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Evaluation Of The Implementation Of Balance Exercises To Improve Muscle Strength In Elderly People At Risk Of Falls: Literature Review

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ABSTRACT

Falls pose a serious threat to the health and independence of older adults over 60 and are a leading cause of death in this age group. Approximately 25-38% of older adults over 65 are at risk of falling, with approximately one-third experiencing serious injuries such as hip fractures or head trauma. Falls in older adults are influenced by various factors, including gait disturbances, leg muscle strength, joint stiffness, and dizziness, as well as external factors such as slippery floors or poor lighting. These conditions interfere with daily activities and reduce the quality of life of older adults. This study aimed to evaluate the effectiveness of balance training in improving muscle strength in older adults at risk of falling. A literature review used articles and journals from the Google Scholar database from 2020 to 2025, using the keywords: balance training AND fall risk AND older adults. Six reviewed journals reported that various forms of balance training, such as Otago exercises, tandem walking, single-leg standing, and ankle strategy training, are effective in improving balance and reducing fall risk in older adults. These exercises, particularly the Otago Exercise Program, which combines strengthening, balance, and walking exercises, work by increasing lower-extremity muscle strength, improving neuromuscular control, and enhancing postural recovery strategies, ultimately reducing the risk of falls. Overall, regular balance training interventions are recommended as a simple yet effective way to optimise muscle function, enhance coordination, improve posture, and enhance quality of life and independence in older adults.

Keywords: Balance training, risk of falls, elderly, muscle strength

INTRODUCTION

Falls are a major threat to the health and independence of older adults over 60 and are a leading cause of death in this age group [1]. Reported falls are particularly high among older adults over 65. 1 Approximately 25-38% of older adults over 65 have a 32-42% risk of falling, and nearly one-third have experienced a fall resulting in a serious injury. Approximately one in three older adults experiences a serious injury from a fall, such as a hip fracture or head trauma [2].

Falls in the elderly are a common problem and are caused by several factors [3]. These factors can be both internal and external. For example, gait disturbances, weak leg muscles, joint stiffness, and dizziness can occur. External factors include slippery or uneven floors, tripping over objects, and poor vision due to poor lighting. As a result,

their daily activities are disrupted, which can reduce a person's endurance and response time by as much as 78% [4].

The global population of elderly people is currently predicted to exceed 629 million and will reach 1.2 billion by 2025. The Central Statistics Agency (BPS) reported that in 2021, the number of elderly people in Indonesia was 29.3 million, accounting for 10.82% of the total population. This number is expected to increase to 33.69 million in 2025, 40.95 million in 2030, and 48.19 million in 2035. The growing number of elderly people brings a variety of complex issues. One common issue is falls. Falls are a major challenge for seniors over 65 because they often cause injuries [5]. In addition to injuries, falls can also lead to permanent mobility limitations and even death. In Indonesia, the incidence of falls among seniors in the community is 12.8% for those aged 50 and over, while in hospitals it is 42.8% for those aged 60 and over.

As the human body ages, changes occur in muscles, bones, and joints. Muscles decrease and change shape, leading to changes in muscle function, such as decreased strength, contractility, elasticity, and flexibility [7]. This makes it more difficult for the elderly to maintain balance. This decline in balance makes the elderly more susceptible to a decline in quality of life, as well as difficulty or inability to perform daily activities [8]. 4. A common problem experienced by the elderly is called geriatric syndrome. Geriatric syndrome is a condition in which the elderly's balance declines, increasing their risk of falling by up to 2.9 times, compared with elderly people who still have good balance. Falls in the elderly can cause various serious impacts, ranging from minor injuries to disability, disability, and can even lead to death [9].

Given these impacts, efforts are needed to prevent falls in the elderly by recognizing the risk of falls and how to address them. Fall risk is closely related to an elderly person's ability to maintain balance. The Berg Balance Scale is a tool used to measure an elderly person's balance, determine their risk of falls, and assess their ability to maintain body position [10]. Therefore, it is important to investigate interventions that can improve balance control in older adults. Compiling the best literature on interventions to improve balance has the potential to update recommendations for clinical practice, supporting efforts to improve the quality of prevention and promotion for older adults affected by falls.

MATERIAL AND METHOD

This literature review collected relevant articles and journals from the Google Scholar database from 2020 to 2025. The search technique for this literature review began by identifying several keywords within the database to find relevant journals. The keywords used were: Balance Exercise, Risk of Falling, Elderly, Muscle Strength, Otago Exercise, Tandem Walking.

RESULTS AND DISCUSSION

Results from six peer-reviewed journals indicate that various forms of balance training, such as tandem walking, Otago exercises, single-leg standing, and ankle strategy exercises, have been shown to be effective in improving balance and reducing the risk of falls in older adults. All studies demonstrated an increase in balance scores, measured using the Berg Balance Scale (BBS) and the Functional Reach Test (FRT), after several weeks of regular exercise intervention. Older adults participating in the exercise program demonstrated improved standing, walking, transitioning, and maintaining body stability compared to pre-exercise levels. Statistical testing from the six articles demonstrated a significant effect of exercise on balance. Overall, the six studies agreed that regular balance training can optimize muscle function, improve coordination, enhance posture, and reduce the risk of falls. Therefore, this training is recommended as a simple yet effective intervention to improve quality of life and independence in older adults.

