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Original Article

The Effect of an Elastic Band Resistance Training Program on Increasing Upper and Lower Limb Muscle Strength in Elderly with Sarcopenia

Rizal Mustofa[1], Rifky Ismail[2], Hari Peni Julianti[3], Budi Setiyana[2]

[1]Department of Mechanical Engineering, Politeknik Negeri Semarang, Semarang, Central Java, Indonesia
[2]Department of Mechanical Engineering, Universitas Diponegoro, Semarang, Central Java, Indonesia
[3]Department of Physical Medicine and Rehabilitation, Universitas Diponegoro, Semarang, Central Java, Indonesia

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Author's affiliation:
Department of Mechanical Engineering, Politeknik Negeri Semarang, Semarang, Central Java, Indonesia

Author's correspondence:
Rizal Mustofa
Prof. Sudarto Street, Tembalang, Semarang, Central Java, 50275, Indonesia

E-mail:
rizal.mustofa@polines.ac.id

Abstract

Background : Prevention and treatment of sarcopenia are important to achieve physical health in aging, including maintaining the physical ability to live independently and carry out daily activities.

Aims : To determine the effect of a muscle-strengthening exercise program using elastic bands for 8 weeks in order to increasing muscle strength in elderly people with sarcopenia. Arm muscles (biceps and triceps) and leg muscles (quadriceps and gastrocnemius) were measured.

Methods : An intervention study with a one-group pre- and post-test design. Subjects were taken from the elderly home by as many as five women and five men. Subjects were given strengthening exercises using elastic bands in as many as 2 sets; each set was done in as many as 10 movements, and each movement was given a rest interval of 30 seconds. The elastic band strengthening exercise program was carried out three times per week, with a period of eight weeks, so that the total training was 24 sessions. Changes in muscle strength were measured using a MicroFET2 hand-held dynamometer. Furthermore, the results of muscle measurements were tested using the paired-samples T test to determine the difference in muscle strength between before and after doing the exercise program.

Results : Female and male subjects had an insignificant average age of 68.80 ± 5.12 years for women and 68.60 ± 5.64 years for men. The average BMI value in women and men had an ideal value of 24.38 ± 2.89 kg/m^2 and 24.82 ± 5.65 kg/m^2. The right limbs in the biceps, triceps, quadriceps, and gastrocnemius muscles each experienced an increase in muscle strength during the intervention, namely 2.67 kg, 2.14 kg, 1.99 kg, and 1.87 kg. Then for the left limbs, the biceps, triceps, quadriceps, and gastrocnemius muscles also experienced an increase, namely 2.96 kg, 1.42 kg, 2.28 kg, and 2.51 kg. The intervention carried out in this study can significantly increase upper limb and lower limb muscle strength (p<.05).

Conclusion : Resistance training using elastic bands routinely for 8 weeks can increase the strength of the biceps, triceps, quadriceps, and gastrocnemius muscles. This exercise can also reduce the risk of sarcopenia and improve the quality of life for the elderly. This exercise program can be a recommendation for intervention because it is economical and easy to do independently at home.

Keywords : elastic bands training; exercise; isometric muscle strength; outcome measures

INTRODUCTION

The European Working Group on Sarcopenia in Older People (EWGSOP) has suggested using the terms "presarcopenia," meaning low muscle mass, and "sarcopenia," meaning poor physical performance or low muscle mass and low muscle strength.[1] As people age, sarcopenia is expected to become one of the important factors that threaten human health and social development.[2] The cause of sarcopenia is a sedentary lifestyle or a lack of physical activity.[3,4] Efforts to maintain the physical ability to live independently while carrying out daily activities have a positive impact on preventing or reducing the risk of sarcopenia.[5,6] Sarcopenia is influenced by several interrelated factors. For example, nutritional factors, such as insufficient protein intake; treatment factors, such as long-term use of certain medications such as corticosteroids; and psychological factors, such as depression, chronic stress, and social isolation, which can lead to decreased motivation for physical activity. Therefore, muscle strengthening exercises are important for the elderly to maintain muscle fitness and health.

