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Effects of Strength and Balance Training on BOSU in Elderly Individuals

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Abstract

This study aimed to investigate the effects of a 12-week BOSU-based strength and balance training program on postural stability, muscle strength, agility, flexibility, and quality of life in geriatric adults aged 65 and over. Thirty elderly men participated in the study. Participants engaged in supervised BOSU exercises three days per week. Pre-test and post-test measurements were conducted using valid tools such as the Y Balance Test, proprioception assessments, isometric strength tests, and the SF-36 Quality of Life Questionnaire. Statistical significance was assessed using appropriate parametric and non-parametric tests. Significant improvements were observed in balance, proprioception, and lower extremity muscle strength. Notable increases were also detected in agility (Hexagon Obstacle Test), flexibility, and vertical jump performance. Quality of life, as assessed by the SF-36, showed significant improvement. However, no statistically significant change was observed in the Closed Kinetic Chain Upper Extremity Stability Test results; this suggests that BOSU exercises may be less effective on closed kinetic chain stability. BOSU-based training was found to be effective in enhancing physical performance and quality of life in geriatric adults. The program positively contributed to balance, strength, and mobility, and was deemed a promising and accessible intervention for preventing falls and supporting independent living in the elderly.
Keywords: BOSU exercises, Elderly individuals, Balance, Muscle strength, Quality of life

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INTRODUCTION

Population aging has become a global reality, bringing heightened attention to age-related declines in physical function and fall risk. By 2030, one in six people worldwide will be aged 60 or older, and the number of older adults is projected to reach 2.1 billion by 2050, nearly doubling its share of the global population from 12% in 2015 to 22% (World Health Organization [WHO], 2024). Falls and fall-related injuries are among the leading threats to older adults' health, functional ability, and autonomy, often precipitating disability, loss of independence, and even premature mortality (Ambrose et al., 2013; WHO, 2021). Globally, falls are the second leading cause of unintentional injury death; WHO (2021) estimates that approximately 684,000 people die each year due to falls, with adults over 60 suffering the greatest number of fatal falls. Non-fatal falls are extremely common roughly one-quarter to one-third of community-dwelling older adults experience at least one fall annually and about 5–10% of these result in serious injuries such as fractures or head trauma. Beyond the immediate harm, falls contribute substantially to years lived with disability, generate considerable healthcare costs, and can lead to a fear of falling, which in turn promotes activity restriction, social withdrawal, and physical deconditioning (Salari et al., 2022). This interplay underscores the urgent need for effective preventive strategies.

Age-related physiological changes, including sarcopenia, muscle weakness, impaired postural control, slowed gait, and sensory deficits, are well-established intrinsic risk factors for falls (Montero-Odasso et al., 2022; Sherrington et al., 2017). In particular, lower-limb strength loss and proprioceptive decline play a crucial role in balance deterioration and fall susceptibility (Pizzigalli et al., 2011). Loss of balance is a strong predictor of falls, and older adults often show reduced capacity to recover stability after perturbations (Delbaere et al., 2010). Given that muscle weakness and balance deficits are modifiable factors, interventions targeting these domains are central to fall-prevention guidelines (WHO, 2021; Zhu et al., 2025).

Evidence from randomized controlled trials and meta-analyses demonstrates that appropriately designed exercise programs can significantly reduce fall incidence and improve functional outcomes in older adults. Sherrington et al. (2017) found that exercise as a single intervention reduces fall risk by up to 39% when performed for at least three hours weekly, with the greatest benefits seen in programs combining balance and strength training. Multi-component interventions, such as the Otago Exercise Program or Tai Chi, have consistently improved postural stability, mobility, and confidence (Cadore et al., 2013; Sherrington et al., 2017). As a result, international guidelines strongly recommend regular, progressive, and challenging balance and resistance training for older populations (Montero-Odasso et al., 2022; WHO, 2021).

