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Quasi-Experimental Comparison of Resistance Band Exercise and Tandem Walking on Dynamic Balance in Community-Dwelling Older Adults

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Abstract

Background: Age-related decline in dynamic balance is a major contributor to falls and functional limitations among older adults. Exercise-based physiotherapy interventions, including resistance band exercise and tandem walking, are frequently implemented in community settings; however, evidence directly comparing their effectiveness remains limited.

Objective: To compare the effects of resistance band exercise and tandem walking on dynamic balance in community-dwelling older adults.

Methods: A quasi-experimental non-randomized comparative study was conducted among 30 community-dwelling older adults aged 60–75 years with impaired dynamic balance, defined as a Timed Up and Go Test (TUGT) score greater than 10 seconds. Participants were allocated to a resistance band exercise group (n = 15) and a tandem walking group (n = 15). Both interventions were administered twice weekly for six weeks under supervised conditions. Dynamic balance was assessed using the TUGT. Within-group changes were analyzed using paired t-tests, and between-group differences were examined using independent t-tests. Effect sizes were calculated using Cohen's d.

Results: Both intervention groups demonstrated significant improvements in dynamic balance after six weeks ($p < 0.001$). The resistance band exercise group showed a greater reduction in TUGT completion time compared with the tandem walking group, with a statistically significant between-group difference ($p = 0.045$; Cohen's $d = 0.62$).

Conclusion: Both resistance band exercise and tandem walking may be beneficial for improving dynamic balance in community-dwelling older adults. Resistance band exercise demonstrated a greater magnitude of improvement; however, findings should be interpreted cautiously due to the non-randomized design.

Keywords
Postural Balance; Elastic Band Exercise; Gait Training; Aged; Timed Up and Go Test

Introduction

Population aging is a global demographic trend accompanied by progressive physiological changes affecting multiple body systems, particularly the neuromuscular, sensory, and musculoskeletal systems. These age-related changes often result in a decline in balance control, mobility, and functional independence among older adults. Dynamic balance, defined as the ability to maintain postural stability during movement and transitional activities, is especially susceptible to deterioration with advancing age and is a key determinant of fall risk.[1]

Falls constitute a major public health problem in older populations worldwide. It is estimated that approximately 28–35% of adults aged over 65 years experience at least one fall annually, with the incidence exceeding 40% among those aged over 75 years.[2] Falls are associated with substantial physical, psychological, and socioeconomic consequences, including fractures, fear of falling, activity restriction, loss of independence, and increased healthcare utilization.[3] In low- and middle-income countries such as Indonesia, the burden of fall-related morbidity among community-dwelling older adults continues to increase alongside demographic aging.[4]

Impairment in dynamic balance among older adults is multifactorial. Age-related reductions in lower-limb muscle strength, proprioceptive sensitivity, reaction time, and central nervous system integration play a critical role in compromised postural control.[5] Degenerative changes in the visual and vestibular systems further limit the ability to respond to postural perturbations during functional movements such as walking, turning, and sit-to-stand transitions.[6] These combined physiological alterations increase instability during daily activities and substantially elevate fall risk.

Exercise-based physiotherapy interventions are widely recommended to improve balance and reduce fall risk in older adults. Current evidence supports multicomponent exercise programs incorporating muscle strengthening, balance training, and functional mobility exercises as effective strategies for fall prevention.[7] Resistance-based exercise using elastic bands has gained increasing attention in geriatric rehabilitation due to its safety, low cost, and adaptability to various functional levels. Resistance band exercise enhances lower-limb muscle strength, neuromuscular activation, and proprioceptive feedback, which are essential components of dynamic balance control.[8] Previous studies have demonstrated that elastic resistance training is associated with significant improvements in functional mobility and reductions in Timed Up and Go Test (TUGT) completion time among older adults.[9]

In addition to resistance training, task-specific balance exercises such as tandem walking are commonly prescribed in clinical and community settings. Tandem walking involves heel-to-toe gait along a narrow base of support, thereby increasing postural demands and challenging balance strategies during locomotion.[10] This exercise requires precise coordination, sensory integration, and attentional control, and has been shown to improve dynamic balance and gait stability in older adults.[11] Due to its simplicity and minimal equipment requirements, tandem walking is particularly suitable for implementation in community-based exercise programs.

