lost to follow-up. Reasons for dropout included illness and family obligations. As a result, follow-up data were available for 72 of 75 subjects in the Tai Chi group and 66 of 75 subjects in the control group. Table 1 lists the baseline characteristics of the subjects. The two groups were well matched at the baseline assessment, and there were no obvious differences in the key outcome variables initially, except the TMIG score, which was significantly higher in the Tai Chi group than in the control group ($p < 0.01$).

In the Tai Chi group, the TMIG score increased at both 3 and 6 months. The eyes opened/one leg standing time and FAB increased at 6 months, but were unchanged at 3 months. By contrast, the right grip strength increased at 3 months, but not at 6 months. There were no significant differences in the eyes open/one leg standing time, left grip strength, and FAB at bedside ($p > 0.05$) between the Tai Chi and control groups at 3 or 6 months (Tables 2, 3).

Participants in the Tai Chi group had a significantly decreased 5-m high walking speed ($p < 0.001$), 10-m normal walking speed ($p < 0.01$), right grip strength ($p < 0.01$), and MMSE ($p < 0.01$) compared with the control group at 3 months. Furthermore, the Tai Chi group experienced a significantly decreased 5-m high walking speed ($p < 0.001$), 10-m normal walking speed ($p < 0.001$), and MMSE ($p < 0.01$) compared with the control group at 6 months (Table 2).

The 5-m high walking speed test decreased in the Tai Chi group at both 3 and 6 months, while the control group showed an increasing trend (Tables 2, 3). A similar trend was observed for the 10-m normal walking speed at 3 and 6 months (Tables 2, 3). The right Grip strength significantly increased after 3 months but decreased at 6 months in the Tai Chi group. In the control group, the right Grip strength decreased at both 3 and 6 months (Tables 2, 3). Finally, the MMSE score increased at both 3 and 6 months in the Tai Chi group (Tables 2, 3).

DISCUSSION

This study shows that Tai Chi practice improves cognitive and physical functions in the elderly. We found that the MMSE score significantly increased in the Tai Chi group compared with the control group, suggesting that Tai Chi may improve the mental function of the elderly in China. In addition, the FAB significantly increased in the Tai Chi group. Exercise is known to increase regional cerebral perfusion in the contralateral motor sensory cortex, which may explain why Tai Chi may increase memory and concentration¹⁷.

Although an increasing number of elderly Chinese people practice Tai Chi, few studies have examined the effects of Tai Chi on preventing dementia. Brown et al.¹⁸ randomly di-

Table 1. Subjects characteristics

Parameter		Tai Chi group, n = 72 (%)	Control group, n = 66 (%)
Gender	Male	14 (19.4)	20 (30.3)
	Female	58 (80.6)	46 (69.7)
Age (years)	Mean \pm SD	68.3 \pm 5.9	70.1 \pm 5.7
	60–64	22 (30.6)	12 (18.2)
	65–69	22 (30.6)	20 (30.3)
	70–74	16 (22.2)	18 (27.3)
	75–79	10 (13.9)	14 (21.2)
	80–84	2 (2.8)	2 (3.0)
Education (years)	0–11	32 (44.5)	18 (27.2)
	≥ 12	40 (55.5)	48 (72.8)
Disease	Cardiac	16 (22.2)	8 (12.1)
	Hyperpiesia	12 (16.7)	16 (24.2)
	Diabetes mellitus	4 (5.6)	4 (6.1)
	Other	18 (25.0)	22 (33.3)
	None	22 (30.6)	16 (24.2)
Physical exercise	Yes	54 (75.0)	54 (81.8)
	No	18 (25.0)	12 (18.2)
Exercise frequency	<3/w	22 (40.7)	20 (47.0)
	≥ 3 /w	32 (59.3)	34 (63.0)
Exercise time (min)	<60	38 (70.4)	36 (66.6)
	≥ 60	16 (29.6)	18 (33.4)
TMIG (4–13 points)	Mean \pm SD	11.6 \pm 1.3	10.8 \pm 2.1**
Physical function	One leg standing time with eyes open (s)	28.7 \pm 27.1	23.3 \pm 23.0
	5-m high walking speed (s)	2.9 \pm 0.7	2.8 \pm 0.8
	10-m normal walking speed (s)	8.7 \pm 2.1	8.9 \pm 2.5
	Left Grip strength (kgw)	24.7 \pm 6.9	23.6 \pm 10.3
	Right Grip strength (kgw)	25.5 \pm 7.0	23.9 \pm 10.5
Brain function	MMSE (20–30)	26.4 \pm 2.4	26.8 \pm 1.7
	FAB (7–18)	14.6 \pm 2.1	14.1 \pm 2.9

