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Gender effect on various standing ability in elderly Thai population

Theerasak Boonwang[1], Wichai Eungpinichpong[2, *], Kwanchanok Yimtae[3]

[1] Division of Exercise and Sport Sciences, Graduated School, Khon Kaen University, Khon Kaen, Thailand
[2] School of Physical Therapy, Faculty of Associated Medical Sciences, Khon Kaen University, Khon Kaen, Thailand
[3] Department of Otorhinolaryngology, Faculty of Medicine, Khon Kaen Univesity, Khon Kaen, Thailand
*Correspondent author: wiceun@yahoo.com

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Abstract

Standing balance is important for daily living activities, especially in the aging population. The objective of this study is to determine the gender effects on standing ability in the elderly Thai population. A cross-sectional study was designed for Thais 60–80 years old (n=109). Eight standing balance tests consisted of bipedal on both a stable and foam surface and unipedal standing on the left and right legs. All tests were performed both with eyes open and with eyes closed. Sway velocity was significantly higher in women compared with men in Right leg standing with eye open condition (p=0.017). Differences between left and right leg were found in men during standing eyes-open tests (p=0.00). ANCOVA found no relationship between demographic data (BMI, weight, and height) and sway velocity in either men or women. Men presented better stability indicated by lower sway velocity on right leg standing balance tests. Balance exercises for the elderly should be implemented for both genders, especially for elderly women. In conclusion, gender differences were presented in one leg standing condition but no relationship between BMI and sway velocity was found in Thai elderly population.

Keywords: Thai, elderly, standing balance, gender difference

1. Introduction

Standing balance is the ability of an individual to maintain his or her body's center of gravity vertically over the base of support with the feet contacting the ground [1]. Appropriate activities of motor control in the central nervous system and sufficient sensory information from the proprioceptive, vestibular, and visual systems are required for individuals to maintain postural equilibrium [2]. Functional decline of visual, neuromuscular, and sensory systems resulting from advanced age were found to be significantly related with falloff postural control capacity [3]. Impairment of balance ability was found to be a strong indicator for falling incidence in the elderly population. Previous studies indicated that falling in the elderly can lead to severe injuries, e.g., skull or lower extremity fractures, that demand a large treatment cost [4]. Early evaluation of balance ability may help to prevent injury in the aging population [5].

Standing balance in the elderly can be evaluated under both bipedal and unipedal standing conditions [6]. The Sensory Organization Test (SOT) is a widely accepted method for determining the utilization of visual, vestibular, and proprioception sensory information for maintaining a balanced standing position [7]. Moreover, the unipedal standing test carries out a somatosensory evaluation while the subject performs a functional task [8].

The search for gender differences in standing balance has been inconclusive. Several studies have found no significant gender differences in standing balance among young, healthy subjects [9], only among older adults [10]. On the other hand, studies have found greater postural sway in elderly males compared with females [12], and one study found greater sway in women, which was caused by a function of body weight: muscle mass ratio [13]. To the author's knowledge, there has been no study that aims to determine standing balance value or determine gender effects in standing balance ability in elderly Thai subjects. Thus, the objective of this study was to determine the gender effects on standing ability in the elderly Thai population. The author also evaluates the relationship between the body mass index (BMI), weight, height, and sway velocity during the performance of eight standing balance tests.

2. Method

2.1 Study Population

Local healthy elderly men and women were included for this study. All participants had healthy standing ability and cognitive functioning and met the following criteria: able to maintain a stable standing position for at least three minutes and no cognitive impairments. Participants who had signs of severe injury of the lower extremities or back that might affect standing and walking performance, reported neurological or musculoskeletal disorders or symptoms of any disease related to impairment of standing or walking, or used a medication involving alteration of standing balance were excluded from this study. All participants completed a visual acuity test using the Snellen chart to ensure that they did not have a problem maintaining balance while visually assisted. Participants who commonly wear glasses in their daily activities wore them during the tests. All participants were shown the normal Snellen test. Participants were also asked to complete the Edinburgh Handedness test [14] online to determine their dominant side. This study was approved by Office of the Khon Kaen University Ethics Committee in Human Research (project number HE591379). All subjects provided their signatures on consent forms after reading and understanding the details of the study as explained by the researchers.

2.2 Equipment and protocol

Postural control performance during standing was evaluated by the Posturography (Basic Balance Master, Natus Medical Inc.). The station consisted of a computer containing software to calculate standing balance ability in various standing conditions. The computer was connected to a 135 x 155 x 15 cm (W x D x H) force plate. The standard foam pad from the manufacturer (46 x 46 x 13 cm, Natus Medical Inc.) was included to evaluate the ability of subjects to stand on an unstable surface.

