



## Effectiveness of Tai-Chi on Balance in Elderly

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### Abstract

**Background:** With age, the task of maintaining balance becomes highly difficult, as evidenced by the increased frequency of falls in older adults. Tai Chi is a traditional Chinese form of exercise among older adults, especially in Asia used for improving balance and other neuromuscular functions. Tai Chi involves a series of slow, smooth, and graceful movements, with an emphasis on coordination of the eyes, head, body, and upper and lower extremities. Hence, this study aimed to investigate the effects of Tai Chi on balance in elderly people.

**Methods:** Thirty elderly subjects fulfilling the inclusion criteria were recruited for the study. Subjects participated in Tai Chi program, for 4 consecutive weeks carried out by a certified Tai Chi trainer. Primary outcome measures included joint position sense of ankle and time up and go test. The readings of the outcome measures were noted on the very first day of the program, week 2 and week 4. Subjects completed a satisfaction questionnaire after completion of the program.

### Results

- 1) Tai Chi showed improvement post training, the *p* values being statistically extremely significant ( $p < 0.0001$ ) for joint position sense of both the ankles ankle on 2<sup>nd</sup> and 4<sup>th</sup> week.
- 2) Tai Chi showed improvement post training, the *p* values being statistically extremely significant ( $p < 0.0001$ ) for time up and go test on 2<sup>nd</sup> and 4<sup>th</sup> week.

**Conclusion:** Tai-Chi is effective in improving balance in elderly.

**Keyword:** Tai Chi, balance, elderly, joint position sense, time up and go.

### INTRODUCTION

Increasingly aging population is a global challenge to human society. Such a population shift arises

from two effects: increasing longevity and declining fertility <sup>[1]-[3]</sup>. Based on World Health Organization (WHO) projections, the proportion of the global

population that is age above 60 years old is expected to increase from 10.0% in 2000 to 21.8% in 2050, and then to rise to 32.2% in 2100<sup>[3][4]</sup>. Due to decreased fertility, many developing countries are going through more rapid fertility transitions and these countries are expected to experience even faster population aging in future years than currently developed countries<sup>[5][6]</sup>.

With this increase number of old age population, simultaneous increase in issues related to elderly such as osteoarthritis, osteoporosis, visual problems, diabetes, reduced strength and endurance as well as cardiovascular problems are also expected to rise.<sup>[7]</sup> As the age increases, balance alterations and risk of fall also increases.<sup>[8]</sup> Thus preventive plans are needed to minimize the disabilities in this population and increase their independence so as to minimize the financial as well as social burden on the society.

With age, the task of maintaining balance becomes increasingly difficult, as evidenced by the high frequency of falling in older adults<sup>[3][9]</sup>. Motor coordination and balance are abilities that decline during the aging process, partially, by the deterioration of proprioception<sup>[10][15]</sup>. One of the major cause of morbidity and mortality in persons older than 65 is fall. It is the leading cause of death from injury, a rate that increases with advancing age. In persons older than 85, approximately two thirds of injury- related deaths are due to falls. It is estimated that 30% of community-dwelling elders older than 65, 40% of those older than 80 years, and 66% of institutionalized elders fall each year. Major morbidity from falls includes hip and other fractures and serious soft tissue injuries that require immobilization or hospitalization. A single fall often results in a fear of falling, which may lead to a loss of confidence in one's ability to perform routine tasks, restriction in activities, social isolation, and increased dependence on others.<sup>[7]</sup>

Proprioception can be defined as the cumulative neural input to the central nervous system from specialized nerve endings called mechanoreceptors which are located in the joint, capsules, ligaments, muscles, tendons, and skin<sup>[9][16][17]</sup>. Joint position

sense (JPS) and the sense of limb movement, as major components of proprioception; are important for the generation of smooth and coordinated movements, maintenance of normal body posture, regulation of balance and postural control, and motor learning and relearning<sup>[10][18-20]</sup>

Tai Chi (TC), Chinese martial art, is a popular form of exercise among older adults, especially in Asia. This form of exercise involves series of slow, smooth, and graceful movements, with an emphasis on smooth coordination of the eyes, head, body, and upper and lower extremities<sup>[21]</sup>. Numerous studies have investigated TC as an intervention for a wide variety of health problems, especially balance and musculoskeletal disease<sup>[22-24]</sup>. Since this technique is gaining more importance day by day, the need of study was to find out the effectiveness of Tai Chi on balance in elderly.

