

# Somatosensory Stimulation of the Foot Versus Tai Chi to Improve Dynamic Balance in the Elderly

## Estimulación somatosensorial del pie versus Tai Chi para mejorar el equilibrio dinámico en ancianos

Khabib Abdullah<sup>1a\*</sup>, Atik Swandari<sup>2a</sup>, Anastasia Putu Martha Anggarani<sup>3b</sup>, Siti Aisyah<sup>a</sup>

### SUMMARY

**Introduction:** Indonesia enters the aging population period with an increasing prevalence of fall injuries. One way to deal with this issue is to improve the balance in the elderly. Two exercises that were recognized improved balance in the elderly are somatosensory stimulation of the foot and Tai Chi. But no one has compared both exercises in improving the balance of the elderly. This study aimed to compare somatosensory stimulation of the foot and Tai Chi exercise in improving dynamic balance in the elderly.

**Methods:** This research was an experimental study with pre and post-test design. The population in this study was all elderly at Griya Wreda Nursing Home, Rungkut, Surabaya. The independent variables were somatosensory stimulation of the foot and Tai Chi exercise, while the dependent variable was dynamic balance. There were two groups, group 1 (10 older

people with somatosensory stimulation of the foot) and group 2 (10 elderly with Tai Chi exercises). Both interventions were given six sessions. The instrument to measure dynamic balance was the time up and go (TUG) test. Data analysis used the Mann-Whitney test with a significance of 0.05.

**Results:** The Mann-Whitney test showed  $p=0.54$  ( $p<0.05$ ), indicating no significant difference in increasing dynamic balance in the elderly between somatosensory stimulation of the foot and Tai Chi exercise groups.

**Conclusion:** Somatosensory stimulation of the foot is as good as Tai Chi exercise in improving the dynamic balance in the elderly. Further studies with a larger sample size and randomized control trial design are needed to enhance the evidence.

**Keywords:** Dynamic balance, elderly, somatosensory stimulation of the foot, Tai Chi.

### RESUMEN

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ORCID ID: 0000-0003-4908-3807<sup>1</sup>

ORCID ID: 0000-0003-0137-3928<sup>2</sup>

ORCID ID: 0000-0002-2229-8165<sup>3</sup>

<sup>a</sup>Universitas Muhammadiyah Surabaya, Indonesia

<sup>b</sup>Physiotherapy Study Program, Sekolah Tinggi Ilmu Kesehatan Katolik St. Vincentius a Paulo Surabaya, Indonesia

\*Corresponding Author: Khabib Abdullah

E-mail: khabibabdullah@fik.um-surabaya.ac.id

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**Introducción:** Indonesia ingresa al período de envejecimiento de la población con una prevalencia creciente de lesiones por caídas. Una forma de lidiar con este problema es mejorar el equilibrio en los ancianos. Dos ejercicios que se han reconocido mejoran el equilibrio en los ancianos son la estimulación somatosensorial del pie y el Tai Chi. Pero nadie ha comparado ambos ejercicios para mejorar el equilibrio en los ancianos. Este estudio tuvo como objetivo comparar la estimulación somatosensorial del pie y el ejercicio de Tai Chi para mejorar el equilibrio dinámico en los ancianos.

**Métodos:** Esta investigación fue un estudio experimental con diseño de pre y pos-prueba. La

*población en este estudio eran todos los ancianos en Griya Wreda Nursing Home, Rungkut, Surabaya. Las variables independientes fueron la estimulación somatosensorial del pie y el ejercicio de Tai Chi, mientras que la variable dependiente fue el equilibrio dinámico. Se formaron dos grupos, el grupo 1 (10 personas mayores con estimulación somatosensorial del pie) y el grupo 2 (10 personas mayores con ejercicios de Tai Chi). Ambas intervenciones recibieron seis sesiones. El instrumento para medir el equilibrio dinámico fue el test time up and go (TUG). El análisis de datos utilizó la prueba de Mann-Whitney con una significación de 0,05.*

**Resultados:** *La prueba de Mann-Whitney mostró que  $p=0,54$  ( $p<0,05$ ), lo que indica que no hubo diferencias significativas en el aumento del equilibrio dinámico en los ancianos entre los grupos de estimulación somatosensorial del pie y ejercicio de Tai Chi.*

**Conclusión:** *La estimulación somatosensorial del pie es tan buena como el ejercicio de Tai Chi para mejorar el equilibrio dinámico en los ancianos. Se necesitan más estudios con un tamaño de muestra más grande y un diseño de ensayo de control aleatorio para mejorar la evidencia.*

**Palabras clave:** *Equilibrio dinámico, anciano, estimulación somatosensorial del pie, Tai Chi.*

## INTRODUCTION

Indonesia enters the aging population period with the prevalence of injuries due to falls being 67.1 percent at the age of 65-74 years, and 78.2 percent at 75 years and above. The elderly have physical and psychological changes (1-4) data about frailty transition is limited. This study aimed to obtain data on prevalence of frailty, its risk factors, frailty state transition and its prognostic factors, as well as to develop prognostic score for frailty state transition. Methods: Multicenter study on subjects aged  $\geq 60$  years old was done to obtain the prevalence of frailty status and to identify risk factors of frailty. Prospective cohort over 12 months was done to obtain data on frailty state transition. Multiple logistic regression analysis was performed to identify its prognostic factors from several clinical data, which then were utilized to develop prognostic score for frailty state worsening. Results: Cross-sectional data from 448 subjects showed that 25.2% of the subjects were frail based on Frailty index-40 items. Risk factors of frailty were age (OR 2.72; 95% CI 1.58-4.76. Those physical

changes lower balance and increase the risk of falls in the elderly. About 30-50 % of the elderly population experiences a fall every year (5-7).

