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Research article

Can The Frequency and Intensity of Tai Chi Influence the Magnitude of Adaptations in Health Markers and Physical Fitness in Older Adults? A Randomized Controlled Study

WenHua Zhai [1], QingHua Zhai [2]✉, LiXin Wei [1] and XiaoYuan Wen [3]
[1] College of Physical Education and Health, Geely University of China, Chengdu, China; [2] Moscow State University, Moscow, Russia; [3] ChengDu Sports Univ, Chengdu, Peoples R China

Abstract
The purpose of this study was to compare the effects of different frequencies and intensities of Tai Chi practice on blood pressure, cognitive function, stress levels, and physical fitness parameters in older adults. A randomized controlled trial with parallel groups was conducted over 16 weeks to evaluate two Tai Chi interventions (3×50 min/week vs. 5×30 min/week) in older adults (n = 46). Outcomes included blood pressure, cognitive function (MoCA), perceived stress (PSS), flexibility (Chair Sit and Reach, Back Scratch), strength (handgrip, arm curl, chair stand), agility (8-Foot Up-and-Go), and functional capacity (Six-Minute Walk Test). Post-intervention, TC5d showed significantly better performance than the control group in arm curl ($p = 0.017$), chair stand ($p = 0.001$), handgrip strength ($p = 0.004$), and 8-foot up-and-go ($p = 0.041$). TC3d performed significantly better than the control group in the 6-minute walk test ($p = 0.013$). MoCA scores were significantly higher in both TC3d ($p = 0.004$) and TC5d ($p = 0.008$) compared to the control group. PSS scores were significantly lower in TC3d ($p = 0.004$) and TC5d ($p < 0.001$) compared to the control group. This study suggests that both Tai Chi interventions improve cognitive function and reduce stress in older adults. The TC5d group showed greater benefits in strength, agility, and flexibility, while the TC3d group improved functional capacity. These results suggest that a higher-frequency Tai Chi regimen (5×30 min/week) is more effective for improving physical fitness and mental health in older adults.

Key words: Tai Chi, aged, physical fitness, stress, health promotion.

Introduction

Physical inactivity in older adults has significant negative health consequences. It increases the risk of all-cause mortality by 34% and reduces the likelihood of healthy aging (Cunningham et al., 2019). Inactivity contributes to secondary health complications such as obesity, diabetes, and cardiovascular disease (Hall and Thomas, 2008). It also accelerates the loss of muscle mass and strength, impairs insulin sensitivity, and increases systemic inflammation (Oikawa et al., 2019).

Regular physical activity is crucial for the health and wellbeing of older adults. It reduces the risk of chronic conditions, falls, and fall-related injuries while improving physical function and quality of life (Schwingel and Chodzko-Zajko, 2019). Physical activity helps prevent osteoporosis, diabetes, hypertension, heart disease, stroke, and certain cancers (Young and Dinan, 2005). Physical activity has been shown to have significant benefits for cognitive health in older adults. Regular exercise can help maintain and even enhance cognitive function, particularly in areas like attention, executive control, and episodic memory (Parimon et al., 2014; Blanchet et al., 2018). The positive effects of physical activity on cognition are supported by various physiological mechanisms, including improved cerebral blood flow, increased neurotrophic factors, and changes in neural architecture (Marmeleira, 2013; Liu-Ambrose and Best, 2017). Additionally, exercise may delay the progression of cognitive impairment and reduce the risk of dementia (Blanchet et al., 2018).

Tai Chi is an ancient Chinese practice combining gentle movements, relaxation, and meditation ("Tai Chi," 2011). It emphasizes proper foot movement, featuring seven support patterns and six step directions, with more double-limb support and less single-limb support compared to normal walking ("Tai Chi," 2011). Tai Chi's slow, deliberate movements simulate gait challenges encountered in daily activities, potentially improving balance and coordination (Mao et al., 2006). The practice offers numerous health benefits, including stress reduction, improved flexibility, and increased blood flow (Mahalakshmi and Shaji, 2024).

Tai Chi offers numerous health benefits for older adults. It improves physical functioning, including balance, muscle strength, and cardiovascular fitness (Blake and Hawley, 2012). Tai Chi reduces falls and fear of falling in the elderly (Blake and Hawley, 2012). It enhances mobility in patients with rheumatoid arthritis and may improve bone density, though evidence is less conclusive (Adler and Roberts, 2006). Psychologically, Tai Chi imparts a sense of well-being, reduces stress, anxiety, and depression symptoms (Szczot et al., 2024). It may also benefit cognitive function and sleep quality (Szczot et al., 2024). As a low-intensity exercise, Tai Chi is suitable for older adults with chronic illnesses and can be adapted for those with mild to moderate cognitive impairment (Adler and Roberts, 2006). While many studies report positive outcomes, more large-scale randomized controlled trials are needed to validate these benefits (Blake and Hawley, 2012).

With a growing number of seniors facing chronic health conditions, physical frailty, and diminished functional abilities, identifying effective interventions to maintain or improve physical health is crucial. However, there remains a notable gap in research regarding the optimal frequency and intensity of Tai Chi practice for older adults.

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Most existing studies either focus on a single modality of practice or do not explore the specific dosages of exercise needed to achieve significant health improvements. This lack of nuanced understanding limits the ability to tailor interventions for older populations based on individual needs and health conditions.

Our study aims to fill this gap by investigating how different frequencies and intensities of Tai Chi practice impact key health and physical markers among older adults. This novel approach will not only clarify the most effective regimens for improving physical capacity but also offer evidence to guide public health recommendations and interventions. The objective of the study is to determine the optimal frequency and intensity of Tai Chi practice that maximizes health benefits, thereby enhancing the quality of life and functional independence of older adults while reducing the burden of age-related health issues.

