DOI: 10.7860/JCDR/2026/77168.22321

Original Article

Physiotherapy Section

Effects of Four-week Progressive Multitask Training on Balance, Gait and Activities of Daily Living Performance in Older Adults: An Experimental Study

PRANALI CHOUGULE[1], SAURABH KUMAR[2], SHWETA SHARMA[3], PRIYANKA RISHI[4]

ABSTRACT

Introduction: The aging population often experiences increased disability, primarily due to insufficient physical activity, which significantly impacts their ability to perform Activities of Daily Living (ADLs). Age-related changes in cognition, gait, and balance further hinder functional independence, so there is a need to develop targeted interventions that address these challenges and promote healthy aging. Understanding the specific limitations and designing effective strategies to enhance physical activity and motor control are essential to improving the overall well-being of older adults.

Aim: To assess the impact of progressive multitask training on balance, gait, and ADL performance in older adults.

Materials and Methods: This experimental study was conducted at SGT Hospital, Gurugram, Haryana, from September 2023 to January 2024. A total of 60 older adults were recruited and divided into three groups: Group A (progressive multitask training), Group B (motor-cognition training), and Group C (control group, instructed to walk 30 minutes daily). Data were collected at baseline and after a Four-week intervention. Outcome measures included the Performance Oriented Mobility Assessment (POMA), Dynamic Gait Index (DGI), Timed Up and Go (TUG) test, and Functional Independence Measure (FIM). Statistical analysis was conducted using Statistical Package for the Social Sciences (SPSS). Paired t-tests and one-way Analysis of Variance (ANOVA) were applied, with a significance level set at $p<0.05$.

Results: The mean ages for Groups A, B, and C were 67.5±2.28, 67.5±2.33, and 67.7±2.18 years, respectively. Group A showed significant improvements (t=19.9) in balance, cognition, gait, and ADL performance compared to Group B (t=18.01) and Group C (t=6.29). Group B also demonstrated improvements in all outcome measures relative to the control group, though progressive multitask training proved more effective.

Conclusion: Progressive multitask training significantly enhances functional outcomes in older adults, improving balance, cognition, gait, and ADL performance. This approach may be beneficial in clinical settings to improve independence and Quality of Life (QoL) in older adults.

Keywords: Cognitive dysfunction, Exercise therapy, Gait disorders, Neurologic, Quality of life

INTRODUCTION

Older adults are generally described as people aged 65 years or older, as traditionally quantified by chronological age [1,2]. In 2019, the United Nations reported that approximately 703 million people worldwide were aged 65 and above, highlighting the substantial presence of older adults across the globe. Globally, the percentage of people aged 65 and older rose from 6% in 1990 to 9% in 2019 [3]. According to a survey conducted by India's National Statistical Office (NSO), the number of older adults in the country is growing faster than the overall population. From 2011 to 2021, the percentage of people aged 65 and older increased from 8.6% to 10.1%, and this is projected to reach 12.1% by 2031. The survey also revealed that a significant 70% of older adults in India depend on others for assistance with their daily activities. The age structure influences public health by affecting social and economic costs for health care [4,5]. Many older adults require assistance with some basic daily activities, which increases the disability rate. Gait disability is the most prevalent impairment among older adults in India, affecting 5.5% of the population. This limits social interactions, psychological well-being, mobility, and self-care activities [6]. A survey reported that ADL dependency among older adults in India increased from 10.9% to 14.2% by 2021; it was also noted that 22% of older adults reported hampered ADL performance, leading to functional disability and reduced QoL [4,7]. These findings underscore the significance of physical rehabilitation for older adults to preserve independence and reduce reliance on the community [5].

Cognition is crucial for preserving functional independence in older adults, alongside physical factors. As people age, cognitive functions can decline due to degenerative changes in the brain. Key areas-such as the hippocampus, caudate, globus pallidus, putamen of the basal ganglia, and particularly the prefrontal cortex-experience significant volume reductions over time. This decline affects various cognitive abilities, including decision-making, working memory, executive function, and processing speed, which can alter behavior and negatively affect QoL in older adults [8]. In older populations, cognitive decline also impacts gait and balance. Alterations in spatiotemporal gait characteristics and reduced gait velocity, together with static balance impairments, are observed in older adults with cognitive decline, ultimately affecting daily living performance [9]. Therefore, early detection of subtle Mild Cognitive Impairment (MCI)-related changes in balance and gait may be important for guiding rehabilitation aimed at slowing future decline [10]. To increase older adults' functional independence, all of these elements must work together. Incorporating interventions that enhance balance, cognition, and gait performance is likely to yield a more favorable outcome [11].

