

Research Paper:

The Effect of Selected Pilates Exercises on Balance, Blood Pressure, and Body Composition of Inactive Healthy Elderly Women



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ABSTRACT

Background and Aim: Aging is a process during which most of the body's physiological functions are gradually weakened and disrupted. This study aimed to investigate the effect of 8 weeks of selected Pilates exercises on balance, body composition, and blood pressure in healthy older women.

Materials and Methods: This randomized quasi-experimental study with the pre-test, post-test design was performed on 20 inactive older women with a Mean±SD age of 62±2.5 years, Mean±SD height of 160.6±4.51 cm, and Mean±SD weight of 67.70±4.60 kg. The participants were randomly divided into experimental (n=10) and control (n=10) groups. The experimental group participated in the Pilates program for 8 weeks, 3 sessions per week. During this period, the control group did not participate in any training program. The studied variables in the training group were evaluated at the beginning and after 8 weeks of the program. Finally, the results of pre-test and post-test exercises of both groups were compared. The Kolmogorov-Smirnov test was used to ensure the normality of the data and paired t test and analysis of variance was used to analyze intra-group and inter-group findings, respectively. The significance level was set as less than 0.05.

Results: Eight weeks of Pilates training significantly increased static (P=0.04) and dynamic (P=0.0001) balance and significantly decreased body fat percentage (P=0.001) in older women. However, the results showed that Pilates exercises had no significant effect on blood pressure and waist to hip ratio in older women (P≥0.05).

Conclusion: Pilates exercises can improve balance and reduce the percentage of body fat in older women, and it is a suitable and inexpensive alternative or complementary treatment to improve balance and reduce falls. However, more studies are needed on the effect of this type of exercise on other indicators of elderly health.

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1. Introduction

Aging is a process in which the body's physiological systems, such as the central nervous system and the immune system, gradually decline [1]. The population of older people is expected to increase to one billion two hundred and nine million in 2025 [1]. According to the Iranian Statistics Center, this number was 7.5% of the total population in 2006 and will reach 9% in 2026 [2]. One of the most critical issues and problems that the elderly face is the poor balance that is considered a necessary and integral component for daily activities [3]. The balance means the ability to maintain the correct situation in both dynamic and static tasks. It requires complex interactions between environmental, vision, and muscle factors. It depends on the delicate interaction between neural networks and the muscle system, which is affected by the natural aging process [4]. Research has shown that one of the leading causes of falling in the elderly is poor balance [5]. The balance and control system of the situation is a compound and complex mechanism that coordinates the three equilibrium systems of vision, visual system, vestibular system (vestibular) and deep sensory system (body sense) (the sense of the image) [6].

On the other hand, one of the most critical issues the elderly face is the underlying diseases caused by senility, immobility, and physical weakness [7]. One of the most common diseases in the elderly is high blood pressure, and 60% of people over 60 suffer from it [8]. The remarkable point is that the prevalence of most underlying diseases, especially cardiovascular disease and high blood pressure, is strongly associated with immobilization and decreasing physical activity [9]. Also, studies have shown that low physical activity, while deforming the appearance of people, causes fat accumulation in different regions of the body, especially the abdomen in older adults [10]. Abdominal obesity is far more dangerous than the accumulation of fat in other parts of the body. It increases the risk of premature death and catching diseases such as hypertension, hyperlipidemia, coronary artery disease, blood adhesion, and depression [11]. Unfortunately, the prevalence of abdominal obesity in societies is increasing. Recent studies have also shown an association between anthropometric indices such as fat percentage, Waist to Hip Ratio (WHR), Body Mass Index (BMI), metabolic indices (high-density lipoprotein, low-density lipoprotein, triglycerides), and blood pressure [12].

Thus, it seems that physical activity and exercise are methods to prevent, delay, or treat problems caused by