Despite growing evidence supporting the independent effectiveness of resistance band exercise and tandem walking, direct comparative studies between these two interventions remain limited, particularly among community-dwelling older adults.[12] Most previous studies have evaluated each intervention separately, limiting conclusions regarding their relative effectiveness when applied under comparable conditions.[13] Moreover, randomized controlled trials may not always be feasible in real-world community environments due to logistical and ethical constraints, highlighting the relevance of quasi-experimental designs for applied physiotherapy research.[14]

Therefore, this study aimed to compare the effects of resistance band exercise and tandem walking on dynamic balance in community-dwelling older adults using a quasi-experimental non-randomized comparative design. It was hypothesized that both interventions would be associated with improvements in dynamic balance, with resistance band exercise producing a greater magnitude of improvement due to its combined effects on muscle strength and neuromuscular control.

Methods

Study Design and Setting

This study employed a quasi-experimental non-randomized comparative design with a two-group pretest–posttest approach. The study was conducted between April and June 2025 at Gereja Injili di Tanah Jawa (GITJ) Karanglegi, Central Java, Indonesia, a community-based setting where older adults regularly participate in organized social and health-related activities. A quasi-experimental design was selected due to practical and ethical constraints that limited the feasibility of randomization in a real-world community environment.

Participants

The study population consisted of community-dwelling older adults aged 60–75 years who were actively involved in community activities at the study site. Participant recruitment was conducted using a total sampling approach. Of 35 older adults screened for eligibility, 30 met the inclusion criteria and were enrolled in the study.

Inclusion criteria were: (1) age between 60 and 75 years; (2) impaired dynamic balance defined as a Timed Up and Go Test (TUGT) score greater than 10 seconds; (3) ability to follow verbal instructions; and (4) willingness to participate as indicated by written informed consent. Exclusion criteria included a history of lower-limb fracture or joint injury within the previous three months, unstable cardiovascular conditions, neurological disorders affecting mobility, or other medical conditions that contraindicated participation in structured exercise.

Group Allocation

Eligible participants were allocated into two intervention groups: a resistance band exercise group (n = 15) and a tandem walking group (n = 15). Group allocation was performed using a non-random, convenience-based approach based on participant availability and scheduling considerations. Randomization and blinding were not applied, which may introduce selection bias and was therefore acknowledged as a methodological limitation.

Intervention Protocols

Both intervention programs were delivered over a six-week period with a frequency of two supervised sessions per week. Each session lasted approximately 30 minutes and was supervised by a physiotherapy researcher to ensure standardized instruction and participant safety. Participants in the resistance band exercise group performed structured lower-limb exercises using elastic resistance bands targeting major muscle groups involved in postural control and mobility. The exercise program included leg press, leg curl, hip abduction, ankle plantarflexion–dorsiflexion, and squat movements. Each exercise was performed for 2–3 sets of 8–12 repetitions with brief rest intervals between sets. Exercise intensity was progressively adjusted according to individual tolerance. The intervention protocol was adapted from previously published resistance training programs for older adults.

Participants in the tandem walking group performed heel-to-toe walking along a straight line over a distance of approximately 3–6 meters. Each session consisted of multiple walking trials with rest periods as needed. Participants were instructed to maintain an upright posture and forward gaze while performing the exercise. This protocol was based on established tandem walking procedures used in balance training among older adults.

Outcome Measure

Dynamic balance was assessed using the Timed Up and Go Test (TUGT). The TUGT measures the time required for an individual to rise from a seated position, walk three meters, turn around, return to the chair, and sit down. The TUGT has demonstrated high reliability and validity in older adult populations, with reported intraclass correlation coefficients exceeding 0.90. Lower TUGT scores indicate better dynamic balance and functional mobility.

Data Collection Procedure

Baseline TUGT measurements were obtained prior to the initiation of the intervention. Post-intervention measurements were collected after completion of the six-week exercise program using the same standardized testing procedure. All assessments were conducted by the same examiner to minimize inter-rater variability and measurement bias.

Statistical Analysis

Data analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 25.0. Descriptive statistics were used to summarize participant characteristics. Data normality was assessed prior to inferential analysis. Within-group differences between pretest and posttest TUGT scores were analyzed using paired t-tests. Between-group differences in post-intervention TUGT scores were examined using independent t-tests. Effect sizes were calculated using Cohen's d to estimate the magnitude of intervention effects. Statistical significance was set at $\alpha = 0.05$.

