วารสารวิทยาศาสตร์และเทคโนโลยีการกีฬา ปีที่ 15 ฉบับที่ 1, กรกฎาคม 2558
Journal of Sports Science and Technology Volume 15, No. 1,July 2015

นิพนธ์ต้นฉบับ (Original article)
เวชศาสตร์การกีฬา (Sports Medicine)

EFFECT OF 4 WEEK SIMPLE BALANCE EXERCISE ON BALANCE ABILITY IN THAI ELDERLY

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ABSTRACT

The objective of this study was to evaluate the short-term effects of 4 weeks balance training program by using simple daily activity living exercise training program on balance ability in Thai elderly person. Forty two participants (36 females and 6 males) were randomly divided into two groups: training (n=21) and control group (n=21). In exercise group, simple balance training was performed at nursing home and controlled by the researcher. Participants were trained once per day, 5 days per week for 4 weeks. In control group, participants were asked to maintain their normal physical activities throughout the experimental period. The two groups of subjects were assessed their balance abilities using single leg balance time test (SLBT) and 3-m timed up and go test, (TUGT) at pre- and post- training program. Balance ability was compared between exercise and control group using Mann-Whitney U test. Within group comparison was used Wilcoxon matched-pair signed-rank test. The level of statistically significant difference for all analyses was set at p-value less than 0.05. The results found that after 4 weeks, the improvement of balance abilities was demonstrated by increment of SLBT and decrement of TUGT in exercise group ($P < 0.05$). Moreover subjects in exercise group achieved significantly higher of percent change in the balance ability than subject in control group ($P < 0.05$). The present study indicated that the designed balance training program used in this study has shown successful effects on improving balance ability for the elderly to prevent falls. Since its ease to use and simply to perform anywhere, anytime in every household, therefore this program should be recommend for the elderly people.

(Journal of Sports Science and Technology 2015;15(1): 203-211)

Key words: simple balance training program, balance ability, fall prevention, elderly

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INTRODUCTION

Falls are common problems in older people which can increase rate of morbidity, bone fractures, disability and mortality. For incidence of falling, previous studies have reported that person (aged 65 – 74 years) has incidence of 28 – 35 % and increase to 32 – 42 % in people aged more than 90 years.[1] Falls can occur from a variety of factors such as lower extremity weakness, gait and balance deficit, functional and cognitive impairment, deterioration of proprioceptive and motor systems, history of falls, impaired activities of daily living[2] which are age-related alterations in body of human. Balance ability is an important skill for the prevention of falls, which based on sensory sensor or sensory input (visual, vestibular, somato-sensory system), analysis part of movement in brain and motor response.[3, 4, 5] Balance training is another sports training to enhance balance and prevent falls while playing sports. Previous study showed the beneficial of balance training effects to the body of persons who participated in the exercise especially elderly persons which can improve the ability in daily life movement and reduce the chance of a fall.[3] Balance training can be trained in various conditions such as one leg or two legs, open-eye or closed-eye, firm-ground or soft-ground and simple exercise or exercise with equipment. Several lines of evidence have demonstrated 4 weeks sensorimotor or balance training was enough to increase the balance ability.[7, 9, 15] However, balance training in some studies was not recommended for the elderly to perform by themselves at home.[6, 7, 8, 9] Since it may require specific equipment (such as Biodex, Wobble board, Balance pads, Rocker board etc.) or high complication in practicing or high intensity, duration and frequency for training program. For these reasons, we have developed an exercise training program using general physical activities in daily life living of aging to improve their balance ability. In addition, this training program was designed for the elderly that should be easy to use and simple to perform anywhere, anytime in every household. Therefore, the aim of this study was to evaluate the effects of 4 weeks balance training program by using simple daily activity living exercise on balance ability in Thai elderly person.

METHOD

This study was performed at nursing home, Thailand from January 2014 till May 2014. Following Mahidol university ethical committee approval, the researcher recruited elderly person who had a single leg balance time lower than 30 seconds.[11, 12] The inclusion criteria were elderly aged more than 60 years, and had resting blood pressure lower than 140/90. The elderly, who could not follow commands or had a severe medical condition that disallowed them to perform exercise, were excluded.

