Functional fitness and fall risk in older adults practitioners or non-practitioners of Tai Chi

Rossana Gómez-Campos (1,2), Rubén Vidal-Espinoza (3), Sebastián Vega Novoa (1), Marcella Silva Ramos de Lázari (4), Luis Urzua-Alul (5), Margot Rivera Portugal (6), Christian de la Torre Choque (7), Marco Cossio-Bolaños (1,2)

(1) Department of Physical Activity Sciences, Maule Catholic University, Talca, Chile; (2) Faculty of Education, Psychology and Sport Sciences of the University of Huelva, Huelva, Spain; (3) Silva Henriquez Catholic University, Santiago, Chile; (4) Faculty of Medical Sciences (FCM) – UNICAMP, Sao Paulo, Brasil; (5) School of Kinesiology, Faculty of Health, Santo Tomás University, Chile; (6) National University of San Agustín de Arequipa, Perú; (7) San Ignacio de Loyola University, Lima, Perú.

Abstract

Tai chi is a fundamental tool that has a significant influence on balance, motor function and fear of falling among older adults. The objective of the study was to verify functional fitness and fall risk in older adults (OAs) practitioners and non-practitioners of Tai Chi. An ex-post-facto study was carried out in practicing and non-practicing OAs of Tai Chi. The sample selection was non-probabilistic (convenience). Thirty-one adults with an age range of 65 to 80 years were studied. Two study groups were formed: Group practicing Tai Chi [GPT (n= 15 subjects)] and Group not practicing Tai Chi [GNPT (n= 16 subjects)]. Age, weight, height, waist circumference were assessed. Body mass index (BMI) and fat mass (FM) were calculated. Five functional fitness tests were assessed: biceps curl (30 sec), chair stand (30 sec), agility (sec), 2 min walk (#rep) and 6 min-1 walk (m). Fall risk was measured using a 13-item scale. The GPT showed better performance in all five functional fitness tests (biceps curl, Chair stand, agility, 2 min gait and 6 min walk) compared to the GPT. The effect size (ES: ~0.20 to 0.48) and Cohen's d (~ 0.39 to 1.10) between both groups were medium to large. There were also differences between the mean values in fall risk between both groups (GNPT: 2.1±1.7points and GNPT: 4.7±1.9points, $p<0.05$). This study demonstrated that the group of OAs practicing Tai Chi presented better levels of functional fitness and less risk of falling in relation to their counterparts who did not practice Tai Chi. These results suggest including this type of old-time exercise in physical activity programs that promote functional fitness wellness and fall prevention among OAs.

Key Words: older adult; Tai Chi; fall risk; functional fitness.

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Functional fitness is a widely used measure to assess the independence, health and quality of life of adults in old age.[1] In recent years, there has been increasing interest in adapting physical functions during old age, especially in improving mobility, balance, and muscle strength, all of which are important in preventing falls among older adults (OAs).[2-4] Indeed, it is widely known that as one ages, physical fitness gradually decreases, thus OAs face risks of functional impairment and frailty, resulting in loss of independence in activities of daily living.[5] In that sense, fall risk is among the most common problems of the elderly, which can cause illness, isolation, dependence, reduced quality of life,[6] as well as morbidity, mortality and increased health care costs.[7] In fact, classically falls have been studied in OAs since from the 1940s and were internationally recognized as a public health problem.[8] In general, this issue emphasizes the need to implement preventive measures to avoid recurrence in older adults,[9] so health care providers, such as primary care physicians and physical therapists, often provide a multi-component set of fall prevention interventions for older adults living in diverse settings.[10] Physical exercise plays a key role in prevention of several age-related pathologies, metabolic and cardiovascular diseases, cancer, loss of bone

quality, loss of muscle mass and balance control.[10,12] In recent years, several studies have reported that Tai Chi physical exercise has significant influence on balance, motor function and fear of falling among older adults.[6,**Errore. L'origine riferimento non è stata trovata.-Errore. L'origine riferimento non è stata trovata.**]

Based on Tai Chi being an ancient physical exercise that helps older adults maintain balance,[15] this study hypothesizes that differences may exist among older adults who practice Tai Chi relative to their counterparts who have never undergone Tai Chi exercises. The aim of this study was to compare functional fitness and fall risk in older adults practitioners and non-practitioners of Tai Chi from a region of Chile.

