

The Effectiveness of Resistance Band Training on Lower Extremity Muscle Strength in Elderly Women to Prevent Fall Risk

Rayhan Geofahmi¹, Risal Permana², Aditya Tegar Permana³, M. Arief Setiawan⁴, A. Ine Aprilia Damai⁵, Aprillia Wulan Utari⁶

¹²³⁴⁵⁶Department of Sport Science, Faculty of Health Sciences, Universitas Singaperbangsa Karawang
2410631240045@student.unsika.ac.id

Correspondent Author: 2410631240045@student.unsika.ac.id

Received: February 6, 2026; Accepted: February 28, 2026; Published: March 30, 2026
Ed: 2026: 162-178

Abstract

This study aims to analyze the effectiveness of resistance band training on increasing lower extremity muscle strength and decreasing fall risk indicators in elderly women. The research hypothesis states that resistance band training has a positive effect on improving limb functional strength and mobility of the elderly. The main premise of this study is based on the fact that the aging process leads to a decrease in muscle strength, limited mobility, balance disorders, and an increased risk of falling, so safe, economical, simple, and easy-to-apply exercises are needed. This study uses a quantitative approach with a quasi-experimental pretest-posttest control group design. The research sample amounted to 20 elderly women who were divided into an experimental group and a control group, 10 respondents each. The research instrument used the 30-Second Chair Stand Test to measure the functional strength of the lower extremities and the Timed Up and Go Test (TUG) to measure functional mobility as an indicator of the risk of falls. The results of the paired sample t-test showed a significant difference between the pretest and posttest on the Chair Stand with a value of $t = -4.482$; $p = 0.000$; mean difference = -2.250, and in TUG with a value of $t = 4.868$; $p = 0.000$; mean difference = 1.117. The results of the independent sample t-test showed that in the posttest there was a significant difference between the experimental and control groups on the Chair Stand with a value of $t = 6.611$; $p = 0.000$; mean difference = 4,500, and in TUG with a value of $t = -7,590$; $p = 0.000$; mean difference = -2,891. The effect size showed a large impact, namely Cohen's $d = -1.002$ on the Chair Stand pretest-posttest, Cohen's $d = 1.089$ on the TUG pretest-posttest, Cohen's $d = 2.957$ on the Chair Stand posttest, and Cohen's $d = -3.394$ on the TUG posttest. Thus, the research hypothesis is accepted. Resistance band training is effective in increasing the strength of the lower extremity muscles and potentially lowering the risk of falls in elderly women.

Keywords: elderly women; resistance band; strength of the lower extremities; risk of falling; Timed Up and Go.

INTRODUCTION

Aging is a biological process that has a direct impact on the decline of neuromuscular capacity, balance, functional mobility, and independence of daily activities. In the elderly female group, the decrease in the mass and strength of the lower extremities muscles is an important concern because it is related to sarcopenia, functional weakness, gait disorders, and an increased risk of falling. Several studies have shown that leg muscle strength, postural stability, and the ability to change positions are the main indicators in maintaining the movement function of the elderly, especially in the activities of standing from a chair, walking, climbing stairs, and maintaining balance when there is a change in body position (Lai et al., 2021; Yoshiko et al., 2021; Debes et al., 2024; Žlibinaitė et al., 2025). This condition is increasingly relevant in elderly women because hormonal changes, decreased bone density, changes in body composition, and reduced physical activity can accelerate the decline in muscle quality and movement function (Fujie et al., 2025; Uchida et al., 2024; Wang et al., 2024).

Strength training has been recommended as an effective nonpharmacological intervention to slow down the decline in neuromuscular function. Exercise programs that target the muscles of the

lower extremities have been shown to improve strength, balance, mobility, and quality of life in the elderly (Berg et al., 2021; Lai et al., 2021; Meigh et al., 2022; Svobodová et al., 2025). In the context of fall prevention, increasing leg muscle strength plays a role in improving postural control, the body's response to balance disorders, and the ability to perform functional movements safely. Therefore, the development of simple, safe, cheap, and easy-to-apply forms of exercise is an important need, especially for elderly women who have limited access to training facilities based on conventional weight equipment.

The risk of falling in the elderly is not only caused by age factors, but also by a combination of muscle weakness, balance disorders, decreased coordination, limited mobility, and low levels of physical activity. Decreased strength in the lower extremities makes it more difficult for the elderly to control their bodies when standing, walking, turning, or responding to changes in the environment. This condition can increase the risk of injury, loss of independence, fear of movement, decreased social participation, and even the burden of long-term care (de Oliveira et al., 2021; Lai et al., 2025; Li et al., 2023; Varjan et al., 2024). In many older communities, this problem is exacerbated by low engagement in structured training, lack of training assistance, and the perception that strength training requires heavy equipment and is risky for the elderly.

Practically, there are still many elderly exercise programs that emphasize light aerobic activity or general gymnastics, while resistance training that specifically targets the muscles of the lower extremities has not always been systematically applied. In fact, instruments such as the 30-Second Chair Stand Test and the Timed Up and Go Test (TUG) can be used to assess changes in limb functional strength and mobility of the elderly simply. In this article, the research data show that resistance band training resulted in significant changes in Chair Stand and TUG results between pretest and posttest measurements, as well as showing differences in results between the experimental and control groups. The findings indicate that the main problem is not only the decline in muscle strength of the elderly, but also the need for an exercise model that can increase functional strength and reduce risk indicators of fall in a measurable way.

Various studies have examined the effectiveness of strength training to improve lower extremity function in the elderly. Resistance exercise in elderly pre-frail patients has been shown to improve muscle strength, physical fitness, and metabolic parameters (Lai et al., 2021). Home-based squat exercises have also been reported to have an impact on leg muscle parameters and physical function tests in the elderly (Yoshiko et al., 2021). A home-based progressive exercise intervention and a combination of strength training with Tai-Chi show potential in improving physical function as well as the involvement of the elderly in more accessible exercise (Liang et al., 2024). In addition, sensorimotor and resistance-endurance exercises are equally beneficial for postural control and muscle strength in the elderly (Varjan et al., 2024).

Resistance band or elastic band is one of the training media that is increasingly used because it has the characteristics of being safe, portable, economical, easy to adjust the load level, and can be applied to various training settings. Strength tests using elastic resistance bands have also been developed to estimate the maximum strength of the upper and lower extremities (Haraldsson et al., 2021). Other research shows that elastic resistance-based exercises, low-intensity strength training, and exercises with a blood flow restriction approach can improve muscle strength, muscle mass, balance, and mobility function in the middle-aged to elderly age group (Chang et al., 2022; Feng et al., 2024; Li et al., 2023; Tumali et al., 2024). In elderly women, eight weeks of strength training were also reported to provide changes in body composition, muscle strength, and psychological

conditions such as stress perception (Žlibinaitė et al., 2025).