Balance ability testing

After signing the informed consent, general information data including age, sex, underlying diseases, a part of medical history and physical activity readiness questionnaire (PAR-Q) were collected. Subjects were tested for their balance abilities using 2 field tests; 1) Single leg balance time test (SBLT) by recording the duration for subject to maintain the balance of body with one leg and 2) 3-m timed Up and Go test (TUGT) by

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measuring the duration for subject to rise from a chair, walk a 3 m distance, turn around, walk back and sit down. All subjects obtained the same testing process before- and after 4 weeks of training.

Single – Leg Balance Time test (SLBT)

Single-leg balance testing (SBLT) is used to assess the ability to maintain position of body in static balance. The time in one-leg standing balance test was used to indicate the static aspect of balance.[10] Moreover it can be used in a variety of settings and requires minimal equipment or training. In 2005, Janet's research has demonstrated the sensitivity and specificity of SLBT, the value that will be living in a good level (Sensitivity = 67% and Specificity = 89%).[12] Decreased eyes open SLBT time is also associated with an increased risk for falls.

This measurement is simple test for static balance skill or assesses ability to maintain upright balance with a reduced base of support (with one leg stance). Subjects were asked for standing on one leg, eye open, and put the hands on the hip for as long as possible without using the arms or any other support for balance or stability. Subjects stood on flat non-slip surface and placed hands on the hip in facing the wall about 1 meter. Then researcher said “start” as well as stopwatch was started counting, subjects were instructed to stand with one leg whereas other leg was raised above the ground and not attached to the standing leg that used to be maintaining the stability. The stopwatch was stopped counting, if the subject’s leg was touched the ground or touched the standing leg or the subject’s hand moved out from the waist or moved from starting point. Each leg was repeated 3 times and was used to find the average value of each side.

3 m Timed Up and Go Test (TUG-T)

The Timed up & go test (TUG-T) is a test of balance that is commonly used to examine functional mobility in older adults. Subject were asked for standing up, walk 3 m (10 ft), turning, walk back, and sitting down, respectively. If the elderly can make time of the TUG-T less than 20 seconds, indicated that elderly people have be able to move freely without supporter device for movement. In contrast, if the elderly spend time longer than 30 seconds to complete the task that elderly people tend to be more dependent in activities of daily living so they require assistive devices for ambulation. Janet's research has demonstrated the sensitivity and specificity of TUG-T, the value equal 75 and 57 percent.[12]

In this test, testing process was started from researcher instructing the subjects to sit in the middle of the chair, put the hand on thighs, one foot slightly ahead of the other foot, body leaning slightly forward direction. After the signal “Start”, subject get up from the chair, walk as quickly as possible around a cone placed 3 meter away, and return to sit on the chair. The duration of subject’s was counted timer from the “start” signal till the subject sit on the chair. For one trial, the test was done three times. Then researchers use the information to calculate the average value for the each individual.

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RESEARCH METHOD

This study consists of 4 weeks balance training program and pre- and post- of balance ability assessment (pre- and post-test). In order to meet the selected criteria of this study, all subjects were asked to perform body stretching for 5 minutes, which were hamstring stretches; standing calf stretches in warm up and cool down phase. Then, they evaluated SLBT and TUG-T for the 1st assessment record. For experiment, subjects were randomly assigned to exercise or control group. The 2nd assessment was conducted again at the end of 4th week in both groups. Throughout the experiment, subjects were asked to drink ad-libitum.

All subjects trained the balance exercises in nursing home environment, 40 minutes per day, 5 days per week for 4 weeks. In this study, simple balance exercises consisted of 5 practicing exercise including 3 directions of walking exercise (including forward tandem walking, side-step walking and backward walking), 1 of static balance exercise training and 1 of strength exercise training of thigh muscles as described in Table1. In walking exercise, participants were trained near the wall with support rail and walked on a line (thickness of 5 cm and long 5 meters). The distance between the line and the wall were 1 m and the rail is located at a height of 1 meter. Two directions of walking exercise (forward tandem walking and side-step walking) were played for 6 repetitions; distance in 1 repetition is 10 meters each for a total of 60 meters. Whereas backward walking exercise was moved to a direction that subjects could not see and played for 3 repetitions. Strength training of thigh muscles were trained by raise - sit continuously 10 times for 1 set (3 sets). Height of raise was 15 cm.