Recently, unstable-surface and perturbation-based training have gained attention as potentially more effective approaches for enhancing neuromuscular responses and balance adaptation (Rizzato et al., 2024). Comparative trials in geriatric populations now indicate that, while stable-surface programs may yield slightly faster gains in raw strength, unstable or

metastable protocols produce superior improvements in dynamic balance, gait-related tasks, and fall-related self-efficacy, which are the clinically more relevant outcomes for this age group (Pillay et al., 2024; Guirguis-Blake et al., 2024; Claußen et al., 2025). Traditional training on stable ground may not fully stimulate the rapid postural adjustments required in real-life situations (Yee et al., 2023). Unstable surfaces such as balance discs, wobble boards, foam pads, and BOSU trainers introduce controlled instability, compelling continuous activation of core muscles and proprioceptive pathways (Tan et al., 2024). Studies have shown that training under these conditions can improve dynamic balance, reactive stability, and muscle activation beyond stable-surface training (Rizzato et al., 2024; Yee et al., 2023).
The BOSU trainer, in particular, allows for both dome-up and platform-up exercises, promoting multi-directional instability. BOSU-based training has been shown to enhance balance, strength, and proprioception simultaneously (Tan et al., 2024). Priyadharshini et al. (2024) reported that BOSU balance training produced greater gains in functional balance among institutionalized geriatric adults than static balance exercises. Similarly, Pentewar et al. (2023) found superior improvements in balance measures when lower-limb resistance training was conducted on BOSU compared to stable ground. Kurtoğlu et al. (2024) demonstrated that an eight-week BOSU program improved core stability, balance, and quality of life (QoL) in geriatric adults. These results suggest that BOSU-based unstable-surface training may provide additive benefits over conventional training for fall prevention and functional independence.

Despite these promising findings, few studies have investigated the long-term effects of BOSU training in community-dwelling geriatric adults, particularly across a comprehensive set of functional and psychosocial outcomes. The present study addresses this gap by examining the effects of a 12-week BOSU-based strength and balance training program on postural stability, muscle strength, agility, flexibility, and QoL in males aged 65 and above. It is hypothesized that BOSU training will yield significant improvements across these domains, supporting its role as an effective and accessible intervention to promote healthy aging and reduce fall risk.

METHOD

Research Model

This study was designed as a prospective, experimental pre-test and post-test comparative study.

Research Groups

A total of 30 geriatric adults (aged ≥65 years) participated in this study. Participants were included if they were able to move independently without assistive devices. Individuals were excluded if they presented with any orthopedic, neurological, or cognitive disorders, or if they had participated in regular exercise within the previous six months.

Procedures

Balance: The Y Balance Test (YBT) was used to assess dynamic balance and postural control by measuring a participant's ability to reach in multiple directions while maintaining a single-leg stance. This test evaluates lower limb stability, neuromuscular coordination, and functional mobility, all crucial for fall prevention in geriatric adults. Participants stood barefoot on one leg at the center of a Y-shaped platform with reach indicators extending anterior, posteromedial, and posterolateral. While balancing on the dominant leg, the participant reached as far as possible in each direction with the other leg and returned to the start without losing balance or touching the ground. Each direction was tested three times, and the maximum reach distance was recorded. Reach distances were normalized to leg length and averaged to provide a composite score reflecting dynamic stability. If balance was lost or the reaching foot touched down, the trial was invalid and repeated (Türkeri et al., 2020).

Proprioception: The active joint angle reproduction test was used to evaluate proprioceptive accuracy and joint position sense, particularly in the knee. This test measures an individual's ability to actively reproduce a predetermined joint angle without visual feedback, reflecting proprioceptive function critical for balance and coordination. Participants were seated with hip and knee at 90° flexion. The dominant leg was secured to minimize movement, and a goniometer measured knee angles. The physiotherapist passively moved the participant's knee to predetermined angles (30° and 60° flexion) and held for 5 seconds to allow sensory feedback. Participants focused on the joint position, then after returning to start, actively replicated the angle without visual cues. Once the participant indicated they reached the perceived target angle, the physiotherapist recorded the actual angle. The absolute error (difference between reference and reproduced angle) was calculated in degrees; a lower error indicated better proprioceptive accuracy (Pincivero et al., 2001).

Muscle Strength: Isometric muscle strength of the hamstrings and quadriceps was measured using a handheld dynamometer (Lafayette Instrument). For quadriceps, participants sat with the device placed on the anterior distal leg; for hamstrings, participants lay prone with the device on the posterior distal leg. Participants exerted maximum force for 3–5 seconds. Each muscle group was tested three times, with the highest value recorded (Brennan et al., 2016).