The balance of older adults before tandem walking training usually presents a moderate risk of falling [12]. The average score obtained from several activities such as standing from a sitting position, standing without support, sitting with an unsupported back, sitting from a standing position, changing places, standing with eyes closed, standing with feet together, reaching forward, picking up an object from the floor, looking back, turning 360 degrees, placing feet alternately on a small stool, standing with one foot in front of the other, and standing on one leg, was mostly 2, and only a small number reached 3 [2].

Table 1. Research Results on the Implementation Of Balance Exercises To Improve Muscle Strength In Elderly People At Risk Of Falls

No	Title	Author	Intervention	Result
1.	The effect of tandem walking exercise on body balance to reduce the risk of falling	Siregar, Rinco Gultom, Rumondang Sirait, Lin Ivining (2020).	The intervention carried out on the elderly in this article is tandem walking exercises	The number of respondents who participated was 29 elderly people. No elderly person withdrew, and all were able to complete the tandem walking exercises for 8 weeks, consisting of 62.1% men and 37.9% women, with an average age of 67 years. The results obtained before the tandem walking exercises showed an average body balance score of 26.38 (SD=4.678), indicating that the elderly had a moderate risk of falling. Meanwhile, after undergoing the tandem walking exercises for 8 weeks, the average body balance score of the elderly increased to 42.14 (SD=5.786), meaning the risk of falling was low.
2.	Tandem walking to reduce the risk of falling	Zulfa Adallia Mualif, Maulidta Karunianingtyas Wirawati (2021)	The intervention carried out on the elderly in this article is Tandem Walking	It was found that of the 73 elderly people who had good nutrition, 91.3% had no risk of falling, which is 67 people or 83.3%, and 3 people had a low risk of falling or 3.8%, and 3 people had a high risk or 3.8%. Meanwhile, of the 7 who were at risk of malnutrition, 3 people or 3.8% had no risk of falling, 3 people or 3.85% had a low risk of falling, and 1 person or 1.35% had a high risk of falling.
3.	Analysis of the implementation of Otago exercise in	Warijan, Ajeng Titah Normawati, Cipto (2022).	The intervention conducted on the elderly in	The initial assessment showed that client I, named Mrs. M, aged 84, had a fall risk score of 22; client II, aged 72, had a fall risk score

	elderly at risk of falling		this article is the implementation of Otago exercise for elderly individuals at risk of falling.	of 31; and client III, aged 68, had a fall risk score of 25. Based on the interpretation of the Berg Balance Score, the lower the score, the higher the risk of falling. Client I showed improvement in her condition, reflected by an increase in her balance score from 22 to 25, although she is still in the moderate fall risk category. The observable developments in the client's condition include an increase in the ability to sit and stand: initially, the client required minimal assistance to stand steadily, but now she is able to stand independently with hand support.
4.	Education and balance training to prevent the risk of falls in the elderly	Suliatiyani, Lamria Situmeang, Rustam Aji, Tirza Laura Itaar (2023)	The intervention carried out on the elderly in this article is the provision of Otaga exercise training.	Of the 32 elderly attendees, 5 admitted to having experienced falls. Three of them had a history of hypertension. This indicates that elderly individuals with high blood pressure are at a higher risk of falling. Those who had fallen mentioned several contributing factors, such as sudden feelings of unsteadiness or imbalance, slippery floors, and symptoms like headache or dizziness. One elderly person shared that a fall from a motorcycle resulted in changes to the bones in their legs or deformities. Elderly individuals also often experience sudden swelling in their feet.
5.	The effect of tandem walking exercise on reducing the	Maritta Sari, Nengke Puspita Sari, Weni	The intervention carried out on the elderly in	The results showed that there were 30 respondents, with 19 elderly individuals having a high risk of falling and 11 elderly individuals

	risk of falls in the elderly.	Sukastri (2024).	this article was the provision of tandem walking exercise	having a low risk of falling. This indicates that before performing tandem walking exercises, the elderly in the nursing home had a higher fall risk percentage of 63.4%, whereas after performing the tandem walking exercise, a decrease in high fall risk of 16.7% was observed. In the bivariate analysis using the Wilcoxon test, a p-value of 0.005 was obtained, which means that there is an effect of administering the tandem walking exercise.
6.	Further research on the provision of single-leg standing exercises and ankle strategy exercises in improving balance in the elderly	Kesit ivanali, Shella Ramadhona, Rena Mailani (2025).	The interventions carried out on the elderly in this article are single-leg standing exercises and ankle strategy exercises.	From the results obtained, there were 20 elderly individuals who met the inclusion criteria, and they were then divided into two groups, namely treatment group I and treatment group II, with each group consisting of 10 participants. Treatment group I was given single-leg standing exercises, while group II was given ankle strategies. Each group underwent training 8 times, with a frequency of 4 times a week for 2 weeks. The participants in the nursing home had an average age of 71-85 years, among which 10 participants were 83-83 years old, accounting for 50%, ages 71-75 years consisted of 7 participants with a percentage of 35%, and ages 78-80 years consisted of 3 participants with a percentage of 15%. This indicates that the prevalence of balance disorders tends to increase with age.