Statistical analysis

Microsoft Office Excel 2010 was used for calculation of all descriptive data (physical characteristics, SLB-T, 3-m TUG-T and FCS-T) and demonstrated as means and standard errors of the mean. Data were analyzed using SPSS (Windows version 18.0). All data were analyzed by the Kolmogorov Smirnov Goodness of Fit Test for distribution testing. At the baseline, physical data were compared between exercise and control group using Independent *t*-test. Balance ability was compared between exercise and control group using Mann-Whitney U test. Comparison of within group was carried out between pre- and post-testing using Wilcoxon matched-pair signed-rank test (Single leg balance time and 3-m Timed up and go test). The level of statistically significant difference for all analyses was set at p-value less than 0.05.

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Table 1 Simple balance exercise program

All exercises were performed near a stable object (such as horizontal rail etc.) and performed under supervision of a caregiver. All exercises were performed for 30-40 min per day, 5 days per week for the 4 week of training.
Walking training section
Tandem walking Walk heel-to-toe in a straight in 5 meter and turnaround, and tandem walk back to the starting position.
Sidestep walking 5 meter to the left side and then 5 meter to right side, return to the starting position (make sure each foot lifts of the floor).
Backward walking 5 meter and turnaround, and backward walk back to the starting position.
Balance training section
Single-leg stance and three-direction tapping Three directions consist of forward, sideward and backward direction. Standing on two legs in facing the wall position about 1 meter. Lift right foot off of the floor and tap in forward (distance of tapping equal 1 phase of leg.) and return to starting position. Following this process in the sideward and backward direction (when participants finish the three directions will be counted as one time). 10 time per set. And following this process in the left leg. Perform 3 set per leg.
Muscle strength training section
Modified Chair Stand exercise Sitting on the chair with both foot contacts the floor. Standing up from the chair but don't full stand (height of rise from the chair is about 15 centimeter). And return to sitting position. Following this process in 10 times per set and perform 3 sets.

RESULT

In this study, 77 elderly persons who came from nursing home had registered to attend the trial. 28 elderly peoples were excluded because they did not pass the selection criteria. Sixty seniors who had been selected were randomly assigned into two groups; training or control group. However, during the time of the trial, seven elderly had been withdrawn from the trial. Finally, there were only 42 participants who were able to complete the experiment (pre-assessment, experimental period and post- assessment). In this study, the selecting protocol began in March 2014 and, the post- assessment was completed in May 2014.

Characteristics result

In this experiment, 42 participants (36 females and 6 males) were divided into two groups: the training (n=21) and a control group (n=21) by random assignment. In baseline, general data of 2 groups (age, height, body weight) are shown in Table 2. The results showed that the two groups were not significantly different in the anthropometric characteristics at pre-test ($P > 0.05$).

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Table 2 Anthropometric characteristics of participants

Characteristics	Mean (SEM)
Age, years	
Control group	79.43 (1.37)
Exercise group	77.43 (1.74)
Height, cm	
Control group	152.86 (0.02)
Exercise group	154.33 (0.02)
Weight, kg	
Control group	51.30 (1.92)
Exercise group	52.65 (2.96)

Balance performance

The two groups were not significantly different in pre- test for the variables tested (SLBT and TUG-T) (P> 0.05). All parameters were analyzed by the Wilcoxon matched-pair signed-rank test (within group) and Mann-Whitney U test (between groups). Table 3 showed the improvement of balance abilities which was demonstrated by increment of SLBT and decrement of TUGT in exercise group. SLBT showed a change in the direction of improvement significantly (P <0.05) in the 2 groups (in the both legs). The post- test value of the exercise group was greater than the value in the control group significantly (P <0.05) in the both leg. In dynamic balance ability, TUGT showed a change in the direction that decreases significantly (P <0.05) in the 2 groups. The post- test of TUGT value in the exercise group was lesser than in the control group significantly (P <0.05).