Physiotherapy treatment plays a crucial role in managing problems related to older adults. There are specific interventions that help improve coordination, balance, and gait difficulties, thereby improving ADL performance. Exercises that challenge cognition, balance, and strength ultimately enhance gait function, enabling independent walking outside the home. Given the relevance of multitask activities in daily living, which require better motor and cognitive functions, older adults often have poor ADL performance and may be dependent on others for basic activities of daily living [12]. Therefore, it is essential to focus on training both the motor and cognitive functions of older adults through multitasking activities. Consequently, this study was conducted to evaluate the impact of a multitask training approach on balance, cognition, gait, and ADLs in older adults.

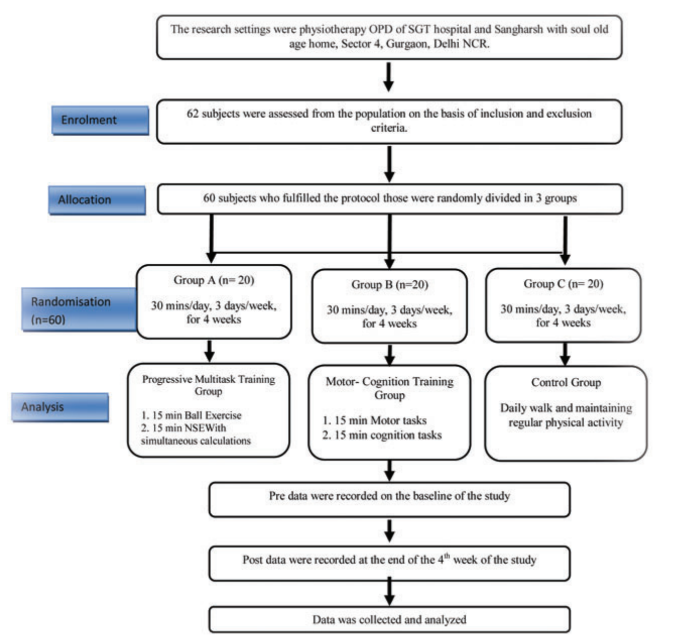
Null Hypothesis (H0): There will be no difference in the effect of progressive multitask training versus motor-cognition training on balance, gait, and ADL performance in older adults.

Alternative Hypothesis (Ha): There will be a significant difference in the effect of progressive multitask training versus motor-cognition training on balance, gait, and ADL performance in older adults.

MATERIALS AND METHODS

This experimental research was conducted at SGT Medical College, Hospital and Research Institute in Gurugram, as well as at Sangharsh with Soul Old Age Home in Sector 4, Gurugram, Delhi NCR from September 2023 to January 2024. Prior to initiating the study, ethical approval was obtained from the Institutional Ethics Committee (approval number: SGTU/FPHY/2022/418), ensuring compliance with ethical guidelines and standards.

Sample size calculation: A total of 60 participants were included by calculating a sample size using G*Power software with a 95% confidence interval and a power of 10%. Convenience sampling was used to divide the participants into three groups of 20 each, i.e., Group A (Progressive Multitask Training Group), Group B (Motor-Cognition Training Group), and Group C (Control Group) [Table/Fig-1].



[Table/Fig-1]: Flowchart of the study.

Inclusion criteria: Participants aged ≥65 years (male and female), POMA score ≥25 [13], DGI score <19 (predictive of falls) [14], TUG test score >13.5 seconds, a minimum of four years of formal education [15], and FIM score ≥109 (mild dependence) [16].

Exclusion criteria: Participants with uncontrolled diabetes for the past five years, any neurological conditions, severe cardiovascular conditions, recent major surgeries, severe deformities of the limbs, psychological conditions, or unwillingness to continue the exercise sessions were excluded.

Outcome measures used in this study are described in [Table/Fig-2] [13-16].

Outcome measures	Assessment method	Reference
Balance and Gait	Tinetti Performance Oriented Mobility Assessment (POMA)	Jahantabi-Nejad S and Azad A 2019 [13]
Gait	Dynamic Gait Index (DGI)	Herman T et al., 2009 [14]
Dynamic balance	Timed Up and Go (TUG) Test	Shumway-cook A et al., 2000 [15]
ADL performance	Functional Independence Measure (FIM)	Ottenbacher K et al., 1996 [16]

[Table/Fig-2]: Outcome measures of the study [13-16].