Muscle strength training significantly contributes to the variance of changes in sarcopenia scores, making it important for sarcopenia-related functional recovery. One type of muscle-strengthening exercise is elastic band resistance training performed by the upper[2,3] and lower limbs.[7–9] Elastic band resistance training is a low- to moderate-intensity exercise that is easy to use, economical, portable so that participants can exercise anywhere, and has safety benefits for the elderly.[10,11] Vikberg *et al*. reported that 10 weeks of instructor-led resistance training can improve functional strength and increase muscle mass in elderly adults with pre-sarcopenia.[10] Chen *et al*. reported that comprehensive exercise and progressive resistance training for 8 weeks can increase muscle mass and handgrip strength in elderly women with sarcopenia.[2] In addition, body weight-based training and elastic band strengthening training for 12 weeks in the elderly can improve body composition and muscle function.[11] The study showed positive results, including an increase in upper- and lower-limb muscle strength after strengthening exercises using elastic bands. So we speculate that elastic band resistance training can be useful for increasing muscle strength in the elderly with sarcopenia. Resistance training is also easy for seniors to do independently at home.

Resistance-based exercise programs require more research to show their effects on increasing muscle strength in the elderly. Such as hand and leg muscles, which are very important for use in daily activities. Therefore, this study aims to determine the effect of a muscle strengthening exercise program using elastic bands for 8 weeks on increasing muscle contraction strength in the elderly with sarcopenia. This study chose 8 weeks of training rather than 10 weeks or 12 weeks of training, which is shorter and has an impact on muscle development. The muscles measured were the hand muscles (biceps and triceps) and leg muscles (quadriceps and gastrocnemius), because these muscles are often used for daily activities.

METHODS

This study used an intervention study with a one-group pre- and post-test design. This study was approved by the Ethics Review Board of the Faculty of Medicine, Diponegoro University (161/EC/KEPK/FK-UNDIP/IV/2024). Participants in this study received a strengthening exercise program using elastic bands, it was carried out three times per week, for eight weeks. All participants were given details of the exercise intervention content and then signed an informed consent in accordance with the ethical standards of the Declaration of Helsinki.

All participants were elderly people with sarcopenia recruited from Pucang Gading Social Home in Semarang between April and June 2024. There were 10 participants, consisting of 5 women and 5 men. In accordance with the 2019 AWGS consensus on sarcopenia parameters, all participants were examined to determine whether they met the diagnostic criteria for sarcopenia.

The recruitment of participants in this study had additional inclusion criteria: (a) men or women over 60 years old; (b) have the ability to walk independently or use a walking aid; and (c) be willing and cooperative in the study. In addition, there were also exclusion criteria, namely: (a) having cognitive dysfunction; (b) having problems with vision, hearing, or vestibular; (c) having a worsening neurological disease, such as Parkinson's and dementia; (d) depression (the depression scale in the elderly is more than 5); (e) having a history of amputation, stroke, or fracture of the upper or lower extremities in the past year; (f) unstable metabolic, cardiovascular, and neuromuscular conditions (NYHA III-IV congestive heart failure, uncontrolled diabetes mellitus, uncontrolled hypertension); (g) psychiatric disorders; (h) knee or hip prosthesis.

The intervention conducted in this study was a strengthening type using elastic bands for 8 weeks with a light-to-moderate intensity of around 4–7 on the OMNI-RES scale. Subjects were given strengthening exercises using elastic bands in as many as 2 sets; each set was done in as many as 10 movements, and each movement was given a rest interval of 30 seconds. The elastic band strengthening exercise program was carried out three times per week, with a period of eight weeks, so that the total training was 24 sessions (see Figure 1).

The exercise begins with warm-up exercises such as light movements and stretching exercises of the upper

Figure 1. Strengthening exercise program using elastic bands

TABLE 1
Procedure for measuring the strength of biceps, triceps, quadriceps, and gastrocnemius muscles using the MicroFET2 hand-held dynamometer

Muscle	Position	Dynamometer Position	Instruction	References
Biceps	Body in sitting position; Elbow angle 90° and arms beside the torso; Hands in supination position.	The wrist is just below the bottom crease of the wrist.	Bend your elbows with a flexion movement.	[15,16]
Triceps	Body in sitting position; Elbow angle 90° and arms beside the torso; Hands in supination position.	The dorsal surface of the wrist just below the joint.	Straighten your elbows with an extension movement.	[15,17]
Quadriceps	The body is in a sitting position; Hips & knees in 90° flexion; Hands on thighs, palmar surface upwards.	Anterior leg proximal to ankle.	Straighten out your knee.	[18–20]
Gastrocnemius	Body in sitting position; Ankle in neutral; Hands by their side palmar surface upwards.	Plantar surface of metatarsal heads.	Point your toes towards me.	[19,21]

limbs and lower limbs for 5 minutes. Then core exercises are performed with elbow flexion, elbow extension, chest press, lateral rise, hip flexion, hip extension, leg press, and ankle plantarflexion.