Table 3 Comparison of the pre- to post-test changes in SLBT and TUGT time between control and exercise group

Balance ability		Group	Pre-test	Post-test	Mean Difference	SEM Mean Difference	Percent Change (%)	*P*
SLBT (sec)	Right	Control	4.66 (0.86)	8.64 (3.93)	3.98	2.18	45.05	0.002*
		Exercise	5.10 (0.89)	30.98 (11.52)	25.88	10.53	1221.25	
	Left	Control	5.36 (1.19)	9.74 (2.79)	4.38	2.25	98.40	0.027*
		Exercise	5.25 (0.79)	29.09 (10.89)	23.84	10.85	1519.75	
TUGT (sec)		Control	17.94 (1.66)	17.12 (1.88)	-0.82	0.59	-4.72	0.011*
		Exercise	14.84 (1.42)	12.35 (1.19)	-2.49	0.67	-15.19	

Abbreviations: SLBT; Single-leg balance time test, TUGT; 3-m timed up and go test. P-value was determined by comparing the percentage change between the control group and the exercise group. All values were represented in Mean±SEM.

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DISCUSSION

The objective of the present study was to investigate the effects of short-term (4 week) simple balance training program by using simple daily activity living exercise training program on balance ability in Thai elderly person. After 4 weeks, the improvement of balance abilities was demonstrated by increment of SLBT and decrement of TUGT in exercise group ($P < 0.05$). Moreover subjects in exercise group achieved significantly higher percent change in the balance ability than the subjects in control group ($P < 0.05$). Improvement in relation to balance ability was demonstrated by the increase in the SLBT and the decrease in the TUGT in the group performed to the simple balance training program (exercise group). In SLBT, similar results were shown that the elderly who performed in balance exercise program can improve on SLBT ability in 4 weeks of training.[7]

Balance ability is an ability of the human body caused by the interaction of multiple systems, such as sensory system, nervous system and musculoskeletal system[3, 4, 5] in order to control the movement of organs according to different events or functional mobility in daily living, such as shopping for groceries, visiting a medical professional, or going out for a movie.[13] The alterations in the aging are 1) deterioration of muscle system including loss of muscle mass, muscle fiber size[16], muscle cross-sectional area[19, 20] and decrease maximum muscle force[18] and mitochondrial activity[21] 2) deterioration of nervous system including decrease weight of brain, function of brain, nerve conduction velocity, rate and magnitude of reflex response, sensory acuity, simple reaction time, touch and pressure sensation on plantar surface, joint position sense, visual acuity, visual edge detection, vestibular input[22] and 3) incremental of arousal threshold, postural sway[24] which related to decrease of functional mobility, and increase risk of falls in elderly person. From previous study, Hirvensalo et al.[13] showed that mobility disability for the elderly can lead to increase risk (three to five times) for dependency in activities of daily living (ADLS). For balance ability assessment, SLBT and TUGT selected in this study are frequently used as simple assessment tools for evaluation the person' s balance ability with this population.[12] The higher time of SLBT and lower time of TUGT may indicate good balance ability. Exercise program that emphasize balance control are more effective at improving balance ability than consist primarily of aerobic, muscular strength or flexibility exercise.[14] We modified the exercise programs to be more suitable for elderly persons since the training programs from previous studies[6, 7] had too complicated and difficult activities for the elderly persons to remember and perform by themselves. In this study, exercise program was focused on muscle strength in leg muscle, walking and leg movement in different directions, muscle endurance and stretching (in warm up and cool down phase). Since the balance or sensory-motor training exercises were affect different parts of the body such as muscles, nerves and brain.[17] Therefore, our results indicate that the designed balance training program used in this study has shown successfully beneficial effect by improving static balance and functional mobility (increasing SLBT and decreasing TUGT time) in the elderly.[6, 7, 13]

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CONCLUSION

In conclusion, 4-weeks of simple balance training can improve both static and dynamic balance ability in the elderly persons by 1) increasing time during stand with single leg condition 2) decreasing walking time in TUGT. However there were some limitations in our study including 1) unable to control the activities of daily living of the elderly, 2) small sample size and 3) affected the performance from the psychological factors such as anxiety and stress etc. which were detected in four participants (with anxiety and stress condition caused by simple illness and daily living). Therefore considering about these matters is recommended for further designed experiment.

