

The difference in the effects of otago exercise and bodyweight squat on lower limb muscle strength improvement in the elderly

Angger Ayu Nur Rahmawati, Rizky Wulandari*, Siti Khotimah

Department of Physiotherapy, Faculty of Health, Universitas Aisyiyah Yogyakarta, Indonesia

*Email: rizkywulan.fisio@gmail.com

Abstract

Background The aging process causes anatomical and functional changes in the body, particularly in the musculoskeletal system, which leads to a decline in leg muscle strength. The decline increases the risk of falling and dependence on others. In Indonesia, the prevalence of muscle disorders in older adults reaches 11.9%. Otago exercise and bodyweight squat have been proven effective in increasing leg muscle strength in older adults. **Objective:** To determine the difference in the effects of otago exercise on increasing leg muscle strength in the elderly. **Methods:** A quasi-experimental study with a pre- and post-test two group design, involving 42 elderly individuals who participated in exercise 3 times a week for 4 weeks. Group I performed otago exercise, while group II performed bodyweight squat exercise. Measurements were taken using the five times sit to stand test. **Results:** Showed an increase in leg muscle strength in both groups, with a significant difference between group I and group II using a Paired Sample t-Test group I $p=12,73$ ($p<0,05$), indicating a difference in effect on each group and an increase in leg muscle strength in the elderly. **Conclusion:** There is a difference in the effect of Otago exercise and bodyweight squat exercise on the increase in leg muscle strength in the elderly. **Conclusion:** There is a difference in the effects of otago exercise and bodyweight squat exercise on increasing leg muscle strength in the elderly. **Suggestion:** Further research should consider environmental factors and energy intake.

Keywords: bodyweight squat; elderly; five times sit to stand test; leg muscle strength; otago exercise

1. Introduction

Based on the World Health Organization (WHO) classification, old age is divided into four groups, namely middle age (45-49 years), elderly (60-74 years), old (75-90 years), and very old (above 90 years) (Suyanto et al., 2021). Meanwhile, according to Indonesian national law, older adults are defined as individuals over the age of 60 (Effendy et al., 2019). The WHO predicts that the number of elderly people worldwide will reach 1.2 billion in 2025 and continue to increase by 2 billion in 2050 (Mashudi, 2020).

As we age, anatomical and functional changes occur in various organs of the body (Setiorini, 2021). Physiological and morphological changes that occur in old age have an impact on the musculoskeletal system, particularly on muscle strength (Hartinah et al., 2019). Muscle strength is the ability of muscles to produce maximum contractile force against resistance in a single contraction (Suyanto et al., 2021). Muscle strength declines after the age of 50, with a rate of decline reaching 1.2-5% per year (Lintin & Miranti, 2019). Muscle strength peaks at age 30 and gradually decreases by 30-40% by age 80 (Suyanto et al., 2021).

The decline in muscle strength, especially in the lower extremities, results in slow and stiff movements, unsteadiness, inhibit to step firmly, short strides, and instability when standing, which can increase the risk of falling (Hartinah et al., 2019). Therefore, these problems limit various daily activities, and their weakness can cause the elderly to become dependent on the help of others (Sunantara et al., 2022). The Indonesian Health Workforce Diagnosis shows that the prevalence of muscle disorders in the elderly reaches 11.9%. Among the elderly over the age of 75, about 33% experience muscle problems. When viewed by gender, the prevalence for women and men is 13.4% (Kurniawati & Widarti, 2023).

The Five Times Sit to Stand Test (FTSST) is a measurement tool used to identify decreased leg muscle strength in older adults aged 60 to 80 years (Mello et al., 2023). FTSST has a sensitivity of 66% and specificity of 65%, and has an ICC value of 0.74-0.99, which means it has a 95% confidence interval (Tapanya et al., 2023) dan (Muñoz-bermejo et al., 2021). Given that most elderly people

suffer from muscle disorders, it is very important to implement effective exercise methods to increase muscle strength in the elderly, one of which is strengthening exercise.