Methods

Experimental design

The study employed an experimental design featuring randomization, parallel groups, and a control condition. Two intervention groups undergoing Tai Chi training and a control group were assessed both before and after the 16-week intervention period. One Tai Chi group participated in 50-minute sessions three times a week (TC3d), while the other received 30-minute sessions five times a week (TC5d).

Setting

The study was conducted during the spring period (March–June) in the community surrounding the university. Using convenience sampling, recruitment was carried out by announcing the study in public spaces and offering free Tai Chi classes to those who met the eligibility criteria. The classes were held in various locations around the city, aiming to increase participation and create favorable conditions for adherence.

Participants

For this study, the following inclusion criteria were required: participants had to be 65 years or older, not have any locomotor injuries that would prevent physical exercise, not be practicing Tai Chi, and not be enrolled in a regular physical exercise program. The exclusion criteria were as follows: missing any of the assessment sessions, missing more than 15% of the sessions in their group during the intervention period, starting another physical exercise program during the study, or having any medical condition that would make physical exercise inadvisable.

Out of 51 individuals who expressed interest, 46 met the inclusion criteria and were enrolled as study volunteers. Participants were then randomly assigned to the groups (Figure 1). The mean age of the total sample was 66.7 ± 2.8 years, and 32 participants were female. The average height was 156.8 ± 7.1 cm, and the mean body weight was 61.2 ± 10.2 kg.

This study was conducted in accordance with the ethical principles described in the Declaration of Helsinki and received approval from the Chengdu Sport University under protocol code 2025/5. All participants provided written informed consent prior to their enrollment in the study, after receiving a thorough explanation of the study's purpose, procedures, potential risks and benefits, and their right to withdraw at any time without consequence. Measures were taken to ensure the confidentiality and anonymity of participant data throughout the study, including the use of coded identifiers and secure data storage.

Tai Chi interventions

The Tai Chi intervention was conducted over 16 weeks and adjusted specifically for older adult beginners, emphasizing gentle progression, safety, and foundational Tai Chi principles. Participants were allocated into two groups: one practicing three times per week for 50 minutes per session, and the other five times per week for 30 minutes, ensuring equal total weekly practice time (150 minutes).

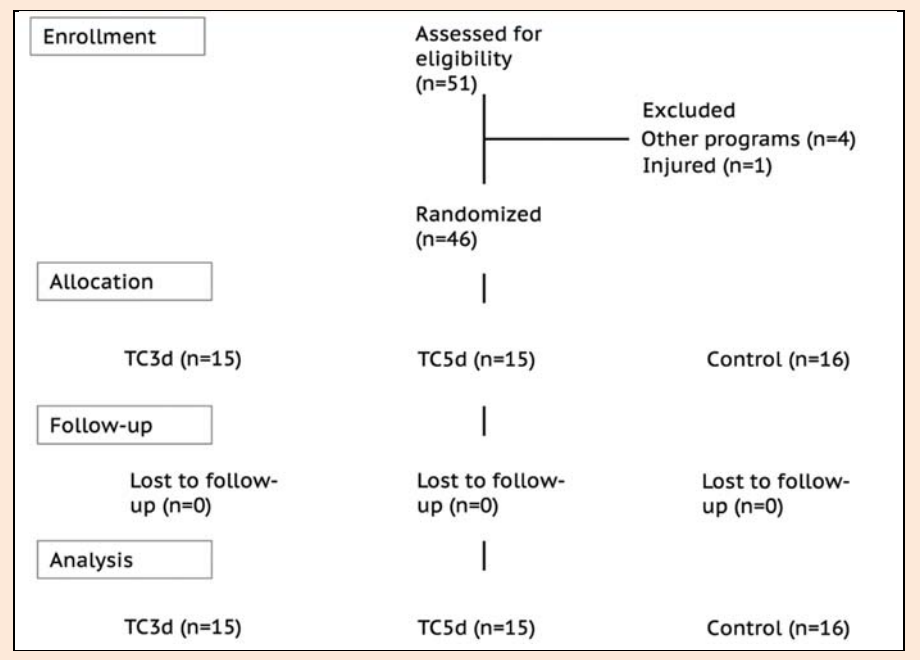

Figure 1. Enrollment, allocation, and analysis of the participants. TC3d: Tai Chi 3 days a week; TC5d: Tai Chi 5 days a week.

Both groups progressed through the same structured weekly content, focusing on postural alignment, breathing, weight shifting, balance, and simplified Yang-style movements, with increasing integration and flow over time (Table 1). Sessions were held in a quiet, well-ventilated community health center room with ample natural light, smooth flooring, and supportive chairs for optional use. Classes took place in the late morning (9:30 - 10:20 or 9:30 - 10:50). All sessions were taught by certified Tai Chi instructors with over 5 years of experience in teaching older adults. The control group maintained their usual daily activities without participating in any structured physical exercise program during the 16-week intervention period.

Evaluations and outcomes

Blood pressure

An automated sphygmomanometer (Omron M2 Compact, HEM 7102-E) was employed to measure blood pressure. Participants rested for five minutes in a comfortable, seated position with their arm at heart level. Subsequently, two blood pressure readings were taken one minute apart, and their average was recorded as the participant's blood pressure. Systolic and diastolic values (mmHg) were documented for subsequent analysis.

Cognitive screening

The Montreal Cognitive Assessment (MoCA) was utilized as a brief cognitive screening tool to detect mild cognitive impairment. This 30-point test evaluates several cognitive domains, including visuospatial/executive functions, naming, memory, attention, language, abstraction, and orientation (Julayanont et al., 2013). The questionnaire was administered by a team of researchers who were familiar with the scoring system and had standardized its application. Responses were collected individually in a private room to minimize external influences.