Participants completed a standing test consisting of four bipedal followed by four unipedal tests. For the bipedal standing test, participants were asked to perform quiet standing with two feet placed on the force plate. Participant's feet were placed at the marking point on the surface of the force plate. The bipedal test included eyes open on stable surface (SEO), eyes closed on stable surface (SEC), eyes open on foam surface (FEO), and eyes closed on foam surface (FEC). The unipedal standing test consisted of left leg standing with eyes open (LEO), left leg standing with eyes closed (LEC), right leg standing with eyes open (REO), and right leg standing with eyes closed (REC). Participants were instructed to perform 10 seconds of quiet standing with both arms placed at the sides for all testing conditions. Participants were allowed to make 2 attempts at each test, and 30 seconds of rest was provided before the next test. The average value of 2 center of pressure velocity for each subject was used for the analysis. Shoes and socks were removed before participants stepped on the force plate in order to discriminate effects of shoe height and prevent slippage that may occur when subjects place their feet on the force plate. Standing balance was determined based on two types of standing: bipedal and unipedal. Sway velocity was determined with center of pressure velocity (COPv) data presented in angular velocities (degree/second) from different standing conditions.

2.3 Statistics

The participants' characteristics were presented in mean and standard deviation. The COPv data from all standing balance tests were examined for normal distribution using the Kolmogorov Smirnov test. Independent t-tests were used to indicate differences in demographics and the COPv data by gender. The COPv data determined homogeneity of variance using Levene's test. Then, analysis of covariance (ANCOVA) was employed to evaluate the relationship by gender between BMI, weight, and height in the eight standing balance tests. The difference in COPv between left and right legs was determined by using a paired t-test. SPSS version 17 was used to analyze all data.

3. Results

There were no significant differences between men and woman regarding age, weight, and height data (Table 1). Most participants were right handed. All participants showed highest sway velocity on FEO and lowest on SEO.

Table 1 Characteristics of subject

	Total (n=109)	Men (n=53)	Women (n=56)	*p* value
Age, year	69.88 ± 5.20	70.53 ± 5.33	69.59 ± 4.98	.565
Weight, Kilogram	60.67 ± 10.38	62.78 ± 10.15	58.81 ± 10.19	.646
Height, centimeters	158.68 ± 8.01	163.87 ± 7.24	153.91 ± 5.40	.050
BMI	24.06 ± 3.54	23.35 ± 3.36	24.76 ± 3.56	.747
Right side dominant	102	49	53	.752

3.1 Gender differences in sway velocity

Sway velocity was significantly higher in women (1.05±0.37 degree/sec) compared with men (0.87±0.42 degree/sec) in REO condition (p=0.017). Another standing condition presented no difference of sway velocity between genders (Table 2). The male group showed significant difference (P < 0.001) between left and right legs during standing with eyes open (Table 3).

Table 2 Sway velocity compare between men and woman in eight standing balance task

	Overall (n=109)	Men(n=53)	Woman (n=56)	*p* value
Sway velocity (degree/sec)				
SEO	0.39 ± 0.16	0.40 ± 0.19	0.37 ± 0.12	.383
SEC	0.52 ± 0.24	0.56 ± 0.30	0.49 ± 0.16	.168
FEO	0.88 ± 0.30	0.84 ± 0.25	0.91 ± 0.35	.258
FEC	1.55 ± 0.43	1.55 ± 0.50	1.56 ± 0.35	.940
LEO	1.12 ± 0.37	1.11 ± 0.33	1.12 ± 0.39	.904
LEC	1.38 ± 0.55	1.33 ± 0.56	1.42 ± 0.54	.437
REO	0.96 ± 0.55	0.87 ± 0.42	1.05 ± 0.37	.017
REC	1.37 ± 0.52	1.28 ± 0.58	1.45 ± 0.44	.094

SEO = Eye open on stable surface, SEC = Eye close on stable surface, FEO = Eye open on foam surface, FEC = Eye close on foam surface, LEO = Left leg standing with eye open, LEC left leg standing with eye close, REO = Right leg standing with eye open, REC = Right leg standing with eye close.

Table 3 Sway velocity compare within subject on unilateral standing

	Sway velocity on unipedal standing (degree/sec)		*p* value
	Left	Right	
Men			
Eye-open	1.11±0.33	0.87±0.42	<.001
Eye-close	1.33±0.56	1.28±0.58	.400
Woman			
Eye-open	1.12±0.39	1.05±0.37	.272
Eye-close	1.42±0.54	1.45±0.44	.744

3.2 Relationship between demographic data (BMI, weight, and height) and sway velocity

According to the results of ANCOVA in SEO, SEC, FEO, FEC, LEO and LEC, BMI, weight, and height were not covariate to sway velocity in any of the eight standing balance tests, and there was no significant difference level (p<0.05) in compared interaction between demographic data and gender (BMI*gender, weight*gender, and height*gender) (Table 4).

