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Comparative Effects of Core Stability Exercises and Obstacle Gait Training on Balance in the Elderly Population: A Randomised Controlled Study

^{*1}Srinivasulu Mandla²Kamalakaran Mohanan³Maheen Attar⁴Divya Chunduri

ABSTRACT

Background: Age-related declines in balance, postural control, and muscle strength significantly increase the likelihood of falls among the elderly, often leading to functional limitations and reduced independence. Core Stability Exercises and Obstacle Gait Training are commonly recommended to address these deficits, but comparative evidence on their effectiveness remains limited. This study aimed to evaluate and compare the effectiveness of Core Stability Exercises and Obstacle Gait Training in minimizing fall risk, improving balance, and enhancing functional independence in daily activities among the elderly population.

Methods: A total of 52 participants aged 65–75 years with documented balance difficulties were recruited and randomly assigned into two groups. Group A received both Core Stability Exercises and Obstacle Gait Training, while Group B received Obstacle Gait Training alone. The intervention lasted 6 weeks, with sessions held 3 times per week. Outcome measures were assessed using the Berg Balance Scale (BBS) and Fullerton Advanced Balance (FAB) Score, before and after the intervention. Appropriate statistical tests, including Paired and Independent t-tests, were used for data analysis with significance set at $p < 0.05$.

Results: Both groups demonstrated statistically significant improvements in BBS and FAB scores post-intervention ($p < 0.0001$). However, Group A, which received combined Core Stability Exercises and Obstacle Gait Training, showed greater improvements in balance compared to Group B. Additionally, some participants in Group A progressed from requiring walking aids to ambulating independently for short distances.

Conclusion: The study concludes that while Obstacle Gait Training alone is efficacious in improving balance, the combination of Core Stability and Obstacle Gait Training yields superior results in enhancing postural control and functional mobility in older adults. Incorporating these targeted, evidence-based interventions can significantly reduce fall risk, promote independence, and improve the quality of life in the geriatric population.

Keywords: Geriatric Patients, Core Stability Exercises, Obstacle Gait Training, Fall Prevention, Balance, Coordination.

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CORRESPONDING AUTHOR

^{*1}Srinivasulu Mandla

Ph.D. Scholar, Saveetha College of Physiotherapy, Saveetha Institute of Medical and Technical Sciences, Chennai, India.
Associate Professor, Vydehi Institute of Physiotherapy, Bangalore, India.
Email: srinuphysio88@gmail.com

²Professor, Saveetha College of Physiotherapy, Saveetha Institute of Medical and Technical Sciences, Chennai, India.

³B.P.T Student, Vydehi Institute of Physiotherapy, Bangalore, India.

⁴City Head, HCAH SuVitas, Bangalore, India.



INTRODUCTION

With rising life expectancy due to advances in healthcare, nutrition, and hygiene, the global elderly population is expected to double by 2050. While longevity is increasing, so is the prevalence of chronic conditions like osteoporosis, arthritis, and reduced cardiovascular endurance. These age-related changes often lead to impaired gait, poor coordination, and generalized weakness. Common gait alterations in older adults include slower walking speed, shorter steps, and increased time in double support. Such changes elevate the risk of falls and can significantly impact functional independence. Additionally, fear of falling often limits mobility and reduces confidence, affecting overall quality of life [1].

Gait, a complex motor function, is heavily influenced by ageing, as declines in coordination, sensory input, and muscle strength heighten fall risk. Environmental challenges like uneven paths or dim lighting further compromise balance in older adults, often leading to injuries and a loss of independence, especially among those aged 65 and above. Gait speed is a critical predictor of fall risk, underscoring the need for targeted interventions. While general gait training is common, structured movements aimed at improving walking ability by enhancing strength, balance, and coordination, obstacle-based gait training using tools like cones and ladders remains underutilized despite its potential to improve mobility and confidence in older people. This approach offers a more functional, real-world strategy to reduce fall-related impairments [2-4].

The core, consisting of the lumbar spine, pelvis, hip joints, and surrounding muscles, is essential for maintaining spinal stability and postural control. Core stability refers to the lumbopelvic-hip complex's ability to resist and recover from external disturbances. While core strength is vital for all age groups, it becomes especially crucial in older adults, where weakness increases the risk of injury. According to the Centre for Disease Control and Prevention (CDC), one in five falls among individuals aged 65 and above results in serious injury. Given that healing slows with age, preventing such injuries through core strengthening becomes a key focus in geriatric care [5-6].

