

Effects of Elastic Band Resistance Exercise on Depression, Stress, and Autonomic Balance when Applied to the Elderly for 12 Weeks: Randomized Controlled Trial (RCT)

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Abstract: This study is to determine how a resistance exercise program with an elastic band affects the elderly. Elderly subjects were studied for 12 weeks to determine the program's effect on depression, stress, and autonomic balance. Methods: There were 30 subjects in the experimental group and 31 subjects in the control group. The experimental group participated in resistance exercise three times a week (Monday, Wednesday, and Friday) for 12 weeks, and the control group did not participate in resistance exercise for 12 weeks. Results: There was no significant difference between the two groups regarding the general characteristics and homogeneity of the dependent variable. There were significant differences in depression and stress, and parasympathetic activity was partially significant but sympathetic activity was not. Conclusion: The resistance exercise program using an elastic band gradually reduced depression and stress over time and helped recover the autonomic nervous system. Therefore, for the elderly, resistance exercise using an elastic band is recommended to reduce depression and stress. We propose a follow-up study to measure the improvement of balance by dualizing the autonomic nervous system into sympathetic and parasympathetic nerves

Keywords: exercise, depression, stress, autonomic nervous system

1. Introduction

In Korea, social, medical, and economic problems related to the elderly are emerging as Korea enters an aging society at a rapid pace without sufficient personal or social response systems [1]. In particular, medical expenses for the elderly are increasing rapidly, and in 2017, the medical expenses for elderly people with health insurance accounted for 39.9% of the total. This is a trend that increases by 1.1% each year compared with the previous year [2]. For the elderly, complete mental and healthy physical functioning are important factors for successful aging. Therefore, among the various characteristics that appear as aging progresses, it is very important to delay declines in mental cognitive function and physical function so that they can engage in active social and physical activities [3].

Depression in the elderly is getting worse, and such a phenomenon is inevitable. In particular, stress is a major cause of depression, and such depression shows an autonomic nervous system imbalance not only in the elderly but in all people with depressive symptoms. It has been reported that the autonomic imbalance caused by depression activates the sympathetic nervous system, reduces parasympathetic activity, induces cardiovascular disease, and increases mortality [4-6].

The autonomic nervous system consists of the sympathetic nervous system and the parasympathetic nervous system. In general, it is known that the response to stress activates the sympathetic nervous system and decreases the activity of the parasympathetic nervous system [7]. These two nervous systems adapt to the ever-changing environmental demands to protect the homeostasis of our body and maintain a constant balance. This is called sympathovagal balance [8].

The balance of the autonomic nervous system is divided into a high-frequency (HF) band and a low-frequency (LF) band. HF is about 0.25 Hz and is related to the parasympathetic nerve. LF is about 0.1 Hz, and both the sympathetic nervous system and the parasympathetic nervous system are related. If one of these nervous systems is more dominant, autonomic imbalance occurs. This situation causes several diseases in our bodies. In particular, activation of the sympathetic nervous system can increase stress and strain the heart. When the parasympathetic nervous system is activated, mood disorders such as depression arise [9]. This is a severe stressful situation for the elderly and can cause serious problems such as heart disease and death by acting as a factor that causes various diseases. Therefore, efforts to remove these risk factors should be made before autonomic imbalance appears.

As one of the efforts to eliminate the imbalance of the autonomic nerve, it was said that resistance exercise controls weight and improves heart function and muscle recovery [10,11]. Looking at previous studies of the elderly, exercise alleviates depression symptoms. It has been reported to improve the vascular function of the heart by reducing stress and improving the autonomic nervous system [12-15]. There are many types of resistance exercises. Among them, exercise using a band guarantees more stability. In addition, it is easy to control the exercise intensity, and resistance exercise can be used to work all the muscles in the body, so it is widely applied at present. Furthermore, elastic band exercises apply force in the opposite direction of gravity, which is helpful i

n improving muscle mass, reducing depression, and relieving stress [11,16,17]. It also has the advantage of being independent of place, making it convenient for the elderly and effective in providing physical stability. Therefore, this study intends to confirm that a 12-week resistance exercise program with an elastic band has a positive effect on the elderly in terms of depression, stress, and autonomic balance.

