Impact of Combined Motor and Cognitive Training on Balance in Older Adults: Assessing the Efficacy of Dual-Task Training in Reducing Fall Risk and Enhancing Stability

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Abstract

Objective: This study assessed the impact of combined motor and cognitive training on balance, fall risk, and functional mobility in older adults.

Methods: A total of 60 participants aged 65 and older were randomly assigned to one of three groups: combined motor and cognitive training, motor training only, or cognitive training only. Each group underwent their respective training for 60 minutes, three times a week over 12 weeks. Balance was assessed using the Berg Balance Scale (BBS), fall risk was measured by the Timed Up and Go Test (TUG), and functional mobility was evaluated with the Dynamic Gait Index (DGI).

Results: The combined training group demonstrated significant improvements in balance (BBS: baseline 42.5, post-intervention 47.8, p=0.035), reduced fall risk (TUG: baseline 15.3 seconds, post-intervention 12.8 seconds, p=0.042), and enhanced functional mobility (DGI: baseline 18.6, post-intervention 22.3, p=0.029) compared to the motor and cognitive training-only groups. The motor training group showed moderate improvements, while the cognitive training group exhibited minimal changes.

Conclusion: Combined motor and cognitive training effectively improves balance, reduces fall risk, and enhances functional mobility in older adults. This integrated approach offers a more comprehensive strategy for managing balance impairments compared to single-task training.

Keywords: Combined Training, Balance, Fall Risk, Functional Mobility, Older Adults, Motor Training, Cognitive Training

Introduction

Balance impairment and increased fall risk are significant concerns in older adults, contributing to decreased mobility, loss of independence, and a decline in overall quality of life (Hill et al., 2015). Falls are the leading cause of injury-related deaths among the elderly, and effective interventions are crucial for mitigating these risks (Stevens et al., 2013).

Motor and Cognitive Training: Motor training focuses on improving physical performance through exercises that enhance strength, coordination, and flexibility (Schoene et al., 2014). Cognitive training, on the other hand, aims to improve mental processes such as attention, memory, and executive function (Bherer et al., 2013). Recent research suggests that combining motor and cognitive tasks—dual-task training—may offer synergistic benefits, particularly in improving balance and reducing fall risk (Li et al., 2020).

Theoretical Framework: The effectiveness of dual-task training is grounded in the concept of cognitive-motor interference, where performing cognitive and motor tasks simultaneously can reveal and address underlying impairments in balance and stability (Schmidt & Lee, 2018). This training approach is thought to enhance both cognitive and physical functioning, potentially leading to improved balance control (Ali et al., 2022).

Research Objectives: This study aims to assess the impact of combined motor and cognitive training on balance in older adults with musculoskeletal and neurological impairments. By comparing the outcomes of a

dual-task training program with those of a standard intervention, we seek to determine whether integrating cognitive challenges with physical exercises offers superior benefits in reducing fall risk and improving balance.

Hypothesis: We hypothesize that older adults who engage in combined motor and cognitive training will exhibit greater improvements in balance and reduced fall risk compared to those receiving standard motor or cognitive interventions alone.

Literature Review

Balance Impairment in Older Adults: Balance impairment in older adults is a major concern, as it significantly increases the risk of falls, which can lead to severe injuries and reduced quality of life (Lesinski et al., 2015). Factors contributing to balance problems include age-related decline in sensory and motor functions, musculoskeletal disorders, and neurological conditions (Gillespie et al., 2012). The importance of effective interventions to address these issues is underscored by the high prevalence of falls in this population (World Health Organization, 2020).

Motor Training and Balance: Motor training, which focuses on improving physical abilities such as strength, flexibility, and coordination, has been shown to enhance balance in older adults. Studies have demonstrated that motor training programs, including exercises like strength training and balance-focused activities, can improve static and dynamic balance, thus reducing the risk of falls (Shafizadeh et al., 2020; Sherrington et al., 2017). For example, a meta-analysis by Sherrington et al. (2017) found that balance training significantly reduces fall rates in older adults by improving balance performance and lower limb strength.

Cognitive Training and Balance: Cognitive training involves exercises designed to improve mental processes such as attention, memory, and executive function. Recent research suggests that cognitive training can also positively impact balance. For instance, Bherer et al. (2013) reported that cognitive interventions could enhance cognitive functions, which, in turn, might improve balance control. Cognitive training has been proposed to reduce the risk of falls by improving cognitive functions that support motor performance and balance (Meng et al., 2022).

Dual-Task Training: Integrating Motor and Cognitive Exercises: Dual-task training combines motor and cognitive exercises to simultaneously challenge physical and mental capacities. This approach is based on the premise that performing two tasks at once can improve overall functional performance and balance by addressing cognitive-motor interference (Schmidt & Lee, 2018). Studies have shown that dual-task training can lead to significant improvements in balance and gait performance in older adults (Li et al., 2020; Ali et al., 2022).

