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Comparative Effects of Balance and Otago Exercises on Fall Risk in Older Adults: A Quasi-Experimental Study

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Abstract

Background: Falls are a major public health problem among older adults, leading to injury, functional decline, and reduced quality of life. Balance Exercise and the Otago Exercise Programme are commonly used exercise-based interventions to reduce fall risk, yet direct comparative evidence remains limited.

Objective: To compare the effects of Balance Exercise and the Otago Exercise Programme on fall risk among older adults.

Methods: This quasi-experimental pre-test–post-test two-group study included 20 community-dwelling older adults aged 60–75 years with Timed Up and Go (TUG) Test scores >12 seconds. Participants were allocated to a Balance Exercise group (n = 10) or an Otago Exercise Programme group (n = 10). Both interventions were performed three times weekly for four weeks. Fall risk was assessed using the TUG Test. Paired and independent sample t-tests were applied ($p < 0.05$).

Results: Both groups showed significant reductions in TUG scores after the intervention (Balance Exercise: mean reduction = 3.00 seconds, $p < 0.001$; Otago Exercise Programme: mean reduction = 2.40 seconds, $p < 0.001$). No significant between-group difference was found in post-intervention TUG scores (mean difference = 0.90 seconds, $p = 0.316$).

Conclusion: Balance Exercise and the Otago Exercise Programme were similarly associated with improved functional mobility in older adults. Given the quasi-experimental design, results should be interpreted as comparative associations rather than causal effects. Both interventions may be considered feasible options for fall risk reduction in community settings.

Keywords
Aged; Accidental Falls; Balance Exercise; Otago Exercise Programme; Timed Up and Go Test

Introduction

Population ageing is a rapidly growing global phenomenon and poses significant challenges to health systems worldwide. The World Health Organization estimates that the global population aged 60 years and older will increase from approximately 1 billion in 2020 to more than 2.1 billion by 2050, with the fastest growth occurring in low- and middle-income countries.[1] In Indonesia, the proportion of older adults continues to rise steadily, including at the regional level, reflecting similar demographic transitions and increasing demands on healthcare services.[2]

Falls represent one of the most common and serious health problems among older adults. Approximately one in three community-dwelling older adults experiences at least one fall each year, and many of these incidents result in injuries, fractures, functional decline, fear of falling, and reduced quality of life.[3] Falls are also a major contributor to disability, hospitalization, and mortality in the elderly population.[4] Both intrinsic factors—such as age-related declines in balance, muscle strength, sensory integration, and neuromuscular control—and extrinsic factors, including environmental hazards, inappropriate footwear, and unsafe living conditions, play important roles in increasing fall risk.[5,6]

Impairments in balance and functional mobility are among the most important modifiable intrinsic risk factors for falls. Physiotherapy interventions aimed at improving postural control, lower-limb strength, and movement coordination are therefore central to fall prevention strategies in clinical and community settings.[5] The Timed Up and Go (TUG) Test is widely used as a simple, valid, and reliable measure of functional mobility and fall risk in older adults.[7] Prolonged TUG times have been associated with increased fall incidence, functional dependence, and mortality, highlighting its clinical relevance as an outcome measure.[8]

Exercise-based interventions focusing on balance and strength have consistently demonstrated beneficial effects in reducing fall risk among older populations. Balance Exercise programs typically emphasize static and dynamic balance training, weight shifting, and lower-limb stabilization to enhance postural control during functional activities.[9,10] Several studies have reported significant improvements in balance performance and functional mobility following structured balance training in community-dwelling older adults.[11,12] These benefits are thought to result from improved neuromuscular coordination and more effective integration of sensory inputs during postural control.

Another widely implemented intervention is the Otago Exercise Programme, a multicomponent exercise program combining progressive lower-limb strengthening, balance exercises, and walking activities. Originally developed for independently living older adults, the Otago programme has been shown to improve balance, muscle strength, and functional mobility, as well as to reduce fall risk.[13,14] Evidence from systematic reviews and meta-analyses further supports the effectiveness of the Otago Exercise Programme when delivered with adequate frequency and supervision.[15,16]

Despite strong evidence supporting Balance Exercise and the Otago Exercise Programme individually, direct comparative studies between these two interventions remain limited, particularly in community-based settings and non-randomized designs.[17,18] Most previous studies have evaluated each intervention separately or compared them with usual care rather than directly with one

another. This lack of head-to-head comparative evidence represents an important research gap, especially for physiotherapists who must select feasible and effective fall prevention programs in real-world practice.