One method to improve the balance in the elderly is somatosensory stimulation of the foot. The stimulation is the direct stimulation of sensory receptors in the foot performed by physiotherapists. Sensory receptors in the legs are components of the motion balance function. It consists of cutaneous receptors and proprioceptors. A previous study reported that somatosensory stimulation of the foot improved balance in the elderly (8-10).

Another method to improve elderly balance is Tai Chi exercise. Tai Chi exercise improves balance control and increases lower limb muscle strength in older adults (11,12). The movement changes the base of support from a double stance to single leg standing. So, the elderly will get used to being in a labile body position. The balance will be trained with the Tai Chi movement repetition (11). Until now, the most effective method of improving balance in the elderly has not been found. This paper compares somatosensory stimulation of the foot and Tai Chi exercise on the dynamic balance in the elderly.

## METHODS

This research was an experimental study with pre and post-test design. The population in this study was all elderly at Griya Wreda Nursing Home, Rungkut, Surabaya. Inclusion criteria: age 60-70; BMI 18.5-24.9 kg/m<sup>2</sup>; no history of stroke, Parkinson's disease, or fractures in the lower extremities; walk independently without using aids such as tripods, walkers, sticks, and wheelchairs; able to communicate both ways. The independent variables were somatosensory stimulation of the foot and Tai Chi exercise, while the dependent variable was dynamic balance.

There were two groups, group 1 (10 older people with somatosensory stimulation of the foot) and group 2 (10 elderly with Tai Chi exercises). Both interventions were given six sessions. The instrument to measure dynamic balance is the time up and go (TUG) test (13)

Somatosensory stimulation of the foot was done 30 minutes in each session daily for six

days. While sitting, the elderly were given fine touch stimulation with an olive oil medium, rough touch with a dry towel medium, skin pressure stimulation, skin vibration, and skin strain. Then, the authors gave passive movement in the joints of the ankles and toes. Meanwhile, Tai Chi exercise was performed twice a week for three weeks for 30 minutes per session. While standing, there are ten movements with eight repetitions for each movement (14).

The tools and materials used in group 1 were olive oil (hypo allergen), a dry towel (one towel in every respondent), a meter, a stopwatch, and stationery. Meanwhile, group 2 used a speaker, a compact disc for Tai Chi exercise, and a stopwatch. Data collection was age, height, and weight measurement in the respondents. In addition, the authors assessed dynamic balance six times every pre- and post-intervention. Furthermore, data analysis used the Mann-Whitney test with a significance of 0.05 to compare the differences between somatosensory stimulation of the foot and Tai Chi exercise on balance in the elderly. This paper obtained ethical clearance from the

Faculty of Medicine, Universitas Airlangga, with certificate number 58/EC/KEPK/FKUA/2016.

**RESULTS**

Table 1 shows that the average and standard deviation of age in group 1 were 63.8±1.8 years and in group 2 were 62±2.2 years. In addition, the average and standard deviation of Body Mass Index (BMI) in group 1 were 22.1±1.5 kg/m<sup>2</sup> and in group 2 was 22.1±1.4 kg/m<sup>2</sup>. The age and BMI were homogeneous because the value p>0,05 on homogeneity tests.

Table 2 shows a decrease in TUG test results in pre and post-intervention in both groups. The interpretation is there is an increased dynamic balance in the elderly. In addition, the data distribution is normal in group 1 but not normal in group 2.

Table 3 and Figure 1 describe that somatosensory stimulation of the foot (group 1) and Tai Chi exercise (group 2) improve dynamic balance

Table 1  
The mean and standard deviations of characteristic demography of subjects

Characteristic of demography	Group 1	Group 2	P-value homogeneity tes
	Mean±SD	Mean±SD	
Age (years)	63.8±1.8	62±2.2	0.07
BMI (kg/m <sup>2</sup> )	22.1±1.5	22.1±1.4	0.07

Table 2  
The mean and standard deviations of the TUG test result (n=10)

Variables	Group 1	Group 2
	Mean±SD	Mean±SD
TUG (second)		
Pre	12.9±0.9*	10.8±0.6
Post	1.1±1.3*	8.7±0.5
p-value	0.02**	0.00**