Ethical Considerations

This study was approved by the Ethics Committee of STIKES Telogorejo Semarang. Written informed consent was obtained from all participants prior to data collection. Participant confidentiality and safety were maintained throughout the study in accordance with ethical standards for research involving human subjects.

Results

Participant Flow

A total of 35 community-dwelling older adults were screened for eligibility. Five individuals were excluded because they did not meet the predefined inclusion criteria. Thirty participants were enrolled and allocated into two intervention groups: the resistance band exercise group (n = 15) and the tandem walking group (n = 15). All participants completed the six-week intervention program and were included in the final analysis. Participant recruitment, eligibility assessment, group allocation, intervention implementation, and inclusion in the final analysis are summarized in the study flow diagram and can be seen in Figure 1.

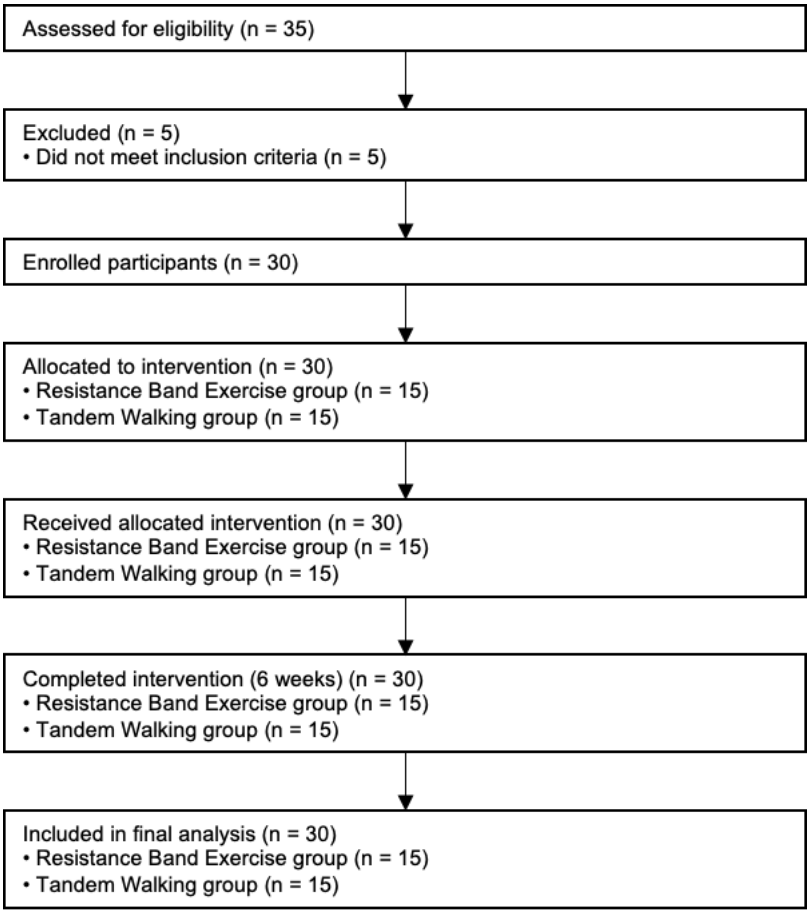

Figure 1. Flow diagram of participant recruitment, allocation, intervention, and analysis

Baseline Characteristics

Baseline demographic and clinical characteristics of participants are presented in Table 1**.** The two groups showed comparable distributions in age, sex, body mass index (BMI), history of chronic disease, and baseline Timed Up and Go Test (TUGT) scores. No clinically relevant baseline imbalances were observed between groups.

Table 1. Baseline Characteristics of Participants

Characteristic	Resistance Band Exercise (n = 15)	Tandem Walking (n = 15)
Age (years), mean ± SD	70.2 ± 4.1	65.8 ± 5.0
Sex, n (%)		
• Male	6 (40.0)	4 (26.7)
• Female	9 (60.0)	11 (73.3)
Body Mass Index, n (%)		
• Underweight	2 (13.3)	1 (6.7)
• Normal	6 (40.0)	5 (33.3)
• Overweight/Obese	7 (46.7)	9 (60.0)
History of chronic disease, n (%)	8 (53.3)	9 (60.0)
Baseline TUGT (seconds), mean ± SD	13.21 ± 1.54	13.08 ± 1.62

Notes: Values are presented as mean ± standard deviation or number (percentage).
Abbreviations: SD = standard deviation; TUGT = Timed Up and Go Test.