## MATERIALS AND METHODOLOGY

### 1) PARTICIPANTS

30 subjects (n = 30; mean age 66.166± 2.853), were recruited from several community elderly centers Pune, India. Out of which there were 17 males and 13 females.

Subjects were required to have had no previous experience in Tai Chi, as well as no regular physical exercise habits. The group performed the assigned exercise thrice a week (45min/session) for 4 weeks.

### 2) SETTING

It was a pre-post intervention study carried out on geriatric population. The group performed the assigned exercise thrice a week (45min/session) for 4 weeks.

### Inclusion Criteria

- Male and female
- Willingness of patient
- Age 65 (chronological criteria used for identifying old) to 80.
- Demonstrate a sufficient active range of motion in their upper limbs and lower limb to perform various tasks.

### Exclusion Criteria

- a) Cardiovascular pathologies such as symptomatic cardiovascular disease or uncontrolled hypertension.
- b) Previous experience in Tai Chi
- c) Any musculoskeletal disease referred to the lower limbs such as low back pain, serious arthritis.
- d) Any pathology affecting lower extremity function such as stroke, Parkinson's disease.
- e) Any other disabling neurologic illness.

### 3) PROCEDURE

The synopsis was approved by institutional ethical committee of Tilak Maharashtra Vidyapeeth. Prior to initiation of the study, all subjects completed a questionnaire that asked for details such as the subject's demographic data, past and present job status and their medical history. Joint position matching (Ankle Joint Position Passive Matching Test )and time up and go tests were conducted at baseline and after the 2-week and 4-week intervention.

### 4) TESTING PROTOCOL

The assessment test was divided into two sections. The first section assessed subject's joint position matching ability of the ankle in different degrees after that time up and go test was performed.

- **Ankle Joint Position Passive Matching Test** <sup>[6,25]</sup>. Each subject was positioned on the testing chair, with the calf of the tested leg resting on a 40 cm high platform. The hip and knee were positioned at a 45° flexion, and the talocrural joint was in neutral position. During testing, subjects kept their eyes closed and wore headphones with music playing to eliminate visual and auditory stimuli from the testing apparatus. There were two reference degrees: (1) ankle at 10° inversion and (2) ankle at 20° inversion. The subject's foot was first passively moved by the investigator to the maximal inversion or eversion position. The

investigator then moved the foot to the two reference positions. This test position was maintained for 10s, with each subject instructed to concentrate on the position of the foot. The foot was then passively brought to maximal inversion or eversion and moved passively back toward eversion or inversion with a speed of 1°/s. The subject was instructed to stop when he or she thought that the test position had been reached. This trial was repeated three times, and the error with which the subject reproduced the initial position was subsequently calculated. The three absolute error values were averaged, and the average value was termed the absolute angle error (AAE).

- **Time up and go test** <sup>[26]</sup>

The patient sits in the chair with his/her back against the chair back. On the command "go", the patient rises from the chair, walks 3 meters at a comfortable and safe pace, turns, walks back to the chair and sits down. Timing begins at the instruction "go" and stops when the patient is seated.

### 5) INTERVENTION

Subjects participated in 45min Tai Chi sessions thrice weekly for 4 weeks. Classes were taught by a certified Tai Chi trainer. In the first session, we explained Tai Chi theory, procedures and safety precautions for the elderly. For the remaining sessions, each subject practiced Tai Chi under the instruction of the Tai Chi trainer. Each session included (1) 5min of warm-up and a review of Tai Chi principles, (2) 30min of Tai Chi movement, (3) 5min of breathing techniques, and (4) 5min of cool down. The program consisted of 7 forms. These were : preparation and holding the ball, turning the wheel, brush the knee and twist step, step back to repulse the monkey, walking the circle, kick heel out to left and right and the partition of the wild horse's mane.