Materials and Methods

Type of study and sample

An ex-post-facto study was carried out in older adults, practitioners and non-practitioners of Tai Chi. The sample selection was non-probabilistic (convenience). Thirty one adults with an age range of 65 to 80 years (23 women and 8 men) were studied. Two study groups were formed: The first group was called Group with Tai Chi practice [GPT (n= 15 subjects)]. This group included adults who did not practice any sports activity, did not attend any other physical activity program and who were enrolled in the Taichi workshop offered by the senior center. This group practiced Tai Chi for general health benefits during one year between 2 to 3 times per week and 60 minutes/day. The content they developed was based on eight elements consisting of: focused attention, imagery and visualization, enhanced integration of physiological systems, moving meditation, strength and flexibility training, more efficient breathing, social support when attending classes, and increased spirituality.[17] Group 2, referred to as the non-Tai Chi group [GNPT (n=16 subjects)], had not engaged in any type of physical activity in the last 12 months.

The study was designed in accordance with the guidelines of the Declaration of Helsinki, and was approved by the Ethics Committee of the Universidad Católica del Maule, Chile (214-2022). All participants were informed of the aim of the study and those within the age range and those who could walk independently were included. Adults who did not complete the anthropometric measurements and physical tests and those with severe visual and hearing impairment were excluded.

Techniques and procedures

Anthropometric variables, functional fitness tests and the fall risk survey were evaluated in a closed laboratory. Initially, demographic variables (age, sex, type of physical activity) were evaluated. Second, the survey measuring fall risk was administered. Thirdly, anthropometric measurements were measured, and fourthly, functional fitness tests were performed. The entire procedure was carried out by 2 evaluators with extensive experience in anthropometric and physical measurement techniques. Fall risk was assessed using the questionnaire proposed by Rubenstein et al.[18] It presents 13 questions with two alternatives (know and don't know). A higher score indicates a higher risk of falling. The survey lasted between 8-9 minutes. Anthropometric measures such as weight, height and waist circumference (WC) were assessed following the recommendations of Ross, Marfell-Jones.[19] Body weight (kg) was assessed with a scale (SECA, Hamburg) accurate to 0.1 kg. Standing height was measured with a stadiometer (SECA, Hamburg) to the nearest 0.1 cm. CC was measured at the midpoint between the lower ribs and the top of the iliac crest using a Seca metal tape measure, graduated in millimeters, to the nearest 0.1 cm. Body Mass Index (BMI) was calculated using the formula [BMI = weight (kg)/height $(m)^2$] and fat mass (FM) was determined using the equation proposed by Cossio-Bolaños et al.**Errore. L'origine riferimento non è stata trovata.** for older adults of both sexes in Chile, using the BMI for each sex. Functional fitness was measured following the recommendations of Rikli and Jones,[20] using four tests from the Senior Fitness test (leg strength, agility, right arm muscular endurance, gait and aerobic fitness). Previously, participants performed 10 min of flexibility and warm-up exercises. Right arm strength endurance (RFBD), also known as biceps curl, was measured using a dumbbell (2.0 kg for women and 3.0 kg for men). The subject must be seated in a chair with a backrest. The number of repetitions was evaluated for 30 seconds. Time was recorded using a Casio brand stopwatch (1/100 sec). The chair stand test (up-and-go) evaluates leg strength and was measured for 30 seconds. The subject must be seated in a chair with a backrest with hands crossed at the chest. The test consists of standing up and sitting down. The number of repetitions is counted. A Casio stopwatch (1/100 sec) was used to record the time. The agility test evaluated the time it took the subject to get up from a chair and walk to a cone located 2.44 m away (turn and sit down again). A Casio stopwatch (1/100 sec) was used to record the time in the tests. The 2-minute walk test for aerobic endurance was evaluated using a Casio brand stopwatch (1/100 sec). To visualize the step height we transferred the thigh mark to the wall so that the participant could have a reference. The number of times the right knee reached the set height was counted. Only one attempt was performed. Aerobic fitness was measured using the 6-minute walk test (6MWT). A distance of 30 meters was demarcated. Subjects were required to walk in one direction back and forth. The terrain is demarcated with colored adhesive tapes with three-meter spacing between the lines. Adults had to walk the greatest number of meters during the six minutes.