2. Body

2.1 Research design

This study was a randomized controlled pre-post parallel study to determine the effects on depression, stress, and autonomic nervous system balance (sympathetic, parasympathetic) in the elderly through participation in an elastic band resistance exercise program for 12 weeks.

2.2 Research subject selection

The subjects were elderly people age 60 or older residing in G city, and were recruited as voluntary participants who were given an explanation of the study and randomly assigned to the experimental group or the control group. Concerned about the spreading effect of this study, the experimental group data were collected first, and then the control data were collected. Data collection was conducted for 12 weeks for each group from May 15, 2019 to November 13, 2019. A total of 71 subjects who met the selection criteria were randomly assigned: 36 subjects in the experimental group and 35 subjects in the control group. After collecting the participant data, the data of 30 subjects from the experimental group were analyzed (six subjects dropped out), and the data of 31 subjects from the control group were analyzed (four subjects dropped out).

2.3 Calculating the sample size

To compare the effects on depression, stress, and autonomic nervous system balance (sympathetic, parasympathetic) in the elderly after participating in resistance exercise programs using elastic bands, a repeated measurement variance analysis in the G-power program (F-test) was conducted on the subjects. The median effect was 0.25, the significance level of the two-sided test was 0.05, the power of the test was 0.95, the number of groups was two, the number of measurements was three, and the correlation coefficient was 0.3. As a result, 30 samples were required per group.

2.4 Experimental treatment

Resistance exercise refers to a method of enhancing muscle mass by applying a load to the relevant muscle [18]. The experimental treatment in this study was conducted by applying a 12-week elastic band resistance exercise program developed for adults that complained of scapular fascia pain syndrome [17].

2.5 Procedures

2.5.1. Configuration

The resistance exercise program using an elastic band was developed and constructed in consideration of the type, frequency, intensity, duration, equipment, and stage of exercise by seeking advice from an orthopedic specialist, orthopedic nurse, nursing professor, and exercise therapist. First of all, the types of resistance exercise programs using elastic bands and tools used were constructed so that subjects could actively exercise themselves by using elastic bands that do not change the elastic force even after long-term use. The frequency and intensity of exercise will be determined by comparing the individual's subjective ability for each program progression. The intensity of the individual's subjective exercise will be determined as the moderate elasticity of the elastic band, and the intensity of physical strength perceived by the subject will be determined as the appropriate intensity by pulling it with a constant motion for 10 times. The frequency will be set at 48 to 52 hours, taking into account the duration of tissue fibrosis and muscle atrophy around the joint, and if one week is considered, the frequency will be set 2 to 3 times a week. The number of times of exercise consisted of 3 sets of 15 repetitions for each set by determining the exercise load based on the Daily Adjustable Progressive Resistive Exercise (DAPRE) method. The step-by-step configuration of the resistance exercise program using the developed elastic band is the internal rotation, external rotation, adduction, abduction, and flexion of the shoulder joint to strengthen the muscles and rotator cuff around the scapula.) And extension range. In order to maintain a constant exercise intensity, the elastic band is fixed to the subject's body, and then the elastic band is placed with both hands in a state where the lower extremities are spread to the width of the shoulder blades on both sides. I will grab it and proceed with the exercise. The elbow will be progressed based on stabilization while the extension is sufficiently extended, and all movements of the elastic band resistance exercise program will be conducted within the range of pain-free to the subject.

2.5.2 Stress

The resistance exercise program proposed in this study was implemented as follows. TheraBand was provided to the subjects and they were allowed to exercise by referring to the produced video. The program lasted for eight weeks and three days. Each session consisted of eight different movements, and resistance exercise was implemented 15 times for each movement. In total, two sets of exercises were performed for three sessions. It took approximately 70 min to complete the full course of each exercise session.

The control group had a daily routine without the intervention of a resistance exercise program for 8 weeks. Instructed to follow their normal daily routine for eight weeks without the intervention of the resistance exercise program. After that, we provided programs like experimental groups to those who wanted <Fig 1>.

