Original Article

Thai Classical Dance Exercise for Fall Prevention

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Background: Falls are one of the major causes of injury and loss of independence in the elderly and are significantly associated with increased morbidity and mortality. Balance impairment and muscle weakness are the most prevalent risk factors for falls in the elderly. Several kinds of therapeutic exercises have been demonstrated to reduce the risk of falls in older people. Thai classical dance uses key muscles of the upper and lower extremities to control body balance and to maintain an upright position. Thai classical dance exercise challenges key muscles, providing both muscle strengthening and balance training which can reduce the risk of falls, although those benefits have not yet been documented.

Objective: To evaluate the efficacy of Thai classical dance exercise for fall prevention in the elderly using physical performance tests.

Study design: Randomized controlled trial.

Materials and Methods: A double-blinded randomized controlled trial was conducted at Ramathibodi Hospital during 2014 to 2015. Self-ambulatory older women were randomly assigned to one of two groups. The experimental group participated in daily 10 minute programmed Thai classical dance exercises; the control group participated in daily 10-minute sessions of arm swing exercise. Both groups participated in the exercise programs for 12 weeks. The primary outcome measure was improvement in physical performance as determined by standard tests including 3-meter tandem gait, timed up and go, and chair rise (sit and stand) tests. Physical performance was evaluated at baseline and after 4, 8 and 12 weeks of exercise. Analysis of variance was used to compare the outcomes between the two groups.

Results: There were 19 participants in experimental group and 20 in control group with an average age of 66.4 and 66.9 years, respectively. After 12 weeks of exercise, the experimental group had significantly improved over baseline on the timed up and go test and on the tandem walk test ($p = 0.002$ and 0.001, respectively), and had also significantly improved on the timed up and go test compared to the control group (average 14.2 ± 4.3 to 9.2 ± 2.9 sec, and 13.0 ± 3.8 to 11.2 ± 4.3 sec, respectively; p-value = 0.0125). There was no difference in the chair rise test between the groups.

Conclusion: Daily Thai classical dance exercise for one month is an efficacious way to improve physical performance in older women and to help reduce the risk of falls.

Keywords: Thai classical dance, Exercise, Fall prevention, Physical performance

J Med Assoc Thai 2018; 101 [Suppl. 3]: S119-S126
Website: http://www.jmatonline.com

Falls in the elderly is a significant problem globally which results in many serious complications as well as increased morbidity and mortality. One third of people aged over 65 years and half the people aged over 85 years have fallen at least once[(1)]. Fall-related fractures are the most common injury, especially in older women. In Thailand, hip fractures have a very high socioeconomic impact. In 2008, a cost-utility analysis of osteoporotic hip fractures in Thais reported that the median total cost of a hip fracture per year was US$4,210.60 and the cost per quality-adjusted life year [QALY] was US$ 6,620.52. Cost-utility of a hip fracture

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How to cite this article: Leelapattana P, Unyaphan S, Kraiwattanapong C, Woratanarat P, Kijkunasathain C, Angsanuntsukh C, Wajanavisit W. Thai Classical Dance Exercise for Fall Prevention. J Med Assoc Thai 2018;101;Suppl.3: S119-S126.

in Thai had high impact on 78.8% of the Thai Gross National Product[2]. A 2007 a hip fracture survey in Chiang Mai Province in northern Thailand found the age-adjusted incidence of hip fracture in women aged over 50 years was 368/100,000[3]. The incidence of vertebral fracture in women aged over 50 years was 32.1/1,000 or 54.5/1,000 per person-year; the incidence increased with age[4]. In addition to the direct physical impact, falls also destroy confidence, increase isolation, reduce independence, and cause mental problems in the faller including fear of falling, anxiety, and depression[5]. Naqvi et al[6] reported that risk factors for falls include both extrinsic and intrinsic factors. The extrinsic factors are environmental hazards, e.g., poorly fitting footwear, and uneven pavement. The intrinsic factors are physiological conditions associated with ageing, e.g., natural deterioration in visual acuity and muscle strength, which can make it difficult to balance and to step over potential hazards. They found that the intrinsic factors are the main problem, causing about 90 per cent of falls.

