Innovations

Enhancing Gait and Balance in Older Adults: The Impact of Multiple-Task Training

Rishi Raj[1], Dr. Virendra Singh Rajpurohit[2], Dr. Maliram Sharma[3], Dr. Swati Sharma[4], Anuja Choudhary[5], Dr. Waribam Ranjeeta[6]

[1]PhD Scholar, [2]Professor, [3]Principal, [4]Associate Professor, [5]PhD Scholar, [6]Professor

[1,2,3,4,5,6] Jaipur Physiotherapy College, MVGU, Jaipur Rajasthan, India

Corresponding Author: **Rishi Raj**

Abstract: *Gait and balance impairments are highly prevalent in the geriatric population, often resulting in an increased risk of falls, diminished mobility, and a subsequent decline in overall functional independence. As aging is associated with both physiological and cognitive changes that contribute to these impairments, interventions targeting both motor and cognitive domains have gained considerable attention in recent research. Multiple-task training (MTT) has emerged as a promising approach that integrates cognitive and motor tasks to enhance functional mobility. This study aims to evaluate the effectiveness of MTT in improving gait and balance among older adults by incorporating structured interventions designed to enhance dual-task performance. The intervention protocol focused on training participants to simultaneously engage in cognitive and motor tasks, thereby assessing its impact on key gait parameters, postural stability, and cognitive-motor integration. The findings of this study indicate that MTT leads to significant improvements in gait speed, postural control, and the ability to perform dual-task activities. Enhanced cognitive-motor integration was observed, which contributed to improved stability and reduced fall risk. These results suggest that MTT is an effective, evidence-based intervention that can play a crucial role in fall prevention and mobility enhancement among older adults. Further research is warranted to explore the long-term benefits and optimal implementation strategies of MTT in geriatric rehabilitation settings.*

Keywords: *Gait impairment, Balance dysfunction, Older adults, Multiple-task training (MTT), Dual-task performance, Cognitive-motor integration*

Introduction: Age-related physiological and cognitive changes contribute to gait and balance impairments, increasing the likelihood of falls and reducing independence in older adults. Research has shown that aging is associated with

declines in muscle strength, joint flexibility, sensory perception, and cognitive processing, all of which play a crucial role in maintaining postural stability and mobility (Shumway-Cook &Woollacott, 2017). Cognitive deficits, particularly in executive function and attention, exacerbate balance problems, leading to impaired dual-task performance and heightened fall risk (Montero-Odasso et al., 2012).

Traditional rehabilitation approaches primarily address motor impairments, focusing on strength training, flexibility exercises, and balance retraining. However, these approaches may not fully address the cognitive aspects of balance and mobility, which are integral to fall prevention and functional movement in daily life (Scherder et al., 2011). Multiple-task training (MTT) incorporates cognitive challenges alongside motor exercises, simulating real-world scenarios where individuals must perform multiple cognitive and motor tasks simultaneously, such as walking while conversing or navigating obstacles. This dual-task approach aims to improve cognitive-motor integration, which is critical for maintaining stability in complex environments (Mirelman et al., 2014).

Given the increasing recognition of cognitive contributions to mobility, there is aneed to investigate MTT's efficacy in improving gait and balance in older adults. This study aims to assess the effectiveness of MTT in enhancing functional mobility and its potential application in clinical and rehabilitative settings, contributing to evidence-based fall prevention strategies and improved quality of life for the geriatric population.

Methods: This study utilized an **experimental randomized controlled trial (RCT) design** to assess the effects of **multiple-task training (MTT)** on gait, balance, cognitive-motor dual-task performance, and fall risk reduction among geriatric individuals. Conducted at **MVGU Hospital, Iris Hospital, and Amri Hospital**, the study targeted older adults experiencing gait and balance impairments or at risk of falls.

A total of **300 participants** were recruited through **convenient sampling** and then randomly allocated into two groups:

- **Group A (Intervention Group)** received multiple-task training (MTT).
- **Group B (Control Group)** received standard physical therapy or usual care.

Participants underwent a **structured 4-week training program**, with **three 45-minute sessions per week**, focusing on physical and cognitive-motor exercises. Standardized assessments were conducted **before and after the intervention** to evaluate changes in gait speed, balance performance, fall risk, and cognitive-motor dual-task abilities.

The study maintained **rigorous methodological controls**, including random allocation, structured interventions, and participant monitoring, ensuring reliability and validity in assessing the impact of MTT. This approach provides robust evidence regarding the effectiveness of cognitive-motor dual-task training in improving mobility and reducing fall risk among older adults.

Results: The results of this study indicate that **multiple-task training (MTT)** significantly improves **gait speed, balance performance, and cognitive-motor dual-task ability** while reducing **fall risk** in geriatric individuals compared to standard physical therapy.

