



Original Article

Effects of elastic band exercises on physical ability and muscular topography of elderly females

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Abstract. [Purpose] This study examined the effects of band exercise types on the physical ability and muscular topography for elderly females. [Subjects and Methods] Twenty-six females older than 65 years were divided into the dynamic band exercise (DBE; n=13) group and the Static band exercise (SBE; n=13) group. Each participant performed 12 weeks of elastic band exercises. Physical abilities were measured by leg extension power, sitting trunk flexion, closed eyes foot balance, and time to get up. Changes in muscle topography were evaluated with Moire measurement equipment for the chest, abdomen, and lumbar region. All results were compared before and after 12 weeks of exercise. [Results] Changes in physical ability were significantly increased in both groups. The scores for the muscular topography of the chest, abdomen, lumbar region, and all body parts was significantly improved in both groups for closed eyes foot balance. There were more improvements in the DBE group. [Conclusion] Two types of static and dynamic elastic band exercises effectively changed the physical fitness and muscle topography of elderly females. Therefore, to increase the effects of exercise, dynamic band exercises are considered useful. Because band exercises are simple, they can be used to maintain the health of elderly people.

Key words: Band exercise, Physical ability, Muscular topography

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INTRODUCTION

Korea has an aging society (proportion of elderly population accounting for 7%) and is about to have an aged society (proportion of elderly population accounting for 14%). This trend of an aging population is increasing the social burden of medical costs for the elderly in Korea. Furthermore, Korea has a lagging medical system that is focused on treatment rather than proactive prevention¹⁾.

Sarcopenia and decreased bone density are furthered in elderly people due to their increasing age and lack of physical activity. These factors create unstable posture, which contributes to further declines in balancing ability. Resistance exercises are highly effective for improving the muscular endurance of the lower limbs and walking function because they not only improve the muscle strength, which has been weakened due to aging, but also help to recover the lost sense of balance²⁾. For elderly people, it is appropriate to exercise intensity and various angles according to physical strength level during muscular resistance exercise and elastic band exercise to minimize impact on exercise¹⁵⁾. Furthermore, the elastic band is also very useful because it improves the strength of the elderly and minimizes the adaptation and injury to the exercise during muscular resistance exercise¹⁶⁾. However, cross-sectional studies have been unable to fully explain the causality of their results, and

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their limitation is that the effect of intervention does not last for a long period due to factors such as the formal approach to exercise.

Elastic band exercises³⁾ are reported to improve muscle strength and require various energy levels suitable for avoiding boredom and maximizing effects. This study implemented exercise static band exercise (SBE) and dynamic band exercise (DBE) for 12 weeks. The results caused changes in physical fitness, walking ability, or twisted spine or muscles were examined with three-dimensional contour lines to identify the state of imbalance, discomfort in the upper and lower muscles, degree of attachment of the curved spine, and muscle disorders. Moire topography⁴⁾ was used to identify the subtle degree of twist in the body, any imbalances and their causes. A sustainable and efficient resistance exercise method was suggested based on the analysis. Therefore as bands are relatively cheap and safe, the main purpose of this research was to investigate the differences in band exercise type on the muscle topography and general physical fitness characteristics.

SUBJECTS AND METHODS

This study randomly selected females between 65 and 80 years of age who usually do not exercise and were registered for health management at the Y welfare center located in I city. A total of twenty-six females were selected and divided into a group of 13 individuals who were to perform SBE (age: 70.00 years; height: 153.85 cm; weight: 57.495 kg) with elastic bands and a group of 13 individuals who were to perform DBE (age: 72.92 years; height: 151.61 cm; weight: 57.495 kg) with elastic bands. Before each of the participants started in this study they each signed a consent form after a verbal explanation and reading an explanation form.

Yellow elastic bands (1.0 kg of resistance for 40 cm of extension) and red elastic bands (1.6 kg of resistance for 40 cm of extension) recommended for the elderly and females by Hygenic Corporation were used. Yellow elastic bands had low elasticity and were used from weeks 1 through 4; during that time, the subjects repeated the same movement 10 times. After adapting to the exercise, the movements were repeated 15 times using the yellow bands during weeks 5 through 8. The movements were performed 10 times using red elastic bands with intermediate intensity from weeks 9 through 12. The SBE group performed all exercises with both the lower body in place, while the DBE group stepped to the music. They had to maintain heart rate ranging 80–100 bpm until week 4 and 90–110 bpm after week 5 until week 12. The SBE group had to perform the following: shoulder press, shrug, front raise, lateral raise, biceps curl, triceps extension, kick back, bent over row, seated row, chest press, leg press, squat, good morning, abdominal curl, pelvic lift, and crunch.