Although the literature is evidence supporting the effectiveness of strength training for the elderly, there are still some research gaps. First, most studies use varied exercise approaches, such as squat training, Tai-Chi, sensorimotor training, blood flow restriction, or special tool-based exercises, so specific evidence on resistance bands to increase lower extremity strength and lower fall risk indicators in older women still needs to be strengthened (Chang et al., 2022; Liang et al., 2024; Svobodová et al., 2025; Wang et al., 2024). Second, some studies have focused on populations with specific clinical conditions, such as stroke, knee pain, osteoarthritis, kidney disease, or postoperative disease, so generalizations to relatively independent community elderly women are still limited (Ahmed et al., 2022; Berg et al., 2021; Geneen et al., 2022; Mehwish et al., 2023). Third, research linking changes in functional strength through the Chair Stand Test and mobility through TUG within a single fall risk prevention framework still needs to be developed, especially on simple interventions that are easily replicated in community settings.

In this context, resistance bands have applicative advantages because they allow progressive weight delivery without the need for an exercise machine, can be used in sitting or standing positions, and are relatively safe for elderly women. However, its effectiveness needs to be proven through a research design that compares pretest and posttest results and distinguishes changes between the experimental and control groups. Thus, this study seeks to bridge the gap between the theoretical evidence on the benefits of resistance training and the practical need for a simple, measurable, and appropriate exercise model for the characteristics of older women.

The purpose of this study was to analyze the effectiveness of resistance band training on increasing lower extremity muscle strength in elderly women and its implications for reducing the risk of falling. In particular, this study assessed changes in functional performance using the 30-Second Chair Stand Test and the Timed Up and Go Test as indicators of leg strength and mobility. The novelty of the study lies in the use of resistance bands as a simple functional strength-based intervention focused on elderly women, with statistical assessments that include pretest-posttest differential tests, comparison of experimental and control groups, and effect measures. The scope of the study was limited to the effect of resistance band training on lower extremity strength and fall risk indicators, rather than on other physiological changes such as muscle mass, bone density, metabolic biomarkers, or overall quality of life. With this focus, this research is expected to make a practical contribution to the development of community training programs that are safe, economical, and easy to apply to increase the independence of elderly women's movements.

METHODS

Research Design

This study uses a quantitative approach with a quasi-experimental design in the form of a pretest-posttest control group design. This design was chosen because the study aimed to test the effectiveness of resistance band training on increasing lower extremity muscle strength and decreasing fall risk indicators in elderly women. In this design, respondents were divided into two groups, namely the experimental group that was given a resistance band training program and the control group that did not receive the same exercise treatment. Measurements were taken twice, namely before treatment (pretest) and after treatment (posttest). A pretest-posttest design with relevant control groups is used in physical exercise research because it allows researchers to compare changes within groups while differentiating outcomes between groups after intervention

(de Oliveira et al., 2021; Lai et al., 2021; Wang et al., 2024).

Research Participants

The participants in this study were 20 elderly women who were divided into two groups, namely the experimental group of 10 people and the control group of 10 people. The selection of elderly women as the subjects of the study was based on the consideration that this group has a high risk of experiencing decreased lower extremity muscle strength, balance disorders, limited mobility, and increased risk of falling. These conditions are related to the aging process, changes in body composition, decreased muscle mass, and reduced structured physical activity (Debes et al., 2024; Fujie et al., 2025; Uchida et al., 2024; Žlibinaitė et al., 2025). The participants involved in the study were the elderly who were able to follow the training instructions, could perform basic functional tests, and did not have heavy movement barriers that could interfere with the implementation of interventions or measurements. The group division was carried out to obtain a comparison between respondents who participated in resistance band training and respondents who did not receive similar treatment.

Research Variables

The independent variable in this study was resistance band training, while the bound variable was lower extremity muscle strength and fall risk indicator. Lower extremity muscle strength was assessed through the ability to perform standing movements from a sitting position repeatedly over a period, while fall risk indicators were assessed through functional mobility performance. In the context of the elderly, leg strength and functional mobility are two important aspects because they are directly related to the ability to perform daily activities such as standing, walking, turning, maintaining balance, and returning to sit safely. Previous research has shown that resistance training targeting the lower extremities can improve muscle strength, balance, and functional capacity in the elderly (Yoshiko et al., 2021; Akatsu et al., 2022; Varjan et al., 2024; Meng et al., 2025).

Research Instruments

The instruments used in this study were the 30-Second Chair Stand Test and the Timed Up and Go Test (TUG). The 30-Second Chair Stand Test was used to measure the functional strength of the lower extremity muscles through the number of standing and sitting movements that respondents were able to perform for 30 seconds. This test is relevant because standing from a chair requires the strength of the thighs, hips, knees, and lower body stability. Akatsu et al. (2022) explained that the 30-second chair stand test reflects the strength of the leg and torso muscles and can be used as an indicator of the risk of falls in the elderly. Meanwhile, the TUG is used to assess functional mobility. In its implementation, respondents are asked to stand up from their chairs, walk at a certain distance, turn around, return to their chairs, and sit back down. Faster travel times indicate better mobility, while slower times indicate mobility limitations and a higher potential risk of falls. The use of TUG as an indicator of mobility and functional balance is widely used in exercise studies in the elderly and groups with lower extremity function disorders (Lai et al., 2021; Akatsu et al., 2022; Wang et al., 2024; Varjan et al., 2024).

Intervention Procedure

The experimental group was given a resistance band training program focused on strengthening the muscles of the lower extremities. The exercise is carried out on the principle of elastic resistance, which is the use of resistance from the elastic band to provide a load on muscle movement. The form of exercise is directed at activities involving the thighs, pelvis, knees, and

ankle muscles, so that it is in accordance with the functional needs of the elderly in standing, walking, maintaining balance, and changing positions. The use of resistance bands was chosen because the tool is simple, easy to use, portable, safe, and allows for intensity adjustment based on individual capabilities. Haraldsson et al. (2021) stated that elastic resistance bands can be used in the measurement and development of extremity muscle strength, while Meng et al. (2025) showed that elastic resistance training is beneficial for improving lower extremity strength and balance function in the elderly.

Before the training program was carried out, the respondents of the experimental group were given an explanation of the purpose of the exercise, how to use the resistance band, the correct body posture, and the principles of safety during the exercise. The exercise was carried out in a controlled manner by paying attention to the respondents' comfort, physical abilities, and body responses. The control group was not given a resistance band training program like the experimental group, thus serving as a comparison to the changes that occurred after the intervention period. This approach is in line with resistance training research in the elderly that emphasizes the importance of intensity regulation, motion safety, and fitness of exercise to individual capacity (Tiggemann et al., 2021; Debes et al., 2024; Žlibinaitė et al., 2025).