Study Procedure

Based on the inclusion and exclusion criteria, a sample of 60 participants was selected and evenly divided into three groups: Group A (Progressive Multitask Training Group), Group B (Motor-Cognition Training Group), and Group C (Control Group). Written consent was obtained from all participants, and the purpose and nature of the study were thoroughly explained. Each group underwent a treatment protocol consisting of 30 minutes of training per day, three days a week, for four weeks, all conducted under the researcher's supervision. Pre and post intervention measurements of the outcome measures (as shown in [Table/Fig-2]) were taken. The treatment protocols for each group are detailed in [Table/Fig-3] [17-19].

STATISTICAL ANALYSIS

Statistical analysis was performed using SPSS software version 28.0. The demographic characteristics and all variables were presented as means and standard deviations. A paired t-test was conducted to compare the means of pre- and post-intervention data within each group. To compare the means of pre- and post-intervention data among Groups A, B, and C, a one-way Analysis of Variance (ANOVA) was utilised.

RESULTS

In this study, 60 participants aged 65 years and older were selected based on the inclusion criteria and completed a Four-week intervention program. The group consisted of 31 males and 29 females and was divided into three groups: Group A, Group B, and Group C. The mean ages for Groups A, B, and C were 67.5±2.28, 67.5±2.33, and 67.7±2.18 years, respectively.

[Table/Fig-4] An equal-variance t-test indicated a statistically significant difference (p<0.001) between the post intervention mean values of the Tinetti POMA and the DGI scores across the groups. Additionally, there were significant differences in the TUG test scores and the FIM at the end of the 4th week post-treatment among Groups A, B, and C (p<0.001).

[Table/Fig-5] summarises the results of the post hoc analysis conducted using the Least Significant Difference (LSD) method to compare differences between the groups at the end of the 4th week. The table outlines key parameters, including the mean difference, p-value, and t-value, for comparisons among Groups A, B, and C. Significant findings include differences in POMA, DGI, TUG, and FIM scores, with significance levels denoted as p<0.05, **p<0.001, and **p<0.001, while non-significant differences are marked as NS. For instance, Group C vs Group A showed a higher mean difference of 6.2 (p<0.001, t=14.21). Similarly, in FIM, Group A vs Group B had a mean difference of 2.75 (p=0.007, t=3.17), but Group B vs Group C showed no significant difference (mean difference = 1.05, p=0.453). Group A showed significant improvements (t=19.9) in balance, cognition, gait, and ADL performance compared to group B (t=18.01) and group C (t=6.29).

[Table/Fig-6] presents the analysis and comparison of mean values of the different outcome measures at baseline and at the end of the 4th week after treatment within Groups A, B, and C. The calculated t-values for POMA, DGI, TUG, and FIM for Groups A, B, and C at baseline and post-intervention were significant, with Group A showing more pronounced changes (p<0.001) than Groups B and C.

Intervention group	Week 1	Week 2	Week 3	Week 4
Group A	a) Ball exercise program 1 Walking with holding 1 ball in both hands. 2 Walking while holding 2 balls in both hands 3 Walking with bouncing of one ball with hands 4 Walking while holding 1 ball on one hand and bouncing other ball with other hand b) Net Step Exercise program (NSE) Walking in a 8*3 squares-Net square grid	a) Ball exercise program 1 Walking with kicking a ball by one leg 2 Walking while holding a ball in one hand and kicking another ball within net 3 Walking while bouncing a ball using one hand and kicking another ball simultaneously b) Net Step Exercise (NSE) Number of steps, stepping in alternate grids will executed	Motor tasks were same as given in week 2 along with third task 15 min ball exercise+calculation (Serial subtraction of 3 from 100) 15 min Net Step Exercise (NSE)+calculation (Serial subtraction of 3 from 100)	Same as week 3
Group B	Following tasks were conducted individually while walking. Motor Tasks: Hooking, unhooking, buttoning a shirt, holding a cup of water without spilling it, receiving and giving back cup of water, holding a ball and returning it (each task for 3 min) Cognition Tasks: Describing colors, subtraction, verbal reasoning, spelling words backwards, counting backwards (each task for 3 min)	Progression was made in terms of combining motor and cognitive tasks together e.g., buttoning a shirt while describing colors buttoning a shirt while describing colors	Progression was made by adding problem solving cognitive tasks while walking and performing motor tasks E.g., Holding a cup of water without spilling it, receiving, and giving back cup of water while engaging in verbal reasoning/ performing subtractions/ giving logical answers to asked questions	Same as week 3
Group C	Participants of this group were instructed to maintain their usual physical and social activities as earlier and were asked to avoid additional exercises during the study period. They were asked to walk according to their comfort 3 times a week for at least 30 min or approximately 90 min a week.	Same as week 1	Same as week 1	Same as week 1

[Table/Fig-3]: The treatment protocols for each group [17-19].