the aging process. Its positive effect on a healthy lifestyle and reducing the risk of mortality of older people has been documented [13, 14]. In addition, studies have shown special benefits of physical activity, including improvement of physical and physiological health parameters [15]. According to the physical and functional conditions of the elderly, professionals should peculiarly choose the type of exercise protocol and sports activity. As previously mentioned, the elderly always avoid participating in various sports programs due to muscle weakness and physical problems caused by the aging process, as well as anxiety caused by falls and underlying diseases. One form of physical activity, which focuses on deep balance and breathing, is Pilates. Pilates exercises are a good way to practice the mind and body postural control by strengthening the muscular and nervous system and increasing the motor control of the trunk and core muscles that improve the balance in healthy people. Many studies have been conducted in relation to the impact of Pilates exercises on the balance and health indicators of older people, some of which have shown that these exercises improve balance and health indicators in the elderly. For example, Aradmehr et al., in a study on 30 older men over 65 years, showed that 6 weeks of Pilates exercise activity improved their static and functional balance [16]. Eghbali et al., in a study on the effect of Pilates exercises on hypertension and resting heart rate in older men, concluded that Pilates exercises reduced blood pressure in study subjects [8]. However, Khajeh Nemat et al. examined the effect of power exercises on the static and dynamic balance of healthy older men. They reported that power exercises did not affect the balance of the elderly [17].

Regarding the research background and the contradictory results, also a lack of studies investigating the simultaneous effect of Pilates exercises on balance, blood pressure, and body composition, we intended to evaluate the impact of 8 weeks of Pilates exercises on the mentioned indices on healthy older women. Because of growing aging in industrial and developing communities, the results of this study are significant and may reduce economic and social damages due to inattention to aging factors.

2. Materials and Methods

This research is a quasi-experimental study and has a pre-test, post-test design with a control group. The study population consisted of older women over the age of 60 living in Qazvin Province, Iran. They lived an inactive life and without a regular exercise program on their daily to-do list. After announcing and advertising in the city,

among the volunteers who participated in the research who had the inclusion, 20 people were randomly selected and divided into experimental (10 people) and control (10 people) groups. The present study was conducted in full compliance with the provisions of the Ethics Committee in Research and accordance with the principles of the Helsinki Declaration. The inclusion criteria included 1) female elderly over 60 years old, 2) no cane use and ability to walk independently, 3) no history of acute cardiovascular disease and brain injury, 4) lack of significant orthopedic disabilities or acute illnesses, and 5) lack of any physical activity. The exclusion criteria included 1) occurrence of any disease that prevents a person from participating in more than 30% of training sessions, 2) failure to participate in the study, 3) having any chronic diseases such as cardiovascular, neuromuscular, hypertensive, and respiratory diseases based on the history and examination of the doctor, and 4) The use of neuroleptics.

After collecting demographic information, a physician examined the participants and permitted them to do the study exercise. In the first stage, the weight (kg) and height (cm) of the subjects were measured using the scales of the SECA model (made in Germany), with an accuracy of 0.1 kg and 0.1 mm, respectively. Before starting the training program, the research purpose was explained to the subjects, and their written consent was obtained. In this study, the Flamingo balance test (Stork test) was used to evaluate the static balance. The procedure was performed by placing the subject's hand on the waist (above the crown of the chin) and placing the sole of the non-dominant foot on the side of the knee of the other foot. She was placed on the dominant toe while maintaining its balance. Individual scores were recorded in terms of time (seconds) from the moment of standing on the chest of the foot to the time when the balance was disturbed, and the legs and arms were separated [18].

To evaluate the dynamic balance, we used the Timed Up and Go (TUG) test. To perform this test, a wheelchair, a stopwatch, and a distance of 3 m are required. The path starts 3 m from the leg of the chair. The subject sits on a chair and leans on the back of the chair while wearing regular shoes and clothes. At the command of the test taker, she gets up and walks the marked 3 m, turns around after reaching the end, and returns to sit on a chair. The task time was recorded in seconds as an individual score [18]. The Berg balance scale was also used to evaluate the functional balance. This scale measures a person's ability to maintain balance while performing 14 routine tasks in daily life, such as sitting in a chair and getting up and standing on one leg. The performance of each task is scored on a 5-point scale from 0 to 4 based on the quality

or time allocated to the task. Grade 0 indicates the need for maximum assistance, and grade 4 indicates the individual's functional independence in doing things. The total score (maximum score of 56 degrees) is obtained by summing the scores of the different sections of the test. A higher score indicates a greater ability to maintain balance [19]. The Berg balance scale was chosen because it is used specifically for older communities and is valid for measuring functional balance [20]. Systolic and diastolic blood pressure were measured by Arka 3000 mercury sphygmomanometer (made in Germany). The subjects' height, waist, and hip were measured with tape. The fat percentage of the participants was estimated using the Harpenden caliper and by Jackson-Pollack 3-point Equation before the exercise and then after 8 weeks of exercise. Both groups were measured, and their Body Mass Index (BMI) was calculated.

