OPEN ACCESS

ORIGINAL ARTICLE

JMHRS JOURNAL OF MODERN HEALTH AND REHABILITATION SCIENCES

Effect of a Supervised Multicomponent Balance, Resistance, Aerobic, and Cognitive Exercise Program on Mobility in Older Adults with Risk of fall

[1]Umm e Habiba[a], [2]Maham Malik[b], [3]Sadia Waqas[c], [4]Arshad Nawaz Malik[b]

[a]Physiotherapy Department District Headquarter Hospital Chakwal, Chakwal, Pakistan

[b]Riphah International University, Islamabad, Pakistan

[c]Southern Health NHS Foundation Trust, United Kingdom

ABSTRACT

Background: Falls are a major cause of morbidity, disability, and loss of independence among older adults. Multicomponent exercise interventions have shown promise in improving balance and mobility while reducing fall risk.

Objective: To compare the effects of a supervised Balance, Resistance, Aerobic, and Cognitive Exercise (BRACE) program with conventional home-based therapy on balance, mobility, cognitive function, and fall risk in older adults at moderate risk of falls.

Methods: A randomized controlled trial was conducted at District Headquarter Hospital, Chakwal, Pakistan, from July to December 2018. Forty participants aged 60–80 years with Berg Balance Scale scores of 20–40 were randomly allocated to either a supervised BRACE group (n=20) or a conventional therapy group (n=20). The supervised group received structured multicomponent exercise for 12 weeks, whereas the control group performed home-based balance and resistance exercises. Outcomes were assessed at baseline and at 3, 6, 9, and 12 weeks using the Berg Balance Scale, Timed Up and Go test, Montreal Cognitive Assessment, Activities-specific Balance Confidence Scale, Elderly Mobility Scale, and Fullerton Advanced Balance Scale.

Results: Thirty-four participants completed the study (18 supervised BRACE; 16 conventional therapy). After 12 weeks, the supervised BRACE group demonstrated significantly better outcomes than the conventional therapy group for Berg Balance Scale (51.70±1.74 vs. 40.06±4.42), Timed Up and Go (10.92±2.49 vs. 15.22±1.94 seconds), Activities-specific Balance Confidence Scale (82.70±7.22 vs. 67.69±11.92), Elderly Mobility Scale (19.39±1.03 vs. 16.19±1.79), and Fullerton Advanced Balance Scale (34.28±2.16 vs. 23.25±5.87) (all $p<0.001$).

Conclusion: Supervised multicomponent BRACE training was more effective than conventional home-based therapy in improving balance, mobility, and reducing fall risk among older adults.

Keywords: Activities of Daily Living, Aged, Balance, Cognitive Training, Exercise Therapy, Falls, Mobility Limitation, Postural Balance, Resistance Training.

Correspondence

Umm e Habiba | hibaa912@gmail.com

Disclaimers

Conflict of Interest: None declared

Data/Supplements: Available on request.

Funding: None

Ethical Approval: Respective Ethical Review Board

Study Registration: N/A

Acknowledgments: N/A

Article Info

Received: 09 October 2025, *Accepted:* 19 April 2026,

Published Online: 20 April 2026

How to Cite: Habiba UE, Malik M, Waqas S, Malik AN. Association Effect of a Supervised Multicomponent Balance, Resistance, Aerobic, and Cognitive Exercise Program on Mobility in Older Adults with Risk of fall. J Mod Health Rehab Sci. 2026;3(2):189.

Available from: https://jmhrs.com/index.php/jmhrs/article/view/189| **DOI:** https://doi.org/10.67108/jmhrs189

Introduction

Population aging has emerged as one of the most significant global demographic transitions, accompanied by an increased prevalence of chronic diseases, functional decline, frailty, and disability. Aging is characterized by a gradual deterioration in physiological reserve, reduced adaptability to environmental stressors, and progressive impairment of musculoskeletal, neurological, and cognitive functions. In contrast, successful aging has been defined as maintaining physical and cognitive health, preserving functional independence, and remaining actively engaged in social and productive activities throughout later life (2,5). Although advances in medical care and healthcare technologies have substantially increased life expectancy, age-related functional decline continues to pose considerable challenges to the health and quality of life of older adults (3,4).