REFERENCE

1. Downton JH. Falls. In: Tails R, Fillit H, Brocklehurst JC, editors. Geriatric Medicine and Gerontology. 5th ed. Edinburgh: Churchill Livingstone; 1998. p. 1359-1370.
2. Stephen RL, Catherine S, Hylton BM, Jacqueline CTC. Falls in older people: risk factors and strategies for prevention. 2nd ed. Cambridge: Cambridge University Press; 2001.
3. James OJ. Balance training to maintain mobility and prevent disability. Am J Prev Med 2003; 25(3 Suppl 2): 150-156.
4. Philippe PP, Gérome CG, Cyril P, Claude J. Effects of physical and sporting activities on balance control in elderly people. Br J Sports Med. 1999; 33: 121-126.
5. Faulkner JA, Larkin LM, Claflin DR, Brooks SV. Age-related changes in the structure and function of skeletal muscles. Clin Exp Pharmacol Physiol 2007; 34:1091-1096.
6. Kuptniratsaikul V, Praditsuwan R, Assantachai P, Ploypetch T, Udompunturak S, Pooliam J. Effectiveness of simple balancing training program in elderly patients with history of frequent falls. Clin Interv Aging 2011; 6:111-117.
7. Miller KL, Magel JR, Hayes JG. The effects of a home-based exercise program on balance confidence, balance performance, and gait in debilitated, ambulatory community-dwelling older adults: a pilot study. J Geriatr Phys Ther 2010; 33: 85-91.
8. Forrest W. Anticipatory postural adjustment and T'ai Chi Ch'uan. Biomed Sci Instrum 1997; 33: 65-70.
9. Tsang WW, Hui-Chan CW. Effect of 4- and 8-wk intensive Tai Chi training on balance control in the elderly. Med. SCi. Sports Exercise 2004; 36: 648-657.
10. Vellas BJ, Wayne SJ, Romero L, Baumgartner RN, Rubenstein LZ, Garry PJ. One-leg balance is an important predictor of injurious falls in older persons. J Am Geriatr Soc 1997; 45: 735-738.
11. Bohannon RW, Larkin PA, Cook AC, Gear J, Singer J. Decrease in timed balance test scores with aging. PHYS THER 1984; 64: 1067-1070.

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12. Thomas JI, Lane JV. A Pilot Study to Explore the Predictive Validity of 4 Measures of Falls Risk in Frail Elderly Patients. Arch Phys Med Rehabil 2005; 86: 1636-1640.
13. Hirvensalo M, Rantanen T, Heikkinen E. Mobility difficulties and physical activity as predictors of mortality and loss of independence in the community-living older population. J Am Geriatr Soc 2000; 48: 493-498.
14. Roger ME, Fernandez JE, Bohlken RM. Training to reduce postural sway and increase functional reach in the elderly. J Occup Rehabil 2001; 11: 291-298.
15. Schubert M, Beck S, Taube W, Amtage F, Faist M, Gruber M. Balance training and ballistic strength training are associated with task specific corticospinal adaptations. Eur J Neurosci 2008; 27: 2007-2018.
16. Taube W, Gruber M, Beck S, Faist M, Gollhofer A, Schubert M. Cortical and spinal adaptations induced by balance training: correlation between stance stability and corticospinal activation. Acta Physiol 2007; 189: 347-358.
17. Llewellyn M, Yang JF, Prochazka A. Human H-reflexes are smaller in difficult beam walking than in normal treadmill walking. Exp Brain Res 1990; 83: 22-28.
18. Kirkendall DT, Garrett WE Jr. The effects of Aging and Training on Skeletal Muscle. Am J Sports Med. , 1998; 26: 598-602.
19. Kent-Braun JA, Ng AV, Young K. Skeletal muscle contractile and noncontractile components in young and older women and men. J. Appl. Physiol 2000; 88: 662-668.
20. Lexell J, Taylor CC, Sjöström M. What is the cause of the ageing atrophy? Total number, size and proportion of different fiber types studied in whole Vastus Lateralis muscle from 15- to 83-year-old men. J Neurol Sci 1988; 84: 275-294.
21. Andersen JL. Muscle fibre type adaptation in the elderly human muscle. Scand J Med. Sci. Sports 2003; 13: 40-47.
22. Otto DP, James LP. Aging process: Implications for clinical practice. PHYS THER 1983; 63: 41-48.