Pilates exercise protocol

The Pilates Exercise Protocol consisted of 60 minutes of exercise, comprising 10 min of warm-up, 40 minutes of Pilates, and 10 min of cooling down. The exercises were done three times a week for 8 weeks. Pilates exercises started at low levels and gradually developed to include advanced stretching, muscular endurance, balance, flexibility, and neuromuscular coordination. The exercises were focused on the large muscles of the upper body and lower body in three positions: standing, sitting, and lying down, without specialized equipment. To observe the principle of speed overload, the movements in each session increased compared to the previous session. It started from 10 repetitions in the first week and gradually increased to 30 repetitions in the eighth week. Also, to control the intensity of training, the formula of maximum heart rate ($\text{age}-220 = \text{maximum heart rate}$) and polar heart rate monitor were used. Accordingly, the exercises started in the first week with an intensity of 50%-55% of the maximum heart rate and reached a maximum of 75%-80% of the maximum heart rate (Approximately 5% increase in training intensity per week) in the eighth week. Pilates exercises are selected according to the tolerance of the elderly (Table 1). It should be noted that the control group did not participate in any training or sports activities during these 8 weeks. Also, all selected Pilates body movements in the present study were adjusted to enable the elderly to perform the movements.

Statistical analysis

The results were expressed as mean and standard deviation. After confirming the normality of the data, the Kolmogorov-Smirnov test was used. To evaluate the ef-

Table 1. Pilates training program in the experimental group

Row	Activity	Period
	Warm-up: Pilates standing and breathing, walking on tiptoe, raising one foot 90 degrees, moving all fours on the floor, sitting cat movement, squat movement	10 minutes
1	Basic squat	10 repetitions
2	Roll up	10 repetitions
3	Roll down	10 repetitions
4	Lunges	10 repetitions
5	Single-Leg circles	10 repetitions
6	Rolling a ball	10 repetitions
7	Shoulder screw (shoulder bridge)	10 repetitions
8	Leg pull front	10 repetitions
9	Double leg stretch	10 repetitions
10	Fillet (swimming)	10 repetitions
	Cooling: flexibility, prostration movement, fetal stretching movement, cat movement, lower limb stretching, shoulder rising and lowering, head and neck stretching	10 minutes

fect of Pilates exercises on the desired variables within each group, the paired t test was used, and to determine the differences between groups, the analysis of variance was used. Data analysis was performed using SPSS version 22. The results were evaluated at a significance level of less than 0.05.

3. Results

Descriptive information about the characteristics of participants (age, height, weight, BMI, and WHR) in the study is shown in [Table 2](#).

According to [Table 3](#), the results of the paired t test showed a significant difference between the pre-test and post-test of the experimental group in the variables of static balance, dynamic balance, and body fat ($P=0.001$). Also, the results of the analysis of variance showed a significant difference between the experimental and control groups in the variables of static balance ($P=0.04$), dynamic balance ($P=0.0001$), and body fat percentage ($P=0.001$). However, no significant difference was observed between the two groups in the Waist to the Hip Ratio (WHR) and blood pressure ($P\geq 0.05$) ([Table 3](#)).

Table 2. Descriptive characteristics of the subjects in the experimental and control groups

Variable	Mean \pm SD	
	Control Group (10 people)	Experimental Group (10 people)
Age (y)	61.25 \pm 2.27	63.81 \pm 2.23
Height (cm)	159.50 \pm 4.72	160.62 \pm 4.3
Weight (kg)	67.37 \pm 5.08	68.04 \pm 4.13
Body mass index (kg/m ²)	26.52 \pm 3.05	26.56 \pm 3.08
Waist to Hip Ratio (WHR)	0.89 \pm 0.05	0.88 \pm 0.08

Table 3. Investigation of intra-group and inter-group changes of variables in the studied groups