TMIG; Functional Capacity Tokyo Metropolitan Institute of Gerontology Index of Competence; MMSE; Mini-Mental State Examination; FAB; Frontal Assessment Battery at bedside; SD; standard deviation, *Significant difference between groups; **p < 0.01

Table 2. Physical and cognitive functions compared between the Tai Chi and control groups

Parameter	Tai Chi (n = 72) mean (SD)			Control (n=66) mean (SD)			
	Pre-intervention	3 months	6 months	Pre-intervention	3 months	6 months	
TMIG (4–13)	11.6 (1.3)	12.1 (0.9)***	12.1 (0.9)***	10.8 (2.1)	11.1 (2.0)*	11.7 (1.4)***	
One leg standing time with eyes open (s)	28.7 (27.1)	36.9 (38.3)	40.0 (47.1)*	23.3 (23.0)	34.3 (37.5)**	38.0 (40.7)***	
Physical exercise	5-m high walking speed (s)	2.9 (0.7)	2.8 (0.5)	2.8 (0.7)	2.8 (0.8)	3.2 (0.8)***	3.4 (0.9)***
	10-m normal walking speed (s)	8.7 (2.1)	8.5 (2.0)	8.6 (1.6)	8.9 (2.5)	9.7 (2.6)***	9.6 (2.6)***
	Left Grip strength (kgw)	24.7 (6.9)	24.9 (6.5)	24.9 (8.8)	23.6 (10.3)	23.1 (11.5)	22.8 (10.3)
	Right Grip strength (kgw)	25.5 (7.0)	26.7 (7.2)**	25.8 (7.7)	23.9 (10.5)	23.4 (11.5)	23.4 (11.0)
	Brain function	MMSE (20–30)	26.4 (2.4)	27.8 (1.7)***	28.0 (2.0)***	26.8 (1.7)	27.1 (1.8)
FAB (7–18)	14.6 (2.1)	14.9 (2.4)	15.7 (2.4)***	14.1 (2.9)	14.3 (2.8)	14.5 (3.2)	

TMIG; Functional Capacity Tokyo Metropolitan Institute of Gerontology Index of Competence; MMSE; Mini-Mental State Examination; FAB; Frontal Assessment Battery at bedside; SD; standard deviation, *Significant difference between groups; ***p < 0.001, **p < 0.01, *p < 0.05

Table 3. Outcome variables after 3 and 6 months Tai Chi training

		3 months after intervention		6 months after intervention	
		Tai Chi group (n = 72) Mean (SD)	Control group (n = 66) Mean (SD)	Tai Chi group (n = 72) Mean (SD)	Control group (n = 66) Mean (SD)
TMIG (4–13)		0.5 (1.0)	0.5 (1.5)	0.5 (1.2)	0.9 (1.3)*
Physical exercise	One leg standing time with eyes open (s)	8.1 (35.5)	11.0 (26.1)	11.3 (45.0)	14.8 (28.9)
	5-m high walking speed (s)	-0.1 (0.5)	0.4 (0.5)***	-0.1 (0.7)	0.6 (0.7)***
	10-m normal walking speed (s)	-0.2 (2.2)	0.8 (1.3)**	-0.1 (1.6)	0.8 (1.7)**
	Left Grip strength (kgw)	0.2 (2.9)	-0.5 (3.5)	0.2 (4.3)	-0.7 (3.3)
	Right Grip strength (kgw)	1.2 (3.2)	-0.5 (4.1)**	0.2 (3.1)	-0.5 (3.5)
Brain function	MMSE (20–30)	1.4 (2.2)	0.3 (2.2)**	1.6 (1.9)	0.5 (2.6)**
	FAB (7–18)	0.3 (1.8)	0.3 (2.6)	1.1 (2.2)	0.5 (2.6)

