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Effect of Six Weeks of Pilates Exercise on Balance in Elderly Women Aged over 60 years

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ABSTRACT: One of the most common physical problems among the elderly that occurs following some diseases or the aging process is falling. One of the major causes of falling is the loss of balance. The impact of physical activity and exercise on balance improvement has been investigated and proven in many studies. Methods: 30 women aged over 60 voluntarily participated in this study. The subjects were randomly divided into experimental and control groups. In this research, the effect of six weeks of Pilates exercise on balance in elderly women aged over 60 was studied. The subjects in both groups were asked to refrain from doing other exercises during the study. One day before the beginning and after the end of exercises, static balance pretest (Biodex Balance Test) with open eye and dynamic balance (timed up and go (TUG) test) were performed. Independent and paired t-test, Wilcoxon marked ranks, and Mann-Whitney U-test were used for comparing changes. Calculations were performed at a significance level of $\alpha<0.05$. Findings: The study results showed that six weeks of Pilates exercise has a significant impact on dynamic balance, internal-external one-legged static balance postural sway index, and general two-legged postural sway index. No significant change was observed in other indices of static balance. Conclusion: Six weeks of Pilates exercise improved dynamic balance in elderly women aged over 60 but did not leave a full impact on static balance. This is because of the dynamic nature of most exercises of Pilates. According to these results, instructors can use Pilates exercise for increasing dynamic balance of athletes or the elderly.

Keywords: Pilates Exercise, Elderly, Dynamic balance

INTRODUCTION

Today, with the development of medical, economic, and social sciences, mortality rate has decreased, life expectancy is increasing, and the world's population is moving towards aging, as the World Health Organization has named the current century as the elderly century (Birckhead, 1978). Aging is the gradual collapse of the structure and the organism of the whole body which occurs over time and makes changes to the structure and function of different body organs (Iwamoto *et al.,* 2009). Changes that occur during aging are partly the result of gradual decline of function of different body systems which leads to the loss of physical, mental, and social well-being (Wojtek *et al.,* 2009). Physical activity and exercise is one of the most important strategies for maintaining health and reducing the risk of physical and mental diseases during old ages. In addition, participation in regular physical activities is a strong predictor of having a good life in old ages (Mc Mullin and Cairney 2004, Elavsky *et al.,* 2005).

Falling, which occurs as a result of impairment in the balance system of the elderly, is one of the problems that is now frequently observed in the elderly population in the world. Annually, falling causes a large number of the elderly population become disabled or loses part of their physical abilities. The problem of falling among the elderly has been of interest to researchers in recent years (Claud, 1999). The results of studies conducted on this issue have shown that physical activity and exercise is one of the most important ways of maintaining health and reducing the risk of physical and mental diseases during old ages (King *et al.,* 2002).

Coordination between three balance-visual, vestibular (atrial), and proprioceptive (somatosensory) systems plays a decisive role in maintaining body status and balance (Claud, 1999, Berini and Perin 2002, Anderson, 1996). Pilates includes a series of aerobic exercises based on the principles of focus, control, breathing, precision, sequence, and loneliness (Steriani and Edward 2005). which was developed by Joseph (Pilates and Miller 2003, Siqueira *et al.,* 2010). The impact of Pilates exercise on increasing the electrical activity of muscles (Kim *et al.,* 2014) and the impact of a combination of Pilates and aerobics exercises on improvement of muscle mass and reduction of fat mass have been reported in many studies (Jesus Ruiz-Montero *et al.,* 2014).

In addition, the effect of Pilates exercise on general health has been studied (Pourvaghar *et al.*, 2014). Pilates also causes reduced depression and increased balance related to falling in the elderly (Mokhtari *et al.*, 2013). Choi studied the effect of 8 weeks of Pilates exercise on the ability of static and dynamic balance in the elderly. The results showed that Pilates improved static and dynamic balance of the subjects. Additionally, Pilates exercise on a mat and balance training on an unstable supporting surface left considerable effects on static and dynamic balance elderly women (Hyun *et al.*, 2014). Eiser *et al.* studied the integration of Pilates with an exercise program in order to reduce the frequency of falling of women aged over 65. The findings revealed that Pilates exercise is effective in the development of dynamic balance, flexibility, reaction time, and muscle strength and also reduces the frequency of falling in elderly women. In another study, Eiser *et al.* found that Pilates is more effective than walking in improvement of fitness parameters. In the present study, the effect of Pilates exercise on balance of elderly women who were free of any special disease was measured using Biodex balance detector device for the first time.