Fall prevention exercise has been demonstrated to be highly effective in reducing falls and, consequently, to significantly contribute to reducing the associated socioeconomic burden by preventing fractures and avoiding hospital admissions. Several kinds of exercise have been developed to improve muscle function and body balance for fall prevention. There are a number of evidence-based studies of exercise programs that reduce the risk of falls. One randomized controlled trial showed that a tailored group exercise program delivered over a nine month period could reduce the risk of falls by up to 54 percent[7]. Tai Chi, a traditional Chinese exercise, has been statistically proven to reduce the risk of falls by increasing body balance and reducing fear of falls[8,9]. However, Tai Chi is not familiar to many Thai people and is only practiced by a limited community.

Thai classical dance has been assumed to affect muscle function of the lower extremities and as well as body balance through synchronous movement of the extremities. If routine practice of Thai classical dance can enhance the muscle strength of the upper and lower limbs which contribute to standing, walking support, and body balance, it could also reduce the incidence of falls.

To fill the evidence gap regarding Thai classical dance, a randomized controlled trial was conducted to compare muscle function and body balance between a group of older women who performed Thai classical dance exercise and a group who performed an arm swing exercise.

Materials and Methods

During December 2014 to April 2015, females aged more than 60 years old were recruited. All participants had to be independent community-dwelling elderly. Individuals with a neuromuscular disease, cerebrovascular disease, Parkinson's disease, or dementia and those who were currently participating in a program of muscle and balance training exercises were excluded from the study. This study was approved by Ramathibodi Ethical Committee.

After the participants were enrolled, computerized randomization was used to divide them into one of two groups, a Thai classical dance exercise group and a control group. The random numbers were generated in a block fashion using the STATA 12.0 program. Group assignments were concealed in sealed envelopes until after the initial physical performance tests. Participants in both groups underwent physical performance tests which were composed of 3 standard tests: the chair rise (sit and stand) test, the up and go test, and the 3-meter tandem walk test (Figure 1 to 3).

Interventions

1) Thai classical dance exercise group

The programmed exercise for this group

Figure 1. Timed up and go test. Start by sitting on a 45 cm high straight back chair, fold the arms over the chest, then rise from the chair and walk straight ahead for 3 meters, turn around and walk back, then sit back down. The elapsed time is recorded in seconds.

Figure 2. Tandem walk test. Walk along a straight line for 3 meters with the heel of the front foot touching the toes of the standing foot at each step. The elapsed time is recorded in seconds.

Figure 3. Chair rise Test. Sit on the same chair with feet flat on the floor and spread apart at shoulder width. Rise from the chair until standing fully erect, then sit down again with arms folded across the chest. Repeat 5 times. The elapsed time is recorded in seconds.

Figure 4. Warm up and Cool down. Before the beginning and the end of the exercise, participants repeated stretching exercises for the upper and lower extremities and the trunk muscles for 5 minutes.

included 3 phases: warm-up, exercise, and cool down (Figure 4, 5). Participants were instructed to dance to Thai classical music following multimedia instructions for 10 minutes each day.

2) Control group

The control group performed an arm swing exercise sitting on a chair for 10 minutes each day (Figure 6).

All participants in both groups received multimedia instructions according to their group assignment. They followed the exercise protocol and recorded their compliance in a logbook.

All participants were followed-up at 4, 8 and 12 weeks. At each follow-up, participants in both groups repeated the physical performance tests, their logbook records were reviewed, and their level of compliance was evaluated. If any participant had a compliance rate less than 80%, they were counselled by a clinical research associate in an effort to improve compliance. In addition, telephone interviews were conducted at least once a week to encourage participants. During the phone interviews, participants were asked about any problems they had and were offered solutions as appropriate.