Index	Variable	Group	Stages	Mean±SD	Intra-Group		Inter-Group	
					t	P	F	P
Equilibrium	Static balance	Experimental	Pre-test	5.02±2.45	3.23	0.001*	0.82	0.04 [†]
			Post-test	8.25±2.61				
		Control	Pre-test	6.67±2.71	-0.58	0.068		
			Post-test	6.09±2.44				
	Dynamic balance	Experimental	Pre-test	41.93±9.32	3.87	0.001*	0.12	0.0001 [†]
			Post-test	45.80±7.2				
		Control	Pre-test	42.20±2.85	0.13	0.499		
			Post-test	42.33±2.41				
Abdominal obesity	Body fat (%)	Experimental	Pre-test	30.01±2.41	-2.34	0.001	23.3	0.001 [†]
			Post-test	27.08±3.61				
		Control	Pre-test	29.80±4.04	0.31	0.173		
			Post-test	30.35±5.03				
	Waist to Hip Ratio (WHR)	Experimental	Pre-test	0.88±0.07	1.34	0.582	15.8	0.832
			Post-test	0.87± 0.09				
		Control	Pre-test	0.89±0.03	2.87	0.253		
			Post-test	0.89±0.01				
Cardiovascular	Systolic blood pressure (mm Hg)	Experimental	Pre-test	131.04±10.07	3.22	0.15	16.3	0.548
			Post-test	129.56±12.21				
		Control	Pre-test	131.12±14.06	-0.10	0.248		
			Post-test	132.56±10.10				
	Diastolic blood pressure (mm Hg)	Experimental	Pre-test	98.12±7.12	2.36	0.82	12.5	0.89
			Post-test	97.48±5.08				
		Control	Pre-test	98.81±5.32	1.55	0.318		
			Post-test	98.02±6.28				

*Significant within-group at the level of $P \leq 0.05$; [†]Statistical between-group at the level of $P \leq 0.05$

4. Discussion

The main purpose of this study was to investigate the effect of a selected Pilates exercise protocol on the balance, blood pressure, and abdominal obesity indices of older women. The present study results showed that 8 weeks of Pilates exercise had a significant effect on the

static and dynamic balance of older women. The results of this study are consistent with the results of most studies such as Ghadiri et al., Casonatto et al., and Lee et al., confirming the importance of physical activity in improving static and dynamic balance [3, 18, 21]. Also, Sharif Moradi et al., in a review article, concluded that Pilates exercises were effective exercises in improv-

ing static and dynamic balance in the elderly [22]. In a study on the effect of Pilates exercises on the balance of older men, Bavardi Moghadam et al. concluded that this type of exercise plays an essential role in improving the balance of older men [23]. Patti et al., in a study, compared the effect of Pilates exercises with a general physical activity program. They showed that Pilates exercises improve static and dynamic balance in the elderly more than a general exercise program [24]. This finding is consistent with the results of the present study.

However, Sauvage et al., in the study of the effect of strength and aerobic exercise on improving balance and gait in the older people during 12 weeks, reported an increase of 5% to 10% in outcome indices, which was not statistically significant [20]. Also, Buchner et al. reported that six months of endurance training with the intensity of 60% to 70% of heart rate and strength had no significant effect on the ability and balance capacity of the elderly [20]. This result was not consistent with the results of this study, which can be attributed to the type of exercises used. Regarding the effect of exercises on static and dynamic balance, it seems that people maintain their balance in performing tests with the help of all three visual, atrial, and sensory systems. Thus, performing exercises improves and facilitates the inputs of one, two, or three systems simultaneously to maintain balance [20]. Improving balance can be achieved by better dividing attention between motor tasks [18]. In addition, studies have shown that deep sensation and sensory input from the sole are the most important sensory signals for maintaining balance in the natural state [25]. Physical activity can improve some of the sensory-motor systems involved in maintaining balance in people. So based on the theory of systems and the effect of exercise on each system, it seems logical that physical activity improves dynamic balance in the elderly. Other possible reasons for improving the balance resulting from exercise can be refining neuromuscular control, such as reducing variability in the use of motor units and improving the synchronicity of motor units [26]. Joseph Pilates also believed that individuals control their bodies in a targeted way through control. This purposive control drives the development and sensory control of motor muscles of the trunk and central muscles of the body. Therefore, doing Pilates exercise provides training opportunities and challenges the mechanisms involved in balance and leads to their improvement [27].

On the other hand, the present study findings showed that 8 weeks of Pilates exercise reduced some indicators of abdominal obesity, such as body fat percentage in older women. The present results are consistent with the