Core stability exercises, which target muscles such as the pelvic floor, obliques, and transverse abdominis, are particularly effective for improving postural control, spinal support, and mobility in older people [8, 9]. These muscles connect the upper and lower body, influencing everyday movements such as lifting, reaching, and bending. In older adults, core strength becomes essential not only for preventing lower back pain but also for maintaining independence and reducing fall risk. Functional activities—ranging from walking and driving to household chores—depend heavily on core engagement. A well-conditioned core enhances balance, stability, and quality of life, while weakness in this region increases the risk of injury even during routine tasks [5, 10].

The core musculature consists of both major and minor muscle groups that work together to support spinal

stability and enable efficient movement. Primary core muscles include the pelvic floor, transversus abdominis, multifidus, and diaphragm, while secondary muscles such as the obliques, rectus abdominis, erector spinae, and quadratus lumborum enhance trunk control. Minor muscles, such as the latissimus dorsi and gluteus maximus, help maintain dynamic balance. The transversus abdominis and multifidus, richly innervated and vascularized, play key roles in stabilizing the spine during daily activities [11, 12]. Together, these muscles work synergistically to stabilize the spine and provide a strong foundation for posture, functional activities, and injury prevention [13]. The internal and external obliques, rectus abdominis, erector spinae, quadratus lumborum, and diaphragm together form the structural and functional foundation of the core. These muscles originate from the pelvis, ribs, and spine and insert along the thorax and abdominal wall, enabling trunk flexion, rotation, side-bending, and spinal stability. The erector spinae group spans from the sacrum to the skull, while the diaphragm supports breathing and internal pressure regulation. Each muscle is uniquely innervated by spinal and peripheral nerves, contributing to posture, movement, and core strength. Collectively, these muscles form a strong and flexible core, allowing us to move, breathe, stabilize, and perform daily tasks safely and efficiently [14-16].

While both Obstacle Gait Training and Core Stability Exercises are recognized interventions for improving balance in the geriatric population, a significant gap exists: there's no clear consensus on which method is more effective. This present study aims to fill this void by directly comparing the effects and efficacy of these two interventions in older individuals aged 65 and above. By meticulously observing, comparing, and documenting the outcomes, this research seeks to determine which method works better and by what degree. Ultimately, this crucial insight will empower physiotherapists and caretakers to provide more targeted, evidence-based care, significantly enhancing the safety and well-being of those most vulnerable to falls.

MATERIALS AND METHODOLOGY

The study design utilized a Randomized Controlled Trial (RCT) with a single-blind approach. This design ensures robust intervention testing by comparing the effects of Core Stability exercise with those of Obstacle Gait Training in the geriatric population. A total of fifty-two participants were recruited from multiple settings. Eligible participants were randomly divided into two distinct groups: Group A serving as the experimental group and Group B as the control group. Before randomization, the study purpose and research methodology were clearly explained to each participant, and written informed consent was obtained.