Statistical analysis

Table 1. *Anthropometric characteristics of samples.*

Variables	Group practicing Tai Chi					Group not practicing Tai Chi					d Cohen y (ES)
	n	X	SD	CI Ul	CI Ll	n	X	SD	CI Ul	CI Ll	
Males											
Age (years)	4	77.8	6.1	68.1	87.5	4	73.4	2.8	68.8	77.9	0.93(0.42)
Weight (kg)	4	76.7	13.6	55	98.3	4	81.2	3.2	76.2	86.3	-0.45(-0.22)
Height (cm)	4	164	7.4	152.2	175.8	4	163.9	2.5	159.9	167.8	0.01(0.00)
C. Waist (cm)	4	99.6	8.9	85.4	113.8	4	104.4	6.9	93.4	115.4	-0.60(-0.29)
BMI (kg/m2)	4	28.3	3.1	23.3	33.3	4	30.3	1.5	27.8	32.7	-0.82(-0.38)
FM (kg)	4	24.7	6	15.1	34.2	4	28.4	3	23.7	33.1	-0.78(-0.36)
Females											
Age (years)	11	70.6	6.1	66.5	74.7	12	69.9	6.6	65.7	74	0.11(0.05)
Weight (kg)	11	68.6	11.4	61	76.3	12	70.8	12.5	62.8	78.7	-0.18(-0.09)
Height (cm)	11	150.1	5.8	146.1	154	12	156	4.8	153	159.1	-1.11(-0.48)
C. Waist (cm)	11	94.8	13.1	86.1	103.6	12	97	6.5	92.9	101.1	-0.21(-0.11)
BMI (kg/m2)	11	30.4	4.2	27.6	33.2	12	29	4.7	26.1	32	0.31(0.15)
FM (kg)	11	30.3	5.6	26.6	34	12	28.5	6.2	24.6	32.4	0.31(0.15)
Both											
Age (years)	15	72.5	6.8	68.8	76.3	16	70.7	6	67.6	73.9	0.28(0.14)
Weight (kg)	15	70.8	12.1	64.1	77.5	16	73.4	11.8	67.1	79.7	-0.22(-0.11)
Height (cm)	15	153.8	8.8	148.9	158.6	16	158	5.5	155	160.9	-0.57(-0.28)
C. Waist (cm)	15	96.1	12	89.5	102.7	16	98.9	7.2	95	102.7	-0.28(-0.14)
BMI (kg/m2)	15	29.8	3.9	27.6	32	16	29.3	4.1	27.2	31.5	0.13(0.06)
FM (kg)	15	28.8	6	25.5	32.1	16	28.5	5.5	25.6	31.4	0.05(0.02)

Legend: X: Mean, SD: Standard deviation, CI: Confidence interval, LI: Lower limit, UL: Upper limit, C: Circumference, BMI: Body Mass Index, LM: Fat mass, ES: Effect size.

The normality of the data was verified by means of the Shapiro-Wilk test. Descriptive analysis of arithmetic mean, standard deviation and confidence interval CI was then performed. The difference between the two groups was determined by means of the Student's test for independent samples. The effect size (d) was calculated for each group according to Cohen,[22] where it was interpreted as small (~ 0.2), medium (~ 0.5) or large (~ 0.8 or more). The significance level adopted was 0.05. The calculations were performed in Excel spreadsheets, in the SPSS program, version 16.0.

Results

Table 1 shows the anthropometric characteristics and body adiposity indicators of the two studied groups. Men categorized as GPT presented higher age, WC, BMI and FM in relation to their GNPT counterparts. Cohen's d and effect size were large (d: -0.60 to 0.92, ES: 0.29 to 0.42). However, in body weight the d Cohen (d: -0.45) and effect size were medium (ES: -0.22) and in height it was small (d: 0.01, ES: 0.001). In women categorized as GPT, Cohen's d and ES values were small (d: 0.11 to 0.31, ES: 0.05 to 0.15), both for age, weight, WC, BMI and FM, while, in height, the difference was large (d: -1.10, ES: -0.48). When compared between both groups, the differences were small for age, weight, WC, BMI and FM, except for height which was medium (d: -0.57, ES: -0.27), where the GPT presented greater height than its similar GNPT. Table 2 shows the comparisons between the two study groups. The GPT men and women showed better functional fitness in the five tests than their GNPT counterparts. Cohen's d (0.39 to 1.10) and ES (0.20 to 0.48) were medium to large. The comparisons of fall risk between both groups can be seen in Figure 1. The GPT obtained an average of 2.1±1.7 points in relation to the GNPT 4.7±1.9 points (p=0.049). In general, both ES (-1.44) and Cohen's d (-0.58) were large. The GNPT

evidenced greater risk of falling than its GPT counterparts.