Agility: The Hexagonal Obstacle Test was used to assess agility and coordination. A hexagon (66 cm side length) was marked on the floor. The participant started at the center and jumped with both feet over each side in a clockwise or counterclockwise sequence, returning to center after each jump. The time to complete three full circuits was measured with a stopwatch, where shorter times indicate better agility (Akaras et al., 2023).

Vertical Jump: The Vertical Jump Test was used to assess explosive lower limb power. Participants stood adjacent to a wall and reached up to mark their standing reach height. Then they jumped off both feet to touch the highest point on the wall. The difference between jump reach and standing reach heights was recorded as the vertical jump height. Three trials were done, with the best jump height recorded (Pilça & Altun, 2019).

Closed Kinetic Chain Lower Extremity Stability (CKCLEST): This test evaluates lower extremity stability, balance, and functional movement. In a plank position (forearms and toes on ground), the participant touches one foot to the opposite side, then returns to plank, and repeats with the other foot. The number of repetitions in 15 seconds was recorded. Three trials were conducted, and the best score was used for analysis (Arikan et al., 2022).

Flexibility: The Sit-and-Reach Test assessed lower back and hamstring flexibility. The participant sat on the floor with legs extended and feet against a sit-and-reach box. They reached forward with hands stacked, and the farthest reach distance was recorded. Three trials were done, with the best distance recorded; greater distances indicate better flexibility (Akaras et al., 2023).

Quality of Life: The SF-36 Health Survey was used to assess physical and mental well-being across eight domains (physical functioning, social functioning, pain, general health, mental health, vitality, and physical/emotional role limitations). Scores for each domain are scaled 0–100, with higher scores indicating better health status. The SF-36 is a validated and reliable measure of QoL (Pınar, 2005).

Ethics Approval

The research protocol was approved by the Erzurum Technical University Scientific Research and Publication Ethics Committee (Ethics Approval Date/No: 16.05.2024 - Meeting No: 6, Decision No: 5). The study was conducted in compliance with the Declaration of Helsinki. All participants were thoroughly informed about the study both verbally and in writing, and written consent was obtained from each individual before participation.

Data Collection

Participants underwent a 12-week BOSU-based balance and strength training program, conducted three days per week for 45 minutes per session. Each session was supervised by a certified physiotherapist to ensure safety and adherence. Participants were required to attend at least 90% of the training sessions to be included in the final analysis. Compliance was monitored through an attendance log maintained by the physiotherapist; participants who missed more than 3 consecutive sessions were contacted for follow-up.

Analysis of Data

Data were analyzed using SPSS 22.0 software. Normal distribution was assessed with the Shapiro-Wilk test. For normally distributed variables, the Paired Samples t-test was used to compare pre- and post-test results; for non-normally distributed variables, the Wilcoxon Signed-Rank Test was used. A significance level of $p<0.05$ was considered statistically significant.

FINDINGS

Table 1. Demographic data

Demographic Parameters	*M ± SD*
Age (years)	71.77 ± 3.70
Height (cm)	169.83 ± 4.86
Weight (kg)	74.80 ± 11.25
BMI (kg/m²)	26.04 ± 4.42

Abbreviations: M: Mean, SD: Standard Deviation, BMI: Body Mass Index

The study included 30 male participants aged 65 and over (mean age 71.77±3.70 years). The participants' baseline demographic and anthropometric characteristics (including height, weight, and BMI) are detailed in (Table 1).

Table 2. Pre-test – post-test measurements

Measurement Parameters	*Pre-test M ± SD*	*Post-test M ± SD*	p
Y Balance Dominant Leg (Total Score)	55.33 ± 6.02	59.70 ± 6.50	**<0.01**
Proprioception 30° (dominant leg)	4.43 ± 1.10	2.93 ± 1.17	**<0.01**
Proprioception 60° (dominant leg)	5.13 ± 1.50	4.40 ± 1.57	**0.04**
Vertical Jump (both legs)	15.23 ± 3.06	17.87 ± 3.43	**<0.01**
Agility (Hexagonal Test)	36.37 ± 5.32	31.60 ± 5.26	**<0.01**
CKCLEST	11.40 ± 2.62	11.87 ± 2.96	0.25
Hamstring Isometric Strength	24.87 ± 4.77	29.67 ± 4.35	**<0.01**
Quadriceps Isometric Strength	28.43 ± 5.16	33.93 ± 5.36	**<0.01**
Flexibility (Sit and Reach Test)	9.70 ± 3.52	12.60 ± 3.63	**<0.01**
Quality of Life (SF-36 Score)	48.97 ± 10.44	57.67 ± 9.88	**<0.01**