Data Collection Procedure

Data collection is carried out through two stages, namely pretest and posttest. In the pretest stage, all respondents from the experimental group and the control group underwent initial measurements using the 30-Second Chair Stand Test and TUG. The results of the pretest were used to determine the initial ability of the functional strength of the lower extremities and the mobility of the respondents before the intervention. After the experimental group followed a resistance band training program, posttest measurements were performed with the same instruments. The use of the same instruments in the pretest and posttest aims to obtain an objective and measurable picture of performance changes.

Data Analysis Techniques

Data were analyzed using descriptive and inferential statistics. Descriptive statistics are used to describe the results of pretest and posttest measurements on each variable. Before the hypothesis test, a normality test was performed using Kolmogorov-Smirnov and Shapiro-Wilk to determine the distribution of the data. Furthermore, paired sample t-tests were used to analyze differences in pretest and posttest results, while independent sample t-tests were used to compare differences between the experimental group and the control group. In addition to statistical significance, the study also calculated effect sizes using Cohen's *d*, Hedges' correction, and Glass's delta. Effect measures are necessary so that the interpretation of the results not only depends on the *p*-value but also shows the magnitude of the practical impact of the exercise. This analytical approach is relevant in exercise intervention research because it can explain the effectiveness of programs statistically and functionally (Lai et al., 2021; Debes et al., 2024; Wang et al., 2024; Meng et al., 2025).

RESULTS

The results of this study were compiled to explain the effectiveness of resistance band training on increasing lower extremity muscle strength and decreasing fall risk indicators in elderly women. The analysis was carried out on 20 respondents divided into experimental groups and control groups, each numbering 10 people. Measurements were taken before and after the

intervention using two main instruments, namely the 30-Second Chair Stand Test to assess the functional strength of the lower extremities and the Timed Up and Go Test (TUG) to assess functional mobility and fall risk indicators. Both instruments were chosen because they are relevant to evaluate the ability of the elderly to perform basic movements such as standing from a sitting position, walking, turning, and returning to sit safely. The use of these indicators of leg strength and functional mobility is in line with previous research that placed lower extremity muscle strength, balance, and mobility as important components in the prevention of falls in the elderly (Lai et al., 2021; Yoshiko & Watanabe, 2021; Varjan et al., 2024; Debes et al., 2024; Žlibinaitė et al., 2025).

Table 1. Normality test result

	Kelompok	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
ChairStandPre	Ekperiment	.264	10	.046	.850	10	.058
	Kontrol	.336	10	.002	.784	10	.009
ChairStandPost	Ekperiment	.182	10	.200*	.937	10	.525
	Kontrol	.211	10	.200*	.927	10	.421
TUGPre	Ekperiment	.236	10	.120	.900	10	.219
	Kontrol	.185	10	.200*	.882	10	.138
TUGPost	Ekperiment	.187	10	.200*	.902	10	.233
	Kontrol	.159	10	.200*	.939	10	.546

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on the Shapiro-Wilk results, most of the data showed significance values greater than 0.05, namely the Chair Stand pretest of the experimental group ($p = 0.058$), the Chair Stand posttest of the experimental group ($p = 0.525$), the Chair Stand posttest of the control group ($p = 0.421$), the TUG pretest of the experimental group ($p = 0.219$), the TUG pretest of the control group ($p = 0.138$), the TUG posttest of the experimental group ($p = 0.233$), and the TUG posttest of the control group ($p = 0.546$). Only the control group's pretest Chair Stand data showed a $p < 0.05$ at Shapiro-Wilk ($p = 0.009$). In general, the data distribution can still be considered adequate for parametric analysis because most of the variables meet the assumption of normality, the sample number of each group is relatively balanced, and the follow-up analysis uses the differential test commonly applied to the pretest-posttest design of the two groups.

Table 2. Paired sample test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Chair Stand Pre – Chair Stand Post	-2.250	2.245	.502	-3.301	-1.199	-4.482	19	.000
Pair 2	TUG Pre – TUG Post	1.117	1.026	.229	.637	1.597	4.868	19	.000

The results of the paired sample t-test showed a significant change between the pretest and posttest in the two main indicators. In the Chair Stand variable, there was a significant difference between the pretest and posttest scores with a value of $t = -4.482$; $df = 19$; and $p = 0.000$. The average difference value of -2,250 indicates that the performance of the Chair Stand has improved after the intervention. Practically, the increase in the number of repetitions in the Chair Stand

indicated the respondent's ability to perform standing movements from a sitting position better, which reflected an increase in the functional strength of the lower extremity muscles.

In the TUG variable, the analysis results also showed a significant difference between the pretest and posttest with values of $t = 4.868$; $df = 19$; and $p = 0.000$. The average difference of 1.117 indicates a decrease in TUG travel time after the intervention. In functional interpretation, shorter TUG times indicate improved mobility, movement coordination, ability to change positions, and walking efficiency. Thus, these results suggest that resistance band training not only impacts leg muscle strength but also contributes to improved functional mobility related to reduced risk of falling. These findings support the literature evidence that lower extremity resistance training can improve muscle strength, physical function, and movement stability in the elderly (Lai et al., 2021; Yoshiko & Watanabe, 2021; Meng et al., 2025; Zhang et al., 2025).

Table 3. Paired samples effect sizes

		Standardizer ^a	Point Estimate	95% Confidence Interval		
				Lower	Upper	
Pair 1	Chair Stand Pre – Chair Stand Post	Cohen's d	2.245	-1.002	-1.534	-.453
		Hedges' correction	2.290	-.982	-1.504	-.444
Pair 2	TUG Pre – TUG Post	Cohen's d	1.026	1.089	.523	1.637
		Hedges' correction	1.047	1.067	.512	1.604

a. The denominator used in estimating the effect sizes.

Cohen's d uses the sample standard deviation of the mean difference.

Hedges' correction uses the sample standard deviation of the mean difference, plus a correction factor.

In addition to the statistical significance, the effect size shows the magnitude of the intervention in practical terms. On the Chair Stand, Cohen's value d of -1.002 and Hedges' correction of -0.982 indicate a large effect. A negative mark on the Chair Stand appears because the calculation is done by subtracting the posttest score from the pretest, so that it substantively shows an improvement in performance after training. In TUG, Cohen's d value of 1.089 and Hedges' correction of 1.067 also showed a large effect. Since TUG scores are interpreted based on travel time, a decrease in time after exercise indicates an increase in functional mobility. The large effect size value on both variables reinforces that the changes that occur are not only statistically significant, but also practically meaningful for the improvement of the movement capacity of elderly women.