METHODOLOGY

30 women aged over 60 from the city of Karaj voluntarily participated in this study. The subjects were randomly divided into two groups of experimental (with mean age, height, and weight of 64±2.11, 160.6±3.4, and 68.6±5.2, respectively) and control (with mean age, height, and weight of 63.44±2.63, 159.7±4.1, and 70.8±4.8, respectively) (Table 1). Inclusion criteria were non-use of assistive devices for walking, no limitation of motion in the hip, thigh, and knee, no problem in the vestibular system of the inner ear, absence of severe vision impairment, not being afflicted with of mental disease, diabetes, epilepsy, Parkinson's, and Alzheimer's, and existence of no platinum or replaced joint in the lower extremities.

One day before the start of exercises, pretest of static balance (Biodex Balance Test with Stabilometre biosway) and dynamic balance (timed up and go (TUG) test) was performed. In Biodex Balance Test, Postural Stability Index and Postural Sway Index in one-legged and two-legged conditions along the anterior-posterior and internal-external directions and also Postural Stability Index and Postural Sway Index in Fall Risk Test in the conditions of two feet on the soft and hard surfaces and with open and close eyes were measured. The, the subjects in experimental group performed Pilates exercise three sessions per week for 6 weeks. Independent and paired t-test, Wilcoxon marked ranks, and Mann-Whitney U-test were used for comparing changes. Calculations were performed in SPSS-20 software at a significance level of $\alpha<0.05$.

RESULTS

No significant difference was found between the subjects in the experimental control groups in terms of age, height, and weight (Table 1).

Table 1: Demographic data of experimental and control groups.

Variable	Experimental group	
Age (year)	64.23 ± 2.11	63.4 ± 2.6
Height (cm)	160.6 ± 3.4	159.7 ± 4.1
Weight (kg)	68.6 ± 5.2	70.8 ± 4.8

Postural Stability Index and Postural Sway Index in different directions of two-legged Stability Test showed no significant difference in none of the variables. Comparison of Postural Stability Index and Postural Sway Index between pretest and posttest in each of the groups in different directions of Stability Test in the two-legged condition of elderly women showed that only Postural Sway Index recorded a significant difference between pretest and posttest in the experimental group ($p=0.045$).

Postural Stability Index and Postural Sway Index in different directions of Stability Test in one-legged condition in the experimental group showed no significant difference with the control, except Postural Sway Index in the internal-external direction.

Comparison of Postural Stability Index and Postural Sway Index between pretest and posttest in each of the groups in different directions of Stability Test in the one-legged condition of elderly women showed that Postural Sway Index in the anterior-posterior direction and internal-external direction in the experimental group have a significant difference with the control (Table 2).

Table 2: The results of paired t-test and Wilcoxon marked ranks for comparison of Postural Stability Index and Postural Sway Index between pretest and posttest in each of the experimental and control groups in different directions of Stability Test in the condition of one-legged among elderly women aged over 60.

Variable		Pre-training	Post-training	Sig
Total Postural Sway Index	**Experimental**	0.81 ± 0.33	0.59 ± 0.08	t_{11} = 2.443, Sig = 0.033*
	Control	1.00 ± 0.45	0.99 ± 0.59	T = 35.0, Z= -0.314, Sig = 0.754
Anterior - posterior Postural Sway Index	**Experimental**	0.87 ± 0.19	0.72 ± 0.09	t_{12} = 2.318, Sig = 0.039*
	Control	1.06 ± 0.31	1.10 ± 0.38	t_{13} = -0.402, Sig = 0.694
Internal- external Postural Sway Index	**Experimental**	1.06 ± 0.75	0.56 ± 0.10	t_{12} = 2.405, Sig = 0.033*
	Control	1.16 ± 0.61	1.60 ± 1.44	T = 40.0, Z= -0.785, Sig = 0.433

Table 3: The results of independent t-test and Mann-Whitney U-test for comparison of Postural Stability Index and Postural Sway Index in Fall Risk m-CTSIB Test in each of the experimental and control groups in the conditions of two feet on the soft and hard surfaces and with open and closed eyes among elderly women aged over 60.

Variable		Experimental	Control	sig
Soft surfaces with open eyes	**Postural Stability Index**	-0.63 ± 2.84	-1.37 ± 2.04	t_{24} = 2.063, Sig = 0.049*
	Postural Sway Index	-0.30 ± 0.39	0.07 ± 0.35	t_{26} = -2.638, Sig = 0.014*

The results related to Postural Stability Index and Postural Sway Index in Fall Risk Test in the conditions of two feet on the soft and hard surfaces and with open and closed eyes among elderly women indicated that Postural Stability Index and Postural Sway Index in the condition of open eyes on a soft surface in the experimental group were significantly different from the control.