Perceived stress scale

In this study, the Perceived Stress Scale (PSS) was employed to evaluate participants' subjective perceptions of stress. As a globally recognized instrument, the PSS provides insight into how individuals appraise their lives in terms of unpredictability, uncontrollability, and overload (Cohen et al., 1983). The version used consists of 14 self-report items, each rated on a 5-point Likert scale ranging from 0 (never) to 4 (very often). Respondents indicate how often they experienced certain thoughts or feelings related to stress over the past month. Some items are positively stated and require reverse scoring before computing the final score. The total score was obtained by summing the responses across all items after appropriate reverse coding, yielding a possible range from 0 to 56. Higher scores reflect greater levels of perceived stress.

Table 1. Weekly structure for both experimental groups.

Week	Content	Group TC3d (3x/week × 50 min)	Group TC5d (5x/week × 30 min)
1	Posture, Breathing, Joint Warm-ups: Wuji stance, abdominal breathing, gentle joint mobility	Full-body warm-up, posture alignment drills, intro to Wuji & breathing	Gentle mobility, seated/standing posture work, breath training
2	Controlled shifting side/front, begin "Commencement"	Weight-shifting games, form posture, practice first movement	Shifting drills, movement breakdown, small-step practice
3	Learn first side, focus on stepping & hand flow	Step-by-step movement instruction, focus on balance & timing	Segment drill: arms, legs, then together; repeat in parts
4	Learn second side, link both sides smoothly	Add second side, practice transition, mirror sides	Alternate side practice, build up to two-part movement
5	Brush Knee and Push: Learn full movement, posture & breathing with stepping	Learn entire movement slowly, body alignment drills	Breakdown into arms and legs, slow recombination
6	Balance work, controlled rising and arm extension	Practice step + raise, balance safety cues, soft arms	Supported balance drills, controlled arm lift
7	Grasp the Bird's Tail: Ward Off, Roll Back, Press, Push – broken down step-by-step	Full movement breakdown, energy direction explained	Repetition of sections, arms-only + foot-only before integration
8	Short sequence	White Crane; slow continuous flow	Daily repetition of mini-sequence with correction focus
9	Repulse Monkey: Backward step, coordination, body awareness	Movement slowly, safe stepping, coordinated arms	Walk-in-place version, low-range stepping, mirror drills
10	Wave Hands Like Clouds: Side-to-side shifting with hands floating	Emphasize waist turning, weight transfer, hand coordination	Drill stepping + hands separately, combine for short practice
11	Golden Rooster: Balance, posture, single-leg awareness	Static and dynamic variations with support	Repetition with wall/chair support, light arm lift
12	Short Form Integration, link all previous forms into a flowing segment	Golden Rooster	Break form into 3 smaller chunks, reinforce daily
13	Breath–Movement Harmony: Coordinate inhale/exhale with each form	Softness, breathing with each motion	Daily breath drills, flow-through sections with cues
14	Peng, Lu, Ji, An Energy Concepts: Focus on feel, structure, and intention	Practice Grasp the Bird's Tail with internal awareness	Static energy feeling, light motion, slow focus drills
15	Moving Meditation: Quiet, slow repetition of full form	Flow practice, soft music optional, meditative tempo	Slow, segmented repetitions with breath & relaxation
16	Full form, personal practice tips, journaling	Practice full sequence, encourage mindful take-home practice	Full form flow, seated breath work

Handgrip strength
Data on handgrip strength were collected using a 5030J1 Jamar hydraulic dynamometer. During the data collection process, participants were seated comfortably, ensuring a 90-degree angle at the elbow and a neutral alignment of the forearm and wrist. Two measurements were taken for each hand, with participants switching hands between trials. The highest value (expressed in kg) obtained for each hand was documented for subsequent data analysis. A 30-second rest was provided between each measurement.

Chair Sit and Reach Test
Participant flexibility was evaluated using the Chair Sit and Reach Test from the Senior Fitness Test (Rikli and Jones, 2013). During the test, individuals sat on a 44 cm high chair with one leg extended straight and the other foot flat on the ground. They then reached forward with both hands along a measuring tape positioned over the extended leg, stretching as far as possible while keeping their knees straight. The distance (in centimeters) between their fingertips and toes at maximum reach, held for two seconds, was recorded by a dedicated observer for each participant. This measurement (n) was subsequently used to analyze participant flexibility.

Back Scratch Test
Upper body flexibility was assessed using the Back Scratch Test, a component of the Senior Fitness Test (Rikli and Jones, 2013). In this test, participants stood comfortably and attempted to touch the middle fingers of both hands together behind their back, with one arm reaching over the shoulder and down, and the other reaching up from the lower back and over the shoulder. The distance between the middle fingers was measured with a ruler. A positive value indicated overlap, while a negative value indicated a gap. Prior to the formal assessment, participants completed two practice trials. The final score, recorded in centimeters, was the best measurement obtained to the nearest centimeter.

Six-minute Walk Test
Functional exercise capacity was evaluated using the Six-Minute Walk Test (Rikli and Jones, 2013). Participants walked along a 45.72-meter rectangular course marked with cones, covering as much distance as possible within the allotted six minutes. Individuals were encouraged to self-pace and could take breaks if needed. An observer tracked the time and measured the total distance covered to the nearest meter. This final distance (in meters) achieved within the six-minute interval was recorded for subsequent analysis.

Sample size
To determine the necessary sample size a priori for a mixed-design ANOVA with three independent groups and two time points (pre- and post-intervention), a power analysis was conducted using G*Power software. A statistical power of 0.80, an alpha level of 0.05 (significance level), and an expected effect size of 0.25 were set. The final suggested sample size was 42 participants.