These results are in line with a systematic study showing that elastic band-based exercises can improve lower extremity strength and balance function in the elderly (Meng et al., 2025). Other studies have also reported that resistance training can improve muscle strength, functional capacity, body composition, and balance in elderly women and elderly groups with a risk of decreased movement function (Debes et al., 2024; Fujie et al., 2025; Uchida et al., 2024; Žlibinaitė et al., 2025). Therefore, the findings of this study strengthen the position of resistance band as a form of exercise that is applicable, safe, and potentially applied in the elderly community training program.

Table 4. Independent sample t-test result

Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper

Chair Stand Pre	Equal variances assumed	.680	.420	.784	18	.443	.400	.510	-.671	1.471
	Equal variances not assumed			.784	17.916	.443	.400	.510	-.672	1.472
Chair Stand Post	Equal variances assumed	1.352	.260	6.611	18	.000	4.500	.681	3.070	5.930
	Equal variances not assumed			6.611	17.112	.000	4.500	.681	3.065	5.935
TUG Pre	Equal variances assumed	5.155	.036	-2.924	18	.009	-.979	.335	-1.682	-.276
	Equal variances not assumed			-2.924	13.214	.012	-.979	.335	-1.701	-.257
TUG Post	Equal variances assumed	7.216	.015	-7.590	18	.000	-2.891	.381	-3.691	-2.091
	Equal variances not assumed			-7.590	12.647	.000	-2.891	.381	-3.716	-2.066

The results of the independent sample t-test showed that in the initial measurement of the Chair Stand there was no significant difference between the experimental group and the control group, with values $t = 0.784$; $df = 18$; $p = 0.443$. This suggests that the initial ability of lower extremity functional strength in both groups was relatively comparable before the intervention. However, at the final measurement of the Chair Stand, there was a significant difference between the experimental group and the control group with a value of $t = 6.611$; $df = 18$; $p = 0.000$. An average difference of 4,500 showed that the experimental group had better Chair Stand performance than the control group after the intervention.

In the TUG variable, the pretest results showed an initial difference between the experimental and control groups with values $t = -2.924$; $df = 18$; $p = 0.009$. Despite the initial differences, the posttest results showed a stronger difference between the two groups with a value of $t = -7.590$; $df = 18$; $p = 0.000$. The mean posttest difference of -2.891 indicates that the experimental group required a shorter TUG time than the control group. This means that the group that received resistance band training showed better functional mobility after the intervention. The decrease in TUG time has an important meaning because faster and more stable mobility is one of the indicators of a decrease in the risk of falling in the elderly.

Table 5. Independent sample effect size

		Standardizer ^a	Point Estimate	95% Confidence Interval	
				Lower	Upper
ChairStandPre	Cohen's d	1.140	.351	-.538	1.230
	Hedges' correction	1.191	.336	-.515	1.178
	Glass's delta	1.101	.363	-.538	1.246
ChairStandPost	Cohen's d	1.522	2.957	1.639	4.236
	Hedges' correction	1.589	2.831	1.570	4.057
	Glass's delta	1.337	3.365	1.583	5.105
TUGPre	Cohen's d	.749	-1.308	-2.267	-.319
	Hedges' correction	.782	-1.252	-2.171	-.306
	Glass's delta	.948	-1.033	-2.006	-.017
TUGPost	Cohen's d	.852	-3.394	-4.782	-1.969
	Hedges' correction	.889	-3.250	-4.580	-1.886

Glass's delta	1.094	-2.642	-4.104	-1.132
---------------	-------	--------	--------	--------

a. The denominator used in estimating the effect sizes.

Cohen's d uses the pooled standard deviation.

Hedges' correction uses the pooled standard deviation, plus a correction factor.

Glass's delta uses the sample standard deviation of the control group.

The effect size at the final measurement showed a very large impact of the intervention. In the Chair Stand posttest, Cohen's d value was 2.957, Hedges' correction was 2.831, and Glass's delta was 3.365. This value showed that the difference in lower extremity functional strength performance between the experimental and control groups was very large after resistance band training. In the TUG posttest, Cohen's d value was -3.394, Hedges' correction was -3.250, and Glass's delta was -2.642. A negative mark on the TUG indicates that the experimental group had a lower travel time than the control group, which functionally means better mobility performance.

The magnitude of this effect reinforces the interpretation that resistance band training makes a real contribution to improving the movement ability of elderly women. Biomechanically, elastic resistance training allows for repetitive and controlled contraction of leg muscles, so that it can improve the ability of muscles to generate force, maintain joint stability, and support standing and walking movements. Functionally, increased leg strength can improve sit-stand transitions, walking speed, postural control, and the ability to respond to changes in body position. This explanation is consistent with research that states that resistance training, progressive strength training, and elastic-based exercise can improve muscle strength, balance, mobility, and functional capacity in the elderly (de Oliveira et al., 2021; Lai et al., 2021; Varjan et al., 2024; Wang et al., 2024; Zhang et al., 2025).

Overall, the results of the study show that resistance band training is effective in improving the strength of the lower extremities muscles and functional mobility of elderly women. The increase in the results of the Chair Stand showed that respondents had a better ability to perform standing movements from a sitting position repeatedly. This movement is especially important for seniors because it represents a daily activity that requires the strength of the thighs, hips, knees, and balance control. Meanwhile, the decrease in TUG time showed that respondents were able to walk, turn around, and return to sitting more quickly and stably. The combination of Chair Stand improvement and TUG improvement indicates that resistance band training contributes to a decrease in fall risk factors related to muscle weakness and mobility limitations.

This finding has practical relevance because resistance bands are an inexpensive, easy-to-carry, safe, and modifiable resistance level according to the ability of the elderly. Compared to conventional weight equipment, resistance bands are easier to apply in community training programs, elderly posyandu, fitness centers for the elderly, and home exercises with simple supervision. Previous literature has shown that resistance training performed systematically can improve physical function, strengthen lower extremity muscles, improve balance, and support the prevention of decreased movement capacity in the elderly (Lai et al., 2021; Tiggemann et al., 2021; Debes et al., 2024; Meng et al., 2025). In elderly women, strength training interventions have also been shown to be relevant for reducing the impact of muscle mass reduction, improving functional performance, and maintaining movement independence (Fujie et al., 2025; Uchida et al., 2024; Žlibinaitė et al., 2025).