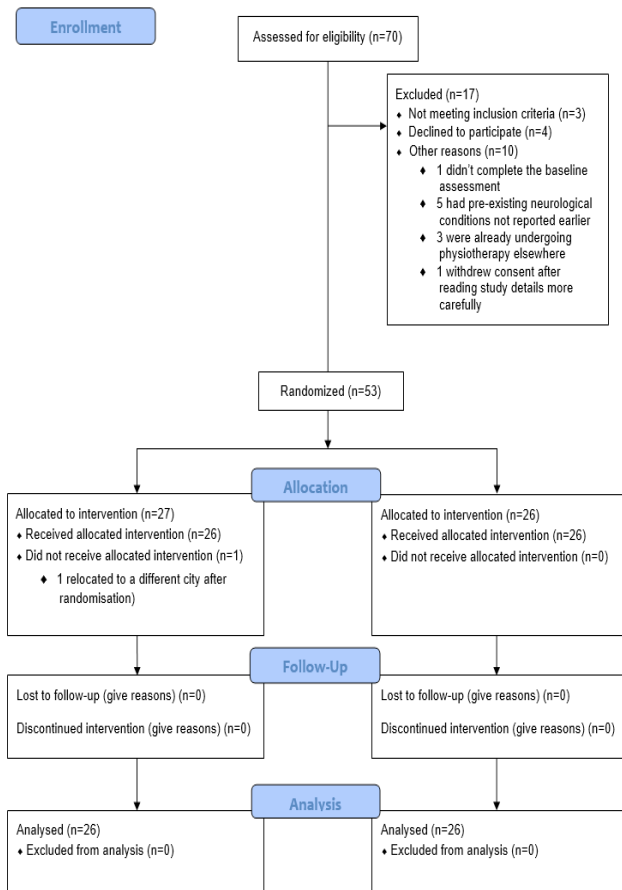


Figure 1: Patient allocation flow diagram

Figure 1 shows the flow diagram for selecting the samples allocated, followed by the analysis. Group allocation was performed using a randomization method with allocation concealment. Participants were randomly assigned to Group A and Group B. To ensure allocation concealment, the randomization process was conducted by a physiotherapy student who was not involved in the study design and was unaware of its objectives. This approach minimized the risk of selection bias. Furthermore, participants were not informed of their group assignments, preserving the single-blind nature of the study.

In total, 52 eligible participants met the eligibility criteria and participated in the study. Inclusion criteria comprised individuals aged 65-75 years, capable of walking short distances independently with the assistance of canes or crutches, and those experiencing balance difficulties, as identified using standardized clinical tools such as the Timed Up and Go Test, Rhomberg Test, and Functional Reach Test [17, 20]. Participants were required to have no significant visual or auditory impairments and no history of knee surgery within the past five years [2]. Exclusion criteria included those dependent on a walker or rollator for ambulation, individuals with severe cognitive or psychological disorders, any recent lumbar surgery, dermatological conditions or infections, and moderate to severe cardiac, pulmonary, neurological, hypertensive, or musculoskeletal disorders. Participants on psychotropic

medications were also excluded [2]. Outcome measures were evaluated both before and after the intervention. Balance performance was assessed using the Berg Balance Scale and the Fullerton Advanced Balance Score to evaluate changes in balance and functional stability.

Intervention

Participants in Group A underwent a combined intervention consisting of Core Stability Exercises along with Obstacle Gait Training, whereas Group B received only Obstacle Gait Training. The core stability exercises included the movements such as abdominal drawing-in maneuvers, bent leg fall-outs, and drawing-in techniques, supplemented with segmental strengthening tasks like:

- lifting a bent leg to 90 degrees of hip flexion,
- sliding the heel to achieve knee extension, and
- performing a straight leg raise to 45 degrees.

These exercises were designed to target and activate the deep trunk stabilizers during functional daily movements.

For the Obstacle Gait Training, tasks included zigzag walking, stepping over varied obstacles, figure-eight patterns, random path walking, and progressive hurdle stepping, all aimed at enhancing balance and coordination under dynamic conditions. Each session lasted 30 minutes, with short 1-minute rest intervals between exercises. All necessary safety measures were strictly observed to prevent falls or injury throughout the intervention and testing periods [16, 19].

Both groups participated in the intervention program, delivered three times per week for six weeks. Before the start of the treatment, baseline measurements were recorded at week 0, and the same outcome assessments were repeated at the end of the sixth week following the completion of the intervention. This pre- and post-assessment approach enabled precise evaluation of changes resulting from the respective training protocols [19].

Statistical Analysis

Post-intervention assessments were carried out on the day following the final exercise session to eliminate any immediate or short-term effects on the outcome measures. Pre- and post-intervention data were systematically compared within and between groups to evaluate the effectiveness of Core Stability Exercises and Obstacle Gait Training. Statistical analysis was performed using SPSS version 17, and results were expressed as Mean \pm Standard Deviation. A significance level of $p < 0.05$ was established to determine the statistical relevance of the findings. A significant p -value was interpreted as a meaningful effect of the interventions on the assessed variables. For within-group comparisons, a paired t -test was used. In contrast, independent t -tests were employed to compare outcomes between Group A (combined intervention) and Group B (core training only), ensuring a rigorous analysis of the intervention outcomes.

RESULT ANALYSIS

The average age of the individuals in groups A and B was 77.82 ± 4.27 and 72.23 ± 4.30 years, respectively (Tables 1 and

2). Group A contains a total of 26 subjects; the majority of them are seven subjects (26%) who had an age of 65-69, 7 subjects (26%) had an age of 70-74, 5 subjects (21.7%) had an age of 75-79, and 1 subject (3.8%) was aged 80. Group B contains a total of 26 subjects; the majority of them are total number of 8 subjects (30.7%) had age of 65-69, 9 subjects (34.6%) had age of 70-74, 7 subjects (26%) had age of 75-79, while one subject (3.8%) had age of 80-81.