Randomization
Participants were randomly assigned to one of the intervention groups or the control group using a computer-generated random sequence (Research Randomizer). This randomization process was conducted by an independent researcher not involved in the recruitment or assessment of participants to ensure allocation concealment and minimize selection bias. Specifically, a stratified block randomization method was employed, with stratification based on sex. The generated allocation sequence was then used to assign participants to their respective groups as they were enrolled in the study.

Blinding
To minimize assessment bias, the evaluators responsible for collecting and analyzing the outcome data were blinded to the participants' group assignments. This blinding was maintained throughout the study period. However, due to the nature of the Tai Chi intervention, it was not feasible to blind either the participants or the therapists delivering the intervention. Participants were aware of whether they were receiving Tai Chi or were part of the control group. Similarly, the therapists administering the Tai Chi sessions were necessarily aware of the intervention they were providing. Despite the lack of blinding for participants and therapists, the blinding of the outcome evaluators aimed to ensure objective and unbiased assessment of the study outcomes.

Statistical procedures
A mixed ANOVA design was utilized to investigate the influence of the intervention on the outcomes, considering the three groups (two Tai Chi and one control) and the two measurement occasions (pre- and post-intervention). The normality of residuals was assessed using the Shapiro-Wilk test ($p > 0.05$), homogeneity of variance was examined with Levene's test ($p > 0.05$), and the sphericity assumption for the repeated measures factor was tested using Mauchly's test. Significant findings from the ANOVA were further analyzed with Bonferroni-adjusted post-hoc tests to identify specific between-group differences. The practical significance of the findings was estimated using partial eta squared (ηp2), with benchmarks of 0.01, 0.06, and 0.14 indicating small, medium, and large effect sizes, respectively. The level of statistical significance for all tests was defined as $p < 0.05$. Data analysis was carried out using SPSS software (version 28.0.0, USA).

Results

Table 2 presents the descriptive statistics for the three groups at both assessment time points, covering the evaluated health and physical fitness parameters. The mixed ANOVA found significant interactions between groups in moments of assessment in systolic blood pressure ($p = 0.010$; $\eta_p^2 = 0.196$), MOCA ($p < 0.001$; $\eta_p^2 = 0.535$), PSS ($p = 0.002$; $\eta_p^2 = 0.255$), handgrip strength ($p = 0.015$; $\eta_p^2 = 0.182$), arm curl test ($p < 0.001$; $\eta_p^2 = 0.487$), chair stand test ($p < 0.001$; $\eta_p^2 = 0.417$), sit and reach ($p = 0.004$; $\eta_p^2 = 0.234$), back scratch ($p < 0.001$; $\eta_p^2 = 0.358$), 8-foot up and go ($p < 0.001$; $\eta_p^2 = 0.451$) and walk test 6-min ($p = 0.005$; $\eta_p^2 = 0.225$). However, no significant interactions were found in diastolic blood pressure ($p = 0.122$; $\eta_p^2 = 0.095$).

Table 2. Descriptive statistics for the three groups at both assessment time points, covering the evaluated health and physical fitness parameters.

	TC3d pre	TC3d post	TC5d pre	TC5d post	Control pre	Control post
Diastolic BP (mmHg)	74.1 ± 10.7	71.1 ± 8.7	73.9 ± 6.5	72.3 ± 6.4	74.1 ± 10.0	74.9 ± 10.6
Systolic BP (mmHg)	129.9 ± 10.5	124.7 ± 8.4	130.9 ± 6.3	127.7 ± 5.9	130.1 ± 10.4	129.7 ± 10.4
MOCA (score)	24.1 ± 2.7	28.8 ± 3.4	24.3 ± 3.0	29.0 ± 3.1	25.6 ± 3.0	24.2 ± 4.2
PSS (score)	33.4 ± 7.0	30.1 ± 4.0	33.5 ± 6.9	27.2 ± 3.0	35.7 ± 4.8	34.9 ± 4.2
Arm curl (n)	17.5 ± 4.4	23.1 ± 4.9	18.7 ± 3.8	24.5 ± 4.1	19.8 ± 4.3	19.5 ± 5.1
Handgrip (kg)	26.4 ± 8.2	28.4 ± 7.8	27.9 ± 11.2	31.9 ± 10.2	24.4 ± 7.2	21.4 ± 7.1
Chair stand (n)	17.6 ± 1.9	19.7 ± 2.7	17.8 ± 3.0	21.5 ± 4.0	17.3 ± 4.6	16.2 ± 4.5
Sit and reach (cm)	2.1 ± 6.0	3.8 ± 5.7	2.0 ± 2.1	4.1 ± 3.6	2.6 ± 5.3	1.8 ± 5.5
Back scratch (cm)	-6.0 ± 4.8	-2.6 ± 4.2	-5.3 ± 5.3	-2.0 ± 4.4	-4.4 ± 3.7	-4.1 ± 3.6
8-foot up and go (s)	5.1 ± 0.7	4.7 ± 0.5	5.3 ± 0.8	4.6 ± 0.7	5.2 ± 1.6	5.6 ± 1.5
Walk test (m)	530.4 ± 84.3	567.4 ± 42.3	524.5 ± 61.9	550.1 ± 48.0	527.6 ± 47.8	508.2 ± 65.8

PSS: Perceived Stress Scale; TC3d: Tai chi training 3 days/week; TC5d: Tai chi training 5 days/week.

