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Original Article

The effects of elastic band resistance training on the physical activities, strength, body composition, and quality of life of the elderly

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Abstract: Objectives: To investigate the effects of elastic band resistance training on the physical activities, strength, body composition, and quality of life of the elderly. Methods: A total of 115 elderly people were recruited as the study cohort and divided into Group A (57 cases) and Group B (58 cases) according to the intervention method each received. Group A received conventional exercise guidance, while Group B received elastic band resistance training. The physical activities (results of the whole body reaction time test, the time up and go test (TUG test), the 10-m walk test (10MWT)), the body composition (body fat percentage (BFP), BMI, basal metabolic rate), myodynamia (grip strength, extensor muscle peak torque, flexor peak torque), the Berg balance scale (BBS) scores, the quality of life scores, and the Pittsburgh sleep quality index (PSQI) scores were compared between the two groups before and after the intervention. Results: After the intervention, compared with the people in Group A, the whole-body reaction times, the TUG times, and the 10-m walk times in Group B were shorter ($P < 0.05$), the BFP and BMI and the PSQI scores in Group B were lower ($P < 0.05$), the basal metabolic rates, the quality of life scores in multiple fields, and the Berg balance scale scores in Group B were higher ($P < 0.05$), and the extensor muscle peak torque and flexor peak torque of lower limb and upper limb grip strength in Group B were greater ($P < 0.05$). Conclusion: Elastic band resistance training can effectively improve physical activities, body composition, quality of sleep and life, and upper and lower limb myodynamia in the elderly.

Keywords: The elderly, elastic band, resistance training, physical activities, strength, body composition, quality of life

Introduction

Physical health underpins the overall well-being of human beings, and people's health serves as an important mark of national prosperity. Currently, the aging population is one of the characteristics of the social structures in countries globally [1, 2]. With the rise in age, the body functions of the elderly are significantly weakened, including decreases in balance and cognitive function, gait disorder and myodynamia significantly affecting the physical and mental health and reducing the quality of life and life satisfaction [3, 4].

Resistance exercises include strength training or resistance training, training that progressively overloads the muscles to promote muscle strength, power, anaerobic endurance, and size [5]. Although free-weight training and equipment training are resistance training methods highly recommended by professional sports coaches, they are not suitable for the elderly because costly professional equipment is required [6, 7]. Currently, according to the characteristics of chronic disease patients and the elderly, circuit resistance training (CRT) is usually adopted [8]. CRT, a progressive resistance training method, can not only improve muscle endurance and cardiovascular function, but it can also increase muscle strength [9, 10]. As a CRT program, elastic band resistance training involves elastic bands that come in a variety of shapes, and the body contracts its muscles by overcoming elastic resistance to increase muscle strength and improve physical activities [11, 12].

In view of this, this study presents the effects of elastic band resistance training on the physical activity (PA), strength, body composition, and quality of life in the elderly using randomized controlled experiments, so as to provide a theoretical basis for the establishment of an old-age service system and the development of elderly sports programs, thereby actively responding to the aging population. Therefore, elastic band resistance training features marked innovation and feasibility.

Materials and methods

Data

A total of 115 elderly people were recruited as the study cohort and were divided into Group A (57 cases) and Group B (58 cases) according to the intervention method each person received. Group A received conventional exercise guidance, while Group B received elastic band resistance training. (1) Inclusion criteria: excellent health, voluntary participation, informed consent from the patients, without exercise contraindications, age ≥ 65 years old, good cognitive function, a clear consciousness, normal cardiopulmonary function, stable vital signs, able to tolerate elastic band training, and approval by the Ethics Committee of Gangneung-Wonju National University. (2) Exclusion criteria: patients who withdrew from the study, patients who live alone, patients with advanced tumors, patients undergoing surgery, patients with painful lower limb joints.

Methods

Group A received conventional exercise guidance. Namely, the subjects were instructed to walk for half an hour every day for 12 weeks, without changing their original lifestyle.