Statistical analysis

Student's t-test was used to calculate normally distributed continuous data and the Mann-Whitney U test was used for data which was not normally distributed. ANOVA and the post-hoc Scheffe test were used to compare differences in elapsed time in both groups. The Chi-square test was used for categorical data. Statistical significance was set as $p<0.05$. All analyses were performed using STATA 12.0 program (StataCorp, College Station, Texas, USA).

Sample size estimation

The sample size was calculated using hypothesis testing. Details of the testing technique

are as follows.

$n/group = 2 (Z_{\alpha/2} + Z_{\beta})^2 SD^2 / (x_1 - x_2)^2$

$= 2 (1.96 + 0.84)^2 (0.98)^2 / (10.96 - 12.01)^2$

$= 14$

An additional 10% was added to for potential cases lost to follow-up.

$n/group = 14 + (14 \times 0.1)$

$= 16$

Alpha (α) = 0.05

Power (β) = 0.90

As reported in a 2010 cross sectional prospective cohort study of fall predictors in the community-dwelling elderly by Gallagher et al, the timed up and go test is a significant predictor of falls[10]. In that study, females who had never fallen completed the test in an average of 10.96 seconds, while those who had fallen previously completed the test in 12.01 seconds.

Figure 5. Thai Classical Dance Exercise. Start by walking forward 3 steps with arms synchronously balanced in Thai dance style, then stand on one leg for 3 seconds. Repeating with arms and leg reversed. Performed to Thai classical music continuously for 10 minutes.

Figure 6. Arm swing exercise. Sit on a chair with feet flat on the floor. Extend both arms forward at shoulder level, then promptly swing the arms down and backward. Continue swinging back and forth for 10 minutes.

Results

Fifty participants were recruited and assessed for eligibility. Of those, five were excluded because of current involvement in other exercise programs and one declined to participate, leaving 44 participants available for the trial. After 12 weeks of intervention, 19 participants in the Thai Classical Dance Exercise group and 20 in the control group completed the protocol. The average age of the experimental group was 66.4 years, and of the control group was 66.9 years. No statistically significant difference in the baseline characteristics between groups was found (Table 1). Similarly, there were no significant difference in the baseline pre-intervention performance test results between the groups (Table 2).

Comparison of physical performance test results pre- and post-intervention showed that the experimental group had statistically significant improvement at 12 weeks in all three tests, while the control group did not improve significantly in any of the tests (Table 3 and Figure 7). In fact, the experimental group began to show statistically significant improvement in the timed up and go test after only 4 weeks of intervention. There was no statistically significant difference in the chair rise test between the groups.

Compliance with the study protocol in the experimental group was 86% and in the control group was 91%. No complications such as falling or fall-related injuries were detected in either group during the trial.

Discussion

The objective of this study was to compare muscle function and body balance in older women who practice daily Thai classical dance exercise with a control group to evaluate the reduction in risk of falls. In this study, physical performance tests were used to assess muscle weakness and balance impairment caused by ageing and disuse, the most prevalent modifiable risk factors of falls and fall-related fractures in the elderly. Published literature[10,11] has indicated that the results on the timed up and go test, the tandem walk test, and the chair rise test have been shown to be correlated with lower fall risk. The timed up and go test is a screening procedure used globally and is a clinically important procedure for the assessment of physical function in older adults[12].

Fall prevention exercises must focus on

Table 1. Baseline characteristics of the Thai dance exercise group and the control group

Variable	Exercise (n = 19)	Control group (n = 20)	*p*-value
Avg. age [years, (SD)]	66.4 (4.2)	66.9 (5.6)	0.74
Avg. age at menopause [years, (SD)]	48.5 (3.1)	49.9 (3.7)	0.21
Avg. weight [kg, (SD)]	58.8 (13.8)	57.9 (9.4)	0.81
Living alone (%)	2 (10.5)	2 (10.5)	0.88
Fear of falling (%)	12 (63.2)	12 (60.0)	1.00
Sitting >6 hours (%)	10 (47.4)	9 (55.0)	0.75
Hypertension (%)	13 (68.4)	13 (65.0)	1.00

Table 2. Baseline physical performance tests of both groups prior to intervention showed no statistically significant difference