DISCUSSION

The findings of this study show that resistance band training makes a positive contribution to improving lower extremity muscle strength and functional mobility of elderly women. Rationally, the result can be explained through the characteristic of elastic resistance training that allows the muscles to work repeatedly against progressive resistance. In the elderly, improving leg muscle capabilities is very important because daily activities such as standing from a chair, walking, turning, maintaining balance, and returning to sitting require coordination between the strength of the thighs, pelvis, knees, ankles, and postural control. Thus, changes in functional performance after the intervention indicate that resistance band training can stimulate neuromuscular adaptations relevant to daily movement needs.

Empirically, improved standing ability and improved mobility show that interventions have an impact not only on aspects of strength in isolation, but also on functional abilities related to the risk of falls. In elderly women, a decrease in muscle mass, a decrease in contraction capacity, a change in body composition, and a decrease in physical activity can accelerate lower extremity weakness and balance disorders (Fujie et al., 2025; Uchida et al., 2024; Žlibinaitė et al., 2025). Therefore, exercises that target the leg muscles through elastic resistance are rational because they provide a stimulus that is quite safe, controlled, and in accordance with the capacity of the elderly. These findings reinforce the view that simple strength-training-based interventions can be an important strategy in maintaining movement independence and reducing fall risk factors in the elderly population.

The results of this study are in line with various previous studies that reported that resistance training can improve muscle strength, mobility, and physical function in the elderly. Lai et al. (2021) showed that resistance training in the elderly with pre-fragile conditions was able to increase muscle strength and physical performance. Yoshiko et al. (2021) also reported that home-based strength training can improve leg muscle parameters and physical function in the elderly. In addition, Meng et al. (2025) through a systematic study concluded that elastic band resistance training contributes to improved lower extremity strength and balance function in older adults. The findings support the results of this study that resistance band is an effective exercise medium to improve the functional movement ability of elderly women.

Research by Zhang et al. (2025) shows that a combination of elastic band training and vibration training can improve muscle strength, balance, and mobility in elderly women with a history of falls. Debes et al. (2024) emphasized that a structured strength training program can improve muscle quality and functional performance in the elderly. Similar findings were also reported by Varjan et al. (2024), who compared sensorimotor and resistance-endurance exercise and found benefits for both on postural control and physical function in the elderly. This support suggests that improved lower extremity function through resistance training is a consistent phenomenon across various training approaches.

However, there are some differences with previous research. Some studies used more complex exercise methods, such as blood flow restriction, a combination of strength training with Tai-Chi, machine-based exercises, sensorimotor exercises, or multidimensional interventions (Chang et al., 2022; Liang et al., 2024; Svobodová et al., 2025; Wang et al., 2024). In contrast to this approach, this study uses resistance bands as the main tool that is simpler and easier to apply. Another difference lies in the characteristics of the subject and the context of the intervention. Several previous studies have been conducted in groups with specific clinical conditions, such as

osteoarthritis, stroke, knee pain, kidney disease, or postoperative recovery (Ahmed et al., 2022; Berg et al., 2021; Geneen et al., 2022; Mehwish et al., 2023). Therefore, the contribution of this study lies in strengthening the evidence that simple resistance exercises are also relevant for community elderly women who need increased strength and functional mobility.

Theoretically, the effectiveness of resistance band training can be explained through the principles of neuromuscular adaptation and exercise specificity. When the muscles of the lower extremities are given repeated restraint, the neuromuscular system adapts through increased activation of motor units, coordination between muscles, movement efficiency, and the ability to generate force. In the elderly, early adaptations of strength training often have to do with improved nerve control and movement coordination before the occurrence of greater muscle structural changes. This explains why resistance training can improve functional performance even with a simple tool such as a resistance band.

The principle of specificity is also seen in this study. Exercises involving the thighs, pelvis, knees, and ankle muscles are directly related to standing, walking, and balancing activities. Therefore, the improvement in functional ability after exercise can be understood as the result of a transfer from the stimulus of exercise to daily activities. Research by Haraldsson et al. (2021) shows that elastic resistance bands can be used to assess and develop upper and lower extremity strength. Meanwhile, Tiggemann et al. (2021), de Oliveira et al. (2021), and Wang et al. (2024) affirm the importance of resistance training in improving physical function, body composition, and neuromuscular capacity in adult and elderly populations.

In terms of intervention development, this study shows that resistance band training can be positioned as a community-based functional training model. That is, the exercises are not only directed at mechanically strengthening the muscles, but also at increasing the movement capacity that has direct relevance to the prevention of falls. This interpretation is in line with modern exercise approaches in the elderly that emphasize the relationship between strength, balance, mobility, and functional independence (Lai et al., 2021; Meng et al., 2025; Varjan et al., 2024; Zhang et al., 2025). Thus, resistance bands can be developed as a progressive training medium that is flexible, easily modified, and can be adjusted to the level of ability of the elderly.

The findings of this study have practical implications that resistance band training can be used as an alternative to strength training programs that are safe, economical, easy to implement, and suitable for elderly women who are at risk of experiencing decreased lower extremity strength, mobility disorders, and increased risk of falling. The characteristics of the resistance band are portable, do not require a large space, and can be used in sitting or standing positions, making this exercise relevant to be applied in elderly posyandu, community fitness centers, social homes, physiotherapy clinics, and home exercise programs with simple supervision.

In its implementation, the exercise needs to be arranged progressively taking into account the initial ability of the elderly, the level of band elasticity, the number of reps, the number of sets, the speed of movement, the complexity of body position, as well as the individual's response during the exercise. Safety principles remain a priority through warm-ups, clear technical instructions, assistance during movement, and periodic evaluations of strength development and mobility. This approach is in line with previous research recommendations that emphasize the importance of safe, individualized, progressive, and sustainable resistance training in the elderly (Debes et al., 2024; Lai et al., 2021; Žlibinaitė et al., 2025). In addition, the use of Chair Stand Test and TUG can help health workers, exercise instructors, physiotherapists, and elderly program managers monitor

changes in lower extremity strength and functional mobility in a simple and objective manner.

CONCLUSION

Based on the results of the study, it can be concluded that resistance band training is effective in increasing the strength of the lower extremity muscles and improving functional mobility in elderly women. The performance improvement on the 30-Second Chair Stand Test showed that respondents who participated in the exercise had better ability to perform repetitive standing and sitting movements, which represented an increase in the functional strength of the leg muscles. In addition, improvements in the results of the Timed Up and Go Test showed that resistance band training contributed to improved walking, reversing, changing positions, and returning to sitting more efficiently. Thus, this exercise not only has an impact on the aspect of muscle strength, but also relates to a decrease in the risk of falling indicators. The research hypothesis that resistance band training has a positive effect on improving lower extremity strength and reducing the risk of falls in elderly women is acceptable. These findings show that resistance bands can be used as a safe, simple, economical, and easily applied exercise medium in elderly exercise programs. This exercise is suitable for use in community environments, elderly posyandu, fitness centers for the elderly, physiotherapy clinics, and home exercise programs with adequate supervision. Practically, resistance band training programs need to be designed progressively according to individual abilities, taking into account movement safety, exercise intensity, execution techniques, and periodic evaluation. This study still has limitations in the relatively small sample count and the scope of measurements that focus on functional strength and mobility. Therefore, follow-up research is recommended involving a larger number of respondents, longer duration of interventions, as well as additional measurements such as static-dynamic balance, muscle mass, quality of life, and history of fall events so that the effectiveness of exercise can be explained more comprehensively.