To examine physical fitness, measurements were conducted using Helmas III (NH-3000G, Korea). Leg extension power (LEP) of both legs, Leg extension power of the left leg (LEPL), and Leg extension power of the right leg (LEPR) were measured in the sitting position. Elasticity was measured in the sitting position with the legs straight. Balance was measured in the single leg stance with eyes closed. Measurements of all items were performed three times. The average of the three measurements was calculated and input as the measured value. Measurements were performed before and after the program. To examine muscular topography, a Moire topography system (Green Moire Technology Co., Republic of Korea, Model: ASKLEPIOS) was used for three-dimensional profiling. Regarding the conditions of imaging and reading, the camera and screen were placed within 153 cm of the individual, and the camera and light source were placed within 51 cm of the individual. Under these conditions, when there was a 46-mm height gap in the surface of the human body, the Moire patterns were represented by contour lines. Eight items (horizontalness of the pattern of the upper scapula, state of the scapula, lordosis and kyphosis of the thoracic vertebrae, horizontalness of the pattern of the lower scapula, the number of contour lines of both back areas below the lower scapula, state of the hip, the number of contour lines of the upper hip, and horizontalness of the pattern of the upper hip) were measured according to the reading reference table for the musculoskeletal system. Then the manufacturer defined check points were used from the reading reference table, and the in-depth reading reference table. Scores were given based on grades, and the highest possible score was 100⁴⁾. Averages and standard deviations were calculated using SPSS version 20.0 for statistical tests based on the measurement results, with a significance level of $p < 0.05$. A two-way repeated ANOVA was conducted to verify differences between the SBE and DBE groups before and after the 12-week exercise program. This study was designed to improve the physical fitness of the elderly, and they were fully aware of the purpose of the study and participated voluntarily.

RESULTS

The results of all test items, leg extension power right, leg extension power left, sitting trunk flexion, closed eyes foot balance, and time to get up, showed no significant differences regarding the groups, time periods, or interaction according to groups. However, comparisons before and after the exercise program showed that the SBE and DBE groups demonstrated a significant difference ($p < 0.05$) (Table 1).

The results for all body parts, chest, abdomen, and lumbar region did not show any significant differences in terms of interactions according to group type and time period. However, in terms of time period, the SBE and DBE groups exhibited improved results with a significant difference ($p < 0.005$) (Table 2).

Table 1. Results of leg extension power, trunk flexion, and balance

Variable	Group	Before exercise (mean ± SD)	After 12 weeks (mean ± SD)	Period	Group	Period × Group
				Significance	Significance	Significance
LEPR (kg)*	SBE	13.86 ± 6.35	15.18 ± 6.80	<0.001	0.530	0.189
	DBE	15.75 ± 6.95	16.67 ± 6.94			
LEPL (kg)*	SBE	9.45 ± 4.90	11.38 ± 4.75	<0.001	0.513	0.110
	DBE	10.95 ± 4.66	12.37 ± 4.88			
LEPD (kg)*	SBE	22.92 ± 14.60	25.21 ± 14.84	0.001	0.417	0.097
	DBE	27.45 ± 10.27	28.87 ± 10.11			
STF (cm)*	SBE	15.94 ± 9.72	17.86 ± 8.29	<0.001	0.240	0.670
	DBE	12.38 ± 5.18	14.55 ± 4.90			
CEFB (sec)*	SBE	6.00 ± 3.72	8.69 ± 3.28	<0.001	0.129	0.164
	DBE	10.15 ± 10.42	13.85 ± 9.88			
Time to get up (sec)*	SBE	12.70 ± 1.65	11.93 ± 0.17	<0.001	0.562	0.661
	DBE	12.48 ± 0.80	11.53 ± 0.00			

LEPR: leg extension power right; LEPL: leg extension power left; LEPD: leg extension power dual (both legs); STF: sitting trunk flexion; CEFB: closed eyes foot balance; SBE: Static Band Exercise; DBE: Dynamic Band Exercise.