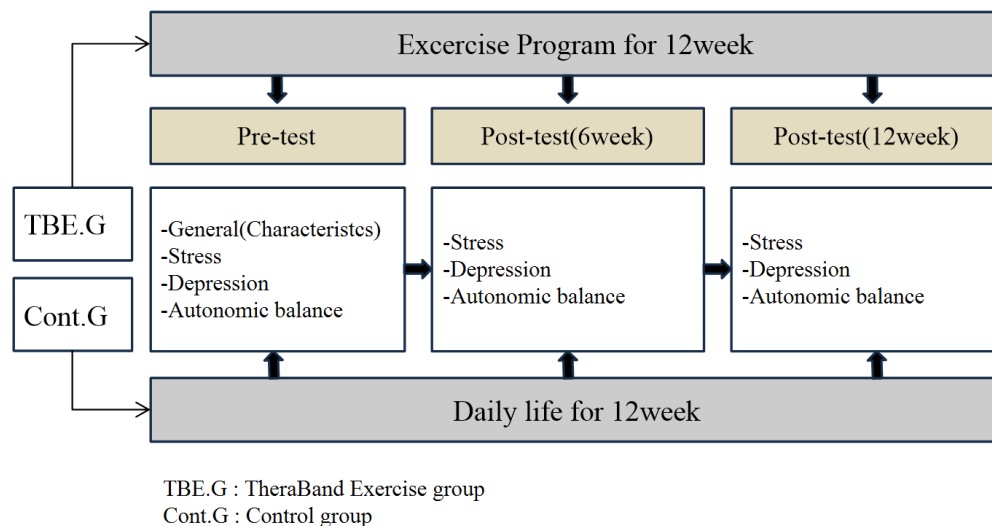


Fig.1. Process flow diagram.

2.6 Research tools

2.6.1 Depression

The depression scale was developed by Radloff in 1977 [19], and Chon *et al.* developed the Korean depression scale CES-D (The Center for Epidemiological Studies Depression Inventory) [20].

2.6.2 Stress

The stress scale was developed by Cohen *et al.* (1983) [21] and was measured by the stress scale [22] developed by Jung *et al.* in Korean.

2.6.3 Autonomic nervous system balance (Canopy9)

In order to evaluate the balance of the autonomic nervous system, the frequency domain was analyzed by continuous measurement for 5 minutes using the Canopy9 PLUS (IEMBIO) device, which analyzes heart rate variability and provides an index evaluating the balance of the autonomic nervous system by a non-invasive method. LF represents the sympathetic nerve activity in the entire autonomic nervous system in the low-frequency region, and HF represents the parasympathetic nerve activity in the high-frequency region. The higher the value of sympathetic activity and parasympathetic activity, the higher the activity is, and the stress state and resistance are evaluated according to the balance between the sympathetic and parasympathetic nerves.

2.7 Data analysis

The collected data were analyzed using SPSS 24.0. The homogeneity test for the general characteristics of the subjects was analyzed by frequency, percentage, mean, χ^2 -test, and t-test, and the pre-dependent variable identity test was analyzed by t-test. To verify the effectiveness of experimental intervention, the results of the experimental group and the control group were analyzed by t-test and repeated measures ANOVA. In addition, the magnitude of the effect between the independent variable and the dependent variable was suggested by analyzing the partial η^2 between groups and time. The value of the partial eta squared is described in the range of 0 to 1, and the closer the value is to 1, the larger the difference between the groups and the error is small. In general, if the partial eta squared is 0.01, the effect is small, if it is 0.06, the effect is medium, and if it is 0.14 or more, the effect is considered large [23].

2.8 Ethical considerations

The ethical considerations in conducting this research were as follows.

- 1) In order to recruit research subjects, a researcher visited the G city health center in person, explained the purpose and content of the study, asked for consent, and voluntarily recruited subjects through bulletin boards and banners in the G city health center and conditional site. Before receiving the consent to participate in the study, the subject was given a sufficient explanation of the study to decide whether to participate.
- 2) The subject's description in the questionnaire included the procedure of the experimental treatment, the possibility of participation and withdrawal, the side effects that may occur during the experiment, the treatment methods when side effects occur, and compensation after participation.
- 3) The collected data were classified and processed by assigning an ID with a unique number according to the guidelines of personal information processing in order to protect the privacy of the participants.
- 4) Cases worth 16,000 won were provided to all subjects participating in the study at the end of data collection.