Group B received elastic band resistance training. In this experiment, the yellow elastic band suitable for the elderly was selected. With the principle of safety, the number of exercises in each group was flexibly adjusted according to the actual physical conditions of the elderly. The intervention lasted for 12 weeks. The training was conducted once on Monday, Wednesday and Friday respectively. There were 7 training exercises, with a break of 5 minutes after every two training exercises. Each training exercise was performed in 3 sets of 10 repetitions each set, and there was a break of 30-60 seconds between the sets. The subjects were instructed to adjust their breathing and avoid holding their breath during the training. First, music and elastic bands were adopted, and the subjects simply stretched and relaxed their whole body, and then we carried out the resistance training. The specific training contents are as follows: (1) Upright row exercises for the back muscles, tied one end of the elastic band on the balance lever, maintained a natural standing state, slightly bent the knees, straightened the back, kept the abdomen tightened, fixed the gaze ahead, lifted both hands horizontally toward the front, and gripped the other end of the elastic band. The elastic band was pulled toward the rear using the two arms, so that the band reached around the scapula. After a few seconds of maintaining the position, the subjects returned to their original posture. (2) Upright arched back exercises for erector spinae muscles. They tied one end of the elastic band on the balance lever, maintained a natural standing state, straightened the back, kept the abdomen tightened, fixed their gazes ahead, crossed their arms on the chest, and gripped the other end of elastic band tightly, with their feet parallel to their shoulders. They kept standing all the time, bent the knees slightly, slowly turned the trunk to the left, pulled the elastic band to the maximum extent, and slowly leaned back to make the upper body maintain the arched shape to the maximum extent. After a few seconds of maintaining the position, the subjects returned to their original posture. (3) Upright trunk rotation exercises for abdominal muscle groups. They tied one end of the elastic band on the balance lever, maintained a natural standing state, straightened their backs, kept their abdomens tightened, fixed their gazes ahead, crossed their arms on the chest, and gripped the other end of the elastic band tightly, with their feet parallel to their shoulders. They remained standing all the time, bent the knees slightly, slowly turned the trunk to the left, and pulled the elastic band to the maximum extent. After a few seconds of maintaining the position, the subjects returned to their original posture. (4) Lunge and hip pressing exercises for quadriceps femoris. They tied one end of the elastic band on the balance lever and the other end at the waist, took a few steps with the left foot towards the

front of the right foot, placed both hands on both sides of their waists, straightened their backs, kept the abdomen tightened, fixed their gazes ahead, bent their knees and pressed their hips down to the left thigh. When the hip was parallel to the ground, there was a strong pulling feeling in the front thigh muscles. After a few seconds of maintenance, the subjects returned to the original posture. After repeating the aforementioned steps five times, the subjects performed the aforementioned steps using the right leg five times. (5) Vertical knee-lifting exercises for the rectus femoris. They tied one end of the elastic band on a lower iron pipe, and they tied the other end on the left leg, and maintaining a natural standing state, they slightly bent their knees, kept their hands naturally bent, gripped the balance lever tightly, straightened their backs, tightened their hip muscles, bent their left thighs, and lifted their thighs to the maximum extent. After a few seconds, the subjects returned to their original posture. After repeating the aforementioned steps five times, the subjects performed the aforementioned steps using the right leg 5 times. (6) Exercises of the intramedullary adductor muscles at a lateral posture for the medial and lateral muscles of the thigh. They stood sideways in front of the balance lever. They tied one end of the elastic band to the lower iron bar and the other end of the elastic band at their left ankles, straightened their backs, kept their abdomens tightened, maintained a natural standing state, bent their knees slightly, clasped the balance lever with both hands, straightened their backs, tightened their hip muscles, turned the left leg toward the inside, and pulled the elastic band as far as possible. When the band was pulled to the maximum extent, the subjects returned to their original posture after a few seconds of maintenance. After repeating the aforementioned steps five times, the subjects performed the aforementioned steps using the right leg five times. (7) Upright back kick exercises for the hip muscle groups. They tied one end of the elastic band at the lower iron bar and the other end at the left leg, maintained a natural standing state, slightly bent their knees, kept their hands naturally bent, and clasped the balance lever, straightened their backs, tightened their hip muscles, pulled the elastic band with the left leg rearwards, and kicked as hard as they could. After kicking as high as they could, the subjects returned to the original posture. After repeating the aforementioned steps five times, the subjects performed the aforementioned steps using the right leg five times.

