

The Effects of Different Exercises on Balance, Fear and Risk of Falling among Adults Aged 65 and Over

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ABSTRACT This study compared the effects of Pilates and a walking exercise program on dynamic balance, flexibility, and muscle strength, fear of falling and falling risk among an elderly population. A total of 45 volunteers aged 65 years and older were recruited from a live-in community center in the province of Mugla in southwestern Turkey. Participants were invited to attend a 14-week exercise program of either Pilates or walking for 1 hour 3 times per week. Dynamic balance, flexibility, muscle strength, fear of falling and risk of falling were measured before and after the 14-week exercise program and at the same time in a control group that did not join either exercise program. Significant differences ($p < 0.05$) were found between pre-and post-exercise scores for all parameters in the Pilates group and in the flexibility scores in the walking group. No significant differences were found in the control group. Thus, it may be concluded that in comparison to walking, Pilates offers a more efficient way of improving certain physical fitness parameters among the elderly.

INTRODUCTION

Given its aging population, preventing falls and other health problems among the elderly is becoming increasingly important in Turkey. In comparison to younger individuals, older adults tend to fall more frequently (Tinetti et al. 1994). Moreover, fall-related injuries and deaths in older adults are a major health problem worldwide (Carter et al. 2001; Dsouza 2014), with nearly one-third of elderly individuals estimated to fall each year, and half of those who fall doing so repeatedly. For this reason, geriatrics researchers have tried to identify risk factors associated with falls and to develop preventive strategies in order to provide secure methods of healthy living among the elderly (Kobayashi et al. 2006; Huang et al. 2003). Fear of falling has been found to increase with age and following a history of falls among the elderly. Fear of falling may lead to inactivity and avoidance of regular daily activities, thus resulting in a decrease in quality of life (Tinetti et al. 1994; Carter et al. 2001; Izumi et al. 2002).

Many studies have noted that the majority of the older adult population is physically inactive (Tinetti et al. 1994; Stathi and Simey 2007). Physical activities can be categorized according to the degree of efficiency in which they provide physiological adaptation to exercise and by the changes in the level of fitness among elderly participants. Certain types of exercises are able to help reduce the risk of falling (Lord et al. 2001) and increase quality of life by improving or main-

taining balance and functional activities and increasing bone-mineral density and muscle strength (Carter et al. 2001; DiBrezzo et al. 2005). While the literature contains many studies examining Tai-Chi (Leung 2011), Pilates (Johnson 2007; Isabela 2012; Hyun 2014) and strength exercises (Joshua et al. 2014), there are a limited number of studies that compare different types of exercises in terms of their effects on balance, muscle strength and fear of falling. Therefore, this study examined the effects of 2 different 14-week exercise programs (Pilates and Walking) on balance, muscle strength and fear of falling among an elderly population in order to identify which type of exercise is most helpful in terms of preventing falls among the elderly.

MATERIAL AND METHODS

Participants

A total of 45 participants from among individuals aged 65 and over living in a residential facility for the elderly were recruited to participate in this prospective, treatment-control study. Volunteers were screened, and only healthy individuals who were able to attend at least 80% of the training sessions were included in the study. Individuals with significant general health or orthopedic problems that could limit their full participation as well as individuals unable to attend at least 80% of the training sessions were excluded from participation. Volunteers were in-

formed of possible significant risks (mostly muscular soreness), and all participants gave their written informed consent. Volunteers were randomly distributed between a Pilates Group (n=15, 10 female/5 male) and a Walking Group (n=15, 5 female/10 male), and 15 healthy individuals (10 female/5 male) living in the same residential facility were included in the study as a Control Group.

Individuals in the Pilates and walking groups participated in a 14-week exercise program held 3 days per week. Each exercise session lasted ~60 min and was led by a certified Pilates instructor (Pilates Group) or a sports specialist (Walking Group). The Pilates Group performed modified Pilates-based mat exercises (Pilates 2001), theraband exercises and Pilates ball exercises for beginners (Latey 2002). Both groups performed low- and moderate-intensity exercises.

Balance, flexibility, muscle strength, fear of falling and fall risk as well as body height and weight were measured in all subjects 1 week before the intervention and at the end of the 14-week program. All measurements were taken at the residential center.

Number of Falls: At the start of the study, participants reported the number of falls they had experienced during the previous 6 months. Subjects were also asked to maintain a "fall calendar" throughout the course of the 14-week program in which they recorded each day as either "F" (if they fell at least once that day) or "N" (if they did not fall that day) (Babayigit-Irez 2011).

Balance Assessments

Berg Balance Scale: The Berg Balance assessment consists of 14 sub-activities (e.g. standing up, picking up an object, standing on one leg) required to perform daily activities. Participants were scored on a five-point scale (0-4) according to the quality of their performance, with 0 indicating an inability to complete a task and 4 indicating independence, for a maximum score of 56. Based on clinical experience, Berg et al. contend that scores below 45 indicate that someone is impaired and at an increased risk of falling (Berg et al. 1992; Bogle 1996; Hawk et al. 2006).