3. Research Results

3.1 Verification of homogeneity of subjects' general characteristics and ethnic variables

Among the general characteristics, the age of the subjects was 68.47 ± 5.08 years in the experimental group and 68.33 ± 4.67 years in the control group, and there was no significant difference between the two groups. As a result of testing the homogeneity of the general characteristics of the two groups, there was no significant difference in age, height, weight, level of education, exercise, and habits, indicating that the two groups were similar

ar. Among the dependent variables, there was no significant difference in shoulder pain, depression, stress, headache, heart rate, scapular motion range, and body composition around the shoulder joint, so homogeneity was secured (see Table 1).

Table 1. Homogeneity Tests of General Characteristics of the Subjects (n = 61)

Characteristic	Category	Exp. (n = 30)	Cont. (n = 31)	X ² or t	p
		Mean ± SD or N (%)	Mean ± SD or N (%)		
Age (yr)		69.23 ± 5.26	67.81 ± 4.55	1.130	.263
Height (cm)		157.70 ± 5.20	159.77 ± 5.89	-1.456	.151
Body weight (kg)		59.50 ± 10.02	59.00 ± 9.95	0.194	.847
Blood pressure	SBP	116.07 ± 10.68	119.68 ± 14.99	-1.080	.284
	DBP	72.30 ± 8.34	73.71 ± 9.94	-0.600	.551
Education	Less than middle	10 (33.4)	14 (45.1)	0.494	.623
	High	14 (46.6)	10 (32.2)		
	More than college	6 (20.0)	7 (22.7)		
Residence	Family	24 (80.0)	22 (70.9)	0.615	.541
	Solitary	6 (20.0)	9 (29.1)		
Exercise (per week)	Less than one time	4 (13.3)	8 (25.8)	1.115	.269
	One to two times	24 (80.0)	21 (67.6)		
	More than two times	2 (6.7)	2 (6.6)		
Depression		38.46 ± 3.46	37.64 ± 3.94	0.863	.391
Stress		36.50 ± 3.45	37.64 ± 3.05	-1.035	.304
Autonomic balance	HF	4.20 ± 1.21	4.18 ± 0.80	.049	.961
	LF	4.12 ± 0.87	4.08 ± 1.00	0.158	.875
Canopy ⁹		2.50 ± 1.19	2.48 ± 1.17	0.053	.958

Exp. = experiment group; Cont. = control group

BPS = Bodymetrix Pro System; NRS = numeric rating scale.; ROM = range of motion.; SD = standard deviation

SBP = systolic blood pressure; DBP = diastolic blood pressure; Lt = left side; Rt = right side

3.2 Resistance exercise program effect on depression

Depression was significantly different according to time as a result of repeated measurement and variance analysis of the scores measured three times for 12 weeks (F = 42.30, p < .001), and there was a significant difference in the shoulder pain scores significant differences in scores between groups (F = 40.88, p < .001). In addition, there was a significant difference in the interaction between group and time (F = 44.49, p < .001). The partial eta squared, which is the effect of the resistance exercise program according to group and time, was 0.361 (see Table 2).

Table 2. Subject Comparison of Depression between the Experimental and Control Groups (n = 61)

Variable		TBE. G (n = 30)	Cont. G (n = 31)	t	p	F(p)
		Mean ± SD	Mean ± SD			
Depression	W ₀	38.46 ± 3.46	37.64 ± 3.94	0.863	.391	Time 33.219 (<.001)

	W ₆	34.10 ± 3.80	36.70 ± 2.88	-3.021	.004	Group 34.957 (<.001) G*T 39.392 (<.001)
	W ₁₂	28.83 ± 2.74	37.70 ± 3.68	-10.653	<.001	

Exp. = experiment group; Cont. = control group; NRS = numeric rating scale

M = mean; SD = standard deviation; F(p) = repeated measures of ANOVA (Wilks's Lambda)

3.3 Resistance exercise program effect on stress

Stress was significantly different according to time as a result of repeated measurement and variance analysis of the scores measured three times for 12 weeks (F = 54.16, p <.001 there was a significant difference over time (F = 88.22, p <.001), and there was a significant difference in the shoulder pain scores significant differences in scores between groups (F=225.84, p<.001). In addition, there was a significant difference in the interaction between group and time (F = 112.06, p <.001), and the partial eta squared, which is the effect of the resistance exercise program according to group and time, was 0.054 (see Table 3).