The same dietary intervention was adopted in both groups. The patients mainly ate a light diet with less oil and salt. We strictly restricted the intake of animal fat, supplemented their meals with appropriate amounts of protein such as shrimp and fish, and they consumed more fresh vegetables and fruit to ensure balanced nutrition.

Observation indices

(1) PA: ① During the whole-body reaction: The subjects stood on the sensing pad and stayed focused. After 1 min, the red signal lamp was observed, and the subjects were instructed to react quickly when the light came on and to take his/her feet slightly off the sensing pad. The tests were performed 5 times. The highest and lowest scores were removed, and the final score was the mean of the other three scores [13]. ② TUG: The subjects sat on chairs with armrests, kept their bodies upright, placed their hands on the armrests. There were obvious markers at the end point 3 m away from the chair. Upon hearing the instruction to start, the subjects stood up from the chairs, walked 3 m with a normal gait, turned around after reaching the marker's position, and returned to sit in the chairs. The time it took to complete this process was recorded [14]. ③ 10-m walk: The subjects kept standing. Upon hearing the instruction to start, the subjects walked forward 10 m with a normal gait, and then stood still, and the timing stopped. The test was performed two times, the interval period was 30 s, and the final score was the mean of the two test scores [15].

(2) Body composition: Before and after the intervention, the BFP, BMI, and basal metabolic rates in the two groups were measured.

(3) Myodynamia: Before and after the intervention, the extensor muscle peak torque and flexor peak torque of the subjects' lower limbs in the two groups were measured using an isokinetic dynamometer, and their upper limb grip strength was measured using the grip dynamometer.

(4) Berg balance scale score [16]: Before and after the intervention, the balance abilities in

Table 1. Comparison of the general data between the two groups [n (%)]/($\bar{x}$ ± s)

Data		Group A (n = 57)	Group B (n = 58)	t/X^2	*P*
Sex (cases)	M	39 (68.42)	41 (70.69)	0.069	0.792
	F	18 (31.58)	17 (29.31)		
Age (years)		75.12±3.28	75.19±3.25	0.115	0.909
Weight (kg)		61.28±1.08	61.32±1.05	0.201	0.841
Height (cm)		168.96±2.28	169.08±2.19	0.288	0.774

the two groups were measured using the Berg balance scale. All the subjects were required to complete 14 actions, and the quality of completion was assessed using a scoring system of 0-4 points. The total scores of the scale were between 0 and 56 points, and the balance abilities were directly proportional to the scores. A score below 40 points indicated a risk of falling.

(5) Quality of life scores [17]: Before and after the intervention, the quality of life in the two groups was assessed using WHOQIL-100 (the World Health Organization Quality of Life Scale). The assessment indices the included environmental field, the social relations field, the independence field, the psychological field, and the life field, and the quality of life was directly proportional to the scores.

(6) Quality of sleep [18]: Before and after the intervention, the sleep quality in the two groups was assessed using the PSQI (Pittsburgh Sleep Index Questionnaire). There were 7 items in the PSQI, including daytime dysfunction, hypnotic drugs, sleep disorders, sleep efficiency, sleep duration, sleep time, and subjective quality of sleep. There were 19 sub-items totally, which were assessed using a scoring system of 0-3 points. The total scores ranged between 0 and 21 points. The quality of sleep was inversely proportional to the scores.

Statistical analysis

SPSS 22.0 was used for the statistical analysis. The measurement data were expressed using the mean ± standard deviation. The data conforming to a normal distribution were analyzed using *t* tests, and the data not conforming to a normal distribution were analyzed using Mann-Whitney U tests. The enumeration data were expressed by [n (%)]. The comparisons of the enumeration data within groups were carried out using X^2 tests. $P < 0.05$ indicated a statistically significant difference.

Results

Comparison of the general data between the two groups

The male and female subjects in Group A made up 68.42% and 31.58% respectively, and the male and female subjects in Group B accounted for 70.69% and 29.31% respectively. There were no significant differences within the groups ($P > 0.05$). Second, there were no significant differences in terms of age, weight, or height within the groups ($P > 0.05$) (**Table 1**).