Furthermore, while randomized controlled trials provide high internal validity, they are not always feasible in community settings due to ethical, logistical, and resource constraints. Quasi-experimental designs therefore play a practical role in generating comparative effectiveness evidence, provided that their methodological limitations are transparently reported and cautiously interpreted. Therefore, this study aimed to compare the effects of Balance Exercise and the Otago Exercise Programme on fall risk among older adults, as measured by the Timed Up and Go Test, using a quasi-experimental pre-test–post-test two-group design.

Methods

Study Design

This study employed a quasi-experimental pre-test–post-test two-group design to compare the effects of Balance Exercise and the Otago Exercise Programme on fall risk among older adults. This design was selected to enable comparative evaluation of exercise interventions in a community setting where randomization was not feasible due to logistical and ethical considerations.

Participants and Setting

The study was conducted at the Adyyuswa Elderly Community of St. Theresia Church, Bongsari, Semarang, Indonesia. The target population consisted of 60 registered community-dwelling older adults. From this population, 38 individuals were assessed for eligibility, and 20 participants met the inclusion criteria and agreed to participate in the study.

Participants were eligible for inclusion if they were aged 60–75 years, were active members of the elderly community, had a Timed Up and Go (TUG) Test score greater than 12 seconds—indicating an increased risk of falls—and provided written informed consent. Participants were excluded if they had acute musculoskeletal injuries, severe neurological disorders, cardiovascular instability, or other medical conditions that contraindicated participation in exercise-based interventions.

Sample Size and Allocation

A total of 20 participants were included as a feasibility-based sample derived from the available population. Participants were allocated into two groups of equal size (n = 10 per group) using a consecutive non-random allocation method based on eligibility and attendance availability at the community center. This approach was chosen to ensure intervention feasibility while maintaining transparency regarding potential selection bias.

Intervention Procedures

Balance Exercise Group

Participants in the Balance Exercise group performed structured balance-oriented exercises targeting static and dynamic postural control, lower-limb strength, and functional stability. The exercise program included activities such as single-leg stance, tandem standing, multidirectional weight shifting, and dynamic balance tasks. Each session lasted approximately 30–40 minutes and was conducted three times per week for four weeks under physiotherapist supervision.

Otago Exercise Programme Group

Participants in the Otago Exercise Programme group followed a standardized Otago protocol consisting of progressive lower-limb strengthening exercises, balance training, and functional walking activities. Exercise intensity was gradually progressed according to participant tolerance. Sessions were delivered three times per week for four weeks, with supervision to ensure safety, adherence, and correct execution.

Outcome Measure

Fall risk was assessed using the Timed Up and Go (TUG) Test, which measures the time required for a participant to stand up from a chair, walk three meters, turn, walk back, and sit down. The TUG Test has demonstrated excellent reliability, with intraclass correlation coefficients ranging from 0.95 to 0.99, and strong validity for assessing functional mobility and fall risk in older adults. Higher TUG scores indicate poorer functional mobility and increased fall risk.

Data Collection Procedure

Baseline TUG measurements (pre-test) were obtained prior to the intervention period. Post-intervention TUG measurements (post-test**)** were collected after completion of the four-week exercise program. All assessments were conducted by trained assessors following standardized testing procedures to ensure measurement consistency.

Statistical Analysis

Data were analyzed using statistical software. Normality of continuous variables was assessed using the Shapiro–Wilk test. Within-group differences between pre-test and post-test TUG scores were analyzed using paired sample t-tests, while between-group differences in post-test scores were examined using independent sample t-tests. A two-tailed significance level of $p < 0.05$ was applied for all analyses. Effect sizes and 95% confidence intervals were calculated to support clinical interpretation of the findings.

Results

Participant recruitment was conducted among members of the Adyyuswa Elderly Community of St. Theresia Church, Bongsari, Semarang, Indonesia. An initial screening was performed to identify eligible older adults based on predefined inclusion and exclusion criteria. The recruitment and allocation process, including reasons for exclusion and participant retention throughout the study, is summarized in Figure 1.