Table 3. Comparison of Stress between the Experimental and Control Groups (n = 61)

Variable		Exp. (n = 30)	Cont.(n = 31)	t	p	F(p)
		Mean ± SD	Mean ± SD			
Stress	Pre-test	36.50 ± 3.45	37.64 ± 3.05	-1.035	.304	Time 54.163 (<.001) Group 76.702 (<.001) Group*Time 194.379 (<.001)
	Post-test 1	31.70 ± 3.90	38.780 ± 2.58	-9.609	<.001	
	Post-test 2	25.13 ± 2.63	38.70 ± 2.39	-23.444	<.001	

Exp. = experiment group; Cont. = control group; NRS = numeric rating scale

M = mean; SD = standard deviation; F(p) = repeated measures of ANOVA (Wilks's Lambda)

3.4 Resistance exercise program effect on autonomic balance

As a result of repeated measurement of the variance analysis of the parasympathetic nervous system using the Canopy9 machine for a total of three times for 12 weeks, there was no significant difference over time. There was a significant difference in the activity between the two groups (F = .864, p = .014). There was no significant difference in the interaction between group and time. In addition, the partial eta squared, which is the effect of the resistance exercise program according to the group and time, was 0.058 (see Table 4).

The result of repeated measurement of the variance analysis of the sympathetic nervous system using the Canopy9 machine for a total of three times for 12 weeks showed no significant difference over time, and there was no significant difference in the activity between the two groups. In addition, there was no significant difference in the interaction between the groups and time (see Table 4).

Table 4. Comparison of Autonomic Balance between the Experimental and Control Groups (n = 61)

Variable		Exp. (n = 30)	Cont. (n = 31)	t	p	F(p)
		Mean ± SD	Mean ± SD			
HF	Pre-test	4.20 ± 1.21	4.18 ± 0.80	.049	.961	Time .110 (.894) Group .864 (.014) Group*Time 3.645 (.058)
	Post-test 1	4.49 ± 0.87	4.03 ± 0.94	1.965	.054	
	Post-test 2	4.43 ± 0.75	4.09 ± 1.11	1.393	.169	
LF	Pre-test	4.12 ± 0.87	4.08 ± 1.00	0.158	.875	Time .314 (.731) Group .543 (.569) Group*Time 1.164 (.285)
	Post-test 1	4.18 ± 0.54	4.11 ± 0.85	0.399	.691	
	Post-test 2	4.36 ± 0.39	4.06 ± 0.87	1.722	.090	

4. Discussion

This study attempted to confirm the effects on depression, stress, and autonomic balance in elderly who participated in a 12-week resistance exercise program. This study is a parallax experimental study before and after randomized control. The effects were analyzed in a total of 61 elderly subjects: 30 subjects were in the experimental group, and 31 subjects were in the control group. As a result, depression and stress were reduced, and the balance of the sympathetic and parasympathetic nervous systems of the autonomic nervous system was improved; thus, the application of a resistance exercise program using an elastic band is effective in improving the quality of life of the elderly. In order to confirm the effect of this study's resistance exercise program subjectively and objectively, a questionnaire was used, and the stress index measurement and sympathetic nervous system and parasympathetic nervous system were measured.

As a result of the study, depression was significantly lower ($F = 40.88$, $p < .001$) in the experimental group who received resistance exercise for 12 weeks compared with the control group. The experimental group decreased ($F = 225.84$, $p < .001$) compared with the control group.

The results of depression and stress in the two groups were consistent with the results of a study of 679 diabetic elderly persons age 65 years or older who performed exercise in the Aging Research Panel [24]. In addition, depression decreased in elderly females who performed circular exercise including resistance exercise for 12 weeks [25], and a study that applied resistance exercise program to the upper and lower extremities for 12 weeks in the elderly showed improvement in depression and quality of life [26]. In addition, as a result of a study that conducted complex exercise including resistance exercise for elderly diabetics for 16 weeks and a resistance exercise program for elderly diabetics for eight weeks, it was confirmed that stress was reduced and is consistent with this study [27,28]. In this study, depression and stress in the experimental group significantly decreased six weeks after experimental treatment and continuously decreased until 12 weeks. Therefore, a resistance exercise program using an elastic band was very effective in reducing depression and stress in the elderly.