Comparison of the physical activities between the two groups

Before the intervention, there were no significant differences in the whole-body reaction times, the TUG time, or the 10-m walk time between the two groups ($P > 0.05$). Compared with before the intervention, the whole-body reaction times, the TUG times, and the 10-m walk times in Group B were markedly shortened after the intervention ($P < 0.05$). There were no significant differences in the whole-body reaction times, the TUG times and the 10-m walk times in Group A before and after intervention ($P > 0.05$). Compared with Group A, the whole-body reaction times, the TUG times, and the 10-m walk times in Group B were shorter after the intervention ($P < 0.05$) (**Figure 1**).

Comparison of the body composition between the two groups

Before the intervention, there were no significant differences in the BFP, BMI, or and the basal metabolic rate between the two groups ($P > 0.05$). Compared with before the intervention, the BFP and BMI levels in Group B were decreased, but the basal metabolic rate was increased after the intervention ($P < 0.05$). There were no significant differences in the BFP, BMI, or basal metabolic rate in Group A before and after intervention ($P > 0.05$). Compared with those in Group A, the BFP and BMI levels in Group B were lower, but the basal metabolic rate was higher after the intervention ($P < 0.05$) (**Figure 2**).

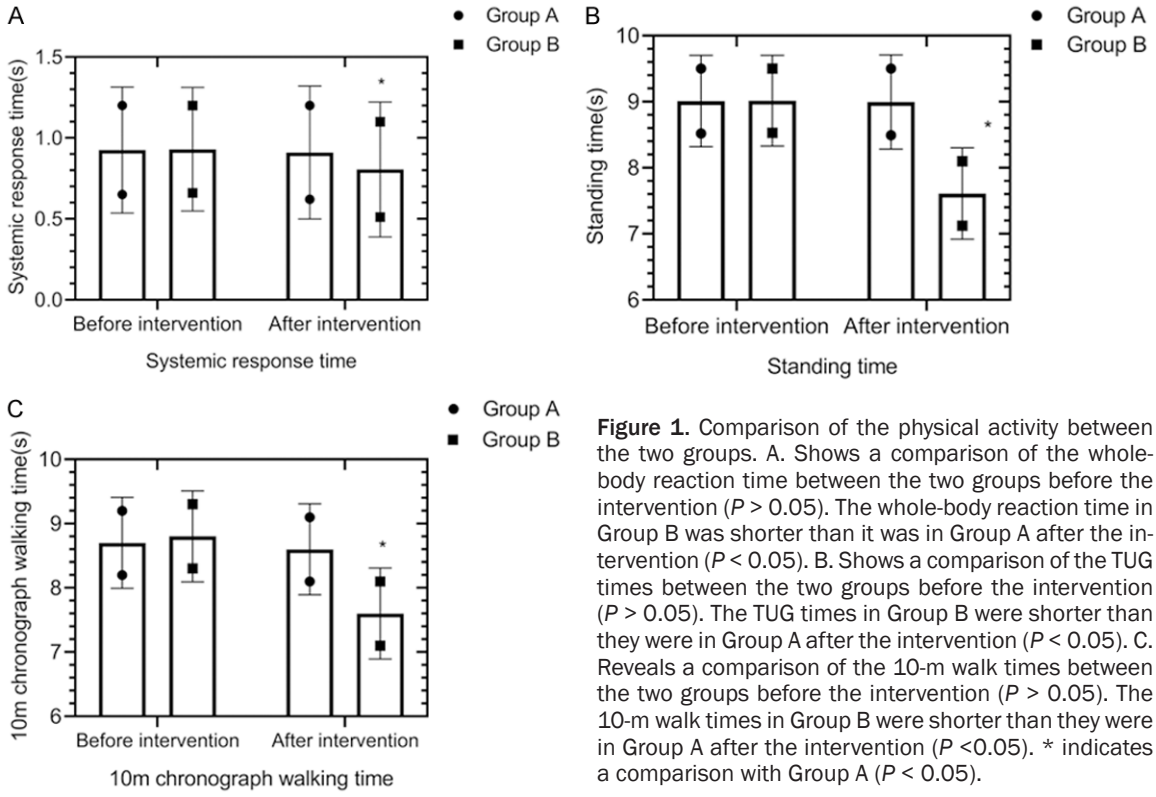

Figure 1. Comparison of the physical activity between the two groups. A. Shows a comparison of the whole-body reaction time between the two groups before the intervention ($P > 0.05$). The whole-body reaction time in Group B was shorter than it was in Group A after the intervention ($P < 0.05$). B. Shows a comparison of the TUG times between the two groups before the intervention ($P > 0.05$). The TUG times in Group B were shorter than they were in Group A after the intervention ($P < 0.05$). C. Reveals a comparison of the 10-m walk times between the two groups before the intervention ($P > 0.05$). The 10-m walk times in Group B were shorter than they were in Group A after the intervention ($P < 0.05$). * indicates a comparison with Group A ($P < 0.05$).