In this study, we used a hand-held dynamometer (MicroFET2, Hoggan Scientific, LLC, Salt Lake City, UT, USA) to measure or assess muscle strength. The muscles to be measured were the biceps muscle, the triceps muscle, the quadriceps muscle, and the gastrocnemius muscle. The subject had to produce a maximal voluntary contraction against the examiner's force, which was applied for 3–4 minutes.[12,13] A hand-held dynamometer can read muscle contraction strength with a range of 0–660 Newtons (N).[14] All subjects were tested in a sitting position. The position of the hand-held dynamometer in this study is presented in Table 1.

We processed the measurement data using SPSS software (IBM, SPSS version 25, Chicago, IL, USA) according to the following steps:

a. All data were checked to ensure that the data to be processed was normally distributed (Shapiro-Wilk test).
b. At baseline, descriptive statistics were calculated for each characteristic variable. Then, we used the

paired-samples T test to determine the difference in muscle strength before and after doing the exercise program.

c. If the p-value is <0.05, it indicates a difference with statistical significance and a 95% confidence interval (95% CI). Data are presented as mean ± SD unless otherwise stated.

RESULTS

Participant characteristics

In total, 10 participants met the inclusion and exclusion criteria and were included in the analysis. Participants consisted of 5 women with an average age of 68.80 ± 5.12 years and 5 men with an average age of 68.60 ± 5.64 years. Then the average BMI (body mass index) of women and men had ideal values of 24.38 ± 2.89 kg/m^2 and 24.82 ± 5.65 kg/m^2. Based on the average data, male and female participants had the same criteria, or there was no significant difference (see Table 2).

Effect of invention on biceps muscle

Bicep muscle strength experienced a significant increase before and after the intervention. The average value of the right bicep muscle increased by 2.67 kg, with a significance value of p <.001. Then, for the left bicep muscle, muscle strength increased by 2.96 kg with a significance value of p =.005. Based on these values, the average participant experienced a significant increase in muscle strength (p <.05) in the right and left bicep muscles. The intervention carried out on the biceps muscle had a positive impact on increasing muscle strength. In this study, the average left bicep muscle increased more than the right bicep muscle; see Table 3 and Figure 2.

Effect of invention on triceps muscle

Triceps muscle strength experienced a significant increase before and after the intervention. The average value of the triceps muscle in the right hand increased by 2.14 kg, with a significance value of p <.001. Then, for the

TABLE 2
Research subject data

Participants	Gender	Age (y)	Height (cm)	Weight (kg)	BMI (kg/m^2)
Subject 1	woman	71	157	61.2	24.83
Subject 2	woman	69	134	46.9	26.12$^+$
Subject 3	woman	61	142	55.5	27.52^{++}
Subject 4	woman	75	137	37.4	19.93
Subject 5	woman	68	155	56.5	23.52
Subject 6	man	66	154	65.9	27.79^{++}
Subject 7	man	71	163	48.5	18.25*
Subject 8	man	60	166	66.3	24.06
Subject 9	man	72	165	57.9	21.27
Subject 10	man	74	158	81.7	32.73^{++}

* Low level of underweight, $^+$ Mild degree of excess weight, $^{++}$ Severe degree of overweight

TABLE 3
Comparison of muscle strength measurements before and after performing a training program (mean ± SD, kg)

Muscle	Right limb			Left limb		
	Baseline	Week 8	*p*-Value	Baseline	Week 8	*p*-Value
Biceps	6.40 ± 1.62	9.07 ± 1.67	.000	6.51 ± 2.21	9.47 ± 3.53	.005
Triceps	4.77 ± 1.74	6.91 ± 1.67	.000	4.56 ± 2.18	5.98 ± 1.19	.039
Quadriceps	6.30 ± 2.35	8.29 ± 1.55	.009	5.43 ± 2.02	7.71 ± 2.00	.001
Gastrocnemius	5.14 ± 1.84	7.01 ± 1.62	.023	4.30 ± 1.36	6.81 ± 1.85	.010