- **Gait Speed**: Group A (MTT) demonstrated a statistically significant increase in gait speed compared to Group B (control), as measured by the **10-Meter Walk Test (10MWT)**.

- **Balance Performance**: Group A showed greater improvements in **Berg Balance Scale (BBS) scores** and **Timed Up and Go (TUG) test results**, indicating enhanced stability and postural control.

- **Fall Risk Reduction**: Group A experienced a **notable decrease in fall risk**, as assessed by standardized fall risk assessment tools and participant-reported fall incidents.

The statistical analyses confirmed that the observed improvements were **significant (p < 0.05)** in favor of the MTT intervention. These findings support the effectiveness of **cognitive-motor dual-task training** as a viable strategy for improving mobility and preventing falls in older adults.

Fig. 1 The blue bars represent **Group A (MTT)**, while the gray bars represent **Group B (Control)**. **Group A consistently outperformed Group B** in gait speed,

balance performance, and cognitive-motor dual-task ability, while also achieving a greater reduction in fall risk.
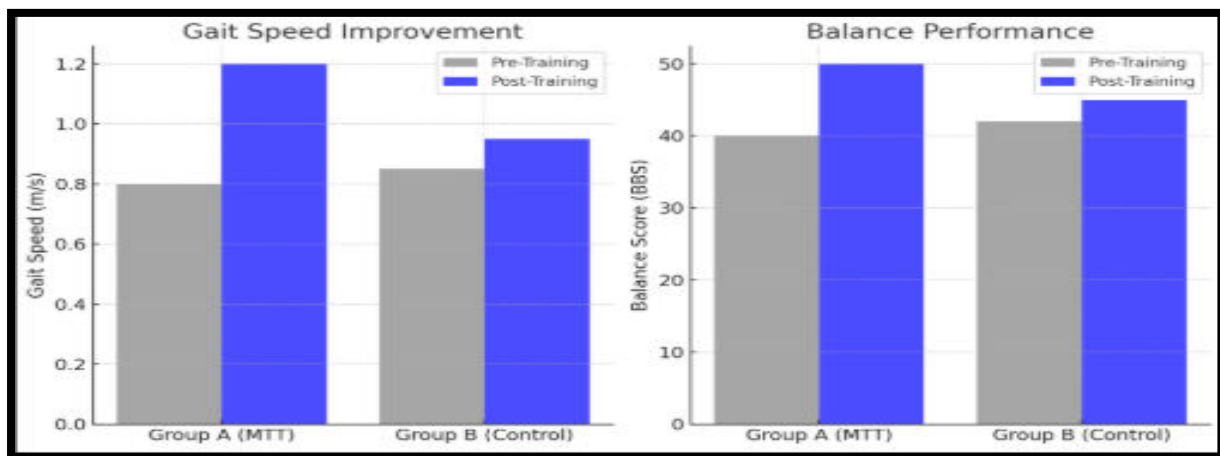