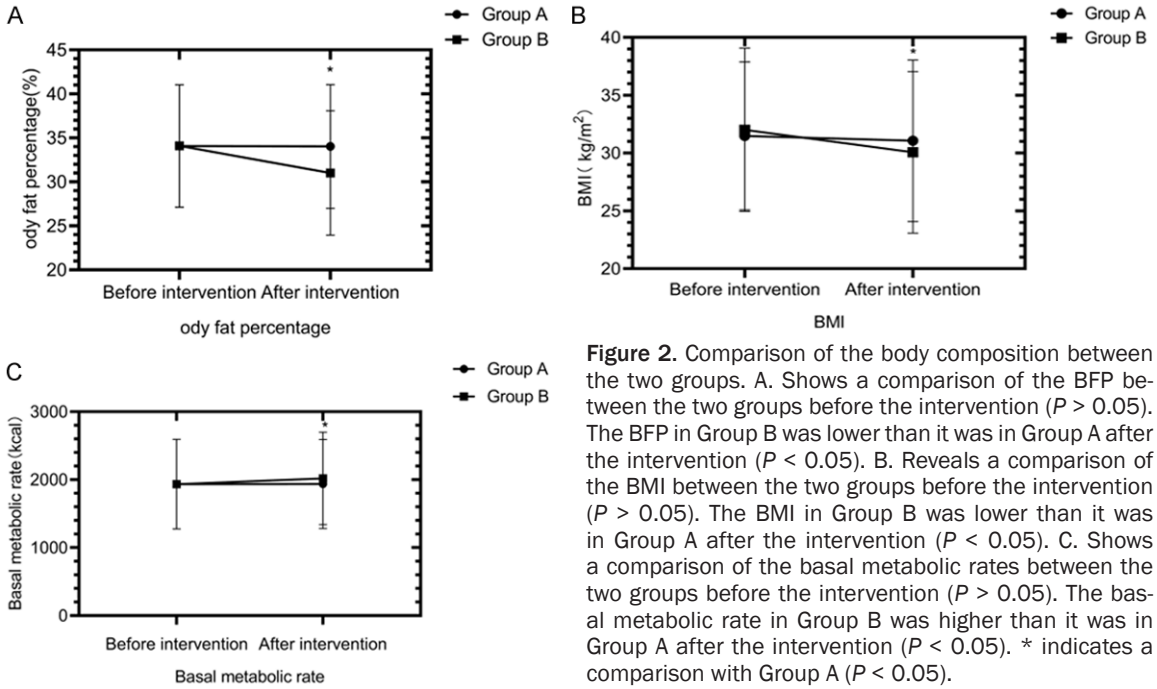

Figure 2. Comparison of the body composition between the two groups. A. Shows a comparison of the BFP between the two groups before the intervention ($P > 0.05$). The BFP in Group B was lower than it was in Group A after the intervention ($P < 0.05$). B. Reveals a comparison of the BMI between the two groups before the intervention ($P > 0.05$). The BMI in Group B was lower than it was in Group A after the intervention ($P < 0.05$). C. Shows a comparison of the basal metabolic rates between the two groups before the intervention ($P > 0.05$). The basal metabolic rate in Group B was higher than it was in Group A after the intervention ($P < 0.05$). * indicates a comparison with Group A ($P < 0.05$).