Within-Group Effects on Dynamic Balance

Within-group analysis demonstrated statistically significant improvements in dynamic balance following six weeks of intervention in both groups (Table 2**).** In the resistance band exercise group, mean TUGT time decreased from 13.21 ± 1.54 seconds at baseline to 10.77 ± 1.31 seconds post-intervention, resulting in a mean reduction of 2.44 seconds ($p < 0.001$). Similarly, the tandem walking group showed a significant reduction in TUGT time, from 13.08 ± 1.62 seconds at baseline to 11.65 ± 1.49 seconds after the intervention, with a mean reduction of 1.43 seconds ($p < 0.001$).

Table 2. Within-Group Comparison of TUGT Scores

Group	Measurement	Mean ± SD (seconds)	Mean Difference	p-value
Resistance Band Exercise	Pretest	13.21 ± 1.54		
	Posttest	10.77 ± 1.31	−2.44	< 0.001
Tandem Walking	Pretest	13.08 ± 1.62		
	Posttest	11.65 ± 1.49	−1.43	< 0.001

Notes: p-values obtained from paired t-tests.

Between-Group Comparison of Intervention Effects

Between-group analysis of post-intervention outcomes revealed a statistically significant difference in dynamic balance favoring the resistance band exercise group (Table 3). The mean posttest TUGT score was 10.77 ± 1.31 seconds in the resistance band exercise group and 11.65 ± 1.49 seconds in the tandem walking group. The between-group mean difference was −0.88 seconds, with a 95% confidence interval ranging from −1.72 to −0.04 seconds. The corresponding effect size was small to moderate (Cohen's d = 0.62), and the difference reached statistical significance (p = 0.045).

Table 3. Between-Group Comparison of Post-Intervention TUGT Scores

Outcome	Resistance Band Exercise (n = 15)	Tandem Walking (n = 15)	Mean Difference (95% CI)	Cohen's d	p-value
Posttest TUGT (seconds), mean ± SD	10.77 ± 1.31	11.65 ± 1.49	−0.88 (−1.72 to −0.04)	0.62	0.045

Summary of Results

Both resistance band exercise and tandem walking were associated with significant improvements in dynamic balance among community-dwelling older adults after six weeks of intervention. A statistically significant between-group difference was observed, indicating a greater magnitude of improvement in the resistance band exercise group compared with the tandem walking group.

Discussion

This study compared the effects of resistance band exercise and tandem walking on dynamic balance among community-dwelling older adults using a quasi-experimental non-randomized design. The main findings indicate that both interventions were associated with significant improvements in dynamic balance after six weeks, as reflected by reductions in Timed Up and Go Test (TUGT) completion time. Importantly, a statistically significant between-group difference was observed, favoring resistance band exercise, with a small-to-moderate effect size (Cohen's d = 0.62).

The magnitude of the observed effect provides clinically relevant insight beyond statistical significance alone. An effect size of 0.62 suggests a meaningful functional improvement, as even modest reductions in TUGT time have been associated with enhanced mobility and reduced fall risk in older adults. From a clinical perspective, improvements of approximately 1 second or more in TUGT performance may translate into better functional independence during daily activities such as walking, turning, and sit-to-stand transitions. Therefore, the observed between-group difference is likely to be relevant in community-based physiotherapy practice.[15]

The greater improvement observed in the resistance band exercise group may be explained by neuromuscular and musculoskeletal adaptations induced by progressive resistance training. Resistance band exercises target key lower-limb muscle groups involved in postural control, including the quadriceps, hamstrings, gluteal muscles, and ankle stabilizers.[16] Strengthening these muscle groups enhances the ability to control the center of mass during dynamic tasks and improves force generation and movement efficiency. In addition, resistance-based exercise stimulates neuromuscular activation and proprioceptive input, which are critical components of dynamic balance control in older adults.[11,17]