Strengthening exercises are ideal for improving lower limb muscle strength in older adults, enabling them to perform daily activities more safely (Pramusinta, 2022). One exercise method that can be used and has been proven effective in increasing leg muscle strength is the otago exercise.

The Otago exercise is a physical exercise specifically designed to increase lower limb muscle strength. In increasing leg muscle strength, this exercise program targets strengthening the knee extensor and ankle plantar flexor muscle groups (Mahendra, 2022). According to research (Rathi et al., 2022) and (Mahendra, 2022) otago exercises also significantly improve lower extremity muscle strength in older adults.

In addition to the otago exercise, there is another exercise method that is also effective in increasing leg muscle strength in older adults, namely the bodyweight squat exercise. This exercise uses one's own body weight as resistance to functionally strengthen the leg muscles (Riantini et al., 2022). Research by (Riantini et al., 2022) and (Kurniawati & Widarti, 2023) shows that bodyweight squat exercises are effective in increasing leg muscle strength in older adults who experience muscle weakness, with additional benefits in improving mobility and independence in daily activities.

2. Method

This study used a quasi-experimental method, namely a pre-post two-group design, to determine the difference in the effects of Otago exercises and bodyweight squat exercises on increasing leg muscle strength in older adults. Before the exercise was given, the sample was measured using a five times sit to stand test with a sitting and standing movement 5 times to determine leg muscle strength. The researcher used two groups, the first group was given Otago exercise and the second group was given bodyweight squat exercise. After undergoing the exercise 3 times a week for 4 weeks, their leg muscle strength was measured again using the five times sit to stand test. Purposive sampling was used to select samples using lottery numbers. A total of 42 samples were obtained. The samples in this study were active elderly people in health centers who had a five times sit to stand score of more than 11.64 seconds. The ethics committee approved this study at Universitas 'Aisyiyah Yogyakarta, on May 27, 2025, with number 4499/KEP-UNISA/V/2025.

3. Result dan Discussion

3.1. Result

This study was conducted at the Kanthil Elderly Health Center, located at Pete Rt 04, Sidomoyo, Godean District, Sleman Regency, Special Region of Yogyakarta 55264. The population of this study site consisted of 57 people, and 42 people were indicated as inclusion criteria. This study began with a pre-test measurement of leg muscle strength using the Five Times Sit to Stand Test, followed by treatment for group I and II. Otago exercise and bodyweight squat exercise were given 3 times a week for 4 weeks, with exercise conducted from June 10 to July 8, 2025.

3.1.1. Respondent Characteristic

Table 1. Characteristics of Respondents Based on Age, Gender, and Physical Activity

Category	Group 1 N=21	Percentage %	Group N=21	Percentage %
Age				
60-74 Year	12	57	18	86
75-90 Year	9	43	3	14
Total				
Gender				
Male	1	4	5	24
Female	20	96	16	76
Total		21 respond		
Physical Activity				

Category	Group 1 N=21	Percentage %	Group N=21	Percentage %
Not exercising	10	48	10	48
1x/week	1	4	3	15
2x/week	2	9	1	4
3x/week	-	-	2	9
4x/week	1	4	-	-
5x/week	-	-	1	4
6x/week	-	-	-	-
Every day	7	35	4	20
Total		21 respond		

Based on the table presented, it can be seen that the majority of respondents in group I were in the 60-74 age range, totaling 12 people (57%), and 18 people (86%) in group II, while in the 75-90 age range, there were 9 people (43%) in group I and 3 people (14%) in group II. Interms of gender, the majority of respondents were female, namely 20 people (96%) in group I and 16 (76%) in group II. Meanwhile, there was only 1 male respondent (4%) in group I and 5 male respondents (24%) in group II. Furthermore, based on the level of physical activity performed by the elderly, it was found that the majority of respondents did not engage in physical activity, with 10 people (48%) in group I and 10 people (48%) in group II. Physical activity with frequency of once a week was performed by 1 person (4%) in group I and 3 people (15%) in group II. Meanwhile, 2 people (9%) in group I and II (4%) in group II performed physical activity twice a week. Physical activity three times a week was only found in group II, namely 2 people (9%). Physical activity 4 times/week was only performed by 1 person (4%) in group I, and a frequency of 5 times/week was only recorded in 1 person (4%) in group II. For the category of daily exercise, there were 7 people (35%) in group I and 4 people (20%) in group II. Thus the number of respondents in this study was 42 people.