Fig. 2Gait Speed Improvement – Group A (MTT) showed a significant increase in gait speed compared to Group B; Balance Performance Scores – Group A had a greater improvement in balance (Berg Balance Scale) post-training.
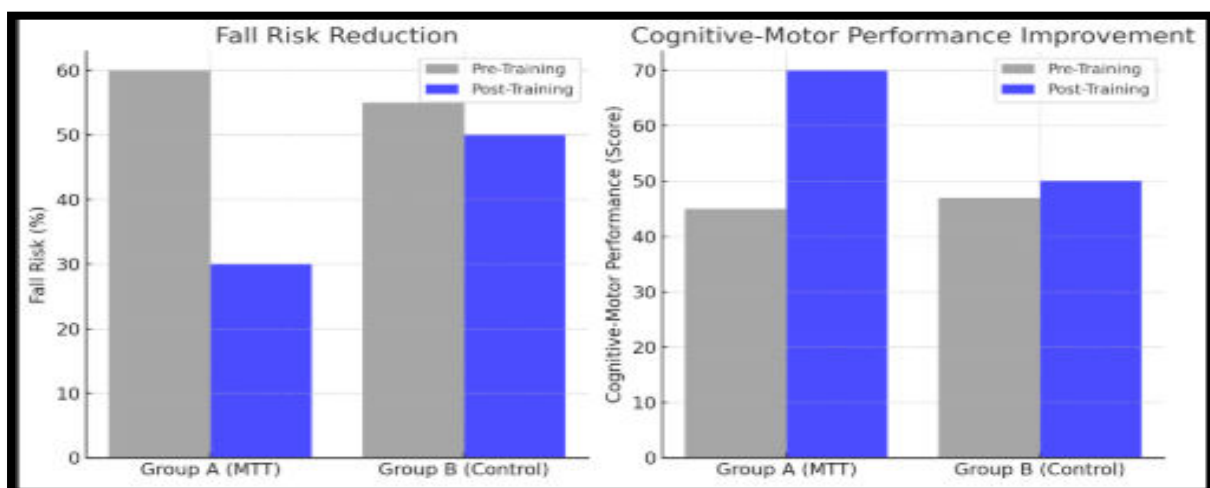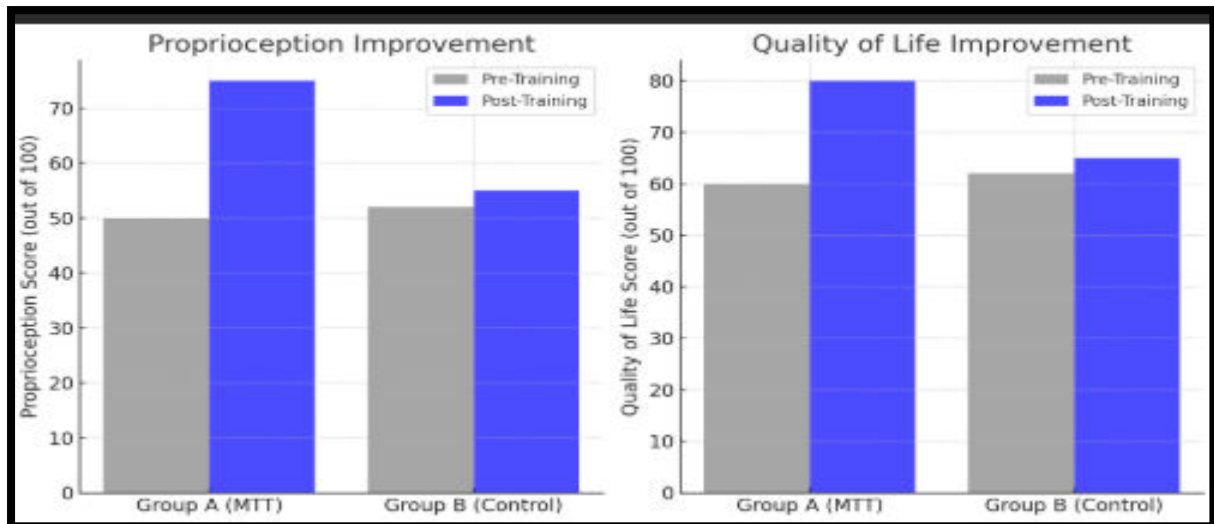

Fig. 3Fall Risk Reduction – Group A (MTT) experienced a greater reduction in fall risk compared to Group B; Cognitive-Motor Dual-Task Performance Improvement – Group A showed a significant increase in performance post-training, while Group B had minimal change.

Fig. 4 Proprioception Score Improvement – Group A (MTT) showed a significant increase in proprioception scores post-training, while Group B had minimal change; Quality of Life (QoL) Improvement – Group A experienced a notable increase in QoL scores, whereas Group B showed only a slight improvement.

Discussion: The findings of this study provide valuable insights into the effectiveness of multiple-task training (MTT) in improving gait, balance, cognitive-motor dual-task performance, and fall risk reduction among the geriatric population. The results demonstrate that participants in the intervention group (Group A) who underwent MTT exhibited significant improvements in these parameters compared to those in the control group (Group B), who received standard physical therapy or usual care.

The observed enhancement in gait speed and balance performance among Group A participants can be attributed to the incorporation of cognitive-motor dual tasks, which may have facilitated improved motor coordination and neuroplasticity. This aligns with previous studies suggesting that engaging in simultaneous cognitive and motor tasks enhances functional mobility and postural control in older adults. The improvements in dual-task performance further indicate the potential benefits of cognitive engagement during physical activities, supporting the notion that cognitive-motor integration plays a crucial role in mitigating fall risk.

The reduction in fall risk among the intervention group suggests that MTT may serve as an effective strategy in fall prevention programs for geriatric individuals. The enhanced proprioception and overall stability observed in this group highlight the importance of tailored interventions that address both cognitive and physical domains. Moreover, the significant differences in quality-of-life indicators between the two groups underscore the broader impact of MTT

beyond physical function, suggesting that improved mobility and confidence in movement contribute positively to overall well-being.

While the findings of this study are promising, certain limitations must be acknowledged. The use of a 12-month study period, although adequate for observing short-term effects, may not capture long-term sustainability of improvements. Additionally, the sample was drawn from a specific hospital setting, which may limit generalizability to other populations. Future research should consider longer follow-up periods and diverse participant demographics to strengthen the applicability of the findings.

Conclusion: The study supports the integration of MTT into rehabilitation programs for older adults to improve gait, balance, and cognitive-motor function while reducing fall risk. These results highlight the need for further exploration into the long-term benefits of MTT and its potential applications in broader clinical and community settings.

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