Table 2. *Comparison of functional fitness between OAs practitioners and non-practitioners of Tai Chi.*

Physical tests	Group practicing Tai Chi					Group not practicing Tai Chi					d Cohen, (ES)
	n	X	SD	CS Ul	CS Ll	n	X	SD	CS Ul	CS Ll	
Males											
Biceps Curl (30sec)	4	27.8	4.9	19.9	35.6	4	22.3	6.0	12.7	31.8	1.00 (0.45)
Chair Stand (30sec)	4	19.8	4.9	12.0	27.5	4	16.5	1.0	14.9	18.1	0.93 (0.42)
Agility (sec)	4	5.8	0.3	5.3	6.3	4	6.1	0.7	4.9	7.3	-0.56(-0.27)
Walk 2min (#rep)	4	114	10	97.7	130	4	110	16.5	83.7	136	0.28(0.14)
Walking 6min-1 (m)	4	561	49	483	638	4	526	110	351	700	0.42(0.20)
Females											
Biceps Curl (30sec)	11	23.7	3.1	21.6	25.8	12	18.8	5.2	15.4	22.1	1.14(0.49)
Chair Stand (30sec)	11	19	2.6	17.3	20.8	12	16.2	4.1	13.6	18.8	0.81(0.37)
Agility (sec)	11	5.9	0.9	5.4	6.4	12	6.7	1.1	6	7.4	-0.79(-0.37)
Walk 2min (#rep)	11	120	58	83.8	157	12	93.5	7.9	88.2	98.7	0.65(0.31)
Walking 6min-1 (m)	11	473	75	426	521	12	415	45	384	445	0.95(0.43)
Both											
Biceps Curl (30sec)	15	24.8	3.9	22.6	27	16	19.6	5.4	16.7	22.5	1.10(0.48)
Chair Stand (30sec)	15	19.2	3.2	17.5	21	16	16.3	3.6	14.4	18.1	0.85(0.39)
Agility (sec)	15	6.0	0.8	5.5	6.4	16	6.4	1.0	5.9	7.0	-0.44(-0.22)
Walk 2min (#rep)	15	118	50	91.1	145	16	98.9	12.4	92	106	0.52(0.25)
Walking 6min-1 (m)	15	486	84	442	531	16	454	80.2	409	498	0.39(0.19)

X: Mean; SD: Standard deviation; CI: Confidence interval; LI: Lower limit; UL: Upper limit; ES: Effect size.

Discussion

The results of this study have shown that OAs who practiced Tai Chi presented better functional fitness values (biceps curl, Chair stand, agility, 2 minute walk, 6 minute walk) and lower fall risk than their non-Tai Chi practicing counterparts. These findings are similar to comparative studies with similar characteristics,[23] as in recent years there has been an increasing number of intervention studies suggesting that Tai Chi is a form of exercise that can help OAs increase muscle strength,**Errore. L'origine riferimento non è stata trovata.** improve balance, postural control,[23,24,25] reduce fall rates, produce less fear of falling,**Errore. L'origine riferimento non è stata trovata.**,25,**Errore. L'origine riferimento non è stata trovata.** improve aerobic fitness in patients with and without cardiovascular disease.[27,28] These results support the practice of Tai Chi in OAs, as it is an exercise that contributes, not only to improve functional fitness, but also decreases the risk of falling due to repetitive and controlled movements resulting from building functional gross motor skills.**Errore. L'origine riferimento non è stata trovata.** In addition, Tai Chi is widely appropriate and suggested for implementation in the community as it is a mild to moderate intensity aerobic exercise.[27] In that sense, it has been considered that maintaining adequate levels of functional fitness, such as muscular strength, walking speed, flexibility, cardiovascular endurance and balance, are important for the prevention of falls in the elderly.**Errore. L'origine riferimento non è stata trovata.**