studies of Ara et al., Yu et al., and Salehzadeh et al. [28-30]. Ara et al. reported in their study that after 12 weeks of endurance exercise, the subjects' fat mass decreased 53.94% [30]. Also, Seraj et al., in examining the effect of Pilates exercises on body composition and flexibility of non-athlete women, concluded that Pilates exercises had a significant positive effect on non-athlete body composition but not on WHR [31]. Although in recent studies, training protocols and how to examine variables are different from the present study, their results are consistent with the present study's findings. In contrast, He et al. did not observe a significant difference in fat percentage and waist circumference after 20 weeks of endurance exercise [32]. One of the possible reasons for the inconsistency of recent studies with the present findings is the subjects' ages and physical and mental fitness. All subjects in the present study were older women (mean age: 65 years) who did not engage in any physical activity, while studies showed that physiological adjustment in untrained individuals was much greater and faster than in trained or relatively active individuals. Inactive people respond and adapt to exercise even at very low loads [32]. However, it was observed that the 8-week course of Pilates exercise had no significant effect on the Waist-to-Hip Ratio (WHR) of the elderly. According to previous studies, women lose more fat in the thighs and buttocks [33]. However, in our study, no significant difference was observed in the reduction of WHR. You et al. [28] and Montazeri et al. also showed in their studies that following a period of regular exercise, no significant difference was seen in the waist to the hip ratio of participants [34]. In contrast, a study by Soori et al. showed that Pilates exercises significantly reduce WHR in older women [35]. It seems that increasing exercise volume can have more effects on subjects' abdominal obesity indices, as studies have shown a strong association between increased exercise volume and changes in WHR [36]. This finding is not consistent with the present study results, which can be attributed to the intensity and duration of training.

In addition, the findings of the present study showed that 8 weeks of Pilates exercise has no significant effect on changes in blood pressure in older women. In this regard, Mir et al., in a study, examined the effect of 8 weeks of Pilates exercises on blood pressure, body composition, and muscle strength of obese women and concluded that Pilates exercises do not have a significant effect on lowering blood pressure in obese women [37]. Also, Amoo Ali et al. study examined the effect of 12 weeks of aerobic exercise on blood pressure levels in older women with hypertension; the results showed that aerobic exercise did not cause a significant change in blood pressure in older wom-

en [38]. Previous studies have shown that the prevalence of stress in women is more common and challenging to control than men [39]; however, the results of a recent study are consistent with our findings. In contrast, Salehzadeh et al. examined the effect of Pilates exercises on double blood pressure and heart rate in women with multiple sclerosis. The results showed that Pilates exercises significantly reduced blood pressure in subjects compared to the control group [29]. One of the reasons for its inconsistency is the difference in the type of subjects, intensity, and duration of training. The study of neuromuscular responses to exercise through the use of non-invasive methods to evaluate the effectiveness of exercise programs aimed at health has been one of the main objectives of this study.

5. Conclusion

This study shows that 8 weeks of Pilates exercise could improve balance and reduce body fat in older adults. If physical activities are performed regularly, it can probably be a preventive factor of falls and imbalance injuries in the elderly. However, due to the contradictory results, it is necessary to conduct more studies on blood pressure and body composition with the present protocol. It is also recommended that Pilates exercises be performed on older men and women with a history of falls, dizziness, vestibular disorders, obesity, and underlying diseases. The effect of Pilates exercises on improving balance and health indicators can be deduced and generalized with more confidence.

In the present study, the researchers faced limitations and problems, such as the lack of complete control of the subjects' diet, the lack of control over their emotions and anxiety, individual differences in genetic characteristics, and their hereditary factors in measuring some indicators. Also, the individual differences of the subjects in terms of mental and psychological state could affect the training sessions. Considering the improvement of balance indices in the present study, Pilates exercises can be regarded as a safe and effective training method in improving the balance of the elderly. Therefore, it is recommended that those who work as exercise coaches in nursing homes and leisure centers use Pilates exercises in their work plan to maintain and keep the physical and mental health of the elderly.

Ethical Considerations

Compliance with ethical guidelines

The study was approved by the Ethics Committee of the Qom University of Medical Sciences (Code: IR.QOM.REC.1400.003). To observe ethical considerations in this study, all subjects participated voluntarily

and after giving their written consent. They were assured that the data collected from them would be analyzed as a group and would not be shared with any third party, and no training program fees would be charged.

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Authors' contributions

Conceptualization: Sajjad Ramezani, Seyed Abbas Biniaz, Nasrin Asadollahi; Methodology: Sajader Ramezani, Mohsen Yaghoubi; Research: Sajjad Ramezani, Nasrin Asadollahi; Writer: Sajjad Ramezani, Seyed Abbas Biniaz; Data collection and analysis: Sajjad Ramezani, Mohsen Yaghoubi, Nasrin Asadollahi; Editing and finalizing: Sajjad Ramezani, Mohsen Yaghoubi, Seyed Abbas Biniaz.

Conflict of interest

The authors declared no conflict of interest.

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