Within-group comparisons showed that TC3d significantly reduced diastolic blood pressure (mean difference: 2.93 mmHg; $p = 0.031$), whereas neither TC5d ($p = 0.569$) nor the control group ($p = 0.484$) showed significant changes. For systolic blood pressure, both TC3d (mean difference: 5.14 mmHg; $p < 0.001$) and TC5d (mean difference: 3.20 mmHg; $p = 0.004$) exhibited significant reductions from baseline to post-intervention, while no significant change was observed in the control group ($p = 0.717$).

Regarding MoCA scores, both TC3d (mean difference: 4.71 points; $p < 0.001$) and TC5d (mean difference: 4.73 points; $p < 0.001$) showed significant improvements following the intervention, while the control group showed no significant change ($p = 0.058$). Similarly, for PSS scores, significant reductions were observed in both TC3d (mean difference: 3.29 points; $p = 0.004$) and TC5d (mean difference: 6.27 points; $p < 0.001$), whereas no significant changes were detected in the control group ($p = 0.422$).

For the arm curl test, both TC3d (mean difference: 5.57 repetitions; $p < 0.001$) and TC5d (mean difference: 5.73 repetitions; $p < 0.001$) showed significant improvements following the intervention, while the control group showed no significant change ($p = 0.741$). Similarly, in the chair stand test, TC3d (mean difference: 2.14 repetitions; $p = 0.003$) and TC5d (mean difference: 3.70 repetitions; $p < 0.001$) significantly improved, with no significant differences observed in the control group ($p = 0.081$). For handgrip strength, only TC5d showed a significant improvement (mean difference: 4.0 kg; $p = 0.022$), while neither TC3d ($p = 0.257$) nor the control group ($p = 0.078$) showed significant changes.

In the 8-foot up-and-go test, both TC3d (mean difference: -0.42 seconds; $p = 0.003$) and TC5d (mean difference: -0.62 seconds; $p < 0.001$) showed significant improvements after the intervention, while the control group showed a significant decline in performance (mean difference: +0.36 seconds; $p = 0.005$). In the 6-minute walk test, significant improvements were also observed in both TC3d (mean difference: +37.0 meters; $p = 0.006$) and TC5d (mean difference: +25.5 meters; $p = 0.043$), while no significant change was found in the control group ($p = 0.108$).

No significant differences were found at baseline for the systolic and diastolic blood pressure, MOCA, PSS, handgrip strength, arm curl test, chair stand test, sit and reach, back scratch, 8-foot up and go and walk test 6-min ($p > 0.05$). However, post intervention, significant differences between groups were found for MOCA ($p < 0.001$; $\eta_p^2 = 0.294$), PSS ($p < 0.001$; $\eta_p^2 = 0.436$), arm curl ($p = 0.016$; $\eta_p^2 = 0.178$), handgrip strength ($p = 0.004$; $\eta_p^2 = 0.227$), chair stand test ($p = 0.001$; $\eta_p^2 = 0.268$), 8-foot up and go ($p = 0.022$; $\eta_p^2 = 0.167$), and walk test 6-min ($p = 0.012$; $\eta_p^2 = 0.190$). However, no significant differences post intervention were found for diastolic blood pressure ($p = 0.504$; $\eta_p^2 = 0.032$), systolic blood pressure ($p = 0.285$; $\eta_p^2 = 0.058$), back scratch test ($p = 0.393$; $\eta_p^2 = 0.044$).

Figure 2 shows the descriptive statistics for the diastolic and systolic, MOCA test and PSS tests. Post-intervention, the control group had significantly lower MoCA scores compared to both TC3d (mean difference: 4.6 points; $p = 0.004$) and TC5d (mean difference: 4.8 points; $p = 0.008$). Similarly, PSS scores were significantly higher in the control group compared to TC3d (mean difference: 4.7 points; $p = 0.004$) and TC5d (mean difference: 4.7 points; $p < 0.001$).

Figure 3 presents the descriptive statistics for the arm curl, chair stand, and handgrip strength tests. Post-intervention pairwise comparisons revealed that only TC5d had significantly greater arm curl performance than the control group (mean difference: 5.0 repetitions; $p = 0.017$). In the chair stand test, the TC5d group performed significantly better than the control group (mean difference: 5.35 repetitions; $p = 0.001$), whereas no significant difference was observed between the TC3d group and the control group ($p = 0.050$). In terms of handgrip strength, only the TC5d group showed a significant difference compared to the control group post-intervention (mean difference: 10.5 kg; $p = 0.004$).

Figure 4 presents the descriptive statistics for the Sit and Reach, Back Scratch, 8-Foot Up and Go, and the 6-Minute Walk Test. In the 8-Foot Up and Go test, the TC5d group performed significantly better than the control group (mean difference: 0.95 seconds; $p = 0.041$), while no significant difference was found between the TC3d group and the control group ($p = 0.064$). Interestingly, in the 6-Minute Walk Test, only the TC3d group demonstrated significantly greater distances than the control group (mean difference: 59.17 meters; $p = 0.013$), whereas no significant difference was observed between the TC5d group and the control group (mean difference: 41.88 meters; $p = 0.105$).