Falls represent one of the leading causes of morbidity, disability, hospitalization, institutionalization, and mortality among older adults worldwide. A fall is defined as an unintentional event resulting in a person coming to rest on the ground or another lower level. The occurrence of falls is multifactorial and is influenced by intrinsic factors, including impaired balance, muscle weakness, cognitive dysfunction, visual impairment, chronic medical conditions, and the physiological changes associated with aging, as well as extrinsic factors such as environmental hazards, inappropriate footwear, poor lighting, unsafe stairways, and medication-related adverse effects (6,8,9). The incidence of falls increases progressively with advancing age and has been reported to be particularly high among individuals aged 65 years and above, with women generally demonstrating a greater susceptibility than men (10,11).

Age-related deterioration in postural control, lower limb muscle strength, gait performance, and executive cognitive function substantially increases the risk of falls and loss of mobility. Functional mobility is essential for maintaining independence in activities of daily living, and its decline often results in reduced participation, diminished confidence, fear of falling, and poorer health-related quality of life. Furthermore, recurrent falls contribute to physical injury, fractures, hospitalization, increased healthcare expenditure, and premature mortality, emphasizing the importance of effective preventive interventions (9–12).

Exercise-based interventions are widely recognized as one of the most effective non-pharmacological strategies for preventing falls and improving physical function among older adults. Previous studies have demonstrated that balance training enhances postural stability, resistance exercises improve muscular strength and endurance, aerobic exercise promotes cardiovascular fitness and walking capacity, while cognitive training enhances attention, executive function, and dual-task performance, all of which contribute to reducing fall risk (12–17). Recent evidence further suggests that multicomponent exercise programs integrating balance, resistance, aerobic, and cognitive training provide greater improvements in mobility and functional performance than single-component interventions because they simultaneously target multiple physiological systems involved in balance control and locomotion (13).

Supervised exercise programs may offer additional advantages over unsupervised home-based interventions by ensuring correct exercise execution, maintaining participant adherence, allowing progression according to individual ability, and reducing the likelihood of exercise-related injuries. Despite increasing evidence supporting multicomponent exercise interventions, limited data are available regarding the effectiveness of supervised Balance, Resistance, Aerobic, and Cognitive Exercise (BRACE) programs in improving mobility and reducing fall risk among older adults in Pakistan. Therefore, the present randomized controlled trial was conducted to evaluate the effects of a supervised BRACE program compared with conventional home-based therapy on balance, functional mobility, cognitive function, and fall risk among older adults with moderate risk of falling.

Material and Methods

This randomized controlled trial was conducted at the District Headquarter Hospital, Chakwal, Pakistan, between July 2018 and December 2018 to evaluate the effects of a supervised multicomponent Balance, Resistance, Aerobic, and Cognitive Exercise (BRACE) program on mobility, balance, cognitive function, and fall risk among older adults. The study protocol was developed in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the relevant Institutional Ethical Review Committee before the commencement of the study, and written informed consent was obtained from all participants prior to enrollment. Participant confidentiality and anonymity were maintained throughout the study.

The sample size was calculated using Epitools statistical software. A total of 46 individuals were screened for eligibility, of whom four did not meet the inclusion criteria and two declined participation. Consequently, 40 participants were enrolled in the study. Individuals of either sex aged 60–80 years with a Berg Balance Scale (BBS) score between 20 and 40, indicating a moderate risk of falling, were included. Participants with neurological disorders, previous fractures, a history of recent falls, or any medical condition that could interfere with exercise participation or outcome assessment were excluded from the study.

Participants were recruited using purposive sampling and were randomly allocated into either the supervised BRACE intervention group or the conventional therapy

group using the sealed-envelope randomization method. Twenty participants were initially assigned to each group. During the intervention period, two participants from the supervised BRACE group withdrew because of personal reasons, while four participants from the conventional therapy group were lost to follow-up, including two due to aggravation of shoulder pain and two because they were unable to attend scheduled follow-up visits.

The supervised BRACE intervention consisted of a structured multicomponent exercise program incorporating balance, resistance, aerobic, and cognitive training under the direct supervision of a physiotherapist. Participants attended supervised exercise sessions three times per week during the first eight weeks, followed by two sessions per week from weeks 9 to 12. Exercise intensity and progression were individualized according to participants' functional capacity and tolerance. The conventional therapy group received education and a home-based exercise program primarily consisting of balance and resistance exercises, with instructions for independent performance throughout the study period.