Table 4 ANCOVA analysis of association between participant's demographic data (BMI, Weight, and Height) and sway velocity by eight standing balance test

	Men	Woman	BMI	Weight	Height
Sway velocity (degree/sec)					
SEO	0.40±0.19	0.37±0.12	.339	.288	.537
SEC	0.56±0.30	0.49±0.16	.973	.711	.387
FEO	0.84±0.25	0.91±0.35	.115	.256	.771
FEC	1.55±0.50	1.56±0.35	.787	.913	.327
LEO	1.11±0.33	1.12±0.39	.915	.638	.128
LEC	1.33±0.56	1.42±0.54	.622	.739	.843
REO	0.87±0.42	1.05±0.37	.937	.996	.678
REC	1.28±0.58	1.45±0.44	.472	.581	.959

SEO = Eye open on stable surface, SEC = Eye close on stable surface, FEO = Eye open on foam surface, FEC = Eye close on foam surface, LEO = Left leg standing with eye open, LEC left leg standing with eye close, REO = Right leg standing with eye open, REC = Right leg standing with eye close.

4. Discussion and conclusion

The objective of this study was to determine the gender effects on standing ability in the elderly Thai population. Results of the study demonstrated that sway velocity was significantly higher in women compared with men in REO condition. Greater sway velocity indicates decrease of postural stability. The results of this study were in agreement with previous work. One leg standing balance time was significantly longer in older Japanese men (62.2 ± 25.1 second) compared with women (53.4 ± 23.1) (p=0.01) [15]. Longer standing time may indicate better ability to maintain balance. A possible explanation of better stability in men lies in motor coordination ability. Longitudinal studies have indicated that elderly women had greater decline of motor coordination than men [16]. Another study indicated that the poorer stability of women was caused by less muscle mass compared to men [17]. Better standing stability in males over females resulted from inequalities of motor and sensory systems between genders [12] and greater maintenance of muscle mass in males [18]. Elderly men presented elevated physical fitness levels and also demonstrated higher levels of stability compared with elderly women [19].

Sway velocity in SEO, SEC, FEO, FEC, LEO, LEC, and REC showed no differences between men and women. The results of the present study were similar with previous work. Bryant et al. compared standing balance ability with feet together with eyes open and closed and with one leg standing with eyes open in 97 people between 50–67 years of age. Results showed no significant differences between gender groups in any double-limb or single-limb standing condition [20]. Another study showed no statistical difference in balance scores between older men and women (over 65 years) in the one-leg standing test and suggests differences of postural stability between genders was caused by physical factors such as strength [21] and physical fitness levels [22,28].

The present study also compares differences in velocity during one-leg standing tests with eyes open and eyes closed for both genders. Sway velocity was significantly higher in left leg (1.11±0.33 degree/sec) compared with right leg standing (0.87±0.42 degree/sec) (p=0.00) in men during eyes-open standing. The results indicated that the right leg showed greater balance performance compared with the left leg. Moreover, right leg sway velocity was signigicantly lower in men than in women when comparing the same standing leg. Elderly men in the present study presented the lowest sway velocity during right-leg standing with eyes open. The result was in agreement with previous studies that have examined gender differences in stability during various types of balance tasks. Older men took a longer time to perform near tandem balance compared with older women in several age ranges (75–89 years) [19]. Less stability in older women compared with men may result from greater decline of neuromuscular control that expresses in lowered ability to stop and turn [23]. and poor lower extremitry performance in ADL activity (walking and stair climbing) [28]. Previous studies reveal that less than 30 seconds of unipedal standing was related to higher risk of falls among the older population [24]. Thus, lower sway velocity in the right leg compared with the left leg in elderly males may be related to a lower risk of falls [25].

Analysis of covariance (ANCOVA) failed to discover a relationship between BMI, weight, and height and sway velocity in elderly men and women. In contrast, some studies indicated that obesity was a factor that altered postural control ability. The amount of fat in the body affects walking and standing balance ability because of the improper ratio of body weight to lean muscle mass. Increased requirements of muscle force to control posture occur during gain of body weight [26]. Thus, differences in sway velocity between men and women may result from greater decline in muscular strength with age in women than in men [27].

The present study has some limitations. First, participants in this study were elderly people. A comparison group such as vertigo patients before and after treatment should be included for extended study. Last, this study did not include other factors related to sway velocity. Previous work indicated that muscle strength [21] and level of physical fitness [22] showed a strong relationship with sway performance while standing.

In conclusion, gender differences in sway velocity among elderly Thai participants were found in REO condition. Differences in sway velocity between left and right leg standing was found in elderly men during eyes-open standing. No relationship was found between demographic data (BMI, weight, and height) and sway velocity in either male or female subjects.

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6. Conflict of Interest

No conflict of interest is declared.

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