Table 2. Hypothesis Testing I and II Using Paired Sample T-Test

Test Results	N	Mean ± SD		p
		Pretest	Posttest	
Otago exercise	21	15,4324 ± 1,61824	12,7310 ± 1,62820	0,000
Bodyweight squat exercise	21	15,3743 ± 1,36203	11,8152 ± 1,00995	0,000

Based on the results of the analysis in tables I and II, a significance value (p) = 0.000 was obtained, which means $p < 0.05$. Thus, H_a is accepted and H_o is rejected. This indicates that there is a significant effect of exercise on increasing muscle strength in the leg of older adults. In the group given the otago exercise, a difference in leg muscle strength improvement 2.7014 was obtained. This finding indicates that the otago exercise program is effective in increasing leg muscle strength in the elderly. Meanwhile, in group that performed bodyweight squat exercise, a difference in leg muscle strength increase 3.5591 was obtained. These results indicate that bodyweight squat exercise also has a significant effect on increasing leg muscle strength in the elderly. Thus, both forma of exercise have been proven to contribute positively to increasing leg muscle strength.

3.1.2. Hypothesis Test III

Table 3. Hypothesis Testing III Using Independent Sample T-Test

Test Results	N	Mean ± SD	p
Otago exercise	21	12,7310±1,62820	0,034
Bodyweight Squat exercise	21	11,8152±1,00995	

Based on this hypothesis test table III using an independent sample t-test, because the data distribution in both group I (otago exercise) and group II (bodyweight squat exercise) obtained $p = 0.034$ ($p < 0.05$), H_a is accepted and H_o is rejected, From these results, it can be concluded that there is a difference in the effects of otago exercise and bodyweight squat exercise on increasing leg muscle strength in the elderly, with a difference of 0.9158.

3.2. Discussion

3.2.1. Age

Based on the results of the study, it was found that the respondents who experienced the most significant decline in muscle strength were those aged 60-74 years old, with 12 people in group 1 and 18 people in group 2. Meanwhile, in the 75-90 age group, there were 9 people in group I and 3 people in group 2. This is in agreement with (Wang et al., 2024), which states that individuals aged 75 and above will experience muscle mass loss of around 0.64% to 0.7% each year. Muscle mass decline in the elderly occurs due to atrophy and loss of muscle fibers, where type II muscle fibers in older adults can be 10% to 40% smaller than in younger individuals. Muscle fibers are divided into two types, namely type I (slow fibers used for endurance activities) and type II (fast fibers for high-intensity activities). In addition to a decrease in size, changes in the composition and structure of muscle fibers also contribute to a decline in muscle quality, as the specific tends to decrease in older individuals (Wang et al., 2024). Meanwhile (Choirunnisa & Pudjianto, 2023), according to, 55% of people aged 50 experience a decline in muscle strength and difficulty standing or sitting, 26% have moderate muscle strength, and 13% have leg muscle strength that is still considered normal.

3.2.2. Gender

Based on the results of the most dominant research, women tend to experience a more significant decline in leg muscle strength than men. This condition is related to physiological and hormonal differences that affect muscle function as we age. This is supported by (Pangka, 2022), who states that men have higher muscle strength than women. The decline in muscle strength caused by the aging process is related to the difference between muscle strength in elderly men and women. In men, the aging process occurs gradually. Meanwhile, in women, these changes occur drastically after entering menopause. This results in muscle strength in elderly women tending to be lower than in elderly men.