For example, a study by Li et al. (2020) found that dual-task training improved balance and mobility in older adults with mild cognitive impairment, suggesting that this approach can effectively address both cognitive and physical impairments. Similarly, Ali et al. (2022) reported that dual-task training resulted in better balance and functional mobility compared to single-task interventions.

Gaps in Current Research: Despite promising results, several gaps remain in the research on combined motor and cognitive training. Many studies have focused on specific training modalities without exploring how these interventions interact in a combined format. Additionally, there is limited research on the long-term effects of dual-task training and its effectiveness across diverse populations with various musculoskeletal and neurological impairments.

The literature indicates that both motor and cognitive training have beneficial effects on balance in older adults. Combining these approaches through dual-task training may offer enhanced benefits by addressing both cognitive and physical aspects of balance. However, further research is needed to explore the optimal design of dual-task interventions, their long-term impact, and their effectiveness across different populations.

Methodology

Study Design: This study employed a quantitative, randomized controlled trial design to assess the impact of combined motor and cognitive training on balance in older adults. The study aimed to determine whether dual-task training, integrating motor and cognitive exercises, is more effective in improving balance and reducing fall risk compared to single-task interventions.

Participants

A total of 60 older adults aged 65 years and above participated in the study. Participants were recruited from a tertiary hospital.

Inclusion criteria:

1. age 65 or older
2. ability to provide informed consent
3. experiencing some level of balance impairment or fall risk.

Exclusion criteria:

1. severe cognitive impairment
2. uncontrolled medical conditions
3. recent major surgery or acute illness.

Participants were randomly assigned to one of three groups

1. combined motor and cognitive training (n=20)
2. motor training only (n=20), or
3. cognitive training only (n=20). Randomization was achieved using a computer-generated random number sequence.
4.

Intervention

- **Combined Motor and Cognitive Training Group:** This group received 60 minutes of combined motor and cognitive training three times per week for 12 weeks. The motor component included exercises such as balance tasks, strength training, and coordination drills. The cognitive component involved activities designed to enhance memory, attention, and executive function, such as memory games and problem-solving tasks.
- **Motor Training Group:** Participants in this group underwent 60 minutes of motor training three times per week for 12 weeks. The training focused on physical exercises aimed at improving balance, strength, and flexibility.
- **Cognitive Training Group:** This group engaged in 60 minutes of cognitive training three times per week for 12 weeks. The training included activities designed to improve cognitive functions such as memory, attention, and executive function, without a physical component.

Outcome Measures

- **Balance Assessment:** Balance was assessed using the Berg Balance Scale (BBS), a 14-item scale that evaluates static and dynamic balance (Berg et al., 1992). Scores range from 0 to 56, with higher scores indicating better balance.
- **Fall Risk Assessment:** Fall risk was evaluated using the Timed Up and Go Test (TUG), which measures the time taken for a participant to stand up from a chair, walk 3 meters, turn around, walk back, and sit down (Podsiadlo & Richardson, 1991). A higher score indicates a greater risk of falling.
- **Functional Mobility:** Functional mobility was assessed using the Dynamic Gait Index (DGI), which evaluates the ability to perform various walking tasks (Shumway-Cook et al., 1997). Scores range from 0 to 24, with higher scores reflecting better mobility.

Data Collection: Data were collected at baseline, midway through the intervention (6 weeks), and at the end of the 12-week intervention period. Assessments were conducted by trained research assistants who were blinded to group allocation.

Data Analysis: Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 26.0. Descriptive statistics were used to summarize participant characteristics. Between-group differences in balance and fall risk were analyzed using Analysis of Covariance (ANCOVA), adjusting for baseline scores. Post-hoc comparisons were performed using Tukey's HSD test. A p-value of <0.05 was considered statistically significant.

Ethical Considerations: The study was approved by the ethics committee. Informed consent was obtained from all participants prior to the commencement of the study. Confidentiality of participant data was maintained throughout the study.

Findings

Participant Characteristics: A total of 60 older adults were enrolled in the study, with 20 participants in each group. Table 1 presents the baseline characteristics of participants across the three groups.

Table 1: Baseline Characteristics of Participants

Characteristic	Combined Motor & Cognitive Training (n=20)	Motor Training (n=20)	Cognitive Training (n=20)	Total (n=60)
Age (years)	72.5 (6.3)	73.2 (6.1)	72.8 (6.5)	72.8 (6.3)
Gender (Male/Female)	8/12	9/11	10/10	27/33
BMI (kg/m²)	26.4 (3.2)	26.7 (3.1)	26.5 (3.3)	26.5 (3.2)
Fall History (Yes/No)	12/8	11/9	13/7	36/24

Effects on Balance: Balance improvements were measured using the Berg Balance Scale (BBS). Table 2 shows the mean scores for balance at baseline, midway (6 weeks), and post-intervention (12 weeks) for each group.

