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Effect of 8-week Small Tool Exercise according to Age on Knee Strength and Balance in Women

Jang Ri Ra*, Jeong hwan Jong**, Kim Ki Hong***

**Master, Department of Leisure and Sports Coaching, Dankook University, Korea*
***Research Professor, Department of Sports Science Institute, Dankook University, Korea*
****Professor, Department of Recreation and Leisure Sports, Dankook University, Korea*
**Oh00231@naver.com, ***ssilverman@naver.com, ***bodykim@hanmail.net,*

Abstract

In order to investigate the effect of an 8-week elastic band exercise program according to age on the isokinetic strength and dynamic equilibrium of the knee, 10 women under 49 years old and 10 women over 50 years old were selected. Dynamic equilibrium was measured through Y-Balance test one week before the exercise program, and power and endurance were confirmed by measuring isokinetic muscle strength of the knee. After measurement, small tool exercise was performed for 8 weeks. After 8 weeks of exercise, isokinetic muscle strength and dynamic equilibrium were measured. As a result, isokinetic muscle strength, which checks muscle strength and muscular endurance, increased after measurement than before measurement regardless of age, and dynamic equilibrium increased after measurement rather than before measurement, and the group under 49 years of age was higher than the group over 50 years old. We think that small tool exercise improves isokinetic muscle strength and is effective in neuromuscular development, improving dynamic stability ability, which is an important factor in preventing falls.

Keywords: *Aging, Exercise, Isokinetic strength, Stability*

1. Introduction

As humans age, many physical changes appear, such as a decrease in nerve conduction speed, a decrease in lung capacity, a decrease in maximum heart rate, and a decrease in fast muscle fibers [1]. These changes cause a decrease in physical abilities such as agility, strength, and agility [2]. Such physical ability rises to the highest possible level in the 20s and 30s, maintains or decreases until the age of 50, and then shows a sharp decline after the age of 50 [3].

In terms of protein aggregation rate and recovery capacity of skeletal muscle, muscle strength loss of 15% or more occurs every 10 years after age 50 [4]. Muscle strength loss due to aging is mainly related to fast muscle fibers, and with aging, more than 50% of fast muscle fibers are lost by the age of 75 [5]. Aging progresses at a faster rate as physical activity decreases, leading to various geriatric diseases and directly affecting the healthy lifespan of the elderly [4].

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Corresponding Author: bodykim@hanmail.net
Tel:*** - **** - ****
Professor, Department of Recreation and Leisure Sports, Dankook University, Korea

Delays in muscle strength gains and muscle mass loss can slow the physical aging process and prevent many aging-related negative events [6], such as falls and loss of independence and ability to perform daily activities [7]. A typical method for this is resistance exercise using dumbbells, barbells, elastic bands, bare body, etc. Resistance exercise is an effective exercise for increasing muscle mass and improving muscle strength [8]. In addition, resistance exercise has a positive effect on the cardiovascular system, musculoskeletal system, and nervous system, and this is more evident in the mid-40s and older [9].

Elastic band exercise, one of the types of resistance exercise, has less burden on joints and muscles, can be exercised in all directions of body movement, and is easy to apply to daily life movements. It is a light exercise [10]. In addition, it is helpful in preventing and rehabilitating movement damage by strengthening muscle strength and improving nervous system functions [11]. In particular, elastic band exercise has a lower risk of exercise damage than other resistance exercises, and it is easy to adjust the intensity according to the individual's physical fitness level, so it is good to perform without restrictions on age and fitness level [12].

In addition to resistance exercise, stability exercise improves muscle flexibility and balance, and provides joint stability through the control of the muscular nervous system to prevent in juries [13]. It also helps sensory information and posture maintenance ability to improve body stability and sensorimotor control ability [14].

In the aging process, the decline in physical strength and the resulting decline in physical ability are unavoidable natural phenomena, so rather than trying to avoid it, it is necessary to slow down the rate and reduce the extent of the decrease [7]. Lack of exercise accelerates aging and reduces the ability to resist various diseases [15]. In order to prevent such a phenomenon, it is thought that it is necessary to develop an exercise program that can effectively help improve muscle strength, body composition, and stamina regardless of age [16].

2. Experiment Materials and Methods

2.1 Subject

The subjects of this study were 20 women who lived in Cheonan City and had no health problems to perform small tool exercise (30 years old and younger: 10 people, 50 years old and under 70 years old: 10 people). was selected as Subjects' voluntary participation consent was obtained and this was performed. Table 1 shows the characteristics of the study subjects.