Abbreviations: M: Mean, SD: Standard Deviation, CKCLEST: Closed Kinetic Chain Lower Extremity Stability Test

BOSU exercises significantly improved balance skills, indicating that these exercises enhance postural stability and coordination ($p<0.01$). BOSU exercises increased participants' proprioceptive awareness, leading to improvements in body perception. A moderate improvement was observed in proprioception, but the progress at 60° was more limited compared to the 30° angle. BOSU exercises contributed to lower limb muscle strength enhancement. The increase in vertical jump performance suggests that leg muscles strengthened and there was an improvement in explosive power ($p<0.01$). BOSU exercises also enhanced participants' agility and movement speed ($p<0.01$). The reduction in Hexagonal Test time indicates a notable improvement in speed and directional change skills. No statistically significant difference was found in the CKCLEST test ($p>0.05$). Since this test evaluates closed kinetic chain movements for lower limb stability, BOSU exercises might not have contributed significantly to functional stability development (Table 2).

Hamstring muscle strength showed a highly significant increase between pre-test and post-test ($p<0.01$). Since BOSU exercises actively engage hamstring muscles to maintain dynamic stability, this result was expected. This improvement is particularly valuable in fall prevention. A highly significant increase in quadriceps muscle strength was observed ($p<0.01$). The quadriceps play a crucial role in balance and walking. BOSU exercises activate the quadriceps more to maintain stability, making this result expected. The Sit & Reach Test, used to evaluate flexibility, showed a statistically significant improvement ($p<0.01$). The dynamic movements involved in BOSU exercises may have been effective in enhancing muscle elasticity and flexibility. This improvement could support increased mobility in older adults during daily activities. There was a statistically significant increase in QoL ($p<0.01$). The enhancement in physical abilities due to BOSU exercises may have increased participants' independence in daily activities. This improvement potentially reduced fear of falling and contributed positively to overall health status and QoL (Table 2).

DISCUSSION and CONCLUSION

The present study demonstrated that a 12-week BOSU-based balance and strength training program produced significant improvements in multiple domains of physical function among community-dwelling older adults. Specifically, participants showed enhanced postural stability, lower-limb muscle strength, agility, flexibility, and health-related (QoL) following the intervention. These multifaceted gains align with the broad consensus in gerontological research that targeted exercise programs can substantially ameliorate age-related declines in mobility and reduce fall risk (Sherrington et al., 2017; Zhu et al., 2025). In particular, combining balance and resistance training as done in our program is known to be especially effective for improving functional outcomes in seniors (Montero-Odasso et al., 2022; Sherrington et al., 2017). Our findings therefore reinforce existing evidence while extending it to a comprehensive BOSU-based regimen, underlining the potential of unstable-surface training as a practical tool for healthy aging.