The elastic band used in this study is a type of rubber band that has excellent elasticity, allows weight bearing in all directions, allows the subject to exercise actively, and minimizes side effects even when using various body parts and angles while exercising. The elastic band resistance exercise program applied in this study was an exercise program developed in the preceding study [16] and is composed of movements that are not significantly affected by the location, and can be done conveniently to exercise various joints. Depression continuously decreased for six and 12 weeks, and the stress score also continuously decreased for six and 12 weeks. As a result, the muscle-strengthening elastic band resistance exercise program that concentrates on the upper limbs can be considered very effective, as depression and stress are reduced in six weeks through 70 minutes of exercise three times a week.

The balance of the autonomic nervous system is very important in maintaining and protecting the homeostasis of our body. This homeostasis helps the human body to be properly balanced in an ever-changing environment [31]. This varies depending on gender, age, lifestyle, personality, genetic factors, and circadian rhythm [32,33]. Also, the autonomic nervous system is affected by both exercising and not exercising. Exercise helps improve the ability of the autonomic nervous system to maintain homeostasis, and exercise helps improve homeostasis of the autonomic nervous system [34].

In order to confirm the effectiveness of the program, as a result of examining the autonomic balance score, the HF band after the experimental treatment was higher in the experimental group than in the control group, but it was not statistically significant. The LF band score was also higher in the experimental group than in the control group after 12 weeks of experimental treatment, but it was not statistically significant. However, as mentioned, the experimental group showed an increase in the sympathetic nervous system and the parasympathetic nervous system, and the control group showed a rather decreased value. This is in line with studies showing that regular exercise is effective in improving the autonomic nervous system function of the sympathetic and parasympathetic nervous systems and reducing the incidence of fatal cardiovascular diseases [35,36]. In addition, the result of applying an exercise program, including resistance exercise for 12 weeks, to skinny women is consistent with this study [37]. However, it has been reported that there is no improvement in heart rate variability after endurance exercise, that is, autonomic balance, and it is still difficult to draw a clear conclusion that exercise improves the autonomic nervous system [38,39]. Therefore, as a limitation of this study, it is necessary to find a method to activate the sympathetic and parasympathetic nervous systems separately and analyze the results more systematically while checking the change of each variable. For this, it is considered that a method with high validity and high reliability is needed to measure the sympathetic nervous system and the parasympathetic nervous system, respectively. In this way, it is considered very important to use objective indicators to check the increase or decrease of each variable of the sympathetic and parasympathetic nerves in the study of the balance of the autonomic nervous system.

5. Limitations

The major limitations of this study included a lack of control over the subject's timing, an important exogenous variable. Therefore, we consider the differences between the periods when most of the elderly are farming, and when muscle strength and stress appear, and we suggest applying these periods to conduct follow-up studies. In addition, the study was conducted in an area with elderly subjects. Therefore, the results cannot be

generalized to other types of population. Thus, future research should include applying exercise programs to different age groups. Body composition acts as a risk factor for diseases throughout the heart and endocrine system, such as high blood pressure and diabetes. In this study, the 12-week exercise program did not significantly change body composition. Therefore, repeated studies are required to determine the effect of exercise programs on body composition.

6. Conclusion

This study was to determine the effects on depression, stress, and autonomic balance in the elderly who participated in a 12-week resistance exercise program. As a result of the study, in the experimental group that applied the resistance exercise program using an elastic band for 12 weeks, depression and stress gradually decreased statistically significantly over time, confirming the effect of the program using an elastic band for 12 weeks. Also, although not statistically significant, the autonomic balance was also regulated. Therefore, resistance exercise using elastic bands is strongly recommended for the elderly to reduce depression and stress, and a follow-up study to measure balance by dualizing the autonomic nervous system into sympathetic and parasympathetic nerves is proposed.

7. Acknowledgments

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8. Data availability statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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