Pre-intervention	Exercise (n = 19)	Control group (n = 20)	*p*-value
Timed up & go (sec), mean (SD)	11.0 (3.3)	10.5 (2.7)	0.613
Tandem walk (sec), mean (SD)	14.2 (4.3)	13.3 (4.8)	0.347
Chair rise (sec), mean (SD)	12.8 (2.6)	11.3 (3.1)	0.126

Table 3. Physical performance test results at baseline and after 4, 8, and 12 weeks of exercise intervention

Outcome	Time to follow-up				
	0 week	4 weeks	8 weeks	12 weeks	*p*-value
Timed up and go test (sec), mean (SD)					
Thai classical dance group	11.0 (3.3)	9.2 (1.8)	8.2 (1.7)	8.0 (1.5)	0.0020
p-value compared with 0 week	-	0.014	0.003	0.002	-
Control group	10.5 (2.7)	10.2 (2.4)	9.5 (2.0)	10.1 (3.0)	0.6833
p-value compared with 0 week	-	0.985	0.698	0.975	-
Tandem walk (sec), mean (SD)					
Thai classical dance group	14.2 (4.3)	13.3 (4.8)	10.8 (3.0)	9.6 (2.9)	0.0010
p-value compared with 0 week	-	0.916	0.067	0.005	-
Control group	13.0 (3.8)	12.7 (3.9)	12.8 (5.8)	11.2 (4.3)	0.5761
p-value compared with 0 week		0.998	1.000	0.675	-
Chair rise test (sec), mean (SD)					
Thai classical dance group	12.8 (2.6)	12.1 (3.1)	10.5 (2.2)	10.4 (2.9)	0.0169
p-value compared with 0 week	-	0.908	0.097	0.069	-
Control group	11.3 (3.1)	11.7 (3.4)	11.0 (2.9)	11.3 (3.4)	0.9075
p-value compared with 0 week	-	0.990	0.984	1.000	-

strengthening leg and ankle muscles and challenging balance. Muscle strength of the lower extremities, including hip abductors, hip flexors, knee extensors, plantar flexors, and body balance are related to falling[13]. Programmed therapeutic exercises for fall prevention must include resistance training and exercises performed while standing. Effective fall prevention cannot be achieved through chair-based programs and seated gym machines. In the present study, the control group was assigned to perform an arm swing exercise while sitting on a chair, whereas the experimental group performed a programmed standing exercise using Thai classical dance.

The results of this study demonstrate that the Thai classical dance exercise group achieved statistically significant improvement over baseline in

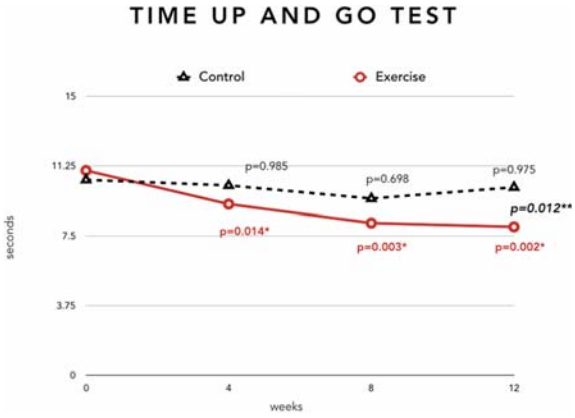

Figure 7. Graph of the timed up and go test measured at each follow-up showed significant improvement in elapsed time from baseline in the Thai dance group (p = 0.014* at 4 weeks, 0.003* at 8 weeks, and 0.002* at 12 weeks) and significant difference from the control group at the end of the 12 week protocol (p = 0.012**).

the timed up and go test at every follow-up period. The experimental group also achieved statistically significant improvement compared to the control group, with better performance evidenced even at only 4 weeks after the start of intervention.