Table 2: Berg Balance Scale Scores

Time Point	Combined Motor & Cognitive Training (n=20)	Motor Training (n=20)	Cognitive Training (n=20)	p-value
Baseline	42.5 (5.1)	42.8 (5.3)	43.1 (5.0)	-
Midway (6 weeks)	45.2 (4.8)	44.1 (5.0)	43.5 (5.1)	0.215
Post-Intervention (12 weeks)	47.8 (4.5)	45.9 (4.6)	44.2 (5.0)	0.035

Effect on Fall Risk: Fall risk was assessed using the Timed Up and Go Test (TUG). Table 3 displays the mean TUG times at baseline, midway, and post-intervention.

Table 3: Timed Up and Go Test Times

Time Point	Combined Motor & Cognitive Training (n=20)	Motor Training (n=20)	Cognitive Training (n=20)	p-value
Baseline	15.3 (2.7)	15.6 (2.9)	15.4 (2.8)	-
Midway (6 weeks)	14.1 (2.5)	14.9 (2.8)	15.2 (2.7)	0.210
Post-Intervention (12 weeks)	12.8 (2.3)	14.2 (2.6)	15.1 (2.8)	0.042

Functional Mobility: Functional mobility was measured using the Dynamic Gait Index (DGI). Table 4 shows the DGI scores at baseline, midway, and post-intervention.

Table 4: Dynamic Gait Index Scores

Time Point	Combined Motor & Cognitive Training (n=20)	Motor Training (n=20)	Cognitive Training (n=20)	p-value
Baseline	18.6 (3.2)	18.4 (3.1)	18.7 (3.4)	-
Midway (6 weeks)	20.1 (3.0)	19.2 (3.2)	19.5 (3.3)	0.180
Post-Intervention (12 weeks)	22.3 (2.8)	20.4 (3.0)	19.9 (3.1)	0.029

Discussion

This study aimed to assess the effectiveness of combined motor and cognitive training on balance, fall risk, and functional mobility in older adults. The results indicate that combined training significantly improves balance and reduces fall risk compared to single-task interventions, highlighting the benefits of integrating both motor and cognitive components in rehabilitation programs

Effectiveness of Combined Training: The findings reveal that the combined motor and cognitive training group experienced the most significant improvements in balance, as measured by the Berg Balance Scale. This is consistent with existing literature suggesting that integrating cognitive tasks with motor exercises can enhance motor performance and balance (Li et al., 2020; Ali et al. 2022). The improvement in balance observed in the combined training group (mean BBS score increase from 42.5 to 47.8) underscores the potential of dual-task training to address both physical and cognitive aspects of balance.

Reduction in Fall Risk: The significant reduction in fall risk in the combined training group, evidenced by the decrease in Timed Up and Go Test (TUG) times from 15.3 seconds to 12.8 seconds, supports the hypothesis that dual-task training enhances functional mobility and reduces fall risk. This finding aligns with previous studies that have demonstrated the effectiveness of dual-task training in improving gait and mobility (Meng et al., 2022). The moderate improvements in the motor training group and lack of significant change in the cognitive training group suggest that combining physical and cognitive challenges provides a more comprehensive approach to managing fall risk.

Improvement in Functional Mobility: The Dynamic Gait Index (DGI) scores showed the greatest improvement in the combined training group, indicating enhanced functional mobility. This finding reinforces the notion that dual-task training not only improves balance but also contributes to better overall mobility and coordination (Bherer et al., 2013). The improvements in the motor training group were notable but less pronounced compared to the combined training group, while the cognitive training group showed minimal changes. This highlights the added value of integrating cognitive elements with motor exercises to achieve more substantial functional gains.

Clinical Implications: The results of this study suggest that incorporating cognitive training into motor exercise programs can be a valuable strategy for improving balance and reducing fall risk in older adults. Clinicians should consider designing rehabilitation programs that integrate both cognitive and physical tasks to maximize functional outcomes. This approach may be particularly beneficial for older adults who experience both cognitive and physical impairments, as it addresses multiple dimensions of balance and mobility.

Limitations and Future Research: This study has several limitations. The sample size was relatively small, which may limit the generalizability of the findings. Additionally, the study duration of 12 weeks may not capture long-term effects of dual-task training. Future research should include larger, more diverse samples and longer follow-up periods to validate and extend these findings. Investigating the specific mechanisms through which combined training affects balance and mobility, as well as exploring different training intensities and modalities, could provide further insights into optimizing rehabilitation strategies for older adults.

Conclusion

In conclusion, combined motor and cognitive training offers significant benefits for improving balance, reducing fall risk, and enhancing functional mobility in older adults. This approach may provide a more effective intervention than single-task motor or cognitive training alone, suggesting that integrating cognitive and physical challenges in rehabilitation programs could enhance overall outcomes for older adults with balance impairments.

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