Table 1. Characteristics of subjects

Group	N	Weight	Age
Thirty-Forty	10	57.94±6.99	42.10±7.52
Fifty-Sixty	10	62.54±11.76	57.80±5.69

2.2 Experimental procedure

After selecting the study subjects, the purpose and procedure of this study were explained well enough. Body composition was measured to investigate the subject's physical characteristics one week before the experiment. , dynamic stability (Y-Balance test), and isokinetic muscle function were measured. For the small tool exercise for 8 weeks, an exercise ball and an elastic band were used, and the intensity was different from the 1-4th week and the 5th-8th week. The measured data were analyzed using SPSS 22.0.

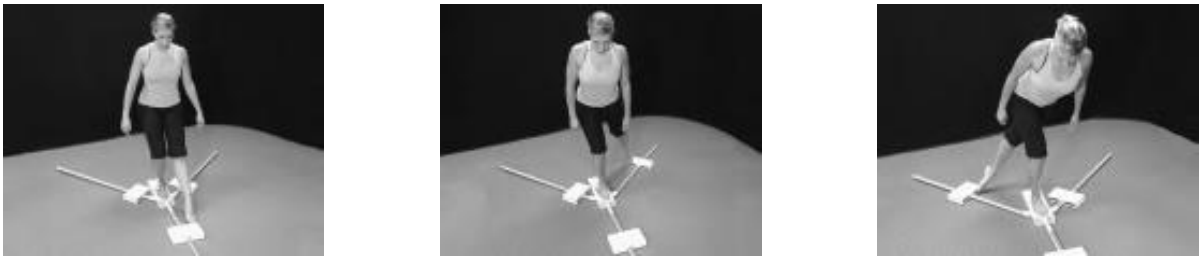
2.3 Variable measurement

2.3.1 Isokinetic strength

Measurement of isokinetic muscle function was modified according to the purpose by referring to the study of [17] according to [18], and flexion and extension of the knee joint were measured with Biodex system 4 (Biodex, USA). The subject sat in a chair with isokinetic equipment and set the seat so that the hip joint was flexed by 90°, and the upper body, pelvis, and thigh were fixed using a belt to exclude external forces from body parts other than the lower extremities during knee extension and bending exercises. After the lateral epicondyle of the femur was aligned with the axis of rotation of the dynamometer, the Tibia lateral malleolus was fixed with a Velcro strap. After that, the maximal extension of the knee joint was set to 0°, and the range of motion to flexion of the knee joint was set to 90°. correct was performed. After performing three pre-exercises at a predetermined load speed before measurement, the knee was extended and bent in accordance with the "start" signal of the measurer in the state of flexion and sufficient rest. It was carried out 5 times at an angular velocity of 60°/sec. Measurement was performed only on the dominant side.

2.3.2 Dynamic stability

The dynamic stability ability test in this study was conducted using the Y Balance Test kit (Functional Movement Systems, Inc, USA: YBT). Before the dynamic stability ability test, both leg lengths of the subject were measured. To measure leg length, the distance from the anterior superior iliac spine to the medial malleus was measured. Limb Length was measured twice and the average value was used. After measuring the Limb Length, the subject listened to the examiner's demonstration and sufficient explanation, and practiced 6 times for the measurement. Subjects maintained a standing posture with one leg on the middle foot of the YBT tool and both legs were measured in the anterior, posterolateral and posteromedial directions with their hands placed on the waist[19], and a total of two measurements were performed. Recorded as average. The dominant leg was first performed, and the ratio to the length of the lower extremities was calculated and used as shown in the formula. The formula for calculating the Composite Scored is as shown in <Figure 5>. When the supporting leg has fallen off the middle platform. If the leg touched the ground or failed to return to the starting position, it was considered a failure and remeasured. The dynamic equilibrium measurement is shown in Figure 1.



(a) (b) (c)

Figure 1(a) Dynamic stability_anterior reach
Figure 1(b) Dynamic stability_posteromedial reach
Figure 1(c) Dynamic stability_posterolateral reach[17]

2.3.2 Static stability

In this study, static equilibrium was measured by standing with eyes closed. The measurement posture was started after the subject stood upright while holding the waist with both hands. With the start signal, the subject closed their eyes and placed their non-dominant foot off the ground by more than 15 cm, and the measurer measured the time. The end points were when the feet were placed on the ground, when the supporting legs moved, when the hands fell from the waist, and when the eyes were opened. Measurements were made twice, and the average recording was used as data.