In recent years, the prevalence of falls and the "fear of falling" have been extensively studied in the

community-dwelling older adult population,[Errore. L'origine riferimento non è stata trovata.,30] as studies have evidenced that lack of confidence to perform body movements leads to fearful behaviors, consequently resulting in decreased functional independence, increased risk of falling and lower quality of life.[Errore. L'origine riferimento non è stata trovata.] In sum, recent intervention studies have reported that OAs who practiced Tai Chi indicated greater confidence

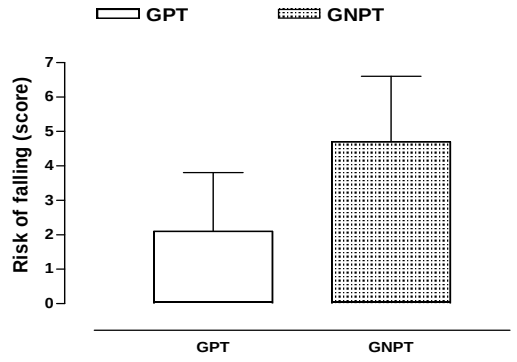

Fig 1. *Comparison of fall risk between practitioners and non-practitioners of Tai Chi. Legend: GPT: Group practicing Tai Chi, GNPT: Group not practicing Tai Chi.*

in walking on a ramp, outdoor mobility at entrances, exits, in residential and/or business hallways.[Errore. L'origine riferimento non è stata trovata.,34] Results of this study are in agreement with those findings, thus Tai Chi has the advantage of improving balance in the elderly, as well as increasing their motivation, confidence, happiness, positive energy, functional independence in their activities, reducing the risk of falls among OAs.[6,33] Reducing the risk of falls and fear of falls and improving mobility, autonomy, quality of life, mood and cognition are very important for OAs to cope with the aging process.[34] Tai Chi is a physical exercises based on mind-body connection, very effective to improve strength, balance, aerobic fitness and to prevent falls.

This study has limitations in both sample selection and study design. A small sample was used in both groups, whose type of selection was non-probabilistic, which prevents generalizing the results to other contexts. In addition, the type of study was ex-post-facto, which did not allow manipulation of the independent variable, but only limited itself to measuring the dependent variable. Therefore, it is necessary that future studies develop randomized experimental designs and control variables such as eating habits, psychological parameters and quality of life.

On the other hand, the study presents some strengths, for example, Tai Chi is a type of exercise that is intrinsically safe for OAs, and the results obtained in this study can serve as a baseline for future comparisons based on longitudinal studies, the purpose of which is to compare changes over time.

In conclusion, after performing an ex-post-facto study, the results indicate that the Tai Chi practicing group of OAs presented better levels of functional fitness and less risk of falling in relation to their non-Tai Chi practicing counterparts. These results suggest including Tai Chi as a type of individual and/or group exercise in physical activity programs that promote functional fitness and fall prevention among OAs.

List of acronyms

6MWT - 6-minute walk test
BMI - Body mass index
FM - fat mass
GNPT - Group not practicing Tai Chi
GPT - Group practicing Tai Chi
OAs - older adults
RFBD - Right arm strength endurance
SPSS - Statistical Package for the Social Sciences
up-and-go - The chair stand test
WC - waist circumference

Contributions of Authors

All authors have read and approved the final edited typescript.

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Conflict of Interest

The authors declare no financial, personal, or other conflicts of interest.

Ethical Publication Statement

We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

Corresponding Author

Marco Cossio Bolaños, PhD, Av San Miguel s/n Talca, Chile.
ORCID iD: 0000-0001-7230-9996
E-mail: mcossio1972@hotmail.com

E-mails and ORCID iD of co-authors

Rossana Gómez Campos: rossaunicamp@gmail.com
ORCHID iD: 0000-0001-6509-5707
Rubén Vidal-Espinoza: rvidal@gmail.com
ORCHID iD: 0000-0002-8593-5248
Sebastián Vega Novoa: sveganovoa@gmail.com

ORCHID iD: 0009-0002-7578-1051
Marcella Silva Ramos de Lázari: marcellasramos@uol.com.br
ORCHID iD: 0000-0002-1667-8137
Luis Urzua Alul: lurzuaa@santomas.cl
ORCHID iD: 0000-0002-5792-2191
Margot Rivera Portugal: mar2608@hotmail.com
ORCHID iD: 0000-0003-0548-2750
Christian de la Torre Choque: cdelatorrec@usil.edu.pe
ORCHID iD: 0000-0002-1560-1445

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