Activities-specific Balance Confidence (ABC) Scale: The ABC is a 16-item questionnaire that assesses confidence in performing an activity without losing balance or becoming unsteady and has been shown to be predictive of falls in the elderly (Powell et al. 1995). Participants

rated their level of confidence in performing a wide range of daily activities, from 0% (no confidence) to 100% (complete confidence) (Powell et al. 1995; Sattin et al. 2005).

Downton Fall Risk Index: Risk of falling was assessed using the Downton Fall Risk Index, which consists of 11 items representing fall risks that are scored as either 0 (no risk) or 1 (risk). A total score of 3 or more is considered to indicate a high risk of falling (Rosendahl et al. 2003).

Muscle Strength: Muscle Strength was assessed based on hip flexion (right and left legs) and shoulder abduction (right and left arms) using a muscle tester (Lafayette Company, Model 01160 Nicholas Manual Muscle Tester MMT). After practicing each task, subjects performed each task three times, exerting maximum effort each time, with at least 15 seconds between trials (Roy et al. 2004; Andrews et al. 1996; Kendall et al. 1971).

Statistical Analysis

All data were analyzed using the statistical software program SPSS, version 16.0 (SPSS, Chicago, IL, USA). Descriptive statistics (means and standard deviations) were calculated. Pre-intervention differences among groups were assessed using the Kruskal Wallis test, and Wilcoxon repeated-measurement tests were used to calculate differences between pre- and post-intervention scores for each group, with a level of $p < 0.05$ considered statistically significant.

RESULTS

Kruskal Wallis test results showed no significant differences among groups in the pre-intervention scores for any of the selected variables (Table 1).

Statistically significant differences were found in the pre- and post-intervention scores for weight ($z = -2.94$, $p = 0.03$), flexibility ($z = -2.87$, $p = 0.04$), hip flexion muscle strength ($z = -2.37$, $p = 0.02$), balance ($z = -2.67$, $p = 0.03$), balance confidence ($z = -2.24$, $p = 0.04$) and Downton fall risk ($z = -2.12$, $p = 0.03$) in the Pilates group. Improvements were also observed in the walking group, but only the improvement in flexibility ($z = -2.20$, $p = 0.03$) was statistically significant ($p > 0.05$). Significant differences were observed in any of the variables in the control group ($p > 0.05$) (Table 2).

Table 1: Pre-exercise scores for Pilates, walking and control groups (Kruskal Wallis test)

Variables	Groups Pilates (N=15)	Walking (N=15)	Control (N=15)	Chi-square	P
	Mean rank	Mean rank	Mean rank		
Weight	12.58	14.42	13.20	0.38	0.53
# of falls	13.62	13.38	13.52	0.01	0.91
Flexibility	14.7	12.27	13.34	0.67	0.41
(Muscle Strength) Hip flexion	12.81	14.15	13.10	1.27	0.25
(Muscle Strength) Shoulder abduction	12.77	15.23	14.32	1.23	0.26
Berg balance test	10.77	14.23	12.14	4.38	0.08
Balance confidence (ABC fear of falling)	12.04	14.84	13.41	0.95	0.32
Downton fall risk	13.54	13.46	13.41	0.01	0.97

$p \leq 0.05$

DISCUSSION

This study found significant differences ($p < 0.05$) in balance, muscle strength, flexibility, balance confidence and Downton fall risk scores after a 14-week Pilates training program for individuals aged 65+ living in a residential facility, whereas individuals who participated in a walking exercise program showed improvements in flexibility only. The differences between groups can be attributed to the type of exercise performed.

One of the major findings of this study was that balance confidence increased and the risk of falling decreased with exercise. Training was found to have a positive effect on balance, flexibility, muscle strength and number of falls, indicating that remaining physically active will help to decrease falls and maintain independence among the elderly.

The positive effects of Pilates exercise have been emphasized by many studies. Bird et al. (2012) studied the effects of Pilates-based exercise on dynamic balance in older adults in residential communities (aged >60y) and found that participation in the Pilates component of the study for 5 weeks led to improved static and dynamic balance, although no significant differences were found between the pre- and post-test scores of the Pilates and exercise groups. Moreover, Hyun et al. (2014) examined the effects of Pilates exercise on a mat and balance exercise on an unstable base of support for trunk stability on the balance ability of elderly females. Researchers conducted exercise three times per week for 12 weeks for 40 minutes in every exercise season. Significant differences found in balance ability of elderly participants. Similarly, the

present study found balance increased after Pilates exercise. In an observational study designed to compare Pilates exercises with and without a resistance band to exercise performed with commercial exercise equipment, Petrofsky et al. (2005) found that Pilates exercises with the resistance band increased the muscle activity of 6 healthy volunteer subjects (4 males, 2 female, mean age: 25.3 years) by at least 50%; the authors concluded that Pilates could be beneficial to individuals seeking a resistance workout that places less stress on joints and muscles. In another study by Segal et al. (2004) that assessed the effects of Pilates training on flexibility and body composition of healthy adults, 31 women (mean age: 41 years) and one man (age 42 years) attended Pilates mat classes comprised of 8-12 students for 1 h per week for 6 months, with the authors reporting improved flexibility among the study participants. In the present study, flexibility increased in both the Pilates and walking groups; considering that the improvements were only significant in the Pilates Group, the difference could be attributed to the equipment used in Pilates.