2.4 Exercise program

The small tool exercise program in this study was conducted for a total of 8 weeks, twice a week, for 2 hours each including a break time. The intensity of exercise was different for weeks 1~4 and weeks 5~8. Exercise tools were performed using an exercise ball and an elastic band. The exercise event consisted of exercises that can use the whole body muscles every time. Table 2 shows the exercise program for each week.

Table 2. Exercise program

Grade	Intensity	Rep * set	Rest	Frequency/week
Grade1(1-4week)	RPE scale 12-13	15 * 2	10minute	2days / 1week
Grade2(5-8week)	RPE scale 14-17	20 * 2	10minute	2days / 1week

Table 3 lists the exercise items of the 8-week exercise program.

Table 3. Exercise

serial number	Exercise
1	Band squat
2	Band lunge
3	Band shoulder press
4	Band side lateral raise
5	Band front raise
6	Band hip flexion
7	Band kick back
8	Band Side Step
9	Band Hamstring Curl
10	Band Hip Abduction
11	Band Single Leg Deadlift
12	Band Deadlift
13	Band Bent Over Row
14	Exercise ball balane
15	Exercise ball jumping jack
16	Exercise ball push up

2.5 Static Analysis

For data processing in this study, the mean and standard deviation of all variables were calculated using the

IBM SPSS statistics (ver 22.0) statistical program. Equilibrium and isokinetic muscle data according to age and time during small tool exercise for 8 weeks were analyzed using the Repeated Measure One-way ANOVA method. The statistical significance level was set as α=.05

3. Result

3.1 Flexion isokinetic strength

The peak torque of 60°/sec knee flexion according to the measurement period showed a statistically significant difference ($p<.01$), and was higher after 8 weeks of exercise than before. There was a statistically significant difference in 60°/sec knee flexion peak torque according to age ($p<.05$), and the group 30-49 years old was higher than the 50-69 years old group. There was no interaction effect according to the measurement period and age. The results of repeated measurement two-way ANOVA analysis isokinetic strength for knee flexion are as shown in Table 4.

Table 4. Flexion isokinetic strength(N/M)

Group	Pre	Post	Contrast	F	P
30-49	55.49±6.45	63.05±9.85	Group(G)	16.385	0.001
50-69	48.37±8.07	55.92±9.46	Time(T)	4.541	0.047
			G * T	0.000	0.998

3.2 Extension Isokinetic strength

The peak torque of 60°/sec knee extension according to the measurement period showed a statistically significant difference ($p<.05$), and was higher after 8 weeks of exercise than before. There was no statistically significant difference in 60°/sec right knee extension Peak Torque according to age. There was no interaction effect according to the measurement period and age. The results of repeated measurement two-way ANOVA analysis knee isokinetic strength for knee extension are as shown in Table 5.

Table 5. Extension isokinetic strength(N/M)

Group	Pre	Post	Contrast	F	P
30-49	89.67±30.18	91.60±30.62	Group(G)	4.935	0.039
50-69	45.58±37.52	48.21±42.14	Time(T)	7.175	0.0.15
			G * T	.461	0.506

3.3 Dynamic stability

There was a statistically significant difference in left dynamic stability according to the measurement period ($p<.05$), and it was higher post-mortem than before. There was a statistically significant difference in left dynamic equilibrium according to age ($p<.05$), and the group 30-49 years old was higher than the 50-69 years old group. There was an interaction effect according to the measurement period and age. The results of repeated measurement two-way ANOVA analysis dynamic stability are as shown in Table 6.

Table 6. Dynamic stability(score)

Group	Pre	Post	Contrast	F	P
30-49	105.39±20.80	117.65±18.55	Group(G)	7.836	0.012
50-69	105.65±17.92	113.60±15.70	Time(T)	0.066	0.801
			G * T	0.352	0.560

3.4 Static stability

There was no statistically significant difference in left dynamic equilibrium according to the measurement period. There was a statistically significant difference in left dynamic equilibrium according to age ($p<.001$), and the group 30-49 years old was higher than the 50-69 years old group. There was an interaction effect according to the measurement period and age. The results of repeated measurement two-way ANOVA analysis static stability are as shown in Table 7.