Comparison of the myodynamia between the two groups

Before the intervention, there was no significant difference in the extensor muscle peak torque or the flexor peak torque of the lower limb and upper limb grip strength between the two groups ($P > 0.05$). Compared with their levels before the intervention, the extensor muscle peak torque and the flexor peak torque of

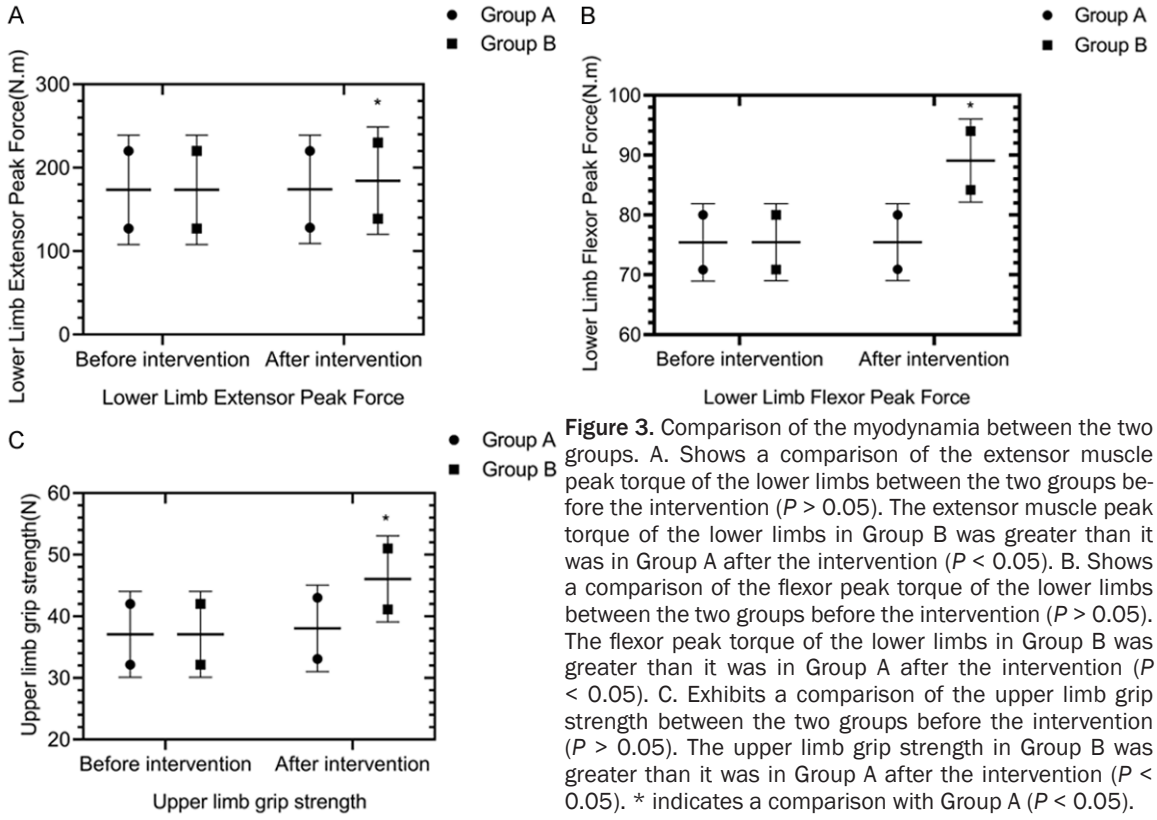

Figure 3. Comparison of the myodynamia between the two groups. A. Shows a comparison of the extensor muscle peak torque of the lower limbs between the two groups before the intervention ($P > 0.05$). The extensor muscle peak torque of the lower limbs in Group B was greater than it was in Group A after the intervention ($P < 0.05$). B. Shows a comparison of the flexor peak torque of the lower limbs between the two groups before the intervention ($P > 0.05$). The flexor peak torque of the lower limbs in Group B was greater than it was in Group A after the intervention ($P < 0.05$). C. Exhibits a comparison of the upper limb grip strength between the two groups before the intervention ($P > 0.05$). The upper limb grip strength in Group B was greater than it was in Group A after the intervention ($P < 0.05$). * indicates a comparison with Group A ($P < 0.05$).

Table 2. Comparison of the Berg Balance Scale scores between the two groups ($\bar{x} \pm s$, points)

Group	Before intervention	After intervention
Group A (n = 57)	38.15±2.52	38.96±2.51
Group B (n = 58)	38.19±2.49	48.96±3.15$^{\#,*}$
t	0.086	18.807
P	0.932	0.00

Note: $^{\#}$indicates the comparison with before intervention, $P < 0.05$. *indicates the comparison with Group A, $P < 0.05$.

the lower limb and upper limb grip strength in Group B increased after the intervention ($P < 0.05$). Before and after the intervention, there was no significant difference in the extensor muscle peak torque or the flexor peak torque of the lower limb and upper limb grip strength in Group A ($P > 0.05$). Compared with the levels in Group A, the extensor muscle peak torque and flexor peak torque of the lower limb and upper limb grip strength in Group B were greater after the intervention ($P < 0.05$) (**Figure 3**).