In a study by Rooks et al. (1997) that looked at the effects of resistance training and walking exercises, 131 subjects were randomly assigned to either a resistance training, walking (three times per week for 10 months), or control group, and muscle strength, balance, reaction time, stair climbing speed and a timed pen pickup task were measured before and after the intervention period. The study reported improvements in muscle strength in the resistance training group and increases in walking speed among the walking group, whereas no improvements were observed in any of the variables for the control group. In

Table 2: Differences in pre- and post-exercise scores for Pilates, walking and control groups (Wilcoxon Sign Ranked Test)

Variables	Pilates group (n=15)			Walking group (n=15)			Control group (n=15)		
	Pre-test	Post-test	Z	Pre-test	Post-test	Z	Pre-test	Post-test	P
Weight	70.2±15.2	68.2±14.8	-2.94	73.1±12.4	72.3±11.8	-1.69	71.8±11.7	70.8±9.7	-1.52
# of falls	0.38±0.8	0.15±0.3	-0.81	0.23±.4	0.07±.7	-1.0	0.28±0.5	0.30±0.4	-1.10
Flexibility	17.0±10.8	20.0±9.8	-2.87	13.6±9.8	16.5±9.9	-2.20	15.8±8.2	16.1±8.8	-1.08
Hip flexion	3.80±3.5	4.33±4.0	-2.37	4.3±3.7	4.8±3.8	-0.86	4.1±3.1	3.8±2.9	-0.56
strength									
Shoulder Abduc-	0.86±1.1	0.99±1.3	-1.36	1.17±1.1	1.80±2.2	-0.80	0.98±1.3	1.03±1.5	-0.78
tion strength									
Berg balance	36.6±8.3	40.6±9.1	-2.67	47.3±9.1	51.4±8.8	-1.85	42.4±8.4	40.8±7.6	-1.49
test									
Balance confi-	52.9±12.2	58±14.7	-2.24	54±13.2	58±15.4	-1.58	55.6±9.8	54.7±7.1	-1.14
dence (ABC									
fear of falling)									
Downton fall	3.2±0.9	2.5±0.8	-2.12	3.3±1.3	2.8±1.2	-1.10	2.8±0.8	3.2±0.9	-1.34
risk									

*p<0.05

the present study, walking exercises were found to have positive effects on muscle strength, flexibility and balance and to reduce fear of falling; however, only the change in flexibility was found to be statistically significant in the Walking Group. In contrast, improvements in all variables were found to be significant for the Pilates Group, with the exception of shoulder abduction strength. This may be related to the number of exercises specifically focusing on improving leg strength and standing balance in the Pilates Group. In another study conducted by Shin (2002) with 27 females between the ages of 60-75 years, an 8-week walking exercise program was found to improve the VO₂max and flexibility of elderly women. This is in line with the finding of the present study that found walking can increase flexibility in older individuals.

In a study that explored whether walking on a regular basis might prove to be beneficial to the cardiovascular system and for maintaining good balance, Melzer et al. (2003) compared 22 healthy older individuals who walked on a regular basis with 121 healthy controls who did not walk regularly. The authors found that participating in a regular exercise program increased muscle strength and decreased the number of falls. In the present study, the number of falls decreased in both groups participating in a regular exercise program. Pata et al (2013) also studied a group of 35 older adults (aged 61-87 years) who participated in an 8-week, Pilates-based exercise program. A comparison of pre- and post-scores for Timed Up and Go (TUG), Forward Reach Test, Turn 180 Test, number of falls, fear of falling and perceptions of Pilates indicate that participants had a positive perception of the Pilates program and that their fear of falling decreased following the program. In line with these findings, the present study found that fear of falling decreased after exercise among the Pilates group, but not among the walking group.

CONCLUSION

In conclusion, all types of exercise can support good health and improve motor functions related to the performance of daily activities among the elderly. The literature contains numerous studies examining the types and amounts of exercise that provide the most benefit. The present study concluded that Pilates exercises

help to maintain health and improve quality of life by increasing balance confidence, reducing fall risks and helping the elderly succeed in daily activities by increasing balance, flexibility and muscle strength and decreasing the number of falls. Although walking exercise has many health benefits, a modified Pilates exercise program represents a good alternative for older people seeking to increase balance confidence and reduce fall risk.

RECOMMENDATIONS

Participants of this study were selected from one residential facility. In future studies, number of participants should be increased by adding other residential facilities.

LIMITATIONS

Inclusion criteria was being healthy (no serious orthopedic problems, neurological problems and etc.) for participants. In residential house, there were small numbers of elderly people with no health problems.

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