Outcome assessments were performed at baseline and after 3, 6, 9, and 12 weeks by trained assessors using standardized and validated outcome measures. Functional balance was assessed using the Berg Balance Scale (BBS), cognitive function using the Montreal Cognitive Assessment (MoCA), functional mobility using the Timed Up and Go (TUG) test and the Elderly Mobility Scale (EMS), balance confidence using the Activities-specific Balance Confidence (ABC) Scale, and advanced balance performance using the Fullerton Advanced Balance (FAB) Scale. All assessments were conducted according to standardized testing procedures to ensure measurement consistency.

Data were collected using structured assessment forms and entered into a computerized database after verification for completeness and accuracy. Statistical analysis was performed using IBM Statistical Package for the Social Sciences (SPSS) version 22. Descriptive statistics were calculated for demographic and baseline characteristics. Continuous variables were presented as mean ± standard deviation, whereas categorical variables were summarized as frequencies and percentages. The normality of continuous data was evaluated using appropriate normality tests prior to inferential analysis. Since the data were normally distributed ($p>0.05$), parametric statistical tests were applied. Within-group comparisons across different assessment time points were performed using repeated-measures analysis, while between-group comparisons were conducted using the independent samples t-test. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 46 older adults were screened for eligibility. Four participants did not meet the inclusion criteria, and two declined to participate. Consequently, 40 participants were randomized equally into the supervised BRACE group (n = 20) and the conventional therapy group (n = 20). During the intervention period, two participants from the supervised BRACE group withdrew due to personal reasons, while four participants from the conventional therapy group were lost to follow-up, resulting in a final analysis of 18 participants in the supervised BRACE group and 16 participants in the conventional therapy group. The mean age of participants was 67.17 ± 5.98 years in the supervised BRACE group and 66.63 ± 5.30 years in the conventional therapy group. Of the 34 participants who completed the study, 23 (67.6%) were male and 11 (32.4%) were female.

Table 1: Demographic characteristics of study participants who completed the intervention

Variable	Frequency (n)	Percentage (%)
Gender		
Male	23	67.6
Female	11	32.4
Total	34	100.0

Table 2: Gender distribution according to study group.

Group	Male n (%)	Female n (%)	Total n (%)
Supervised BRACE	12 (66.7)	6 (33.3)	18 (100)
Conventional therapy	11 (68.8)	5 (31.2)	16 (100)

The gender distribution was comparable between the two treatment groups. In the supervised BRACE group, 12 (66.7%) participants were male and 6 (33.3%) were female, whereas the conventional therapy group included 11 (68.8%) males and 5 (31.2%) females. Within-group analysis demonstrated statistically significant improvements from baseline to week 12 in both intervention groups across most outcome measures ($p < 0.01$). However, between-group comparisons at the completion of the 12-week intervention revealed significantly greater improvements in the supervised BRACE group than in the conventional therapy group for balance, functional mobility, balance confidence, and advanced balance performance. No statistically significant between-group difference was observed for cognitive function as assessed by the Montreal Cognitive Assessment (MoCA). Participants receiving the supervised BRACE program demonstrated significantly higher Berg Balance Scale, Activities-specific Balance Confidence Scale, Elderly Mobility Scale, and Fullerton Advanced Balance Scale scores compared with those receiving conventional therapy after 12 weeks of

intervention. Furthermore, the supervised BRACE group completed the Timed Up and Go test in significantly less time, indicating superior functional mobility. Although both groups showed improvement in cognitive performance over the intervention period, the between-group difference in MoCA scores was not statistically significant ($p = 0.170$).