RECOMMENDATION

Based on the results of the study, resistance band training is recommended as a form of strength training that can be applied to elderly women to increase the strength of the lower extremity muscles and improve functional mobility. This exercise program should be carried out regularly, gradually, and adjusted to the physical abilities of each elderly. The implementation of the exercise needs to begin with warm-up, the provision of correct technical instructions, supervision during the exercise, and cooling down to reduce the risk of injury. For health workers, physiotherapists, exercise instructors, and senior program managers, resistance band training can be included in community physical activity programs because the tools are simple, easy to obtain, inexpensive, and do not require special facilities. Exercises can be carried out at elderly posyandu, fitness centers for the elderly, physiotherapy clinics, social institutions, or home environments with appropriate assistance. The use of simple tests such as the 30-Second Chair Stand Test and the Timed Up and Go Test is also recommended to monitor the development of limb strength and mobility of the elderly on a regular basis. For the elderly, this exercise needs to be done by paying attention to the sense of security, comfort, and limits of the body's capabilities. If pain, dizziness, excessive fatigue, or instability when moving occurs, exercise should be stopped temporarily and consulted with a companion or health professional. For subsequent researchers, it is recommended to involve a larger sample count, longer duration of exercise, more controlled variations in exercise

intensity, as well as additional measurements such as static-dynamic balance, muscle mass, quality of life, and history of fall events. Follow-up research can also compare the effectiveness of resistance bands with other forms of exercise to obtain recommendations for a more comprehensive exercise program for the elderly.

REFERENCES

- Ahmed, I., Mustafaoglu, R., & Erhan, B. (2022). The effects of low-intensity resistance training with blood flow restriction versus traditional resistance exercise on lower extremity muscle strength, walking capacity, and balance in ischemic stroke survivors: A study protocol for the BFR-Stroke RESILIENCE trial. *Haseki Tip Bulteni*, 60(4), 287. <https://doi.org/10.4274/haseki.galenos.2022.8361>
- Akatsu, H., Manabe, T., Kawade, Y., Masaki, Y., Hoshino, S., Jo, T., Kobayashi, S., Hayakawa, T., & Ohara, H. (2022). Effect of ankle weights as a frailty prevention strategy in the community-dwelling elderly: A preliminary report. *International Journal of Environmental Research and Public Health*, 19(12), 7350. <https://doi.org/10.3390/ijerph19127350>
- Bae, Y. K., Kang, M. H., Lee, J. H., Sim, Y. J., Jeong, H. J., & Kim, G. (2024). Changes in bone mineral density and clinical parameters after stroke in elderly patients with osteopenia. *Medicine*, 103(4), e37028. <https://doi.org/10.1097/MD.00000000000037028>
- Berg, O. K., Stutzer, J.-M., Hoff, J., & Wang, E. (2021). Early maximal strength training improves leg strength and postural stability in elderly following hip fracture surgery. *Geriatric Orthopaedic Surgery and Rehabilitation*, 12. <https://doi.org/10.1177/21514593211015103>
- Brown, R., Sharafi, A., Slade, J. M., Convit, A., Davis, N., Baete, S., Milton, H., Mroczek, K. J., Kluding, P. M., Regatte, R. R., Parasoglou, P., & Rao, S. (2021). Lower extremity MRI following 10-week supervised exercise intervention in patients with diabetic peripheral neuropathy. *BMJ Open Diabetes Research and Care*, 9(1), e002312. <https://doi.org/10.1136/bmjdr-2021-002312>
- Chang, H., Yao, M., Chen, B., Qi, Y., & Zhang, J. (2022). Effects of blood flow restriction combined with low-intensity resistance training on lower-limb muscle strength and mass in post-middle-aged adults: A systematic review and meta-analysis. *International Journal of Environmental Research and Public Health*, 19(23), 15691. <https://doi.org/10.3390/ijerph192315691>
- Chen, C.-F., Chiu, S.-C., Chiang, C. K., & Lu, Y.-W. (2025). Effects of seated Baduanjin training modalities on body composition, muscle strength, and gait parameters in older adults: A cluster-randomised controlled trial. *Complementary Therapies in Medicine*, 95, 103300. <https://doi.org/10.1016/j.ctim.2025.103300>
- Chien, Y.-H., Tsai, C.-J., Wang, D.-C., Chuang, P.-H., & Lin, H.-T. (2022). Effects of 12-week progressive sandbag exercise training on glycemic control and muscle strength in patients with type 2 diabetes mellitus combined with possible sarcopenia. *International Journal of Environmental Research and Public Health*, 19(22), 15009. <https://doi.org/10.3390/ijerph192215009>
- da Silva, S. D. C. S., Pires, F. O., Batista Junior, M. T., Serra, L. L. P., Reis, C. B. F., de Abreu, L. P., Pereira, P. T. V. T., Cabido, C. E. T., & Leite, R. D. (2023). Linear and undulating resistance training programming induce similar outcomes on physical fitness in elderly women. *Revista Brasileira de Cineantropometria e Desempenho Humano*, 25, e77528. <https://doi.org/10.1590/1980-0037.2023v25e77528>
- de F. Silva, A., Maia, L. B., Mendonça, V. A., dos Santos, J. M., Coelho-Oliveira, A. C., Santos, J. N. V., Moreira, L. L. V., Mascarenhas, R. D. O., Gonçalves, G. T., Oliveira, V. C., Teixeira, L. A. C., Rapin, A., Lacerda, A. C. R., & Tairar, R. (2022). Efficacy of hip strengthening on pain intensity, disability, and strength in musculoskeletal conditions of the trunk and lower