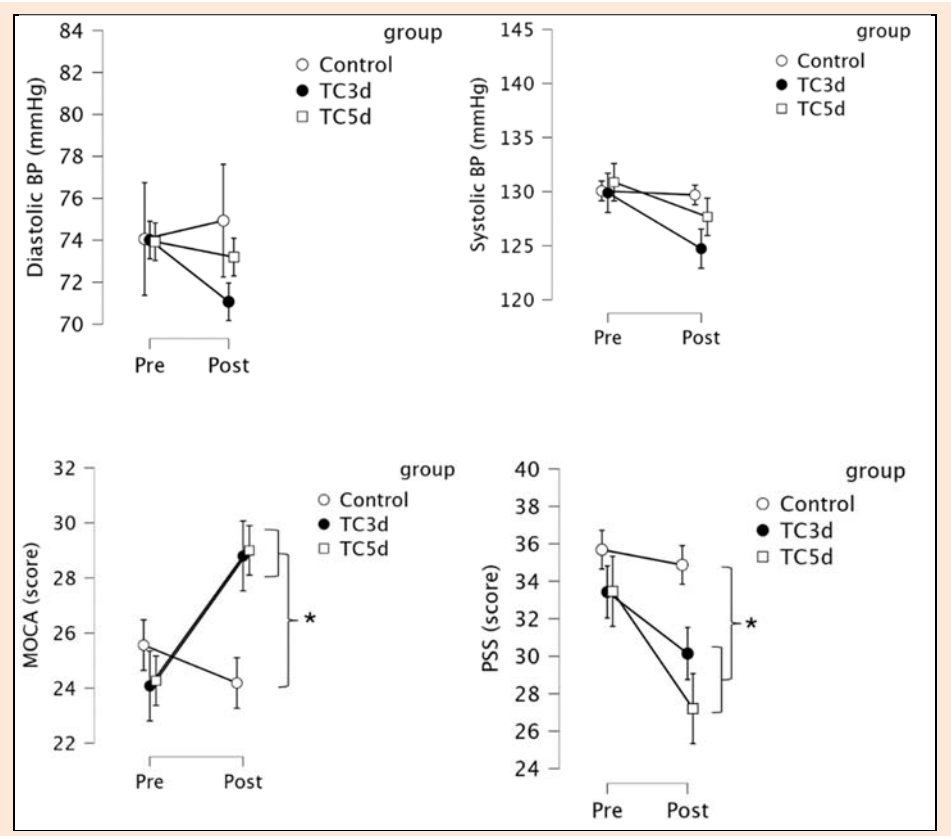

Figure 2. Mean and confidence intervals (95%) for the diastolic and systolic blood pressures (BP), MOCA test and Perceived Stress Scale (PSS) tests. *: significant differences between groups ($p < 0.05$): TC3d: Tai chi training 3 days/week; TC5d: Tai chi training 5 days/week.

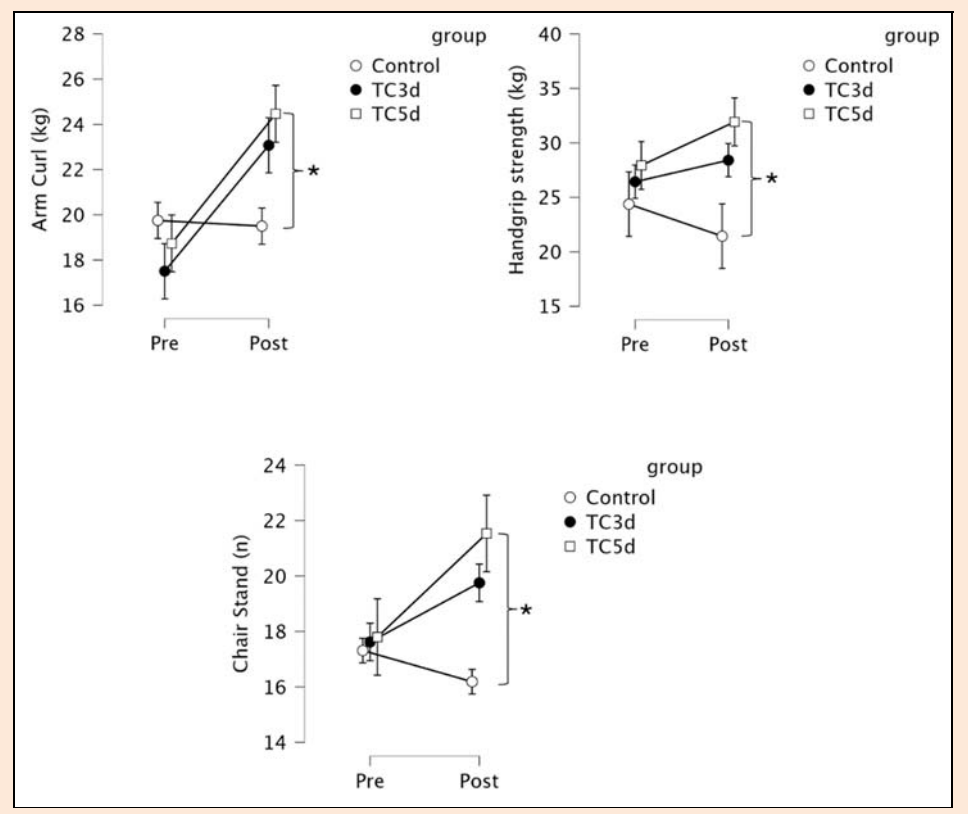

Figure 3. Mean and confidence intervals (95%) for the arm curl test, handgrip strength and chair stand tests. *: significant differences between groups ($p < 0.05$): TC3d: Tai chi training 3 days/week; TC5d: Tai chi training 5 days/week.