Table 1: Descriptive statistics of Group A (Experimental Group)

	N	Mean	Std. Deviation
Age Valid N (list wise)	26	77.82	4.27

Table 2: Descriptive statistics of Group B (Control Group)

	N	Mean	Std. Deviation
Age Valid N (list wise)	26	72.23	4.30

Table 3 shows that Group A comprised 16 females (61.5%) and 10 males (38.5%), while Group B included 15 females (57.7%) and 11 males (42.3%). Overall, there were slightly more female participants across both groups. This gender distribution provides a fair representation for evaluating the effectiveness of the interventions.

Table 3: Frequency table of Gender

	Frequency		Percent		Valid Percent		Cumulative percent
	Group A	Group B	Group 1	Group 2	Group 1	Group 2	
Female	15	16	57.7%	61.5%	60.00	62.00	39.00
Male	11	10	42.30%	38.5%	42.00	39.00	100.00
Total	26	26	100%	100%	100.00	100.00	

In Group A (n=26), participants showed a marked improvement in balance following the intervention. Table 4 shows that the mean Berg Balance Scale score rose from 39.19 ± 2.62 to 45.46 ± 2.48 , with median values increasing from 39.00 to 45.50. Post-intervention scores also showed a broader interquartile range and higher minimum and maximum values. This significant enhancement, supported by a p-value of < 0.0001 , highlights the effectiveness of combining Core Stability Exercises with Obstacle Gait Training in enhancing balance in older adults.

Table 4: Intra-group comparison (pre and post) for Group A by using a paired t-test

Statistics	Pre intervention	Post intervention	p-value
N	26	26	t = 12.36 (< 0.0001)
Mean (SD)	39.19 (2.623)	45.46 (2.486)	
Median	39.00	45.50	
Q1, Q3	37.00, 41.25	43.75, 48.00	
Min, Max	35.0, 44.0	41.0, 50.0	

Group B (n=26) also demonstrated significant improvements in balance following the intervention. Table 5 shows that the mean Berg Balance Scale score increased

from 37.42 ± 1.74 to 41.23 ± 1.63 , with median values rising from 37.00 to 41.00. The interquartile range and overall score distribution also improved, reflecting consistent gains across participants. With a p-value < 0.0001 , the findings confirm that independent Obstacle Gait Training is beneficial for promoting balance and postural control in older people.

Table 5: Intra-group comparison (pre and post) for Group B by using a paired t-test

Statistics	Pre intervention	Post intervention	p-value
N	26	26	t = 9.83 (< 0.0001)
Mean (SD)	37.42 (1.748)	41.23 (1.632)	
Median	37.00	41.00	
Q1, Q3	36.00, 39.00	40.00, 43.00	
Min, Max	35.0, 41.0	39.0, 44.0	

In Group A, participants showed a marked improvement in balance, as indicated by Fullerton Advanced Balance (FAB) Scale scores. Table 6 shows that the mean score increased from 28.15 ± 2.31 pre-intervention to 33.92 ± 2.64 post-intervention. The median also rose from 28.00 to 34.00, with the interquartile range shifting from 26.00–30.00 to 32.00–36.00. Minimum and maximum scores improved notably as well. A paired-samples t-test revealed a highly significant difference (t = 10.72, p < 0.0001), indicating the intervention's effectiveness.

Table 6: Intra-group comparison (pre and post) for Group A for FAB by using a paired t-test

Statistics	Pre intervention	Post intervention	p-value
N	26	26	t = 10.72 (p < 0.0001)
Mean (SD)	28.15 (2.312)	33.92 (2.645)	
Median	28.00	34.00	
Q1, Q3	26.00, 30.00	32.00, 36.00	
Min, Max	24.0, 32.0	29.0, 38.0	

In Group B, the Fullerton Advanced Balance (FAB) Scale scores demonstrated significant improvement after the intervention. Table 7 shows that the mean score increased from 26.46 ± 2.00 to 30.73 ± 1.97 , while the median rose from 26.00 to 31.00. The interquartile range expanded from 25.00–28.00 at baseline to 29.00–32.00 post-intervention, indicating consistent progress among participants. Minimum and maximum scores also improved from 23.0–30.0 to 27.0–34.0. A paired-samples t-test confirmed the significance of this improvement, with a t-value of 8.53 (p < 0.0001).