In contrast, tandem walking primarily challenges balance strategies by narrowing the base of support during gait and increasing reliance on sensory integration and coordination. While this task-specific training effectively improves postural control, it does not directly increase muscle strength. The smaller magnitude of improvement observed in the tandem walking group may therefore reflect the absence of a direct strengthening component. Nevertheless, the significant within-group improvement indicates that tandem walking remains a valuable intervention, particularly for older adults with limited access to equipment or those who may not tolerate resistance-based exercise.[18]

The findings of this study align with previous research demonstrating that resistance-based exercise programs produce small-to-moderate improvements in functional mobility and balance outcomes among older adults. Similarly, prior studies have reported beneficial effects of gait-based balance exercises, including tandem walking, on dynamic balance and fall-related outcomes.[19] However, most previous investigations have evaluated these interventions independently. The present study contributes to the literature by providing direct comparative evidence under similar conditions in a community-dwelling population.[20]

From a practical standpoint, the results have important implications for community-based physiotherapy and fall-prevention programs. Both resistance band exercise and tandem walking are low-cost, feasible, and easily implemented in non-clinical settings such as community centers or religious institutions.[21] Resistance band exercise may be particularly appropriate for older adults with pronounced lower-limb weakness, whereas tandem walking may serve as an accessible alternative for individuals with limited resources or as a complementary balance-focused intervention. Tailoring intervention selection based on individual functional capacity and contextual constraints may optimize outcomes in real-world settings.[12]

Several methodological limitations should be considered when interpreting the findings. First, the non-randomized design introduces the potential for selection bias and limits internal validity. Second, the relatively small sample size may have reduced statistical power and contributed to wider confidence intervals, indicating variability in effect estimates. Third, the absence of blinding may have influenced participant performance or outcome assessment, despite standardized procedures. Additionally, potential confounding variables were not formally adjusted for in the analysis, which may have affected the observed between-group differences.

Despite these limitations, the study provides meaningful evidence regarding the comparative effectiveness of two commonly used physiotherapy interventions in a community-dwelling older adult population. The consistency of within-group improvements and the presence of a clinically relevant between-group effect support the role of structured exercise interventions in improving dynamic

balance at the community level. Future studies employing randomized controlled designs, larger sample sizes, longer follow-up periods, and multiple balance outcome measures are warranted to confirm these findings and to further explore the mechanisms underlying intervention effects.

Conclusion

This study demonstrated that both resistance band exercise and tandem walking were associated with significant improvements in dynamic balance among community-dwelling older adults following a six-week intervention period. Improvements were reflected by reduced Timed Up and Go Test (TUGT) completion times in both intervention groups, indicating enhanced functional mobility.

A statistically significant between-group difference was observed, with resistance band exercise showing a greater magnitude of improvement compared with tandem walking. The observed effect size suggests that resistance band exercise may offer additional functional benefits, potentially due to its combined influence on lower-limb muscle strength and neuromuscular control. However, given the quasi-experimental non-randomized design, these findings should be interpreted with caution, and causal inferences cannot be drawn.

From a practical perspective, both interventions represent feasible, low-cost, and accessible physiotherapy strategies for community-based older adult populations. Resistance band exercise may be particularly appropriate for individuals with lower-limb weakness, while tandem walking may serve as an alternative or complementary balance-focused intervention in settings with limited equipment availability. The adaptability of these exercises supports their integration into community-based fall prevention and functional mobility programs.

Future research should employ randomized controlled designs with larger sample sizes, longer follow-up periods, and multiple balance outcome measures to confirm these findings and to better understand the long-term clinical impact of these interventions. Such studies may help inform evidence-based guidelines for optimizing balance training strategies in community-dwelling older adults.

Author Contribution

Yessa Kristia Dhikta: Conceptualization, Methodology, Data curation, Formal analysis, Writing—original draft.
Laksmita Dewi Adzillina: Methodology, Writing—review & editing.
Mianti Nurrizky Sutejo: Conceptualization, Writing—review & editing, Supervision.
Ragil Aidil Fitriani Addini: Formal analysis.

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Conflict of Interest Statement

The authors declare no conflict of interest.

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Ethics Statement

This study was approved by the Ethics Committee of STIKES Telogorejo Semarang. Written informed consent was obtained from all participants prior to data collection. All procedures were conducted in accordance with ethical standards for research involving human participants.

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