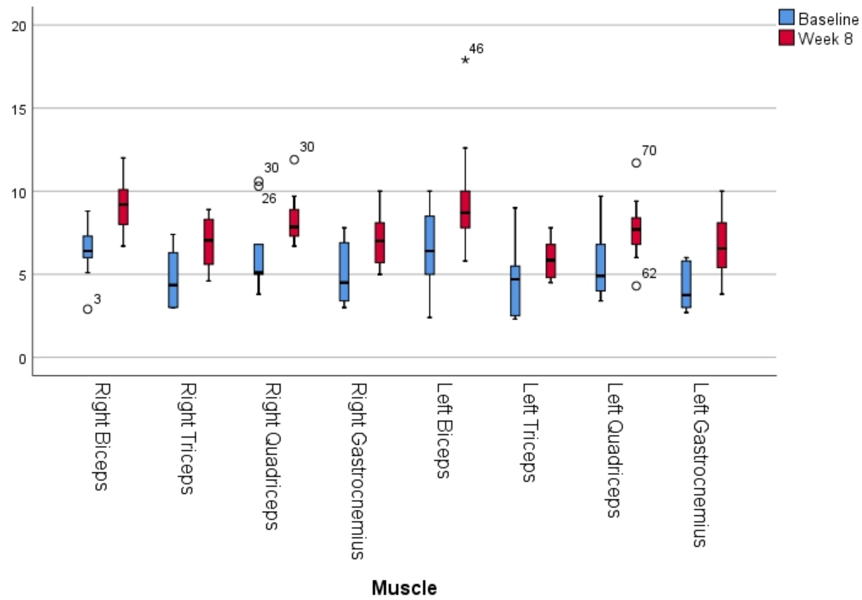

Figure 2. Changes in upper and lower limb muscle strength from baseline to the eighth week in all genders

triceps muscle of the left hand, there was an increase in muscle strength of 1.42 kg with a significance value of p =.039. Based on these values, the average participant experienced a significant increase in muscle strength (p <.05) in the triceps muscles of the right and left hands. The intervention carried out on the triceps muscles had a positive impact on increasing muscle strength. In this study, the average triceps muscle of the right hand experienced a greater increase than the triceps muscle of the left hand (see Table 3 and Figure 2).

Effect of invention on quadriceps muscle

Quadriceps muscle strength experienced a significant increase before and after the intervention. The average value of the quadriceps muscle in the right leg increased by 1.99 kg, with a significance value of p =.009. Then, for the quadriceps muscle in the left leg, there was an increase in muscle strength of 2.28 kg with a significance value of p =.001. Based on these values, the average participant experienced a significant increase in muscle strength (p <.05) in the quadriceps muscles of the right and left legs. The intervention carried out on the quadriceps muscles had a positive impact on increasing muscle strength. In this study, the average quadriceps muscle in the left leg experienced a greater increase than the quadriceps muscle in the right leg (see Table 3 and Figure 2).

Effect of invention on gastrocnemius muscle

Gastrocnemius muscle strength experienced a significant increase before and after the intervention. The average value of the gastrocnemius muscle in the right leg increased by 1.87 kg, with a significance value of p =.023. Then, for the gastrocnemius muscle in the left leg, there was an increase in muscle strength of 2.51 kg with a significance value of p =.010. Based on these values, the average participant experienced a significant increase in muscle strength (p <.05) in the gastrocnemius muscles of the right and left legs. The intervention carried out on the gastrocnemius muscles had a positive impact on increasing muscle strength. In this study, the average gastrocnemius muscle in the left leg experienced a greater increase than the gastrocnemius muscle in the right leg (see Table 3 and Figure 2).

DISCUSSION

To our knowledge, this intervention is the first report of a muscle strengthening training program using elastic bands to improve arm (biceps and triceps) and leg (quadriceps and gastrocnemius) muscle strength. All interventions were designed to be easily performed by older adults. Low muscle strength is known to independently affect quality of life in older adults,[11] predicting falls,[22] fractures, poor overall health, and mortality.[23] Therefore, the development of physical and resistance training is of interest because it can improve muscle strength in older adults.