Table 3: Comparison of clinical outcomes between Supervised BRACE and conventional therapy groups

Outcome Measures	Group	Baseline	Week 3	Week 6	Week 9	Week 12
Berg Balance Scale (0–56)	S-BRACE	31.2 ± 3.8	36.5 ± 3.5	41.8 ± 3.1	47.6 ± 2.5	51.70 ± 1.74
	Control	31.0 ± 3.6	33.2 ± 3.7	35.8 ± 3.9	38.2 ± 4.2	40.06 ± 4.42
Montreal Cognitive Assessment (MoCA) (0–30)	S-BRACE	22.4 ± 2.8	23.5 ± 2.7	24.8 ± 2.7	25.9 ± 2.6	27.00 ± 2.67
	Control	22.3 ± 2.6	23.0 ± 2.5	23.8 ± 2.5	24.6 ± 2.5	25.75 ± 2.48
Timed Up and Go (seconds)	S-BRACE	17.8 ± 2.9	15.9 ± 2.8	13.9 ± 2.7	12.2 ± 2.5	10.92 ± 2.49
	Control	17.7 ± 2.8	17.0 ± 2.6	16.4 ± 2.4	15.8 ± 2.1	15.22 ± 1.94
Activities-specific Balance Confidence (ABC) Scale	S-BRACE	55.2 ± 9.5	62.1 ± 8.8	69.8 ± 8.0	76.5 ± 7.5	82.70 ± 7.22
	Control	55.0 ± 9.2	58.6 ± 9.4	61.8 ± 10.5	64.8 ± 11.1	67.69 ± 11.92
Elderly Mobility Scale (EMS)	S-BRACE	13.1 ± 1.8	14.8 ± 1.6	16.3 ± 1.4	17.9 ± 1.2	19.39 ± 1.03
	Control	13.0 ± 1.7	13.9 ± 1.8	14.8 ± 1.9	15.5 ± 1.8	16.19 ± 1.79
Fullerton Advanced Balance (FAB) Scale (0–40)	S-BRACE	21.5 ± 3.4	25.3 ± 3.0	28.8 ± 2.8	31.8 ± 2.4	34.28 ± 2.16
	Control	21.4 ± 3.5	21.9 ± 4.0	22.4 ± 4.6	22.8 ± 5.1	23.25 ± 5.87

Discussion

The present randomized controlled trial evaluated the effectiveness of a supervised multicomponent Balance, Resistance, Aerobic, and Cognitive Exercise (BRACE) program compared with conventional home-based therapy in improving balance, mobility, cognitive function, and reducing fall risk among older adults with moderate risk of falling. The findings demonstrated that both intervention groups exhibited significant improvements over the 12-week intervention period; however, participants receiving supervised BRACE training achieved significantly greater improvements in balance, functional mobility, balance confidence, and advanced balance performance than those receiving conventional therapy. Although cognitive performance improved in both groups, no statistically significant difference was observed between the interventions. These findings suggested that supervised multicomponent exercise programs provided superior functional benefits compared with unsupervised home-based exercise among community-dwelling older adults.

The substantial improvement observed in balance performance among participants receiving supervised BRACE training was consistent with previous evidence demonstrating that structured, supervised exercise programs are more effective than unsupervised interventions in enhancing postural control and reducing fall risk in older adults. Lacroix et al. reported that supervised balance and strength training produced significantly greater improvements in balance and muscle strength than home-based exercise programs because supervision improved exercise adherence, progression, and execution quality (13). Similarly, the present findings indicated that regular supervision by physiotherapists may have facilitated appropriate progression of exercise intensity and ensured correct performance of balance and resistance activities, thereby contributing to greater functional gains.

The improvement in Berg Balance Scale and Fullerton Advanced Balance Scale scores observed in the supervised BRACE group was also supported by previous randomized trials investigating balance-oriented interventions. Bieryla and Dold demonstrated that balance

training using interactive exercise programs significantly enhanced postural stability and clinical balance measures among older adults (14). Likewise, Ogaya et al. reported that structured balance exercises performed on unstable surfaces improved both static and dynamic balance in elderly individuals residing in nursing homes (15). The present study extended these findings by demonstrating that combining balance exercises with resistance, aerobic, and cognitive training produced clinically meaningful improvements in multiple dimensions of balance rather than relying on a single exercise modality.

Functional mobility, assessed using the Timed Up and Go test and the Elderly Mobility Scale, also improved significantly following supervised BRACE training. These findings were consistent with previous reports indicating that multicomponent exercise interventions improve gait performance, lower extremity strength, coordination, and mobility among older adults at increased risk of falling (12,13). Improved mobility may have resulted from the synergistic effects of resistance exercises that enhanced muscular strength, aerobic activities that improved endurance and walking capacity, and balance training that enhanced neuromuscular control. Collectively, these adaptations likely contributed to safer and more efficient mobility during daily functional activities.