Parameters	Group A Mean±SD	Group B Mean±SD	Group C Mean±SD	F value	p-value#
POMA					
Preintervention	25.4±0.60	25.5±0.68	25.4±0.60	0.04NS	0.959
Postintervention	27.6±0.67	26.7±0.80	25.9±0.71	28.63**	<0.001
DGI					
Preintervention	19.9±0.93	19.9±1.04	19.9±0.81	0.00NS	1.00
Postintervention	23.4±0.60	21.6±1.08	20.6±1.04	47.08**	<0.001
TUG					
Preintervention	17.0±1.50	16.6±1.22	16.8±1.04	0.47NS	0.62
Postintervention	13.5±0.80	15.3±1.03	16.3±1.10	40.68**	<0.001
FIM					
Preintervention	118.3±2.82	118±3.56	118.6±3.03	0.15NS	0.856
Postintervention	123.3±1.95	120.6±3.15	119.5±2.98	10.20**	<0.001

[Table/Fig-4]: Balance and gait on POMA, gait on DGI, dynamic balance on Time Up and Go Test (TUG) and ADL performance on FIM score at preintervention (baseline) and post intervention (end of 4th week) between the groups.
#Significance between groups: *p<0.05; **p<0.001, ***p<0.001; NS: Non-significant

Parameters	Mean Difference	p-value#	t-value
POMA			
Group A Vs Group B	0.95	<0.001	4.10**
Group B Vs Group C	0.8	0.003	3.46*
Group C Vs Group A	1.75	<0.001	7.56**
DGI			
Group A Vs Group B	1.8	<0.001	6.06**
Group B Vs Group C	1.05	0.002	3.53*
Group C Vs Group A	2.85	<0.001	9.59**
TUG			
Group A Vs Group B	-1.82	<0.001	-5.82**
Group B Vs Group C	-0.96	0.009	-3.06*
Group C Vs Group A	-2.78	<0.001	-8.88**
FIM			
Group A Vs Group B	2.75	0.007	3.17*
Group B Vs Group C	1.05	0.453	1.21NS
Group C Vs Group A	3.8	<0.001	4.37**

[Table/Fig-5]: Explains the summery of post hoc analysis by Least Significant Difference (LSD) between the groups at the end of 4th week.
#Significance between groups: * p<0.05; ** p<0.001, *** p<0.001; NS: Non-significant

Parameters		Group A		Group B		Group C	
		t-value	p-value#	t-value	p-value#	t-value	p-value#
POMA	Pre vs postintervention	-14.1	<0.001	-6.99	<0.001	-3.94	<0.001
DGI	Pre vs postintervention	-16.2	<0.001	-9.66	<0.001	-4.68	<0.001
TUG	Pre vs postintervention	10.7	<0.001	8.86	<0.001	6.64	<0.001
FIM	Pre vs postintervention	-13.3	<0.001	-9.58	<0.001	-4.25	<0.001

[Table/Fig-6]: Comparison of mean value of balance and gait on POMA, gait on DGI, dynamic balance on Time Up and Go Test (TUG) and ADL performance on FIM score at preintervention (baseline) and postintervention (end of 4th week) within the groups.
#Significance between groups: *p<0.05; **p<0.001, ***p<0.001; NS: Non-significant

DISCUSSION

This study examined the impact of progressive multitask training on balance, cognition, gait, and ADL performance in older adults. Previous studies have shown that dual-task training can improve QoL in older adults. However, there is limited evidence on the effects of multitask training in the elderly population, and to our knowledge, little is known about progressive multitask training that incorporates Net Step Exercise (NSE) and Ball Exercise Program (BEP) with progressively added calculation tasks and its effect on QoL.

Previous studies suggest that multitasking in daily chores is important for maintaining social participation and independence in older adults; hence, it is crucial to address this in interventions [20-22]. Training that combines balance, gait, and cognitive tasks simultaneously can improve cognition in older adults, potentially via prefrontal cortex activation. The combined motor and cognitive training may enhance attention, memory, and decision-making-cognitive components essential for engaging in social environments [22,23].

Gait and balance, assessed using the POMA and the DGI, showed significant improvements. Across all groups, there were significant within and between-group improvements (p<0.001), with the POMA score improving from 19.9±0.93 at baseline to 23.4±0.60 after 4 weeks in Group A, indicating greater improvement in gait and balance. Group A showed statistically greater improvement after 4 weeks compared with the other groups. Thus, the gradual progression of physical and cognitive tasks during walking effectively improved balance and gait performance. A synergistic interaction of motor training (strength and endurance) with cognitive and balance training can improve the ability to walk independently while maintaining balance, thereby reducing the risk of falls indoors and in the community [23].