The main finding of this study is that a muscle-building exercise program using elastic bands for 8 weeks can significantly increase the strength of biceps, triceps, quadriceps, and gastrocnemius muscles in elderly people with sarcopenia living in the elderly community. Increasing muscle strength is very important for people with sarcopenia because sarcopenia is a muscle disease (muscle dysfunction) that can interfere with daily activities. According to EWGSOP, low muscle mass is no longer the main cause of sarcopenia; the main cause of sarcopenia is low muscle strength. Indeed, muscle strength has been shown to be a worse cause of sarcopenia than muscle mass.[24] Strengthening exercises with elastic bands can increase motor unit recruitment activity and activate Golgi tendon organs and muscle spindles, thereby increasing muscle contraction.[25] This exercise will cause the muscles to contract while holding the weight and can be increased by increasing the number of repetitions of the exercise or increasing the resistance to a higher level as needed.

Previous researchers have shown that resistance training for eight weeks has a positive effect on increasing muscle strength in the upper,[2] lower limbs[9] and delaying sarcopenia in the elderly.[2,9] The results of this study confirm our findings. This is a clinically useful finding for the elderly with sarcopenia because increasing muscle strength can have a major impact on an individual's ability to remain independent in the community.[26,27] These beneficial results can provide guidance to caregivers on how to provide exercise programs that have benefits for increasing muscle strength in the elderly.

Muscle-strengthening exercise program can also reduce the risk of sarcopenia and improve the quality of life for the elderly. This exercise program can be a recommendation for intervention because it is economical and easy to do independently at home. These findings indicate that the intervention we developed can be an effective way to encourage safer movement and reduce the risk of sarcopenia among the elderly living in the community. Therefore, we recommend that the exercise program we developed be done by the elderly at home independently. In addition, the elderly can change the pulling force of the elastic band to increase the intensity of exercise and move the limbs from head to toe when doing this exercise. Thus, this intervention can provide more benefits to improve physical performance.

The limitation of this study is that we only trained the elderly using elastic bands without any combination of other exercises. In the future, we hope to combine this exercise program with other activities, for example, gymnastics or light-weight lifting. We also aim to compare or group the elderly with different treatments so that the differences in the results of the treatments we do can be known. This research must continue to be developed to help the elderly carry out their daily activities.

Seniors can then use elastic band exercises independently at home by starting with a light warm-up, choosing a resistance band with an appropriate level of elasticity, and performing simple movements that target major muscle groups such as the arms, legs, and hips. Examples of movements include pulling up with a band to work the back and arms, squats with a band for the thighs and glutes, and stretching and strengthening muscles while standing or lying down. Exercises should be performed slowly and in a controlled manner, about 2–3 times a week, with 10–20 repetitions per movement, and interspersed with light stretches to maintain flexibility. Seniors are also advised to maintain proper posture during exercise for safety and effectiveness.

Caregivers or healthcare professionals can integrate elastic band exercises into community or senior care programs by designing structured exercise programs tailored to the senior's physical abilities, including adjusting the intensity and frequency of the exercises. Healthcare professionals should provide direct education and training to both the senior and caregiver on safe and effective elastic band use techniques. Furthermore, caregivers can accompany the senior during the exercises to monitor safety and progress and provide motivation. This integration can also be achieved by holding regular sessions at senior centers or care facilities so that the exercises become part of a routine that supports increased muscle strength and balance, significantly reducing the risk of falls.

An exercise intervention using elastic bands effectively prevents falls and hospitalizations due to sarcopenia in older adults by improving leg muscle strength, dynamic balance, and joint flexibility. This exercise stimulates neuromuscular adaptations, resulting in stronger muscles and a more responsive sensorimotor system, which is crucial for maintaining stability and reducing fall risk. Research shows that several weeks of elastic band intervention significantly increase the strength of arm muscles (biceps and triceps) and leg muscles (quadriceps and gastrocnemius).

CONCLUSION

Resistance training using elastic bands routinely for 8 weeks can increase the strength of the biceps, triceps, quadriceps, and gastrocnemius muscles. This exercise can also reduce the risk of sarcopenia and improve the quality of life for the elderly. This exercise program can be a recommendation for intervention because it is economical and easy to do independently at home.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest related to this work.

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