

The Effects of Pilates Mat Exercise on the Balance Ability of Elderly Females

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Abstract. [Purpose] The purpose of this study was to examine 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. [Subjects and Methods] Forty elderly women aged 65 or older were equally assigned to a Pilates mat exercise (PME) group and an unstable support surface exercise (USSE) group. They conducted exercise three times per week for 12 weeks for 40 minutes each time. In order to examine balance, sway length and the speed of the center of foot pressure were measured for one minute, and in order to examine dynamic balance, the Timed Up and Go (TUG) test was conducted. [Results] After the intervention, sway length, sway speed, and TUG significantly decreased in both groups. A comparison of sway speed after the intervention between the two groups revealed that the PME group showed larger decreases than the USSE group. [Conclusion] PME and USSE elicited significant effects on the static and dynamic balance of elderly female subjects, suggesting that those exercises are effective at enhancing the balance ability of this group of subjects. However, the Pilates mat exercise is regarded as being safer than exercise on an unstable base of support.

Key words: Pilates mat exercise, Unstable support surface exercise, Elderly females

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INTRODUCTION

Elderly people have many risk factors for contracting disease due to aging and lack of exercise. Aging is the process in which the number of cells comprising the body decreases, the activity of each cell degrades, and physical adaptability is gradually lost, ultimately leading to death¹⁾.

Decrease in balance ability resulting from aging triggers motor and gait disabilities in elderly people, which greatly affects their mobility in day-to-day life. Therefore, in the assessment of an exercise program for elderly people, the main focus should be on whether it prevents falls and affects gait in a positive way²⁾.

Physical factors that influence falls include weakening of lower extremity muscular strength, a decrease in gait ability, a reduction in balance ability, and a decrease in sensory motor control³⁾. There are diverse interventions for fall prevention, such as strengthening of muscle power through exercise and gait training, medication, and preventive education. Among these, strengthening of muscle power and balance training has largely been used as exercise for methods.

That exercise is effective at improving balance for the prevention of falls by elderly people has become generally accepted⁴⁾, and different studies have verified that balance exercise programs improve elderly people's balance and gait abilities⁵⁾. In particular, Sherrington et al.⁴⁾ stressed that training, including balance training, lowers the risk of fall by 17% compared to muscle strength training, and that in order to prevent falls, balance training should take precedence, emphasizing the importance of balance ability.

Balance ability is a very complicated function that maintains positions through diverse functional elements, and intervention of the nervous and musculoskeletal systems⁶⁾. Adjustment of balance ability is a complicated process that requires integration of sensory information and appropriate postural response practice. Visual information and articular and muscular sensory information are integrated through the central nervous system by non-sequitur the visual somatic senses and the vestibular system in order to maintain an erect position⁷⁾. Balance adjustment also requires well-coordinated voluntary movement and reflexive muscular response⁸⁾. In general, various sensory motor neurons interact in response to changes in gravity, base of support, vision, and physical stability, and the external environment, resulting in stability of the body⁹⁾.

To increase physical stability, trunk stabilization exercise is helpful for enhancing balance ability, as the muscular strength of the trunk, among other different factors, is related to balance and functional activities¹⁰⁾. Activity of the trunk muscles maintains balance against gravity, adjusts posture, and prepares for the movement of the extremities

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in activities of daily living¹¹).

Most exercises for the improvement of balance ability aim to stabilize the trunk. Pilates exercises also stresses strengthening of the muscles to stabilize the trunk through core exercise¹². Balance exercise on an unstable base of support is also used clinically to stabilize the trunk¹³.

Accordingly, this study compared the effects of Pilates exercise on a mat and balance exercise for trunk stability in on the balance ability of elderly female subjects.

SUBJECTS AND METHODS

The study subjects were 40 elderly people living in a local community located in Busan Metropolitan City in South Korea. The criteria for selection of the subjects were as follows: those who were aged 65 or older, those who had not fallen in the past year, and those who had no disease that affected the performance of exercise. Those who had problems with their visual, auditory, neural, or vestibular systems, and those who did not understand the content of the experiment were excluded. Information about this study was provided to all subjects, and their consent to participation in this study was obtained (Table 1). All the subjects understood the purpose of this study and provided their written informed consent prior to their participation in the study in accordance with the ethical standards of the Declaration of Helsinki. This study equally divided the subjects into a Pilates mat exercise (PME) group and an unstable support surface exercise (USSE) group, and the subjects conducted exercises three times per week for 12 weeks for 40 minutes each time.

In this study, the Pilates mat exercise program complied with the recommended amount of exercise for the improvement of elderly people's health, and movements appropriate for the elderly to perform were selected from the work of Cathleen Murakami¹⁴. The Pilates exercise program had a five-minute warm-up exercise, and the order was as follows: breathing, 2 repetitions (reps); imprint and release, 2 reps \times 2 sets; supine spinal, 2 reps \times 2 sets; arm circles, 4 reps \times 2 sets; knee over knee twist stretch, 2 reps \times 2 sets; pelvic peel and hinge, 2 reps \times 2 sets; spine spinal with arms crossed, 2 reps \times 2sets; and the seated hip stretch, 2 reps. The main exercise was performed for 30 minutes in the following order: hundred, 10 reps \times 1 set; roll up and roll down, 3 reps \times 2 sets; single leg circle, 5 reps \times 2 sets. The cool-down exercise was conducted in the same way as the warm-up exercise¹⁵).