Participants who underwent supervised BRACE training also demonstrated significantly greater improvements in Activities-specific Balance Confidence scores than those receiving conventional therapy. Increased balance confidence is clinically important because fear of falling frequently results in reduced physical activity, functional dependence, social isolation, and diminished quality of life among older adults. The observed improvement corresponded with the findings of Hatch et al., who reported that enhanced balance performance through targeted rehabilitation significantly increased confidence during activities of daily living while reducing fear of falling (16). Improved confidence may have encouraged participants to engage more actively in routine physical activities, thereby reinforcing functional recovery.

Although both groups demonstrated improvement in Montreal Cognitive Assessment scores, the between-group difference was not statistically significant. This finding suggested that both supervised exercise and conventional home-based exercise may have contributed to modest improvements in cognitive performance through increased physical activity and participant engagement. Previous studies have reported beneficial effects of aerobic exercise on cognitive function, executive processing, and memory among older adults (17). The absence of a statistically significant difference between groups may have been attributable to the relatively small sample size, limited intervention duration, or the inclusion of participants with relatively preserved baseline cognitive function, thereby reducing the potential to detect clinically meaningful between-group differences.

Several factors may explain the superior effectiveness of supervised BRACE training observed in the present study. Supervised exercise ensured better adherence, individualized progression, immediate feedback, correction of exercise technique, and enhanced participant motivation. In contrast, home-based exercise programs relied heavily on participant compliance and self-monitoring, which may have resulted in inconsistent exercise performance and lower adherence. These observations further supported current recommendations advocating supervised multicomponent exercise as an effective strategy for fall prevention among older adults (13).

The present study possessed several strengths. Its randomized controlled design minimized selection bias and enhanced internal validity. The intervention incorporated multiple evidence-based exercise components that addressed several modifiable risk factors for falls simultaneously. Furthermore, validated outcome measures, including the Berg Balance Scale, Timed Up and Go test, Activities-specific Balance Confidence Scale, Elderly Mobility Scale, Fullerton Advanced Balance Scale, and Montreal Cognitive Assessment, provided comprehensive evaluation of physical and cognitive outcomes. Repeated assessments throughout the intervention period also allowed monitoring of participant progress over time.

Despite these strengths, several limitations should be acknowledged. The study included a relatively small sample size recruited from a single healthcare center, which may limit the generalizability of the findings to broader populations. The intervention period was limited to 12 weeks, and long-term follow-up was not performed to determine whether improvements were maintained over time or translated into sustained reductions in fall incidence. Blinding of participants and therapists was not feasible because of the nature of the intervention, potentially introducing performance bias. Additionally, adherence to the home-based exercise program was not objectively monitored, which may have influenced the observed between-group differences.

Future research should include multicenter randomized controlled trials with larger and more diverse populations, extended intervention periods, and long-term follow-up to evaluate the sustainability of treatment effects and actual fall incidence. Further studies should also investigate cost-effectiveness, participant adherence, quality of life, psychological outcomes, and the integration of technology-assisted or tele-rehabilitation approaches to enhance accessibility and long-term compliance with supervised multicomponent exercise programs. Such evidence would further strengthen recommendations for implementing structured exercise interventions within

routine geriatric rehabilitation and community healthcare services.

Conclusion

The present study concluded that a supervised multicomponent Balance, Resistance, Aerobic, and Cognitive Exercise (BRACE) program was more effective than conventional home based therapy in improving balance, functional mobility, balance confidence, and reducing fall risk among older adults, while both interventions produced comparable improvements in cognitive function. These findings supported the incorporation of supervised multicomponent exercise programs into routine geriatric rehabilitation and community healthcare services to promote functional independence, prevent falls, improve quality of life, and reduce the healthcare burden associated with fall related injuries in the aging population.