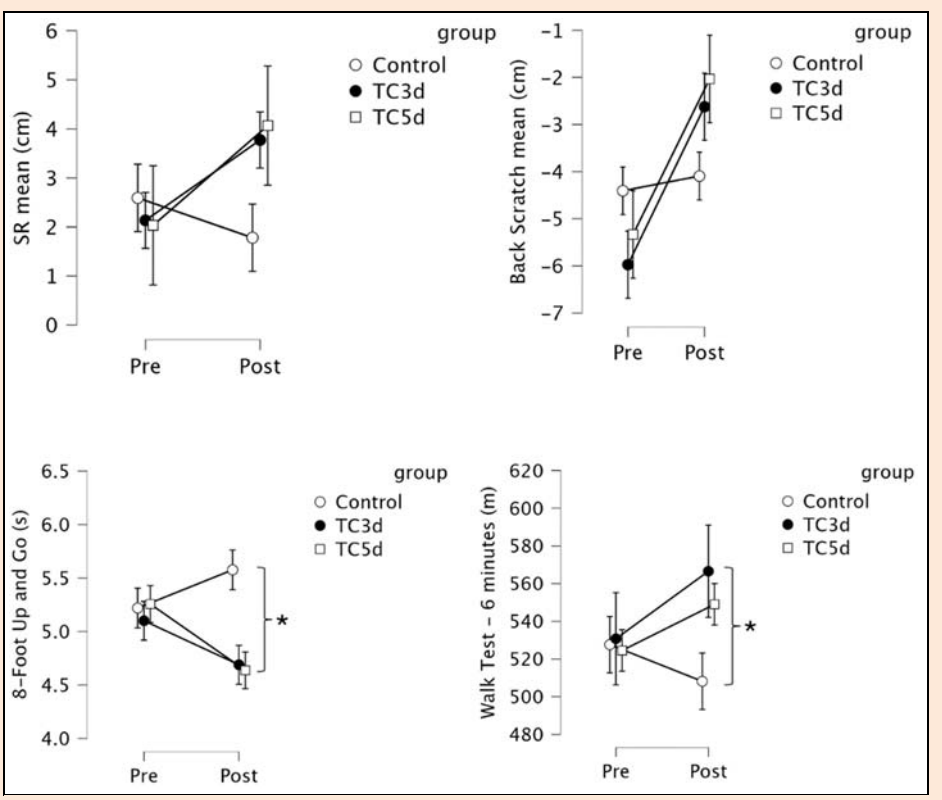

Figure 4. Mean and confidence intervals (95%) for the sit and reach test (SR), back scratch test, 8-foot up and go and the walt test - 6 minutes. *: significant differences between groups ($p < 0.05$): TC3d: Tai chi training 3 days/week; TC5d: Tai chi training 5 days/week.

Discussion

Our findings suggest that both frequencies of Tai Chi training, hold promise for enhancing both cognitive and physical well-being. The significant improvements observed in global cognitive function and reduced perceived stress across both training frequencies indicate that engaging in regular Tai Chi, regardless of the weekly frequency within the tested range, can positively impact these key aspects. Furthermore, the positive changes in measures of physical performance, including upper and lower body strength and functional mobility, highlight the potential of consistent Tai Chi practice to improve physical capabilities. Interestingly, the differential effects observed between the two training frequencies on specific physical outcomes, with the more frequent training (TC5d) showing a particular benefit for strength and agility and the less frequent training but longer sessions (TC3d) showing a specific advantage for walking endurance, suggest that training frequency may differentially influence distinct aspects of physical function. While the overall impact on measures did not significantly differ between the two frequencies, the consistent pattern of improvement across a range of health, cognitive and physical domains stresses the value of regular Tai Chi as a multi-modal intervention.

Multiple randomized controlled trials have demonstrated significant improvements in MoCA scores for Tai Chi practitioners compared to control groups (Lyu et al., 2019; Huang et al., 2019; Yu et al., 2022). Tai Chi interventions have also been associated with reduced depressive symptoms and behavioral issues (Lyu et al., 2019; Huang et al., 2019). Notably, Tai Chi appears to be as effective as aerobic exercise in improving cognitive function (Chu and Lim-Khoo, 2014; Yu et al., 2022), with some evidence suggesting superior benefits in global cognitive function and cognitive flexibility compared to conventional exercise (Yu et al., 2022). While the optimal frequency of Tai Chi practice is still being investigated, research suggests that interventions lasting at least 12 weeks, with sessions occurring three times per week for 30-60 minutes, may be beneficial (Wei et al., 2022; Wan et al., 2022). Further exploring this gap, our research suggests that regardless of whether the Tai Chi interventions were more frequent with shorter sessions or less frequent with longer sessions, both approaches successfully improved MOCA scores and reduced stress levels in older adults after the intervention period. Physiologically, Tai Chi may promote neuroplasticity and increase cerebral blood flow, particularly to regions involved in attention and memory, such as the prefrontal cortex and hippocampus (Zhou et al., 2018). Psychologically, Tai Chi integrates mindfulness, focused attention, and controlled breathing (Gilliam et al., 2021), which likely helped to regulate the stress response by reducing cortisol levels and promoting relaxation (Zhang et al., 2012).

Our results also revealed an interesting finding: while both Tai Chi programs enhanced strength levels (as measured by the chair stand test, handgrip strength, and arm curl), only the Tai Chi practice conducted five days a week was effective enough to produce scores that were significantly different from the control group after the intervention period. Studies have found that Tai Chi practitioners reveal greater eccentric knee extensor and flexor strength compared to sedentary controls (Xu et al., 2008; Lu et al., 2013). Tai Chi practice also improves ankle

dorsiflexor strength (Xu et al., 2008) and activates ankle dorsiflexors and knee extensors for longer durations and at higher magnitudes than normal walking (Wu, 2008). Tai Chi likely promotes muscle hypertrophy and neuromuscular coordination by engaging slow, controlled movements that activate various muscle groups, particularly in the lower and upper extremities (Wingert et al., 2020). These movements possibly improve functional strength, as seen in tests such as the chair stand, arm curl, and handgrip strength. Interestingly, our findings revealed that frequency of practice played a significant role in effectiveness. Tai Chi performed five times a week eventually promotes more frequent neuromuscular stimulation. Studies have shown that more frequent practice (such as 5 days per week) results in more substantial gains in muscle strength and functional mobility, likely due to the enhanced muscle adaptation and neuroplasticity achieved through increased practice intensity (Grgic et al., 2018).