The USSE group the subjects conducted balance exercises for a total of 40 minutes standing on an aero-step (TOGU, Germany). They adapted to the base of support and lightly flexed their muscles for five minutes, stood on both feet balancing the body for five minutes, stood on both feet moving the center of the body for five minutes, stood on one foot for five minutes, conducted squats for five minutes, walked in place for five minutes, maintained a squatting position for five minutes, and conducted cool-down exercise for five minutes.

In order to measure the static balance ability of the subjects who participated in this study, AP1153 BIORESCUE

Table 1. General characteristics of the subjects

	PME	USSE
Age (year)	70.0 \pm 2.2	69.3 \pm 2.6
Height (cm)	157.3 \pm 3.6	157.7 \pm 3.0
Weight (kg)	55.7 \pm 4.4	55.4 \pm 3.1

Mean \pm SD. PME, Pilates mat exercise; USSE, unstable support surface exercise

Table 2. Comparison of measurement values between pre-test and post-test

Variable	Group	Pre	Post
Length (cm)	PME	50.85 \pm 2.46	44.02 \pm 2.13 ^{ab}
	USSE	50.59 \pm 2.50	45.82 \pm 2.64 ^{ab}
Average speed (cm/sec)	PME	0.83 \pm 0.04	0.68 \pm 0.04 ^{ab}
	USSE	0.83 \pm 0.04	0.73 \pm 0.04 ^{ab}
TUG (sec)	PME	20.59 \pm 1.43	16.12 \pm 2.12 ^a
	USSE	20.57 \pm 1.55	16.42 \pm 0.95 ^a

^a significant difference between pre and post, ^b significant difference between Pilates mat exercise (PME) and unstable support surface exercise (USSE) at post

(RM INGENIERIE, France) was used, and center of foot pressure sway length and sway average speed were measured in Romberg's test, with the subjects' eyes open. In order to measure dynamic balance ability, subjects' performance time in the Timed Up and Go test was measured. All measurement results were expressed as mean \pm standard deviation.

SPSS for Windows (version 18.0) was used to analyze the data. The paired t-test was used to examine within-group pre- and post-intervention differences, and the independent t-test was used to examine differences between the groups. The statistical significance level was chosen as $\alpha = 0.05$.

RESULTS

After the intervention, sway length, sway speed and TUG time had significantly decreased ($p < 0.05$) in both groups. A comparison of sway speed after the intervention between the two groups revealed that the PME group showed a larger decrease than the USSE group ($p < 0.05$) (Table 2).

DISCUSSION

Balance is a complicated process involving the integration of senses, the musculoskeletal system, and the nervous system¹⁶. Due to aging, elderly people undergo degradation of these functions. In particular, a decline in proprioceptive sense impairs the physical functions that maintain balance ability, resulting in falls. Falls by elderly women occur more often than by elderly men. Countries across the world have recognized this as a serious public health problem and are proceeding with various prevention programs¹⁷).

Many studies have verified that for the prevention of falls by elderly women, trunk stabilization exercises that improve balance ability¹⁸) are required. This study exam-

ined the effects of exercise on an unstable base of support for trunk stabilization, and Pilates mat exercise focusing on trunk core activation, on the static and dynamic balance abilities of elderly women.

Static balance measures of both the PME group and the ISSE group significantly decreased over time, suggesting that their balance abilities improved; however and the USSE group showed less improvement in balance ability than the PME group. This result means that continuous control of Pilates mat exercise was possible relative to the exercise on an unstable base of support, and Pilates mat exercise on a stable base of support was more effective. According to a study by Cressey et al.¹⁹⁾, exercise on a stable base of support was more effective than on an unstable base of support for static balance ability, which is consistent with the present study's results. An uncontrolled unstable base of support improves static balance ability through positive stimulation of the vestibular system rather than by strengthening deep muscles, and Pilates mat exercise on a controlled stable base of support enhances static balance ability through organic activation of the deep muscles of the trunk. Pilates mat exercise also resulted in greater improvement in the static balance ability of elderly women than exercise on an unstable base of support in the present study.

This study employed the TUG test in order to measure dynamic balance ability prior to and after exercise. Both groups showed significant decreases in TUG time, and the PME group showed more improvement in dynamic balance ability than the ISSE group. Shumway-Cook et al.²⁰⁾ noted that TUG as test times of 14 seconds or longer indicated a risk of fall; 20 to 29 seconds indicated the possibility of gait disability; and 30 seconds or longer suggested impaired gait ability.

According to the TUG results of our present study, prior to the exercise, the subjects had TUG test performance times of 30 seconds or longer. After they conducted exercises three times per week for 12 weeks, their TUG test performance times were within the range was 20 to 29 seconds; indicating an improvement in gait classification from possible gait impairment to possible gait disability. Both exercises performed in the present study elicited positive effects, but steady performance of Pilates mat exercise elicited better improvements in static and dynamic balance abilities than exercise on an unstable base of support.

In this study, PME and USSE elicited significant improvements in static and dynamic balance ability when they were performed by elderly female subjects; i.e., both were effective at enhancing balance ability. Therefore, both exercises are considered appropriate for elderly women subjects. However, in terms of stability, Pilates mat exercise was safer than exercise on an unstable base of support, and in particular, the Pilates mat exercise program was easier to adjust to each individual's balance ability.

Based on the results of the present study, a future study

that conducts a Pilates mat exercise program with a greater number of subjects, and patients with musculoskeletal system disease, as well as elderly women, is considered necessary. In addition, research into the Pilates mat exercise program's relevant effects on motor functions, and more appropriate exercises for improving subjects' balance ability are also regarded as necessary.

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