\* Abnormal distribution data  
\*\* significant if p<0,05

Table 3  
Mann-Whitney test in the TUG test results between bot groups

Variables	Delta	p-value
ΔTUG Group 1	1.8±1.6	0.54
ΔTUG Group 2	2.1±0.3	

\* significant if p<0,05

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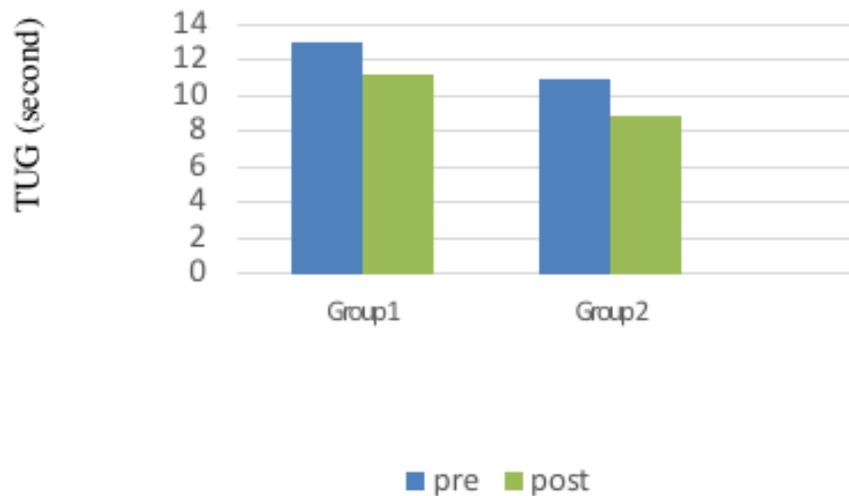


Figure 1. Dynamic balance changes in both groups.

in the elderly. However, the Mann-Whitney result obtains  $p=0.54$ , indicating no significant difference in increasing dynamic balance in the elderly between somatosensory stimulation of the foot and Tai Chi exercise groups.

### DISCUSSION

In this study, most respondents were late elderly at the age of 56-65 years old. Women aged 60 to 70 years are the most unstable when standing on a flat floor due to the increasing body sway (15). In this paper, Body Mass Index (BMI) in most respondents was less than 24.9 (normal weight). Obese individuals experience posture instability because they do not have a quick reaction from the body when there is a balance disorder. Obesity also decreases flexibility, which will reduce the dynamic balance. So the sample in this study was limited to a BMI value below 24.9 kg/m<sup>2</sup> (normal weight) to minimize bias (15,16).

The somatosensory stimulation of the foot increases the sensitivity of somatosensory receptors and neuromuscular stimulation. In addition, it also improves the elasticity of the muscles in the leg. In this paper, there was improved dynamic balance in group 1, possibly because proprioceptive stimulation of the legs

was responded to continuously by the cerebellum. Physiologically, the cerebellum serves as an error correction in every repetitive movement in the body (17). Furthermore, Merkel's receptors respond to pressure stimuli on the soles of the foot, and Ruffini's receptors react to strain stimuli on the skin of the feet. The activation of both receptors plays a role in maintaining balance (18).

A previous study reported that the somatosensory stimulation of the foot with vibration in the soles of healthy elderly feet for several minutes could immediately affect the increased sensitivity of the soles (19). Passive movement in the ankle joint over and over again will also stimulate muscle spindle muscle receptors. The muscle spindle is the main component of the proprioceptive builder in the ankle joint, providing input to the cerebellum. The cerebellum is a center to correct movement reactions that disrupt balance (18).

Improved dynamic balance in group one is in line with a study by Chatchawan et al. (2015). The study provided mass intervention and passive movement in the legs for 30 minutes each session, three times per week for two weeks. The results obtained improved dynamic balance (20). In this paper, Tai Chi exercises also improved dynamic balance in the elderly. Tai Chi exercise provides motor (motor order) and sensory stimulation (sensory order) in the body. Muscle contractions in motor stimulation improve muscle strength

to affect dynamic balance. At the same time, sensory stimuli in muscles and joints improve proprioceptive functions. Furthermore, the increased musculoskeletal and proprioceptive functions improve postural control. Good postural control increases dynamic balance, especially in the elderly. This paper aligns with previous studies that reported increased mobility in older adults (21) and middle-aged women (22) providing a smooth, continuous and low intensity activity. It has been promoted to improve balance and strength and to reduce falls in the elderly, especially those 'at risk'. The potential benefits in healthy younger age cohorts and for wider aspects of health have received less attention. The present study documented prospective changes in balance and vascular responses for a community sample of middle-aged women. Seventeen relatively sedentary but healthy normotensive women aged 33-55 years were recruited into a three times per week, 12-week Tai Chi exercise programme. A further 17 sedentary subjects matched for age and body size were recruited as a control group. Dynamic balance measured by the Functional Reach Test was significantly improved following Tai Chi, with significant decreases in both mean systolic (9.71 mmHg after Tai Chi intervention.

### CONCLUSION

Somatosensory stimulation of the foot and Tai Chi exercise improve dynamic balance, both are equally effective in increasing the balance of the elderly. Further research should evaluate how long it takes to maintain increasing dynamic balance in both interventions.

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