Improvement in dynamic balance was one of the most pronounced outcomes of this study, as evidenced by significantly better Y-Balance Test scores. Effective balance is fundamental for fall prevention and independent living in older populations, and our results corroborate prior studies showing that progressive balance training interventions of similar duration (12 weeks, 2–3 sessions/week) yield substantial enhancements in stability measures (Lesinski et al., 2015; Rizzato et al., 2024). Notably, the BOSU-based exercises in our program elicited greater gains in balance performance than typically seen with equivalent training on stable surfaces, which is consistent with recent comparative trials. For example, Priyadharshini et al. (2024) and Pentewar et al. (2023) both reported superior improvements in balance outcomes for older adults when exercises were conducted on a BOSU or unstable platform, compared to traditional ground-based training. The added instability of the BOSU likely stimulates continuous engagement of core and ankle stabilizer muscles and challenges the vestibular and somatosensory systems, leading to enhanced proprioceptive acuity and postural control (Tan et al., 2024; Yee et al., 2023). This mechanism is supported by Lizardo et al. (2017), who found that BOSU proprioceptive training significantly increased electromyographic activity in ankle stabilizers, indicating heightened neuromuscular responsiveness to perturbation. Likewise, short-term training on unstable platforms has been shown to improve static and dynamic stabilimeter indices (Romero-Franco et al., 2013) and joint position sense (Winter et al., 2022; Yoon et al., 2022), reflecting enhancements in the body's ability to detect and correct deviations in center-of-mass position. In our study, improved proprioception (as assessed by joint position reproduction tests) likely underpinned the observed balance gains. These findings collectively suggest that incorporating unstable-surface exercises such as BOSU drills can amplify the effectiveness of balance training programs for older adults by targeting proprioceptive pathways and reactive balance capabilities. Importantly, however, not all aspects of stability showed uniform improvement: we observed no significant change in the Closed Kinetic Chain Lower Extremity Stability Test (CKCLEST). This newly developed measure of dynamic knee stability (Arikan et al., 2022) may not have been sufficiently targeted by our BOSU exercises, which focused more on whole-body balance and functional movements. The lack of CKCLEST improvement could indicate that BOSU training, while excellent for dynamic postural control, might need to be complemented with more specific closed-chain or high-intensity drills to influence certain stability parameters. This nuance invites further investigation into how unstable-surface training transfers to different facets of balance and joint stability.

The BOSU-based program led to significant increases in lower-extremity strength, particularly in the quadriceps and hamstrings, which are crucial for gait, transfers, and fall prevention. This result aligns with the growing body of literature showing that older adults can achieve meaningful strength gains even with balance-challenging exercises. Traditionally, there has been concern that instability might limit maximal force production; however, our findings and those of others demonstrate that perturbation-rich training can stimulate muscle activation and strength development effectively (Bencke et al., 2023; Shultz et al., 2015). Bencke et al. (2023) observed that performing exercises under unstable conditions elicited greater thigh muscle activation (electromyography amplitude) than on stable ground, presumably due to the co-contraction and reflex engagement required to maintain balance. Similarly, Shultz et al. (2015) reported improved agonist–antagonist co-contraction around the knee during BOSU training, which enhances joint stability and can protect against injuries. These neuromuscular adaptations likely contributed to the strength improvements in our study. It is also notable that our combined approach improved strength without the need for heavy external loads, highlighting the efficiency of functional, body-weight exercises on unstable surfaces for relatively deconditioned populations. Improving muscular strength is particularly important given its known relationship to fall risk, older adults with greater lower-body strength are more capable of correcting balance losses and preventing falls (Pizzigalli et al., 2011). Indeed, a recent meta-analysis confirmed that resistance training interventions alone can reduce falls in seniors (Claudino et al., 2021). Our program's success in increasing strength while simultaneously training balance is therefore a significant outcome, as it addresses two key modifiable risk factors for falls simultaneously. The positive effect on vertical jump performance observed (as a proxy for lower-body power) further suggests that BOSU exercises can improve not just slow, controlled force production but also explosive ability, potentially through enhanced motor unit recruitment and intermuscular coordination. This improvement in power can translate to quicker stepping responses and recovery actions when balance is perturbed, an important aspect of fall avoidance.

We found that participants' agility, assessed via a timed directional-change test (e.g., Hexagonal Obstacle Test), improved significantly post-intervention. Agility, the capacity to rapidly and accurately change body position is not commonly measured in geriatric exercise studies, yet it has direct relevance for real-world fall avoidance (e.g., quickly stepping around an obstacle or regaining balance). Our results indicate that dynamic balance training on a BOSU can confer benefits for these high-level mobility skills. The mechanism for agility gains likely overlap with those for balance and power: the BOSU drills required quick reflexive adjustments and engaged multiple sensory inputs (visual, vestibular, proprioceptive) to maintain stability during movement. Over 12 weeks, this likely improved the integration of sensory feedback with motor responses, enabling faster and more coordinated reactions. Yoon et al. (2022) reported analogous findings in a different context, showing that a proprioceptive training program enhanced not only balance and joint position sense but also agility in adult volleyball players. Although athletes differ from older adults, the underlying principle is similar – training the neuromuscular system to respond quickly and accurately to instability can improve agility-related performance. Additionally, the strength gains from our program would have contributed to agility improvements, since stronger leg muscles can generate the propulsive forces needed for rapid movements more effectively (Yoon et al., 2022). This interdependence between strength and agility is well recognized in functional tasks: an older adult who is stronger is better equipped to make a quick protective step or to change direction swiftly during walking. In practical terms, improved agility in our participants may mean better ability to avoid a trip hazard or to recover from a stumble, complementing the improvements seen in static and dynamic balance. This broad enhancement of functional mobility highlights the benefit of a multimodal approach (combining balance, strength, and movement exercises) on tasks that are crucial for safe ambulation in daily life.