## STATISTICAL ANALYSIS

Statistical analysis were performed using Microsoft Excel 2007 software. Data are expressed as mean  $\pm$  SD. Changes in variables between pre and post training were analyzed. A one-way analysis of variance (ANOVA) was used to examine the differences among the characteristics at baseline, week 2 and week 4 of the Tai Chi Exercise. Statistical significance was assumed extremely significant at p less than 0.0001.

## RESULTS

Out of the 40 individuals initially recruited for the study, 10 were deemed ineligible for participation; 5 subjects did not meet the inclusion criteria, 3 subject's work schedule was incompatible, and 2 subjects withdrew consent. A total of 30 subjects completed the 4week study program.

There were 17 males and 13 females in the group. The average age was  $66.166 \pm 2.853$ . According to the old age classification<sup>[27]</sup> there were 21 participants in young old, 9 in middle old and none in old old category. The two outcome measures i.e.

Ankle Joint Position Sense and Time Up and Go test were used to examine the differences among the characteristics at baseline, week 2 and week 4.

### Ankle Joint Position Sense.

The absolute angle errors of bilateral ankle were noted during the baseline, week 2 and week 4 assessment. Table 1 shows subsequent improvement in the absolute angle error of both the ankles. It showed extremely significant improvement in the absolute angle error of ankle joint position passive matching test for both the ankles. The p values were extremely significant ( $p < 0.0001$ ) for right as well as left ankle.

### Time up and go (TUG) test

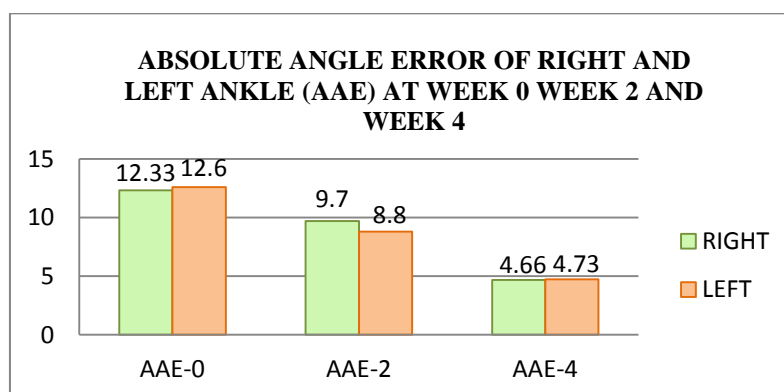
The time required to complete the test were noted during the baseline, week2 and week 4. Table 2 shows subsequent improvement in the readings of TUG test. . It showed extremely significant improvement with p values being extremely significant ( $p < 0.0001$ )

### Ankle Joint Position Sense

**TABLE-1** : Absolute Angle Error Of Right And Left Ankle (Aae) At Week 0 Week 2 And Week 4

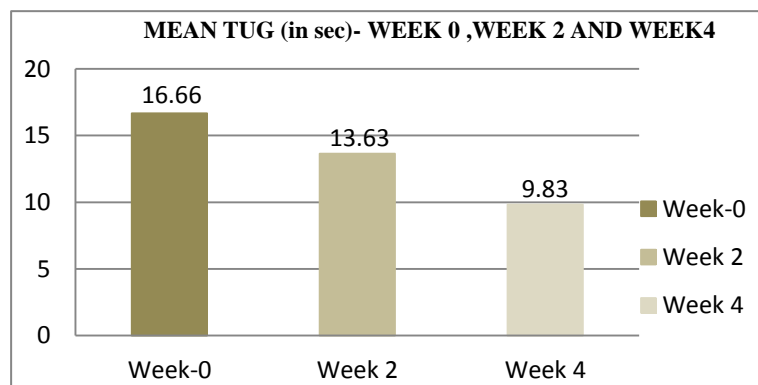
	Baseline	Week- 2	Week-4	p-value
RIGHT AAE(in degrees)	12.33( $\pm 2.648$ )	9.7( $\pm 2.070$ )	4.66( $\pm 1.493$ )	<0.0001
LEFT AAE(in degrees)	12.6( $\pm 2.357$ )	8.8( $\pm 2.148$ )	4.73( $\pm 1.387$ )	<0.0001