- limbs: A systematic review with meta-analysis and GRADE recommendations. *Diagnostics*, 12(12), 2910. <https://doi.org/10.3390/diagnostics12122910>
- de Oliveira, T. M. D., Felício, D. C., Filho, J. E., Quagliotti Durigan, J. L., Fonseca, D. S., José, A., Oliveira, C. C., & Malaguti, C. (2021). Effects of whole-body electromyostimulation on function, muscle mass, strength, social participation, and falls-efficacy in older people: A randomized trial protocol. *PLoS ONE*, 16(1), e0245809. <https://doi.org/10.1371/journal.pone.0245809>
- Debes, W. A., Sadaqa, M., Németh, Z., Aldardour, A., Prémusz, V., & Hock, M. (2024). Effect of resistance exercise on body composition and functional capacity in older women with sarcopenic obesity—A systematic review with narrative synthesis. *Journal of Clinical Medicine*, 13(2), 441. <https://doi.org/10.3390/jcm13020441>
- Feng, M., Li, J., Zhao, J., Pan, X., Wang, M., & Han, Q. (2024). Effect of blood flow restriction training on health promotion in middle-aged and elderly women: A systematic review and meta-analysis. *Frontiers in Physiology*, 15, 1392483. <https://doi.org/10.3389/fphys.2024.1392483>
- Fong, S. S. M., Chung, L. M. Y., Yam, T. T. T., Chung, J. W. Y., Bae, Y.-H., Gao, Y., Chan, J. S. M., & Wang, H.-K. (2023). Effects of Ving Tsun sticking-hand training on lower limb sensorimotor performance among community-dwelling middle-aged and older adults: A randomized controlled trial. *Trials*, 24(1), 143. <https://doi.org/10.1186/s13063-023-07133-2>
- Fujie, S., Horii, N., Kajimoto, H., Yamazaki, H., Inoue, K., Iemitsu, K., Uchida, M., Arimitsu, T., Shinohara, Y., Sanada, K., Miyachi, M., & Iemitsu, M. (2025). Impact of resistance training and chicken intake on vascular and muscle health in elderly women. *Journal of Cachexia, Sarcopenia and Muscle*, 16(1), JCSM13572. <https://doi.org/10.1002/jcsm.13572>
- Geneen, L. J., Kinsella, J., Zanotto, T., Naish, P. F., & Mercer, T. H. (2022). Resistance exercise in people with stage-3 chronic kidney disease: Effects of training frequency (weekly volume) on measures of muscle wasting and function. *Frontiers in Physiology*, 13, 914508. <https://doi.org/10.3389/fphys.2022.914508>
- Hanssen, B., Peeters, N., De Beukelaer, N., Vannerom, A., Peeters, L., Molenaers, G., Van Campenhout, A., Deschepper, E., Van den Broeck, C., & Desloovere, K. (2022). Progressive resistance training for children with cerebral palsy: A randomized controlled trial evaluating the effects on muscle strength and morphology. *Frontiers in Physiology*, 13, 911162. <https://doi.org/10.3389/fphys.2022.911162>
- Haraldsson, B. T., Andersen, C. H., Erhardsen, K. T., Zebis, M. K., Micheletti, J. K., Pastre, C. M., & Andersen, L. L. (2021). Submaximal elastic resistance band tests to estimate upper and lower extremity maximal muscle strength. *International Journal of Environmental Research and Public Health*, 18(5), 2749. <https://doi.org/10.3390/ijerph18052749>
- Henriksen, P., Junge, T., Bojsen-Moller, J., Juul-Kristensen, B., & Thorlund, J. B. (2022). Supervised, heavy resistance training is tolerated and potentially beneficial in women with knee pain and knee joint hypermobility: A case series. *Genetics Research*, 2022, 8367134. <https://doi.org/10.1155/2022/8367134>
- Kang, B., Kim, D., Lee, C., Kim, D., Lee, H.-J., Lee, D., Kim, Y., Jeon, H.-G., & Jung, K. (2026). Bot fit: A novel approach to assessing lower limb muscular strength. *PLOS ONE*, 21(3), e0339187. <https://doi.org/10.1371/journal.pone.0339187>
- Kennedy, F., Cheallaigh, C. N., Romero-Ortuno, R., Doyle, S. L., & Broderick, J. (2024). Outcomes of the LEAP feasibility trial—A low-threshold, exercise programme with protein supplementation to target frailty and poor physical functioning in people experiencing homelessness and addiction issues. *PLoS ONE*, 19(5), e0301926. <https://doi.org/10.1371/journal.pone.0301926>
- Kumari, N., Nayak, A., Joshua, A. M., Pai, S. D., Kumar, S. K. K., Mascarenhas, R., & Karnad, S. D. (2025). Effectiveness of additional structured strength training of unaffected lower

- extremity on balance and gait among acute poststroke individuals. *Scientific World Journal*, 2025(1), 1663116. <https://doi.org/10.1155/tswj/1663116>
- Lai, X., Bo, L., Zhu, H., Chen, B., Wu, Z., Du, H., & Huo, X. (2021). Effects of lower limb resistance exercise on muscle strength, physical fitness, and metabolism in pre-frail elderly patients: A randomized controlled trial. *BMC Geriatrics*, 21(1), 447. <https://doi.org/10.1186/s12877-021-02386-5>
- Lai, Z., Cao, M., Wang, R., Zhong, G., Gong, P., & Wang, L. (2025). Effects of intrinsic foot muscle training combined with the lower extremity resistance training on postural stability in older adults: A randomised controlled trial. *BMC Geriatrics*, 25(1), 732. <https://doi.org/10.1186/s12877-025-06407-5>
- Li, S., Wang, P., Xin, X., Zhou, X., Wang, J., Zhao, J., & Wang, X. (2023). The effect of low intensity resistance training with blood flow restriction on fall resistance in middle-aged and older adults: A meta-analysis. *International Journal of Environmental Research and Public Health*, 20(6), 4723. <https://doi.org/10.3390/ijerph20064723>
- Liang, I. J., Perkin, O. J., Williams, S., McGuigan, P. M., Thompson, D., & Western, M. J. (2024). The efficacy of 12-week progressive home-based strength and Tai-Chi exercise snacking in older adults: A mixed-method exploratory randomised control trial. *Journal of Frailty and Aging*, 13(4), 572. <https://doi.org/10.14283/jfa.2024.32>
- Liu, C., Sun, Z., Jiang, X., Liu, B., & Zhao, Y. (2026). Cross-education effects of healthy-side lower-limb strength training on neuromuscular function recovery following anterior cruciate ligament reconstruction: A randomized controlled trial. *Journal of Orthopaedic Surgery and Research*, 21(1), 269. <https://doi.org/10.1186/s13018-026-06776-6>
- Mehwish, B., Ali, S. S., & Baig, A. A. M. (2023). Effect of hip joint mobilisations and strength training on pain, physical function and dynamic balance in patients with knee osteoarthritis: A randomized controlled trial. *Journal of the Pakistan Medical Association*, 73(4), 749. <https://doi.org/10.47391/JPMA.6223>
- Meigh, N. J., Keogh, J. W. L., Schram, B., Hing, W., & Rathbone, E. N. (2022). Effects of supervised high-intensity hardstyle kettlebell training on grip strength and health-related physical fitness in insufficiently active older adults: The BELL pragmatic controlled trial. *BMC Geriatrics*, 22(1), 354. <https://doi.org/10.1186/s12877-022-02958-z>
- Meng, Y., Hu, Y., Yang, W., Xue, Y., & Yang, S. (2025). Effects of elastic band resistance training on lower limb strength and balance function in older adults: A systematic review and meta-analysis. *Frontiers in Sports and Active Living*, 1–13. <https://doi.org/10.3389/fspor.2025.1649305>
- Ney, B., Lanzi, S., Calanca, L., & Mazzolai, L. (2021). Multimodal supervised exercise training is effective in improving long term walking performance in patients with symptomatic lower extremity peripheral artery disease. *Journal of Clinical Medicine*, 10(10), 2057. <https://doi.org/10.3390/jcm10102057>
- Stafuzza, J., Gonnelli, F., D'Alleva, M., Martino, M. D., Mari, L., Zaccaron, S., Floreani, M., Floreancig, A., Padovan, D., Ursella, G., Brugnola, G., Rejc, E., & Lazzer, S. (2026). Neuromuscular and functional adaptations promoted by lower limb isometric training with NMES conditioning contractions in older adults. *International Journal of Environmental Research and Public Health*, 23(1), 107. <https://doi.org/10.3390/ijerph23010107>
- Svobodová, L., Sebera, M., Vodička, T., Svobodová, A., Horáková, A., Stračárová, N., Svobodová, Š., Eclerová, V., Vespalec, T., Kasović, M., Paludo, A. C., Bienertova-Vasku, J., & Gimunová, M. (2025). The effect of 12-week long exercise intervention, and 2-weeks of detraining period on lower limbs strength parameters and postural stability in older adults: A linear mixed model analysis. *BMC Geriatrics*, 25(1), 305. <https://doi.org/10.1186/s12877-025-05970-1>
- Taul-Madsen, L., Dalgas, U., Riis, H., Brolø, M. K., Lundbye-Jensen, J., & Hvid, L. G. (2025).