Another notable outcome was the increase in flexibility (assessed by the sit-and-reach test). While flexibility training was not a primary focus of the program, many BOSU exercises involved dynamic stretching and a greater range of motion than habitual activities for sedentary older adults. For instance, BOSU lunges and single-leg reaches inherently require a stretch of the calf, hip, and hamstring muscles, and the inclusion of a cooldown with static stretching likely augmented these effects. Improvements in flexibility with balance or strength training interventions are not frequently reported, but our findings suggest that a well-rounded exercise regimen can yield ancillary benefits in joint range of motion. This is consistent with the idea that regular physical activity attenuates the loss of flexibility associated with aging, thereby reducing stiffness and improving posture and gait (Stathokostas, 2013). Enhanced flexibility is functionally important for tasks such as reaching overhead or bending down, and it may also contribute to fall prevention by expanding the "safe" range of motion in which an individual can recover balance without injury. In our study, greater hamstring and lower-back flexibility could have eased the performance of certain balance tasks and improved stride length in gait, although these specific mechanisms were not directly measured. From a physiological standpoint, the unstable surface training might promote flexibility by continually activating stretch reflexes and improving muscle length-tension relationships through the small postural adjustments required on the BOSU (Tan et al., 2024). Overall, while flexibility was a secondary outcome, its improvement adds to the comprehensive profile of benefits from the BOSU program and underscores the value of including stretching and multi-planar movements in exercise routines for older adults.

Beyond the physical performance metrics, our intervention produced a significant enhancement in participants' self-reported QoL as measured by the SF-36 questionnaire. After 12 weeks, improvements were noted in both physical health and perceived well-being domains. Such findings are in agreement with the literature linking regular exercise to better health-related QoL in older populations. A meta-analysis by Raafs et al. (2020) found that exercise training has a moderate positive effect on overall QoL in community-dwelling older adults, particularly improving the physical and psychological components of well-being. In our study, participants' gains in strength, balance, and mobility likely translated into greater confidence and independence in daily activities, which in turn reduced anxiety about falling and improved mental health indices. This interpretation is supported by Yang et al. (2025), who reported that a 12–24 week exercise program (encompassing aerobic, resistance, or balance exercises) led to significant improvements in both the physical and mental components of SF-36 scores in an older adult cohort. Notably, Kurtoğlu et al. (2024) observed that even an 8-week BOSU-based exercise regimen (albeit in a younger population with disabilities) yielded enhanced core strength and balance accompanied by higher life-quality scores, highlighting the link between functional fitness and perceived health status. Although Kurtoğlu's sample differs from ours, both studies emphasize that improving core stability and balance can boost confidence in movement, thereby positively influencing daily functioning and social participation (Kurtoğlu et al., 2024). It is worth mentioning that QoL is a multifactorial construct; while physical improvements play a major role, the social aspect of participating in a supervised group exercise program (even if not explicitly measured) may also have contributed to better emotional well-being in our participants. Many reported enjoying the sessions and feeling a sense of accomplishment, which can combat the social isolation and sedentary behavior that often undermine older adults' QoL. Thus, our findings reinforce the recommendation that exercise programs for seniors should be promoted not only for physical benefits but also for the substantial psychosocial gains and improved life satisfaction they confer (Raafs et al., 2020; Yang et al., 2025).

A strength of this study is the comprehensive scope of outcomes assessed. By evaluating balance, strength, agility, flexibility, and QoL together, we were able to capture a broad picture of functional health in our participants and demonstrate that BOSU-based training can concurrently improve multiple aspects of fitness. The use of well-validated objective tests (e.g., Y-Balance Test, isometric strength measures) alongside subjective measures (SF-36 questionnaire) strengthens the credibility of the results and reduces the likelihood that improvements were due solely to placebo or expectation effects. Additionally, the intervention was supervised by qualified professionals, ensuring a high level of adherence and safety factors that mirror real-world implementation in community exercise programs.