TMIG; Functional Capacity Tokyo Metropolitan Institute of Gerontology Index of Competence; MMSE; Mini-Mental State Examination; FAB; Frontal Assessment Battery at bedside; SD; Standard deviation,

*Significant difference between groups; ***p < 0.001, **p < 0.01, *p < 0.05

vided 135 subjects into a Tai Chi group and control group for 16 weeks of moderate and low intensity exercise programs, and found that exercise with Tai Chi was more effective than exercise alone in promoting psychological benefits in both men and women. Unfortunately, they did not examine elderly subjects.

Winter and Tse^{19, 20} showed that Tai Chi could improve walking speed and grip strength in the elderly. Consistent with these previous reports, in this study, we found that walking speed was significantly improved in the Tai Chi group compared with the control group. In addition, Schaller²¹) reported that Tai Chi practitioners had significantly better eyes open/leg standing times. However, in this study we found that the eyes open/one leg standing time significantly increased in both the Tai Chi and control groups after 3 and 6 months, and there was no difference between the two groups. Of note, the participants in the control group in Schaller's study maintained their current activity level, while the control group in this study participated in non-athletic activities such as playing cards or singing. This may explain the inconsistent results between our study and Schaller's study. Our results also showed a significantly increased TMIG in both the Tai Chi and control groups. However, there was no difference between the two groups, which may be because all of the subjects read a document about dementia prevention before beginning the study.

Currently, family care and community support systems are not well established in China. Therefore, it is particularly important to take precautions for the prevention and early treatment of dementia. Presently, there are few intervention studies in China on dementia prevention by Tai Chi. We conducted a randomized controlled trial to evaluate the potential to prevent dementia using Tai Chi, and our results demonstrate that Tai Chi can improve cognitive function in elderly people.

Many studies, especially those evaluating older adults or significantly impaired individuals, have reported functional changes over 3 to 6 months following intervention, but the six-month duration of this study only evaluated the potential effect of Tai Chi on age-related dementia. Tai Chi is tradi-

tionally considered a life-long skill, and it is believed that with time, both proficiency and health benefits improve. Long-term interventional studies and well-designed observational studies comparing long-term Tai Chi practitioners (e.g. >10 years) to matched controls are needed to fully evaluate the long-term impact of Tai Chi on healthy aging²²).

In conclusion, our results confirmed that Tai Chi is potentially useful in preventing dementia in elderly people. Tai Chi could be an easy and effective preclinical treatment strategy of preventing dementia in elderly people and enhancing the quality of life.