Table 2. Results of muscular topography

Variable	Group	Before exercise (mean ± SD)	After 12 weeks (mean ± SD)	Period	Group	Period × Group
				Significance	Significance	Significance
Total of body parts*	SBE	37.54 ± 17.76	46.92 ± 11.14	<0.001	0.854	0.592
	DBE	37.54 ± 12.57	48.77 ± 10.71			
Chest*	SBE	17.08 ± 10.59	22.46 ± 8.93	<0.001	0.519	0.564
	DBE	19.92 ± 8.28	24.08 ± 8.36			
Abdomen*	SBE	8.35 ± 4.23	11.54 ± 3.69	0.002	0.382	0.237
	DBE	7.77 ± 4.39	9.31 ± 5.20			
Lumbar*	SBE	11.31 ± 6.39	14.08 ± 5.36	<0.001	0.960	0.109
	DBE	10.23 ± 6.13	15.39 ± 6.25			

SBE: Static Band Exercise; DBE: Dynamic Band Exercise.

DISCUSSION

Among various methods to prevent the decline of physical functions, resistance exercise training increases the basal metabolic rate of the elderly, improves insulin sensitivity, and increases neuromuscular functions. Because they are characterized by effects that reduce various risk factors related to loss of muscle mass, resistance exercise and DBE are strongly recommended⁵. As the aging of the body continues, body functions and physical fitness decline, including balance, muscle strength, elasticity, and agility; this decline is the major cause of falls for the elderly⁶. Improvements in LEP of the elderly improve balance and walking ability. In this study, leg left and right extension power were measured separately and together before and after exercise. The SBE and DBE groups showed significantly improved results ($p < 0.05$). The balance indicator related to leg extension power and sitting trunk flexion and the walking ability indicator time to get up were also significantly improved. Therefore, the study results confirmed that exercise that improves leg extension power which may be effective to increase balance and walking ability⁸. In general, as one ages, muscle strength decreases and muscle imbalances occur, negatively affecting posture of the elderly. Consequently, the functions of the viscera, muscles, and bones decrease, thus affecting metabolism and blood supply and prompting aging⁷. In addition, when muscles are weakened by aging, the volume of the entire body generally declines and the body becomes smaller. When either side of the muscle declines in function for any body part, the entire muscle loses balance, which triggers changes in posture.

There are musculoskeletal and neurological factors that affect balance control and muscular topography. These factors are strongly associated with one another in terms of effects. Therefore, proper exercises using joints, muscle strength, and elasticity are required for sound human body dynamics⁸. This study attempted to induce changes to enhance muscle strength and elasticity. Analysis of the effects of exercise on muscular topography showed that each individual body part and the sum of all body parts, including the chest, abdomen, and lumbar region, demonstrated significant changes and improvements ($p < 0.05$). Kim et al.⁹ conducted a program involving sling exercises and stretching and reported that changes were observed

in muscular topography of the entire body, including the chest, lumbar region, and all body parts, through the analysis of changes in body fat mass, muscle mass, and bone density. Park et al.⁴⁾ reported that continued training, such as qigong exercise or stretching, can create positive changes in muscular topography. Therefore, enhancement of muscle strength and elasticity through band exercise is confirmed to be useful for effectively improving muscular topography. Exercises consisting of very simple movements cause the elderly to lose interest in the activity. The introduction of active and diverse changes and exciting movements will engage them in physical activity and encourage continued participation¹⁰⁾. It was confirmed that the band exercises were highly effective for changing the muscular topography by enhancing muscle strength and elasticity, however, it must be noted that this study did not use a control group as other previous studies have already shown the effectiveness of elastic band exercises in comparison with control groups^{15, 16)}. As there were no significant differences between the exercise types, the exercise with the lower intensity should be recommended as it may be safer for the older female population. In addition, auditory stimulation caused by music during exercise influences cardiopulmonary capacity. Exercise speed and heart rate increase with fast music¹¹⁾. The heart rate is lower with slower music compared to faster music¹²⁾. Therefore, musical rhythms are effective for improving cardiopulmonary endurance¹³⁾ and have a positive effect on muscle exercise¹⁴⁾. In conclusion, DBE with an elastic band to enhance the physical fitness of the elderly and to prevent falls encourages continued participation in exercise and provides positive effects.

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