Comparison of the Berg balance scale scores between the two groups

Before the intervention, there was no significant difference in the Berg balance scale scores between the two groups ($P > 0.05$). Compared with the levels before the intervention, the Berg balance scale scores in group B were improved after the intervention ($P < 0.05$). There was no significant difference in the Berg balance scale scores in group A before and after the intervention ($P > 0.05$). Compared with the scores in Group A, the Berg balance scale scores in Group B were higher after the intervention ($P < 0.05$) (**Table 2**).

Comparison of the quality of life scores between the two groups

Before the intervention, there was no significant difference in the quality of life scores between the two groups ($P > 0.05$). Compared with the scores before the intervention, the environment, social relations, independence, psychology, and life scores in Group B were increased after the intervention ($P < 0.05$). There was no significant difference in the qual-

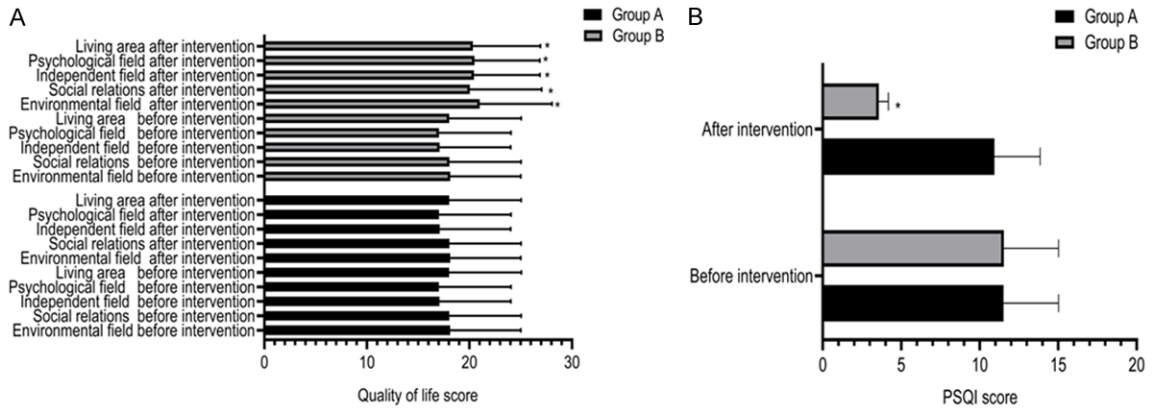

Figure 4. Comparison of the quality of life and PSQI scores between the two groups. A. Shows a comparison of the environment, social relations, independence, psychology, and life scores between two groups before the intervention ($P > 0.05$). After the intervention, the environment, social relations, independence, psychology, and life scores in Group B were higher than the scores in Group A ($P < 0.05$). B. Shows a comparison of the PSQI scores between the two groups before the intervention ($P > 0.05$). The PSQI scores in Group B were lower than the scores in Group A after the intervention ($P < 0.05$). * indicates a comparison with Group A ($P < 0.05$).

ity of life scores in Group A before and after the intervention ($P > 0.05$). Compared with the scores in Group A, the quality of life scores in the multiple fields in Group B were higher after the intervention ($P < 0.05$) (**Figure 4**).

Comparison of the PSQI scores between the two groups

Before the intervention, there was no significant difference in the PSQI scores between the two groups ($P > 0.05$). Compared with the scores before the intervention, the PSQI scores in Group B were decreased after the intervention ($P < 0.05$). There was no significant difference in the PSQI scores in Group A before and after the intervention ($P > 0.05$). Compared with the scores in Group A, the PSQI scores in Group B were lower after intervention ($P < 0.05$) (**Figure 4**).