Additionally, in the 8-foot Up and Go test, while both Tai Chi groups showed significant improvements, only the group practicing five days a week achieved superior scores compared to the control group after the intervention. Some research suggests that Tai Chi enhances key physical attributes crucial for functional mobility, including balance, lower limb strength, and proprioception (Chen et al., 2021). The slow, deliberate movements and weight-shifting inherent in Tai Chi challenge postural control and strengthen the muscles responsible for standing and stepping (Li et al., 2005). The superior performance of the five-day-a-week group compared to the control, and even the less frequent Tai Chi group, likely is based on dose-response stimulus, although lacks specific outcomes to explain the causality. Higher frequency of training likely leads to greater neural adaptations, improved muscular endurance, and enhanced motor control, ultimately translating to faster and more efficient performance in the agility-based Up and Go test (Garber et al., 2011).

Interestingly, in the 6-minute walk test, while both Tai Chi interventions led to significant improvements, only the group practicing three times a week with longer (90-minute) sessions showed significantly better outcomes at post-intervention compared to the control group. For instance, a previous study found, in patients with knee osteoarthritis, Tai Chi improved walking function, posture control, and physical performance measures like the 6-minute walk test and timed up-and-go test (You et al., 2021). The superior outcome in the group practicing three times a week with longer (90-minute) sessions, compared to the control group, suggests that a certain threshold of training volume and duration might be necessary to elicit meaningful improvements in this specific functional measure. The longer sessions likely provided a greater cumulative training stimulus, allowing for more sustained engagement of the relevant physiological systems and potentially leading to enhanced muscular endurance and aerobic capacity (Taylor et al., 2004).

Despite the improvements observed in the previous outcomes, our research also revealed no significant impact of the Tai Chi interventions on blood pressure parameters, nor on flexibility, as measured by the sit-and-reach and back-scratch tests. While some studies have suggested modest reductions in blood pressure with Tai Chi practice, particularly in individuals with hypertension, the effects are not consistently observed across all populations or study designs (Hwang et al., 2014). In our case, since the participants were not hypertensive, this may help explain the relatively smaller impact observed. Regarding flexibility, our results did not confirm previous findings that revealed positive effects on this (Zou et al., 2017). Ultimately, the intensity and range of motion may explain the lack of effects, as well as the relatively high baseline levels.

The present study has some limitations that should be considered when interpreting the findings. First, the relatively short intervention period may not have been long enough to capture long-term effects of Tai Chi practice on cognitive and physical health, particularly for more chronic conditions. Further studies could also explore the effects of different Tai Chi styles and intensities to better understand how these variables interact with frequency to influence cognitive and physical health. In addition, future studies should investigate the potential mechanisms underlying the observed benefits, such as neural adaptations, to provide a deeper understanding of the physiological and psychological processes that contribute to the efficacy of Tai Chi.

This study suggests that Tai Chi can enhance both cognitive and physical health, with positive outcomes observed across different training frequencies. For improvements in strength and agility, a higher frequency of practice (five days per week) may be more effective. Consistency in practice is crucial, and individuals, particularly beginners, should start with a lower frequency and progressively increase it.

Conclusion

In conclusion, this study suggests the potential of Tai Chi as a versatile intervention for improving both cognitive and physical health. Our findings suggest that regular practice, regardless of training frequency, can lead to significant improvements in cognitive function, stress reduction, and physical performance. While more frequent sessions (five days a week) were particularly effective for enhancing strength and agility, longer, less frequent sessions (three days a week) showed advantages for walking endurance. These results emphasize the value of Tai Chi as a multimodal intervention that can be adapted to individual needs and goals.

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The author reports no actual or potential conflicts of interest. The datasets generated and analyzed in this study are not publicly available, but are available from the corresponding author who organized the study upon reasonable request. All experimental procedures were conducted in compliance with the relevant legal and ethical standards of the country where the study was performed.

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Key points

- Tai Chi Improves Mental Health in Older Adults: Both Tai Chi regimens (3×50 min/week and 5×30 min/week) significantly improved cognitive function (MoCA scores) and reduced perceived stress (PSS scores) compared to the control group, demonstrating the mental health benefits of regular Tai Chi practice.
- The higher-frequency Tai Chi group (5×30 min/week) showed significantly greater improvements in muscular strength (arm curl, chair stand, handgrip), agility (8-foot up-and-go), and flexibility compared to the control, indicating more robust physical fitness gains.
- The lower-frequency group (3×50 min/week) significantly improved in the Six-Minute Walk Test, suggesting that even a moderate Tai Chi routine can enhance cardiovascular endurance and overall functional mobility in older adults.

AUTHOR BIOGRAPHY

Wenhua ZHAI
Employment
College of physical education and health,Geely University of China, Chengdu, China
Degree
ME.d
Research interests
Traditional martial arts, etc.
E-mail: 842771249@qq.com

Qinghua ZHAI
Employment
Moscow State University , Moscow, Russia
Degree
ME.d
Research interests
Sports management, etc.
E-mail: 1119694576@qq.com

Lixin WEI
Employment
College of physical education and health,Geely University of China, Chengdu, China
Degree
M.A.
Research interests
Physical exercise, etc.
E-mail: 26315077@qq.com

Xiaoyuan WEN
Employment
ChengDu Sports Univ, Chengdu, Peoples R China
Degree
PhD
Research interests
Sports training, sports monitoring, etc.
E-mail: dawnloveslh@outlook.com

✉ **QingHua Zhai**
Moscow State University, Moscow, 119991, Russia