Tandem walking is also used to train parameters related to balance and mobility [13]. This exercise is often used as a test to help diagnose ataxia, particularly truncal ataxia caused by damage to the cerebellar vermis or related tissues [14]. People with this disorder tend to have an unsteady gait and a wide stride base. Tandem walking performed with the assistance of an older adult will improve because it requires the older adult to walk along a specific line, with the toes of one foot behind the heel of the other, and to slowly control their posture [15]. This process is accomplished by utilizing cognitive abilities and muscle coordination from body parts such as the trunk, lumbar spine, hips, pelvis, abdominal muscles, and calf muscles [2].

Older adults experiencing physical decline, particularly those affecting their ability to control balance, such as reduced muscle strength, changes in posture, fat accumulation in certain areas, decreased body perception (proprioception), and decreased vision, may experience balance disorders [16]. These disorders potentially increase the risk of falls. To address these issues, physical exercises that can improve balance are needed. One type of such exercise is tandem walking [4].

This exercise involves narrowing the area where the feet touch by walking straight with the heel of one foot touching the toes of the other. This exercise is expected to improve dynamic balance, especially on the sides of the body (lateral), which helps reduce the risk of falls in the elderly. Tandem walking is a type of balance exercise that involves developing body perception (proprioception) to maintain body stability [4].

The Otago Exercise Program, which combines strengthening, balance training, and gait training, has been shown to improve functional ability and balance scores in older adults at risk of falls [17]. A case study showed that Berg Balance Scale scores improved after six Otago sessions over a three-week period, although fall-risk categories did not decrease due to the intervention's short duration. However, there were clear improvements in walking, standing, and transferring abilities because of the Otago protocol. The program works by improving motor skills and muscle strength in the lower body, which in turn reduces fall risk [6].

Decreased balance in older adults increases the risk of falls, which can lead to serious injury and reduce quality of life. Therefore, education about fall risk factors and the importance of maintaining balance, along with physical exercises such as Otago gymnastics, is implemented as an intervention [18]. Elderly individuals who experience falls generally report contributing factors, including balance problems,

slippery floors, and other physical symptoms like dizziness. This community-based balance education and training program has been shown to be effective in increasing awareness and health in older adults, particularly in preventing falls and managing hypertension [19].

Tandem Walking Exercise trains body positioning, muscle coordination, and movement. It also trains visual acuity by looking ahead and expanding the field of vision to allow for straight walking [20]. Tandem Walking Exercise also activates the sensory and vestibular systems, which help maintain an upright body position and a correct gait pattern while walking. Tandem Walking has been proven to be effective in improving balance and reducing the risk of falls in the elderly [9].

Otago walking and strengthening exercises target both distal and proximal muscles (e.g., gastrocnemius, tibialis anterior, quadriceps) as well as the proprioceptive system, thereby improving neuromuscular control and postural recovery strategies. Findings from a study comparing single-leg standing exercises with ankle strategy exercises showed that dynamically activating ankle control (ankle strategy) led to greater balance improvements, suggesting additional benefits when Otago walking/strengthening exercises are combined with ankle-specific exercises/postural strategies to improve postural distraction response and distal strength[7].

In addition, exercises that narrow the base of support, such as tandem walking, have been reported to improve dynamic balance, supporting the idea that the dynamic balance component of the Otago program (walking exercises, tandem-like drills) is important for transfer to everyday activities[4].

CONCLUSION

It can be concluded that the six articles reviewed discuss the evaluation of balance training, which is highly effective and applicable, especially the Otago Exercise Program, which combines strengthening, balance, and gait training. It works by increasing lower-extremity muscle strength, improving neuromuscular control, and postural recovery strategies, ultimately reducing the risk of falls. Therefore, overall, regular balance training interventions are recommended as a simple yet effective effort to optimize muscle function, improve coordination, enhance posture, and enhance quality of life and independence in older adults.

AUTHORS' CONTRIBUTIONS

Kibitia Mahu: Conceptualisation, Writing, reviewing & editing, original draft. **Sitti Johri Nasela**: Writing –review & editing, Methodology, Writing, original draft preparation. **Masrikat Maya Diana Claartje**: Writing, review & editing, Methodology, Investigation. **Nur Baharia Marasabessy**: Writing, review & editing, Writing –original draft, Visualisation, Validation.

DISCLOSURE STATEMENT

The authors declare that they have no financial conflicts of interest or personal relationships that could have influenced the results reported in this paper. The data were obtained from Google Scholar databases. The authors acknowledge that although they have used these data for academic research purposes, they do not claim any ownership rights to them. All authors contributed to the conception and design of the study, the collection of the literature, and the analysis and interpretation of the results. The authors confirm that the manuscript has been read and approved by all named authors. The authors confirm that this manuscript is an original work that has not been published elsewhere and is not currently under consideration for publication elsewhere.

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