Discussion

Currently, physical therapy is usually adopted clinically to improve the balance function of the elderly. Functional balance exercises are the most commonly-implemented therapy, including the excursion of the center of gravity (COG) when standing, sitting, standing, etc. However, the physical therapy training programs are too boring and monotonous, and some complex actions should be completed under the guidance of professional therapists. Therefore, physical therapy has certain limitations [19, 20]. Studies indicate that resistance training can improve bone quality, bone density, and the physical quality of bones, delay the aging of muscles, promote the body's metabolism, and effectively prevent multiple chronic diseases [21]. During resistance training, people overcome external resistance through self-strength. Resistance usually comes from elastic bands, dumbbells, barbells, self-gravity exercises, and other exercises. Among them, elastic bands, also known as, rubber bands or resistance bands, are a type of medical and health care device, and they are easy to use and carry [22, 23]. In order to improve the PA, body composition, quality of sleep and life, and the myodynamia of the upper and lower limbs in the elderly, elastic band resistance training was analyzed in this study. The results suggest that the extensor muscle peak torque and the flexor peak torque of the lower limb and upper limb grip strength in Group B were greater than they were in Group A after the intervention, indicating that elastic band resistance training can enhance the myodynamia of the upper and lower limbs. According to our investigation of the mechanism, this may be due to the fact that elastic band resistance training can not only promote myodynamia, but it can also expand the range of joint activities and improve ligament flexibility. In this study, during the elastic band resistance training, the actions, such as rotation, flexion and extension, were fully adopted. When one is

overcoming his or her gravity, the elastic band also increases the muscle load. Therefore, the myodynamia is markedly enhanced [24]. Second, the results of this study revealed that, compared with those in Group A, the BFP and BMI in group B were lower, while the basal metabolic rate was higher after the intervention, suggesting that the elastic band resistance training can effectively improve body composition. The mechanism was investigated. Based on the elastic band resistance training and the characteristics of the elderly, resistance training of muscle groups in different directions can be performed. The training is not subject to space or time, and the direction and amount of the resistance can be adjusted. During the training, the pressure on joints can be reduced to the lowest extent to avoid injuries to other body parts. Second, during elastic band resistance training, the coordination and cooperation of muscles are necessary. This facilitates the functions of the muscles through coordination, thereby promoting the body's metabolism and reducing the BFP and BMI and the basal metabolic rate [25].

Balance is an important body function. With increasing age, there is a declining balance ability, particularly among the elderly [26]. In this study, the balance functions in the two groups were assessed using Berg balance scale before and after the intervention. The results show that the Berg balance scale scores in Group B were higher than the corresponding scores in Group A after the intervention, indicating that elastic band resistance training can effectively improve the body's balancing ability. The mechanism has been investigated. Elastic band resistance training can not only improve the postural control ability, but it can also elevate the stability of the vestibular organs and the sensitivity of muscle proprioception. During elastic band resistance training, patients' proprioception, vision, vestibule, and other organ systems are constantly stimulated by multiple actions. Long-term training can significantly improve the comprehensive processing ability and proprioception sensitivity of the brain center to sensory stimulation, resulting in an improved balance function of the body and a markedly reduced incidence of falls [27].

Second, the results of this study also show that, compared with Group A, the whole-body reaction times, the TUG times, and the 10-m walk times in Group B were shorter after the intervention, suggesting that elastic band resistance training can effectively improve PA. The mechanism was explored. This may be due to the fact that elastic band resistance training can not only enhance the strength of the upper and lower limbs and shoulders, but it can also specifically train the core parts, such as the buttocks, abdomen, back, and waist. This is conducive to significantly improving one's core stability and core strength. The quality of life scores in Group B were higher than they were in Group A, and the PSQI scores in Group B were lower than they were in Group A. This further proves the effectiveness of elastic band resistance training, which is conducive to improving patients' quality of life and sleep. The mechanism was investigated. This may be due to the fact that, after the elastic band resistance training, the patients' upper and lower limb muscle strength and balance ability were enhanced, and their PA was improved, resulting in improved quality of sleep and life [28].

In summary, elastic band resistance training can effectively improve physical activity, body composition, quality of sleep and life, and the myodynamia of the upper and lower limbs.

In this study, although some achievements have been obtained, there is the limitation of the small sample size. Therefore, in future studies with larger sample sizes, a longer study period with a more comprehensive analysis should be carried out.

Disclosure of conflict of interest

None.

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