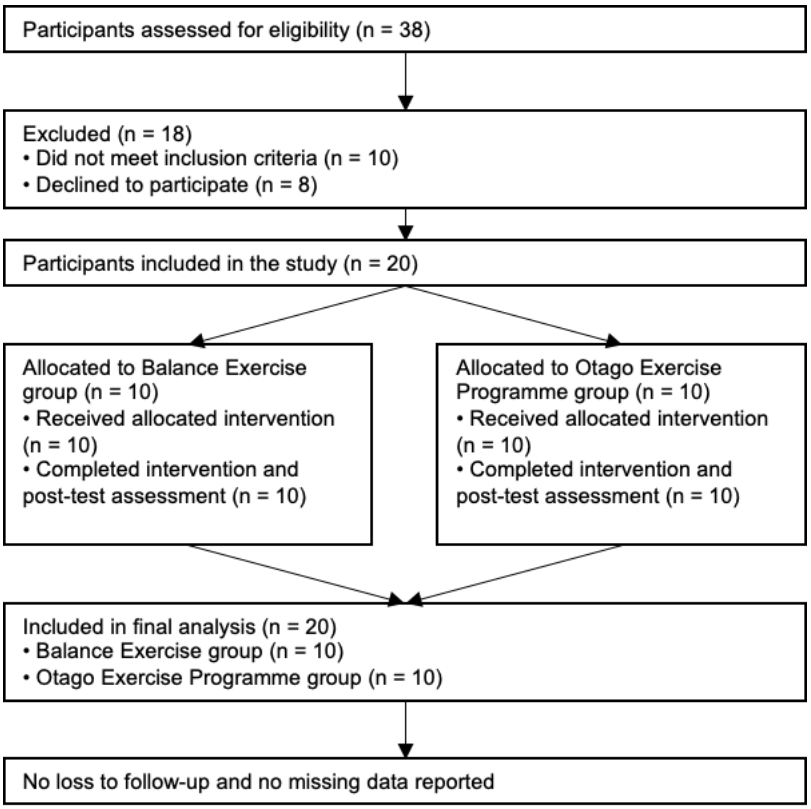

Figure 1. Flow Diagram of Participant Recruitment, Allocation, and Analysis

Baseline demographic characteristics were collected prior to the intervention to describe the study sample and to assess comparability between groups. The age distribution of participants in the Balance Exercise and Otago Exercise Programme groups can be seen in Table 1**.**

Table 1. Age Distribution of Participants by Group

Age Group (years)	Balance Exercise n (%)	Otago Exercise n (%)
60–65	5 (50.0)	5 (50.0)
66–70	3 (30.0)	2 (20.0)
71–75	2 (20.0)	3 (30.0)
Total	10 (100)	10 (100)

In addition to age, participant characteristics were also described based on sex. The distribution of male and female participants in each intervention group is presented in Table 2.

Table 2. Sex Distribution of Participants by Group

Sex	Balance Exercise n (%)	Otago Exercise n (%)
Male	2 (20.0)	3 (30.0)
Female	8 (80.0)	7 (70.0)
Total	10 (100)	10 (100)

To describe changes in fall risk classification before and after the intervention, participants were categorized according to Timed Up and Go (TUG) Test cut-off values. The distribution of TUG-based fall risk categories in both groups before and after the intervention is shown in Table 3.

Table 3. TUG Test Risk Categories Before and After Intervention

TUG Category	Balance Pre	Balance Post	Otago Pre	Otago Post
< 20 s (Low risk)	2	8	5	8
20–30 s (Moderate risk)	8	2	5	2
Total	10	10	10	10

Within-group comparisons were conducted to examine changes in TUG Test scores following the four-week intervention. In addition, between-group comparisons were performed to assess differences in post-intervention outcomes. A summary of within-group changes and between-group comparisons is provided in Table 4.

Table 4. Within-Group Changes and Between-Group Comparison of TUG Scores

Group	Pre-test Mean (s)	Post-test Mean (s)	Mean Difference (s)	p-value
Balance Exercise	21.10	18.10	3.00	< 0.001
Otago Exercise Programme	19.60	17.20	2.40	< 0.001
Between-group (post-test)	–	–	0.90	0.316

Information regarding missing data and participant retention was also assessed. As indicated in Figure 1 and the tabulated results above, no missing data or participant drop-outs were observed during the study period.

Discussion

This study aimed to compare the effects of Balance Exercise and the Otago Exercise Programme on fall risk among older adults using the Timed Up and Go (TUG) Test as an indicator of functional mobility. The main findings indicate that both interventions were associated with statistically significant improvements in TUG performance after four weeks of training. However, no statistically significant difference was observed between the two exercise programs in post-intervention outcomes.

Participants in the Balance Exercise group demonstrated a significant reduction in TUG scores following the intervention. Balance-focused exercise programs are designed to enhance postural control through improvements in neuromuscular coordination, sensory integration, and lower-limb stabilization. These mechanisms are essential for maintaining balance during transitional movements such as standing, turning, and walking, which are key components assessed by the TUG Test.[19,20] Improved integration of visual, vestibular, and proprioceptive inputs may allow older adults to respond more effectively to postural perturbations, thereby reducing functional mobility limitations and fall risk.[21,22]

Similarly, participants who performed the Otago Exercise Programme showed significant improvements in TUG performance. The Otago programme combines progressive lower-limb strengthening, balance exercises, and functional walking activities, targeting multiple physiological systems involved in fall prevention. Strength gains in the lower extremities may contribute to improved sit-to-stand performance and gait stability, while balance training enhances postural responses during dynamic activities.[16,23,24] These findings are consistent with previous studies and meta-analyses demonstrating that the Otago Exercise Programme improves balance and functional mobility in community-dwelling older adults.[25,26]

The presence of statistically significant improvements in both groups supports the role of structured exercise interventions as effective strategies for improving functional mobility and reducing fall risk among older adults. Importantly, reporting mean differences alongside p-values provides clinically meaningful information regarding the magnitude of observed changes, particularly in studies with relatively small sample sizes.