- Implications of maximal muscle strength and aerobic capacity for lower extremity physical function in people with multiple sclerosis: A cross-sectional study. *Multiple Sclerosis Journal - Experimental, Translational and Clinical*, 11(1). <https://doi.org/10.1177/20552173251326171>
- Taul-Madsen, L., Hvid, L. G., Sellebjerg, F., Christensen, J. R., Ratzner, R., Sejbæk, T., Svendsen, K. B., Papp, V., Højsgaard Chow, H., Lundbye-Jensen, J., Dawes, H., & Dalgas, U. (2024). Study protocol: Effects of exercise booster sessions on preservation of exercise-induced adaptations in persons with multiple sclerosis, a multicentre randomised controlled trial-the MS BOOSTER trial. *BMJ Open*, 14(8), e085241. <https://doi.org/10.1136/bmjopen-2024-085241>
- Tiggemann, C. L., Pietta-Dias, C., Schoenell, M. C. W., Noll, M., Alberton, C. L., Pinto, R. S., & Krueger, L. F. M. (2021). Rating of perceived exertion as a method to determine training loads in strength training in elderly women: A randomized controlled study. *International Journal of Environmental Research and Public Health*, 18(15), 7892. <https://doi.org/10.3390/ijerph18157892>
- Tumali, J. W., Satyawati, R., & Sulastri, N. (2024). Low-intensity blood flow restriction and moderate-intensity improves quadriceps strength and thigh circumference in older women. *Romanian Journal of Neurology/ Revista Romana de Neurologie*, 23(3), 289. <https://doi.org/10.37897/RJN.2024.3.10>
- Uchida, M., Park, J., Fujie, S., Hosomi, K., Horii, N., Watanabe, K., Sanada, K., Shinohara, Y., Mizuguchi, K., Kunisawa, J., Iemitsu, M., & Miyachi, M. (2024). Effect of resistance training and chicken meat on muscle strength and mass and the gut microbiome of older women: A randomized controlled trial. *Physiological Reports*, 12(12), e16100. <https://doi.org/10.14814/phy2.16100>
- Varjan, M., Žiška Böhmerová, E., Oreská, E., Schickhofer, P., & Hamar, D. (2024). In elderly individuals, the effectiveness of sensorimotor training on postural control and muscular strength is comparable to resistance-endurance training. *Frontiers in Physiology*, 15, 1386537. <https://doi.org/10.3389/fphys.2024.1386537>
- Wang, Y., Zhang, C., Wang, B., Zhang, D., & Song, X. (2024). Comparative effects of cognitive and instability resistance training versus instability resistance training on balance and cognition in elderly women. *Scientific Reports*, 14(1), 26045. <https://doi.org/10.1038/s41598-024-77536-x>
- Xiong, Z., Zheng, W., Wang, H., Gao, Y., & Wang, C. (2025). Effects of functional strength training on pain, function, and lower extremity biomechanics in patients with patellofemoral pain syndrome: A randomized clinical trial. *Journal of Orthopaedic Surgery and Research*, 20(1), 50. <https://doi.org/10.1186/s13018-025-05482-z>
- Yabe, H., Kono, K., Yamaguchi, T., Ishikawa, Y., Yamaguchi, Y., & Azekura, H. (2021). Effects of intradialytic exercise for advanced-age patients undergoing hemodialysis: A randomized controlled trial. *PLoS ONE*, 16(10), e0257918. <https://doi.org/10.1371/journal.pone.0257918>
- Yoshiko, A., & Watanabe, K. (2021). Impact of home-based squat training with two-depths on lower limb muscle parameters and physical functional tests in older adults. *Scientific Reports*, 11(1), 6855. <https://doi.org/10.1038/s41598-021-86030-7>
- Zhai, H., Wei, H., Xia, J., & Wang, W. (2023). Dose-response relationship of resistance training for muscle morphology and strength in elderly cancer patients: A meta-analysis. *Frontiers in Medicine*, 10, 1049248. <https://doi.org/10.3389/fmed.2023.1049248>
- Zhang, Z., Xiong, W., & Liu, H. (2025). Synergistic effects of elastic band and vibration training on muscle strength, balance, and mobility in older women with a history of falls: A randomised controlled trial. *Frontiers in Bioengineering and Biotechnology*, 1–10. <https://doi.org/10.3389/fbioe.2025.1525000>

Žlibinaitė, L., Amšiejūtė, L., Baltaduonienė, D., Gintilienė, M., Matukynienė, K., & Mažeikė, L. (2025). Effect of eight-week strength training on body composition, muscle strength and perceived stress in community-dwelling older women. *Geriatrics*, 10(6), 136. <https://doi.org/10.3390/geriatrics10060136>