Table 7: Intra-group comparison (pre and post) for Group B for FAB by using a paired t-test

Statistics	Pre intervention	Post intervention	p-value
N	26	26	t = 8.53 (p < 0.0001)
Mean (SD)	26.46 (2.008)	30.73 (1.968)	
Median	26.00	31.00	
Q1, Q3	25.00, 28.00	29.00, 32.00	
Min, Max	23.0, 30.0	27.0, 34.0	

A total of 52 participants were included, with 26 in each group. Table 8 shows the BBS scores; both Group A (Obstacle Gait Training + Core Stability) and Group

B (Obstacle Gait Training only) showed statistically significant improvement from pre- to post-intervention ($p < 0.0001$). Group A showed greater mean improvement than Group B, as confirmed by a statistically significant between-group difference ($t(50) = 6.42, p < 0.0001$). Similarly, FAB scores also showed significant pre-post improvements in both groups ($p < 0.0001$), with Group A showing superior gains ($t(50) = 5.82, p < 0.0001$). These findings suggest that combining obstacle gait training with core stability exercises may offer greater benefit in improving balance than core stability training alone.

Table 8: Inter-group comparison (pre and post) between Group A and Group B by using an independent t-test.

Measure	Test Type	Groups Compared	t(df)	p-value	Result
Berg Balance Scale (BBS)	Paired t-test	Group A (Pre vs Post)	t(25)=12.36	<0.0001	Significant improvement
		Group B (Pre vs Post)	t(25)=9.83	<0.0001	Significant improvement
	Independent t-test	Group A vs Group B (Post)	t(50)=6.42	<0.0001	Group A > Group B
Fullerton Advanced Balance (FAB) Score	Paired t-test	Group A (Pre vs Post)	t(25)=10.72	<0.0001	Significant improvement
		Group B (Pre vs Post)	t(25)=8.53	<0.0001	Significant improvement
	Independent t-test	Group A vs Group B (Post)	t(50)=5.82	<0.0001	Group A > Group B

DISCUSSION

The present study was designed to compare and evaluate the effects of Obstacle Gait Training and Core Stability Exercise on balance in geriatric adults, a population particularly vulnerable to falls, reduced independence, and related health complications. The results revealed that while both methods were effective in improving balance, the group that underwent Obstacle Gait Training demonstrated greater improvement. The use of cones, ridges, and agility tasks challenged their ability to navigate obstacles and demanded greater postural control and adaptability. These findings are in strong agreement with those of Reed Jones RJ et al. (2012), who observed that an intervention involving obstacle gait training led to a significant reduction in falls and improvements in balance among elderly participants [3].

Furthermore, Le Ge et al. (2023) supported these findings by demonstrating the benefits of core stability training in improving motor balance and symptoms associated with low back pain in older women. Although the effects were positively pronounced, their results were not as robust or task-specific as those stemming from gait training with obstacles. Nonetheless, this highlights the role of deep trunk muscles in postural control and stability, which form a strong base for movement and functionality in

daily life. The present findings are also in harmony with those of Yamada et al. (2012), who investigated the effects of complex obstacle-negotiation exercises and reported a dramatic reduction in falls and related injuries among their elderly participants. The complexity of the tasks challenged their ability to adapt, respond, and move safely in their environment, which is a key component of functional independence in the elderly population [9, 20].

Similarly, Sadeghi et al. (2020) demonstrated that core stability training, performed regularly over 8 weeks, resulted in measurable improvements in balance and gait within the elderly population presenting with mild cognitive decline and a documented tendency to fall. The intervention successfully addressed their postural control and stability, adding to the growing body of knowledge that strengthening the core can translate into functional benefits. Nevertheless, the greater improvement in the Obstacle Gait Training group underscores the necessity to incorporate functional, challenging, and context-specific tasks into intervention programs [21]. Furthermore, Patra et al. (2023) investigated the effects of motor relearning with obstacle walking. They found that adding obstacles to their training regimen led to greater improvements in dynamic walking ability and overall functional mobility among individuals recovering from subacute stroke. The present results align with these findings, emphasizing that negotiating obstacles provides a powerful stimulus for motor control, adaptability, and stability, all crucial components of balance in daily life [22].