Analogously, there was a significant improvement in gait performance after four weeks of progressive multitask training as assessed by the DGI in both within and between-group analyses. The gradual progression of physical and cognitive tasks during walking effectively improved walking performance and can enhance confidence to walk in community environments, as well as improve gait performance and the ability to cope with changes in gait speed [24]. Previous studies have shown a strong correlation between cognition and dynamic balance in older adults; accordingly, we found significant improvement in dynamic balance as measured by the TUG after four weeks of progressive multitask training compared with other groups [2,25,26]. This suggests that performing ADLs requires the ability to manage multiple cognitive and physical tasks simultaneously. Aging affects the ability to perform ADLs independently. Therefore, physical–cognitive training can improve ADL independence and thereby improve QoL. Similarly, our findings suggest that Group A showed significant improvement in ADL performance after four weeks of progressive multitask training compared with the other groups in this study.

Previous studies have shown that progressive training interventions, even over short durations, can yield significant improvements in balance, cognition, and gait performance [27,28]. While the current study found significant improvements in gait, balance, and ADL performance following progressive multitask training, it is important to recognise that other research has yielded mixed results. For example, while some studies support the effectiveness of multitask training [20,24], others highlight limitations in its ability to produce long-lasting effects or show cognitive improvements only in certain subgroups, such as those with severe cognitive impairments [23-25]. Furthermore, challenges related to maintaining the benefits of multitask training over time and ensuring safety in frail individuals are crucial considerations that warrant further investigation. These findings emphasise the need for more personalised and carefully designed interventions, taking into account individual health conditions and cognitive abilities.

Moreover, findings of this study have significant clinical implications. Progressive multitask training can be integrated into rehabilitation programs for older adults to address multiple functional domains simultaneously. By improving cognition, balance, gait, and ADL performance, such interventions can reduce fall risks, enhance independence, and improve overall QoL. These benefits are particularly relevant in settings where older adults face frailty and cognitive decline. The incorporation of cognitive tasks into physical training can provide a cost-effective and scalable approach to addressing the growing healthcare needs of the aging population.

In conclusion, the present research contributes valuable evidence to the field of multitask training for older adults, demonstrating its potential to improve balance, gait, and activities of daily living (ADLs). However, it also highlights the need for continued research to explore the limitations and long-term effects of such interventions, especially in populations with advanced cognitive decline or physical impairments. Further studies are necessary to refine training protocols, ensure safety, and assess the sustainability of benefits over time.

Future study recommendations include extend the program to 8-12 weeks for lasting results. Include follow-up sessions to maintain improvements. Tailor training to individual abilities for better adherence.

Limitation(s)

The duration of the study was four weeks with 30-minute sessions; a longer duration is necessary. Effectiveness may vary due to differences in fitness, cognition, and health conditions. Improvements may result from task familiarity or placebo effects. The program may be physically and mentally demanding, potentially leading to fatigue or injury. The study duration was limited to four weeks; a longer study is needed. Due to time constraints, proper follow-up was not maintained.

CONCLUSION(S)

The findings indicate that progressive multitask training produced greater improvements in gait, balance, and ADL performance than motor-cognition task training. However, motor-cognition training also showed improvements in gait, balance, and ADL performance in older adults compared with the control group. Overall, progressive multitask training may be more favorable for patients and could be used in clinical settings.

Acknowledgement

The authors thank all the participants involved in this study for their cooperation and support.

Author contributions: All authors contributed equally to the writing of this paper. All authors read and approved the final manuscript.

Data availability: The data sets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

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PARTICULARS OF CONTRIBUTORS:

1. Postgraduate Student, Department of Physiotherapy, SGT University, Gurugram, Haryana, India.
2. Associate Professor, Department of Physiotherapy, SGT University, Gurugram, Haryana, India.
3. Assistant Professor, Faculty of Physiotherapy, SGT University, Gurugram, Haryana, India.
4. Associate Professor, Department of Physiotherapy, SGT University, Gurugram, Haryana, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Saurabh Kumar,
SGT University, Gurugram, Haryana, India.
E-mail: saurabh04pt@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: Dec 10, 2024
- Manual Googling: Jun 19, 2025
- iThenticate Software: Jun 21, 2025 (5%)

ETYMOLOGY: Author Origin

EMENDATIONS: 7

AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Dec 06, 2024**
Date of Peer Review: **Jan 25, 2025**
Date of Acceptance: **Jun 23, 2025**
Date of Publishing: **Jan 01, 2026**