Authors' Contributions

ICMJE authorship criteria	Detailed contributions	Authors
Substantial Contributions	Conception or Design of the work	1,2,4
	Data acquisition	1, 2
	Data analysis or interpretation	1,3
Drafting or Reviewing	Draft the work	1
	Review critically	1,2,3,4
Final approval	Final approval of the version to be published.	1,2,3,4
Accountable	Agreement to be accountable for all aspects of the work.	1,2,3,4

References

1. Rubenstein LZ. Falls in Older People: Epidemiology, Risk Factors and Strategies for Prevention. Age Ageing. 2006;35(Suppl 2):ii37-ii41. https://doi.org/10.1093/ageing/afl084
2. Flatt T. A New Definition of Aging? Front Genet. 2012;3:148. doi:10.3389/fgene.2012.00148. https://doi.org/10.3389/fgene.2012.00148
3. Harman D. Aging: A Theory Based on Free Radical and Radiation Chemistry. J Gerontol. 1955;10(3):298-300. doi:10.1093/geronj/10.3.298. https://doi.org/10.1093/geronj/11.3.298
4. Pathy MSJ, Sinclair AJ, Morley JE. Principles and Practice of Geriatric Medicine. 4th ed. Chichester: John Wiley & Sons; 2006.
5. Rowe JW, Kahn RL. Successful Aging. Gerontologist. 1997;37(4):433-440 https://doi.org/10.1093/geront/37.4.433
6. Chelluri L. Critical Illness in the Elderly: Review of Pathophysiology of Aging and Outcome of Intensive Care. J Intensive Care Med. 2001;16(3):114-127. https://doi.org/10.1177/088506660101600302
7. López-Otín C, Blasco MA, Partridge L, Serrano M, Kroemer G. Hallmarks of Aging: An Expanding Universe. Cell. 2023;186(2):243-278. https://doi.org/10.1016/j.cell.2022.11.001
8. Beard JR, Officer A, de Carvalho IA, Sadana R, Pot AM, Michel JP, et al. The World Report on Ageing and Health: A Policy Framework for Healthy Ageing. Lancet. 2016;387(10033):2145-2154. https://doi.org/10.1016/s0140-6736(15)00516-4
9. Rubenstein LZ. Falls in Older People: Epidemiology, Risk Factors and Strategies for Prevention. Age Ageing. 2006;35(Suppl 2):ii37-ii41. https://doi.org/10.1093/ageing/afl084
10. Ungar A, Rafanelli M, Iacomelli I, Brunetti MA, Ceccofiglio A, Tesi F, et al. Fall Prevention in the Elderly. Clin Cases Miner Bone Metab. 2013;10(2):91-95.
11. Pu-Lin Y, Zhao-Hui Q, Jing S, Zhang J, Mei-Zhe X, Zheng-Lai W, et al. Prevalence and Related Factors of Falls Among the Elderly in an Urban Community of Beijing. Biomed Environ Sci. 2009;22(3):179-187. https://doi.org/10.1016/s0895-3988(09)60043-x
12. Zhuang J, Huang L, Wu Y, Zhang Y. The Effectiveness of a Combined Exercise Intervention on Physical Fitness Factors Related to Falls in Community-Dwelling Older Adults. Clin Interv Aging. 2014;9:131-140. https://doi.org/10.2147/cia.s56682
13. Lacroix A, Hortobágyi T, Beurskens R, Granacher U. Effects of Supervised Versus Unsupervised Training Programs on Balance and Muscle Strength in Older Adults: A Systematic Review and Meta-Analysis. Sports Med. 2017;47(11):2341-2361. https://doi.org/10.1007/s40279-017-0747-6
14. Bieryla KA, Dold NM. Feasibility of Wii Fit Training to Improve Clinical Measures of Balance in Older Adults. Clin Interv Aging. 2013;8:775-781. https://doi.org/10.2147/cia.s46164
15. Ogaya S, Ikezoe T, Soda N, Ichihashi N. Effects of Balance Training Using Wobble Boards in the Elderly. J Strength Cond Res. 2011;25(9):2616-2622. https://doi.org/10.1519/jsc.0b013e31820019cf
16. Hatch J, Gill-Body KM, Portney LG. Determinants of Balance Confidence in Community-Dwelling Elderly People. Phys Ther. 2003;83(12):1072-1079. https://doi.org/10.1093/ptj/83.12.1072
17. Dustman RE, Ruhling RO, Russell EM, Shearer DE, Bonekat HW, Shigeoka JW, et al. Aerobic Exercise Training and Improved Neuropsychological Function of Older Individuals. Neurobiol Aging. 1984;5(1):35-42. https://doi.org/10.1016/0197-4580(84)90083-6