3.2.3. Physical Activity

Based on the data above, the most significant decline in leg muscle strength was observed in 10 elderly people in groups I and II who did not engage in physical activity. This is supported by research by (Suyanto et al., 2021), which states that regular and routine physical activity (at least 2-3 times a week) will increase muscle strength and slow down the aging process. Elderly people who are physically inactive tend to experience faster aging and a significant decline in muscle strength, because muscle strength undergoes a decline due to reduced protein synthesis and a decrease in muscle fiber count. This decline in physical activity causes a reduction in muscle fiber size and number, accompanied by an increase in connective tissue and fat in the muscle area due to structural changes that occur because the muscle are rarely used, thereby triggering muscle atrophy and progressive functional decline (Sunantara et al., 2021).

Therefore, the World Health Organization (WHO) recommends that every individual, including those under 65 years of age, over 65 years of age, and those with chronic conditions or disabilities, continue to engage in regular physical activity. The WHO recommends that individuals under 65 years of age engage in moderate intensity aerobic activity for 150-300 minutes per week or high-intensity activity for 75-150 minutes per week, as well as muscle-strengthening exercise at least twice a week. Meanwhile, for individuals over 65 years of age, physical activity focused on balance and muscle strengthening exercise of moderate or higher intensity is recommended at least three times a week (Bull et al., 2020)

3.2.4. The Difference Between Otago Exercise and Bodyweight Squat Exercise in Improving Leg Muscle Strength in the Elderly

The results showed that group I, which received otago exercise treatment, had a mean five times sit to stand test score of 15.4324 on the pretest and 12.7310 on the posttest, indicating an increase in leg muscle strength after the exercise, with a difference between the pretest and posttest scores of 2.70. The data from group II, which received the bodyweight squat exercise treatment, had a mean FTSSST score of 15.3743 on the pretest and 11.8152 on the posttest, with a difference of 3.56. The results of hypothesis test III using the Independent Sample T-test to determine the difference in the effects of the two groups

showed a p-value of 0.001 or $p < 0.05$, which indicates that the two groups had a significant difference in effect. Based on the results, the highest difference was in the bodyweight squat exercise treatment because it had the highest pre- and post-test difference.

Research conducted by Napu et al. (2022) explains that Otago exercise has been proven to increase leg muscle strength, focusing on the main muscles of the lower leg, namely the knee flexors and extensors, as well as the thigh abductor muscles, which play an important role in functional movements. On the other hand, Riantini et al. (2022) stated that bodyweight squat exercises have been proven to be significantly effective in increasing lower limb muscle strength in the elderly. Slowly performed squats can stimulate a noticeable increase in the size and strength of leg muscles. By utilizing one's own body weight as exercise resistance, this exercise can trigger the process of muscle hypertrophy, thereby strengthening the muscles in the legs of the elderly.

The difference in effectiveness between interventions can be explained by the main mechanism used. The main mechanism of bodyweight squat exercises is through a multi-joint, multi-set approach, which provides greater stimulation. Simultaneous muscle contraction in the large leg muscles recruits more motor units and triggers greater muscle hypertrophy. This exercise also uses more intensive movements because the elderly must bear their full body weight when performing knee flexion and extension movements, resulting in faster and more significant muscle strength adaptation.

Meanwhile, Otago exercises are more low-intensity exercises for muscle stability, resulting in a gradual and relatively slower increase in muscle strength. The majority of participants were postmenopausal elderly women, so their estrogen levels had decreased. When estrogen levels decrease, muscle mass loss occurs more rapidly and the adaptive response to exercises such as Otago exercises becomes slower. Nearly half of the respondents also had low physical activity levels, so this condition made bodyweight-based exercises during squats provide a greater strength stimulus. Based on the findings from the measurements, it can be concluded that high-intensity multi-joint exercises are more effective in increasing leg muscle strength in the elderly because they have a higher pre- and post-difference value compared to the low-intensity and gradual group.

4. Conclusion

Based on the results and discussion in this thesis, the following conclusions can be drawn:

1. Otago exercise has an effect on increasing leg muscle strength in older adults.
2. There is an effect of bodyweight squat exercises on increasing leg muscle strength in the elderly.
3. There is a difference in the effects of Otago exercises and bodyweight squat exercises on increasing leg muscle strength in older adults.

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