REFERENCES

- Prince M, Bryce R, Albanese E, et al.: The global prevalence of dementia: a systematic review and metaanalysis. *Alzheimers Dement*, 2013, 9: 63–75.e2. [Medline] [CrossRef]
- Tian JZ, Shi J: Alzheimer: a new unit of clinical pathology. *Chin J Gerontol*, 2008, 10: 1974–1976.
- Aoki TK: An attempt at collage therapy for the elderly with dementia: possibility of the assessment from a case study. *Jpn Bull Art Ther*, 2010, 39: 15–28.
- Hayashi AK: Rehabilitation therapy for Parkinson's disease. *Med Frontline*, 2010, 65: 892–896.
- Hirai TY, Tanaka TM, Kimura YI: Translation from physical differences to cognitive differences by active touch: comparison between healthy adult, healthy elderly and patient with dementia. *Esercizio Terapeutico Conoscitivo*, 2010, 9: 143–154.
- Verghese J, Lipton RB, Katz MJ, et al.: Leisure activities and the risk of dementia in the elderly. *N Engl J Med*, 2003, 348: 2508–2516. [Medline] [CrossRef]
- Zhang JG, Ishikawa-Takata K, Yamazaki H, et al.: The effects of Tai Chi Chuan on physiological function and fear of falling in the less robust elderly: an intervention study for preventing falls. *Arch Gerontol Geriatr*, 2006, 42: 107–116. [Medline] [CrossRef]
- Li F, Harmer P, Fisher KJ, et al.: Tai Chi: improving functional balance and predicting subsequent falls in older persons. *Med Sci Sports Exerc*, 2004, 36: 2046–2052. [Medline] [CrossRef]
- Tsang WW, Hui-Chan CW: Comparison of muscle torque, balance, and confidence in older tai chi and healthy adults. *Med Sci Sports Exerc*, 2005, 37: 280–289. [Medline] [CrossRef]
- Shi ZM, Wen HP, Liu FR, et al.: The effects of tai chi on the renal and cardiac functions of patients with chronic kidney and cardiovascular diseases. *J Phys Ther Sci*, 2014, 26: 1733–1736. [Medline] [CrossRef]
- Deschamps A, Onifade C, Decamps A, et al.: Health-related quality of life in frail institutionalized elderly: effects of a cognition-action intervention and Tai Chi. *J Aging Phys Act*, 2009, 17: 236–248. [Medline]

- 12) Yao L, Giordani B, Alexander NB: Developing a positive emotion-motivated Tai Chi (PEM-TC) exercise program for older adults with dementia. *Res Theory Nurs Pract*, 2008, 22: 241–255. [[Medline](#)] [[CrossRef](#)]
- 13) Koyano W, Shibata H, Haga H: Developing the functional capacity Tokyo Metropolitan Institute of gerontology index of competence. *Nippon Koshu Eisei Zasshi*, 1987, 34: 109–114.
- 14) Kim S, Li S: Effects of Taijiquan on the physical fitness of elderly Chinese people. *J Phys Ther Sci*, 2006, 18: 133–136. [[CrossRef](#)]
- 15) Folstein MF, Folstein SE, McHugh PR: “Mini-mental state”. A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res*, 1975, 12: 189–198. [[Medline](#)] [[CrossRef](#)]
- 16) Dubois B, Slachevsky A, Litvan I, et al.: The FAB: a frontal assessment battery at bedside. *Neurology*, 2000, 55: 1621–1626. [[Medline](#)] [[CrossRef](#)]
- 17) Chen YC: Retard the aging brain study. *Physiol Sci*, 1995, 26: 329–330.
- 18) Brown DR, Wang Y, Ward A, et al.: Chronic psychological effects of exercise and exercise plus cognitive strategies. *Med Sci Sports Exerc*, 1995, 27: 765–775. [[Medline](#)] [[CrossRef](#)]
- 19) Winter DA, Patla AE, Prince F, et al.: Stiffness control of balance in quiet standing. *J Neurophysiol*, 1998, 80: 1211–1221. [[Medline](#)]
- 20) Tse SK, Bailey DM: T'ai chi and postural control in the well elderly. *Am J Occup Ther*, 1992, 46: 295–300. [[Medline](#)] [[CrossRef](#)]
- 21) Schaller KJ: Tai Chi Chih: an exercise option for older adults. *J Gerontol Nurs*, 1996, 22: 12–17. [[Medline](#)] [[CrossRef](#)]
- 22) Wayne PM, Manor B, Novak V, et al.: A systems biology approach to studying Tai Chi, physiological complexity and healthy aging: design and rationale of a pragmatic randomized controlled trial. *Contemp Clin Trials*, 2013, 34: 21–34. [[Medline](#)] [[CrossRef](#)]