Table 7. Static stability(sec)

Group	Pre	Post	Contrast	F	P
30-49	10.91±8.30	20.76±16.23	Group(G)	1.119	0.304
50-69	12.81±16.21	9.54±8.44	Time(T)	30.835	0.000
			G * T	4.448	0.049

4. Discussion

As humans age, the musculoskeletal system deteriorates, and it is known that this progresses from the 30s to 40s[20]. The function of the muscles around the knee joint plays a major role in daily life movements and gait, and the isokinetic muscle function evaluation used to evaluate the muscle function for each joint is the By measuring torque, muscle function is evaluated by measuring peak torque, which is an index of muscle strength, total work, and average power, which are indicators of muscular endurance[20] body weight, body composition, muscle cross-sectional area, and neuromuscular activity[21]. Therefore, in this study, we try to study the appropriate exercise program through the physical and functional changes of women as the aging progresses through 8 weeks of elastic band exercise. To this end, 10 women in their 30s and 40s and 10 women in their 50s and 60s were exercised with an elastic band twice a week for 2 hours for 8 weeks, and body composition, dynamic equilibrium, and isokinetic muscle strength were investigated before and after the exercise program.

Elastic band exercise is used as an exercise that can replace weight training and is performed as a rehabilitation or functional improvement exercise[23]. In the past, elastic bands were used to improve functional movement and initial muscle strength in rehabilitation using the elasticity of rubber. Elastic banding exercise can also be performed by adjusting the type and length according to the individual's strength and purpose, and when performed at an appropriate intensity, strength improvement of 10-20% can be expected. In this study, to investigate the effect of elastic band exercise, knee isokinetic muscle strength was measured before and after 8 weeks of exercise. The post-mortem was higher than the before, and the 30-49 year-old group was higher than the 50-69 year-old group, and there was no interaction effect.

This is thought to reflect the effect of resistance exercise due to the inherent characteristics of the elastic band. The exercise program of this study focused on improving the muscle strength of the whole body, and it

was composed of a program to increase the strength of each joint using a band. Therefore, the increase in isokinetic muscle strength shown in this study is considered to be an adaptation phenomenon and the effect of strength increase in women who did not exercise continuously. Gardner, Robertson, McGee, and Campbell[24] reported that there was an improvement in lower extremity muscle strength through elastic band exercise for 6 months. It was said that there was a significant improvement in muscular endurance, and whole-body muscular endurance improved in 12-week elastic band exercise for elderly women. In particular, Jung[25] reported similar results to this study by reporting that 12-week elastic band exercise for elderly women improved both upper and lower extremity muscle strength. Jung[23] reported that 12-week elastic band exercise for elderly women improved both upper and lower extremity muscle strength. As such, many studies on elastic band training reported improvements in muscle strength and muscular endurance in women, showing similar results to this study.

Balance ability requires correct response and coordination of the musculoskeletal system and central nervous system, and stabilization exercises for trunk muscles and lower extremities are important to improve such ability. Appropriate elastic band exercise is known to be suitable for stabilizing the musculoskeletal system and training the nervous system that can meet such demands. In addition, balance is a phenomenon that is based on the harmony of movement and stability, and vestibular vision and somatosensory are important factors[26]. According to [27], factors that decrease balance ability include a decrease in proprioceptive sensory ability, weakening of reflexes, loss of postural maintenance function due to decreased muscle strength, and decreased coordination of lower extremity joints.

In this study, the Y-Balance Test was conducted to confirm the dynamic stability ability, and there were differences according to age and measurement time for both left and right sides ($p<.05$), and the Y-Balance score after elastic band exercise at all ages was came out high

4. Conclusion

When a person reaches the age of 50, muscle strength, muscle function, and athletic ability decrease due to aging. This loss with aging is unavoidable and happens to everyone. Such aging may reduce activity and further lead to geriatric diseases, which may directly affect the healthy lifespan of the elderly. This is more evident in women. Therefore, it is important to continuously perform the correct exercise to reduce the decrease and delay the decrease. Therefore, this study tried to find out the effect of elastic band exercise by applying elastic band exercise according to age for 8 weeks according to age for proper application of exercise program, checking knee isokinetic function and dynamic equilibrium, and obtained the following results. First, there was no 60°/sec Peak Torque in women according to age when elastic band exercise was applied for 8 weeks, but it increased after measurement rather than before measurement. Second, when the elastic band exercise was applied for 8 weeks, the dynamic equilibrium of women according to age and the dynamic equilibrium according to the measurement period were different. Third, there was a difference in static equilibrium according to time when elastic band exercise was applied for 8 weeks. We found that small tool exercise helps with strength and balance, and this phenomenon becomes more pronounced with age. Therefore, I think it is important to improve and maintain muscle strength through exercise before aging progresses.

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