Despite significant improvements within both groups, no statistically significant difference was identified between the Balance Exercise and Otago Exercise Programme in post-intervention TUG scores. This finding suggests that, when delivered with similar frequency and duration, both interventions provide comparable benefits in improving functional mobility among older adults. This result aligns with previous comparative studies reporting no clear superiority of one balance-oriented exercise program over another when core components such as balance training and lower-limb strengthening are shared.[26,27] From a clinical perspective, the absence of a significant between-group difference is relevant, as it allows physiotherapists flexibility in selecting exercise programs based on patient preferences, resource availability, and contextual feasibility rather than perceived differences in effectiveness.

The interpretation of these findings must take into account the quasi-experimental, non-randomized design of the study. Although baseline characteristics such as age and sex were comparable between groups, the lack of random allocation increases the risk of selection bias and limits internal validity. Consequently, the observed effects should be interpreted as comparative associations rather than causal relationships.

Additionally, the relatively small sample size may have limited the statistical power to detect subtle differences between interventions, increasing the possibility of a type II error. While both interventions demonstrated meaningful within-group improvements, a larger sample size may be required to identify smaller but potentially clinically relevant between-group differences.

Another limitation relates to the duration of the intervention and outcome assessment. The four-week intervention period and absence of follow-up measurements preclude conclusions regarding the long-term sustainability of the observed improvements. Moreover, fall risk was assessed using a functional mobility test rather than direct recording of fall events, which may not fully capture real-world fall incidence.

Despite these limitations, the findings of this study have important clinical implications. Both Balance Exercise and the Otago Exercise Programme appear to be feasible and effective options for improving functional mobility among community-dwelling older adults. Given the comparable outcomes, physiotherapists may tailor intervention selection to individual patient needs, preferences, and environmental contexts without compromising effectiveness.

Future studies should employ randomized controlled designs with larger sample sizes to strengthen causal inference. Longer intervention periods and follow-up assessments are needed to evaluate the long-term effects of these exercise programs and their impact on actual fall incidence. Additionally, future research may explore adherence, cost-effectiveness, and implementation strategies to optimize the delivery of fall prevention programs in diverse community settings.

Conclusion

This study demonstrated that both Balance Exercise and the Otago Exercise Programme were associated with significant improvements in functional mobility among community-dwelling older adults, as indicated by reductions in Timed Up and Go (TUG) Test scores following a four-week intervention period. However, no statistically significant difference was observed between the two exercise programs in post-intervention outcomes.

Given the quasi-experimental, non-randomized design of the study, the findings should be interpreted as comparative associations rather than causal effects. Nevertheless, the results provide evidence that both interventions may serve as effective and feasible exercise-based options for reducing fall risk in older adults within community settings.

From a clinical perspective, the absence of a significant difference between interventions suggests that physiotherapists may select either Balance Exercise or the Otago Exercise Programme based on individual patient characteristics, preferences, available resources, and contextual feasibility without compromising functional outcomes.

Future research employing randomized controlled designs, larger sample sizes, longer intervention durations, and follow-up assessments of actual fall incidence is warranted to strengthen the evidence base and to determine the long-term effectiveness of exercise-based fall prevention strategies in older populations.

Author Contribution

Deasy Virka Sari**:** Conceptualization; Methodology; Formal analysis; Writing—original draft; Supervision.
Virginia Eka Putri A. Baharudin**:** Methodology; Data curation; Writing—review & editing.
Ragil Aidil Fitriasari Addini: Data curation; Investigation; Writing—review & editing.

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Conflict of Interest Statement

The authors declare that there are no conflicts of interest associated with this study.

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This study received no external funding.

Ethics Statement

This study was conducted in accordance with the principles of the Declaration of Helsinki for research involving human participants. Ethical approval was obtained from the Research Ethics Committee of STIKES Telogorejo Semarang, Indonesia (Approval No. 023/IV/EC/P3M/STIKES/2025**).**

All participants received a complete explanation of the study objectives, procedures, potential risks, and benefits prior to enrollment. Written informed consent was obtained from all participants. Participant confidentiality and data anonymity were strictly maintained throughout the study.

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