Although the tandem walk test results showed significant improvement over baseline after 12 weeks of exercise in the experimental group, there was no significant difference compared to the control group. Results were the same for the chair rise test. The chair rise test is usually used to measure the muscle power of upright movement, especially the strength of the hip and knee muscles. Tandem standing and tandem walking measure the postural capacity to control side swaying which determines static and dynamic body balance, whereas the timed up and go test is a combination test of muscle function, flexibility, and body balance. The programmed exercises for both groups in this study also included stretching exercises during warm up and cool down which could enhance the flexibility and muscle strength of the lower extremities. Participants in this study were rather healthy community-dwelling women, with an average age of 66 years. The chair rise test, which is a test for assessing the motor power of the lower extremities, showed gradual significant improved in all participants in both groups. However, the timed up and go test, which is a combined measure of muscle function and body balance status, showed significant improvement in the experimental group compared to the control group.

Li et al[14] reported that Tai Chi exercise can improve physical performance test results after exercising for 12 weeks. Voukelatos et al[15] demonstrated that Tai Chi can prevent falls in healthy older people. Tai Chi can be effective for those who have not yet fallen or who have only mild deficits of strength or balance; it is less effective for those who have already fallen or who are more frail[16]. However, as Tai Chi is generally practiced by larger groups at a central location, it would be problematical to implement a Tai Chi program for Thai community-dwelling older adults. On the other hand, Thai classical dance is the basis of all traditional Thai folk dances and is routinely performed in rituals throughout the country. Practicing of Thai classical dance has been observed to vigorously train muscle strength of the both lower and upper extremities. The authors invited a volunteer with expertise in Thai classical dance to attend the gait laboratory at Ramathibodi Hospital to analyze muscle performance during Thai classical dancing using surface EMG recording electrodes (Figure 8). It has convinced that the key muscles which can help prevent falls include the hip flexor, hip abductor, knee extensor, and ankle plantar flexor, are actively employed and actually predominate during the one-leg standing phase of Thai classical dance.

The Thai classical dance exercise appeared to be easy and familiar to the participants, as reflected in the 86% compliance with the daily Thai classical dance exercises in the experimental group.

The strength of this study is that it is a randomized controlled trial with a double-blinded. Compliance by all participants was monitored for contamination and co-intervention using a participant logbook and by telephone interviews to minimize potential bias.

The limitation of this study is the short duration of the follow-up. The authors of this study followed the participants for 12 weeks. However, this study shows significant improvement in the 2 tests as early as 12 weeks. Longer term follow-up could potentially show significant improvement in the other tests. Further study with long-term follow up is necessary. Second, our study was based on healthy older women, so the results do not necessarily extend to older men or to patients with medical co-morbidities and frailty.

Conclusion

Daily practice of Thai classical dance exercises

Figure 8. A volunteer has attended the gait laboratory of Ramathibodi hospital to analyze the muscle performance during Thai classical dancing using surface EMG recording electrodes. The key muscles which can prevent falls are actively employed during the one-leg standing phase.

is effective for enhancement of physical performance in elderly women. It challenges the effects of muscle deterioration, particularly those muscles that keep posture upright and control body movement to allow walking without swaying. Thai classical dance is easy to practice and is familiar to Thai people. Programmed exercise with Thai classical dance for 4 to 12 weeks is effective in improving results on physical performance tests and is an alternative therapeutic exercise to help older women prevent falls. Many of traditional dances in the world are ancient dance rituals or folk dances, belonging to the heritage of ethnic minorities. In all dance, which emphasizes on the slow movements of the legs, arms and hands could be modified to fall prevention exercise for the elderly.

What is already known on this topic?

Falls in elderly people are associated with a higher rate of morbidity and mortality. Several kinds of exercises can improve muscle strength and body balance and thus reduce the risk of falls. Thai classical dance exercise, which is easy and familiar to Thais, improves muscle function and body balance by synchronous movement of both upper and lower extremities, but these benefits have not been documented.

What this study adds?

This study demonstrates that ten minutes of daily Thai classical dance exercise for 4 to 12 weeks is efficacious in improving physical performance in older women and is an alternative means of helping reduce the risk of falls in the elderly.

Potential conflicts of interest

The authors declare no conflict of interst.

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