This study has several limitations that should be acknowledged. First, the sample consisted solely of community-dwelling geriatric men, which limits the generalizability of the findings to women, institutionalized elders, or individuals with higher frailty levels. Second, the intervention lasted 12 weeks and outcomes were assessed immediately post-intervention; therefore, we cannot determine the durability of the improvements or the minimum maintenance dose required, which recent fall-prevention guidelines emphasize (Guirguis-Blake et al., 2024; van der Velde et al., 2025). Third, a pre–post single-group design was used, so we were not able to directly compare BOSU-based training with alternative evidence-based programs such as Otago, Tai Chi, or high-challenge balance circuits that are frequently recommended in network meta-analyses (Pillay et al., 2024). Finally, although several functional outcomes improved, fall incidence and balance confidence were not tracked; future trials should add these clinically meaningful endpoints.

Building on these findings, future research should aim to address the limitations and open questions identified. Randomized controlled trials (RCTs) with larger sample sizes are needed to confirm the efficacy of BOSU-based training against control conditions or alternative interventions. For instance, comparing BOSU training to conventional strength training or to multimodal programs (like Tai Chi or Otago exercise) would clarify the added value of unstable-surface elements. Such comparative studies could also illuminate whether BOSU exercises mainly enhance certain capacities (e.g., dynamic balance and agility) more than traditional methods, which could guide tailored exercise prescriptions. It would be valuable to include older women and more frail individuals in future BOSU trials, as these groups might respond differently or face different practical barriers. Longitudinal follow-up is another important direction: examining if gains from a 12-week program are retained over 6 or 12 months, and whether periodic “booster” sessions are necessary to sustain improvements. Future studies might also explore the optimal training dose and intensity for this population – for example, is three days per week for 12 weeks sufficient, or would a longer or more frequent program yield significantly greater benefits? Recent meta-analytic evidence suggests that certain exercise dose parameters (like higher weekly frequency and challenging balance exercises) maximize fall-risk reduction (Sherrington et al., 2017; Zhu et al., 2025). BOSU training could be integrated into such regimes, and research should determine the ideal balance between intensity and safety for very old adults. Additionally, mechanistic studies could enhance our understanding of how BOSU training works: for example, using motion capture and muscle activation analysis to quantify improvements in reactive stepping or perturbation responses pre- vs. post-training. This could elucidate the specific neural and muscular adaptations (e.g., faster reaction times, improved muscle coordination) that underpin functional improvements. We also encourage exploring the psychological impacts of BOSU and balance training – does successful mastery of unstable exercises reduce fear of falling or improve cognitive function (through heightened concentration and dual-task training)? Preliminary evidence links physical training with cognitive and mood benefits in seniors, and unstable-surface training might have unique effects in these domains (Winter et al., 2022). Finally, from a public health perspective, implementing BOSU-based exercise programs in community centers or rehabilitation settings warrants investigation. Factors such as cost, accessibility, and adherence in unsupervised or group settings should be studied, potentially through implementation trials. For example, Vandervelde et al. (2023) highlight strategies for deploying multifactorial fall-prevention interventions in the community; incorporating novel tools like BOSU within such frameworks could be tested for feasibility and effectiveness.

In summary, this study provides evidence that a structured 12-week BOSU-based exercise program can yield broad-ranging benefits for older adults, improving their balance, strength, agility, flexibility, and QoL. These improvements, achieved through engaging and relatively low-tech unstable-surface exercises, suggest that BOSU training is a promising and accessible intervention to bolster functional fitness in geriatric adults. Our findings contribute to the growing literature advocating for multi-component exercise approaches in geriatric health and underscore the potential of proprioceptive-rich training to enhance both physical and psychosocial outcomes. By improving the physical capabilities that underlie fall prevention and daily function, such programs can play a key role in supporting independent living and healthy aging. Future research and clinical efforts should continue to refine these interventions, striving to maximize their effectiveness, ensure their inclusivity (for different populations), and facilitate their implementation on a broader scale. With the global population rapidly aging, investing in evidence-based exercise strategies like BOSU training is a proactive step toward reducing fall-related morbidity and improving the QoL of our seniors.

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