Comparing the results of Postural Stability Index and Postural Sway Index between pretest and posttest in Fall Risk Test in the conditions of two feet on the soft and hard surfaces and with open and closed eyes among elderly women suggested that Postural Stability Index and Postural Sway Index showed a significantly changed in posttest compared to the pretest in the conditions of open eyes and soft surface in both experimental and control groups (p=0.009).

Comparison of dynamic balance between pretest and posttest in both experimental and control groups in TUG test on elderly women showed that there is a significant difference between two groups. After six weeks of Pilates exercise program, duration of performing TUG test in the experimental group showed a significant decrease compared to the control (Table 4).

Reviewing the information related to dynamic balance in pretest and posttest in each of groups in TUG test revealed that the values of posttest of dynamic balance is significantly less than the values of its pretest. This is indicative of decreased duration of performing TUG test and improved dynamic balance.

Table 4: The results of independent t-test and Mann-Whitney U-test for comparison of changes in dynamic balance among elderly women aged over 60.

variable	Experimental	Control	sig
dynamic balance	0.82 ± 0.95	-1.25 ± 1.39	U = 47.0, Z = -2.717, Sig = 0.007

Table 5: Data of Paired T test to compare Dynamic balance in elderly women aged over 60 years.

Group	Pre training	Post training	sig
Experimental	9.35 ± 1.74	7.61 ± 0.94	t_{14} = 5.902, sig=0.000
Control	10.42 ± 2.12	10.50 ± 2.32	t_{14} = -0.333, sig=0.744

DISCUSSION

The present research aimed to study the effect of 6 weeks of Pilates exercise on balance of elderly women aged over 60. Pilates exercise did not change Postural Stability Index and Postural Sway Index in different directions of Stability Test in the two-legged condition in the experimental group.

However, comparison of pretest and posttest in the experimental group showed that Postural Stability Index has increased in the two-legged condition. This probably suggests an improvement in balance. These results are inconsistent with the findings of some other studies conducted on the effect of Pilates exercise on balance (Hyun *et al.,* 2014, Choi, 2014).

The reason for this discrepancy could be found in the duration of exercises, type of exercises, individual differences among subjects, and, most importantly, methods of measurement.

Also, Pilates exercise did not change Postural Stability Index and Postural Sway Index in different directions of Stability Test in the two-legged condition in the experimental group, except for Postural Sway Index in the internal-external direction. However, comparison of pretest and posttest in the experimental group showed that Postural Stability Index and Postural Sway Index in the anterior-posterior direction and Postural Sway Index in the internal-external direction recorded decreases in posttest, which is an indicative of improved balance. This is consistent with the findings of Hyun *et al.* (2014) who studied static balance and concluded that balance in the internal-external direction improves faster.

Pilates exercise changed Postural Stability Index and Postural Sway Index in Fall Risk Test in the condition of two feet on a soft surface with open eyes in elderly women. Comparison of pretest and posttest in the experimental group showed that Postural Stability Index in Fall Risk in the condition of two feet on a soft surface with open eyes improved in posttest. This is consistent with the findings of Choi *et al.* (2014) who studied balance on unstable surfaces.

Pilates exercise changed dynamic balance (TUG) of elderly women aged over 60 which is consistent with findings of some previous studies [16, 17, and 18].

Pilates exercise can improve muscle strength and mental factors of the participants, because decreased muscle strength of the lower extremities causes the center of gravity to be situated in front of the ankle joint and leads to imbalance and falling. On the other hand, improved muscle strength can cause the displacement of the center of gravity towards the ankle joint and improve balance. During Pilates exercise, the subject, through stretching and focus on muscles and the whole body, can improve and increase the strength of involved muscles (active-agonist) and also increase the fixing effect on other muscles (inactive-antagonist). In addition, through deep inhaling and exhaling, respiratory capacity and cardiovascular performance can be increased. This also causes muscle relaxation. When performing the exercises, the subject's blood pressure increases and supply of blood and feeding the involved muscles and tissue will be facilitated. In addition, muscles strengthen during Pilates exercise and strengthened muscles causes increased proprioceptive stimulation. This can be another reason for justifying the increase in dynamic balance of the subjects.

The present study showed that six weeks of Pilates exercise improved dynamic balance in elderly women aged over 60 but did not leave a thorough impact on their static balance. This is because of the dynamic nature of most exercises of Pilates. Since achieving and maintain a healthy body and mind is of important goals of Pilates exercise and as these exercises have features such as saving in costs, no need for advanced and complicated equipment and facilities, and ease of performing for the elderly, it can be asserted that Pilates exercise can be considered a safe and effective exercise program for improving balance and cognitive processes in the elderly. Hence, those who are working as sport instructor in the care centers for the elderly are recommended include Pilates exercise in the exercise program for the elderly in order to maintain high physical and mental health of them.

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