Additionally, Manjusha Kutty et al. (2021) advocated core strengthening as an effective intervention to improve functional mobility and balance in the geriatric population. Nevertheless, the present study highlights that when this approach is combined with task-specific training, such as obstacle negotiation, the benefits are more pronounced and applicable to real-world scenarios, thereby reducing the risk of falls and improving independence [23]. The findings from Elizabeth V. Cyarto (2008) further underscore this view. His study demonstrated that a well-structured exercise and balance training intervention could produce substantial improvements in community-living older adults. Improvements were observed in both stationary and movement-based balance, thereby reducing fall risk. The current results reflect this principle, suggesting that a combination of physical challenge and adaptability is key to developing protective strategies against falls in this population [24].

Furthermore, Petrofsky et al. (2005) recognized the importance of strengthening the core muscles to provide a stable base for movement and balance. His intervention, which incorporated specialized abdominal and back-strengthening exercises, resulted in greater independence and improved ability to perform daily tasks, a testament to the fundamental role of core stability in overall physical function. Nevertheless, the present study highlights the additional benefits of a functional, task-specific approach when combined with core strengthening. This view is further supported by Lamoureux EL et al. (2003), who

demonstrated the effects of progressive resistance training combined with obstacle gait training in improving lower body strength and balance in older adults. The ability to navigate obstacles safely depends not just on pure muscle power but also on motor control, coordination, and adaptability, the components that are profoundly challenged during gait training in a realistic environment [25, 26].

Finally, Yamini et al. (2024) explored the synergistic effects of the Strain-Counterstrain method combined with targeted core conditioning on outcomes in adults with persistent low back pain. The study demonstrated that although both modalities produced positive results, combining manual therapy with core-focused exercise yielded greater improvements in pain alleviation and daily function. This provides additional support for the inclusion of core stability work in managing musculoskeletal dysfunctions and improving overall function. Our study builds on this by showing that while core stability is vital, incorporating functional, task-specific training, such as obstacle gait, can amplify these benefits, especially in the elderly [27]. The benefits of core stability training are not limited to the geriatric population alone. Recent evidence by Praveenkumar R. et al. (2025) highlights that incorporating jump training alongside neuromuscular core exercises significantly enhances functional capacity and reduces anterior knee pain and dynamic knee valgus among soccer players [28]. Similarly, Mohammed Luqman S. et al. (2024) demonstrated that Neurokinetic Therapy, a corrective approach targeting motor control dysfunctions, can produce meaningful improvements in core muscle endurance [29]. These findings open new possibilities for integrating diverse therapeutic approaches with core stability training to optimise outcomes. However, additional scientific inquiry is needed to better understand the interactive effects of these techniques on functional performance across various populations.

Overall, the present study underscores the superiority of Core Stability Exercise along with Obstacle Gait Training over Obstacle Gait Training alone in improving balance and reducing fall-risk in geriatric adults. Although both methods have their unique benefits and can be valuable components of a physical therapy regimen, the functional and task-specific nature of Obstacle Gait Training makes it a more potent intervention for this population. Importantly, this approach not only strengthens the body physically but also prepares it to respond effectively to real-world challenges, which is a key consideration in designing effective fall-prevention programs for the elderly. The present study had certain limitations, including the absence of long-term follow-up, a restricted age range of 65 to 75 years, and data collection limited to individuals residing in old-age homes and NGOs, possibly constraining the extent to which these results can be generalized to wider populations. Future research is recommended to address these gaps by conducting similar studies across broader age groups and different community settings. Larger randomized controlled trials with diverse outcome measures and

longer observation periods (e.g., longer follow-up) would be valuable for strengthening the evidence. Exploring alternative interventions within the same age group can also yield valuable insights into effective fall-prevention and balance-improvement strategies for the elderly.

CONCLUSION

The study demonstrates that while both Core Stability Exercises and Obstacle Gait Training effectively improve balance in the elderly, Core Stability Exercises showed superior outcomes. Strengthening the deep stabiliser muscles of the spine enhances postural control, providing a stable foundation for efficient limb movement. Obstacle Gait Training also proved beneficial by simulating real-life scenarios that often contribute to falls, such as navigating over obstacles, thereby improving functional balance. Notably, several participants who previously relied on walking aids were able to ambulate short distances independently by the end of the intervention.

Findings from this study reinforce the importance of embedding specialized, evidence-based exercise programs into geriatric rehabilitation to mitigate vulnerability to falls and promote independence. By applying such interventions, physiotherapists can improve mobility, confidence, and overall quality of life in older adults. This study adds valuable insight to existing research on fall prevention strategies, reinforcing the role of Core Stability and Obstacle Gait Training as effective, non-invasive tools for enhancing balance and reducing fall-related risks among the ageing population.

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