## GRAPH-1



**Time up and go test:****TABLE 2 : MEAN TUG (In Sec)- WEEK 0 ,WEEK 2 AND WEEK4**

	Baseline	Week-2	Week-4	p-value
TUG (sec)	16.66( $\pm$ 2.33)	13.63( $\pm$ 1.73)	9.83( $\pm$ 1.31)	<0.0001

**GRAPH-2****DISCUSSION**

The Tai Chi intervention showed improvements in the joint position sense of bilateral ankles in this study and also the time required to perform time up and go test. The p values of both the outcome measures were statistically extremely significant ( $p=0.0001$ ).

Tai Chi showed a major role in improving balance in elderly. This may be because it creates a stable stance by improving and strengthening ankle flexibility. It might have enabled to distribute movement more evenly among the ankle, knee, and hip joints, enabling faster and smoother walking. Also postural sways could have been reduced because of optimized use of proprioception sensory input received by the brain from touch sensors in the muscles and joints—in the balancing process. This generally promotes a greater awareness of body and movement.

A study conducted by D Xu et al in 2003<sup>[26]</sup> cited that elderly people who regularly practiced tai chi not only showed better proprioception at the ankle and knee joints than sedentary controls, but also better ankle kinaesthesia than swimmers/ runners. The large benefits of tai chi exercise on proprioception may result in the maintenance of balance control in older people. Another study conducted by Anna Schmid et in 2013<sup>[28]</sup> concluded that Tai Chi appears to be beneficial for knee

proprioception in people with severe knee OA at a 30 degree test angle immediately following 12 weeks of practice.

The positive effects of Tai Chi may be due to its relaxing meditative aspects. In addition to balance benefits, Tai Chi offers a broad range of well studied positive health impacts for cardiovascular, respiratory, and immune system improvement. Increased endurance and mental focus, as well as an improved sense of well-being, have also been reported from programs using Tai Chi activities. With the right style and program, Tai Chi is a gentle, low-impact activity easily enjoyed by a wide range of people, including older adults, who are disproportionately affected by vestibular disorders coupled with complicating factors affecting compensation. These factors include multi-sensory loss and general mobility limitations. Tai Chi improves performance of the activities of daily living, and is also particularly helpful in reducing the fear of falling and the general stress that so often accompany symptoms of dizziness and vertigo<sup>[29]</sup>.

The current data suggest that Tai Chi can influence older individual's functioning and well being .Tai Chi is a new upcoming technique widely accepted for treatment purpose. It can be performed at home as well if learnt under supervision .The components in Tai Chi makes the exercise form especially effective for seniors.



## CONCLUSION

Results of the study demonstrated different effects of 4-week Tai Chi on joint position sense of ankle joint and time up and go test in elderly people. Both the outcome measures showed significant change post training in the Tai Chi group.

## LIMITATIONS AND FUTURE SCOPE

Although our study elicited important observations regarding the usefulness of Tai Chi on the ankle in elderly people, the present findings cannot be generalized to elderly people living in nursing homes or hospital settings, as these individuals are more likely to have limited mobility and/or a preestablished exercise program that does not permit physical interventions such as those assessed here. As subjects had not learned the movements of tai chi previously, it sometimes proved difficult for subjects to correctly perform this exercise.

Further ,randomized control trail can be carried out with various levels of progression. This will also avoid monotonicity and disinterest of the participant.

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