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An 8-week reactive balance training program in older healthy adults: A preliminary investigation

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Abstract

Background: This preliminary study examined the effects of an 8-week supervised reactive balance training program on reaction time (RT) and foot speed, static balance and balance confidence in healthy older adults compared to an exercise control group.
Methods: Twenty-five older adults were randomly assigned to a reactive balance training group (QuickBoard; $n = 12$; 71.0 ± 8.6 years) or a stationary cycling group (control; $n = 13$; 70.2 ± 6.0 years). Both groups were tested for foot RT foot speed, static balance, and balance confidence at baseline, 4-week, 8-week, and 4-week follow-up.
Results: Results indicated significant improvements in QuickBoard foot RT and speed in both groups with greater improvements in the QuickBoard group. However, no group difference was found in static balance performance.
Conclusion: Although the improvements in RT and foot speed may be beneficial for fall and trip prevention, the implications of the current findings for trip avoidance and performance of daily tasks are unclear.

Keywords: Balance; Elderly; Exercise; Reactive training

1. Introduction

Falls are a well-known problem among the elderly and it has been reported that one in three people aged 65 years and over fall once or more each year.[1,2] Moreover, falls often lead to fractures and related illnesses, loss of independence, functional limitation, and mortality in the elderly population.[3,4] A recent review of the literature on risk factors for falls in older adults indicated that gait changes and poor balance ability are among the major fall risk factors.[5] Specifically, gait patterns in older adults tend to be less coordinated with poorer postural control. Older adults may also be less capable of weight shifting or executing rapid response steps to avoid falls when their balance is unexpectedly perturbed. Due to this ineffective stepping reaction and reduced sensory-motor coordination along with other risk factors such as reduced lower extremity strength, balance control for the elderly populations is significantly reduced.

A large amount of research has focused on balance improvement and fall prevention through exercise programs in older adults.[6–13] A portion of these efforts have been devoted to assess the effectiveness of reactive balance training through rapid responses to visual stimulus which are of great importance for preventing falls during daily tasks in the elderly. Grabiner et al.[14] found that a fall-specific training program (i.e., forward-directed stepping response to backward-directed postural perturbations) can reduce the number of falls during laboratory-induced trips compared to a non-trained control group. Moreover, a recent study found that a general exercise program (i.e., general strength and aerobic training), an agility program and a visual training program all lead to significant gains in fitness, mobility, and power.[15] However, the study showed that visual training (i.e., Nintendo™ Wii Fit Balance Plus) lead to the most significant obstacle course performance

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improvements (i.e., faster completion times and less errors). The authors concluded that training of sensory-motor integration through visual training may be an important component for dynamic balance improvements and fall prevention in older adults during functional integrative gait tasks (i.e., daily gait tasks). Furthermore, Hagedorn and Holm[16] found significant improvements of static balance for traditional static balance training (i.e., standing on soft surfaces with eyes open and closed) but not for visual computer feedback balance training (i.e., weight shifting in response to visual feedback) over a 12-week period in frail elderly patients. However, their visual feedback training showed clear improvements in two dynamic functional mobility tests. Training on a virtual-reality system (i.e., postural virtual training games) has shown to significantly improve static balance (i.e., limits of stability), reduce fear of falling and number of falls during a 6-week training period in older adults.[9] Based on current literature findings,[9,14–16] it appears that task-specific stepping response and visual training may be effective for fall prevention through functional balance and mobility improvements in older adults.

Previous research indicates that fear of falling and impaired balance confidence may negatively affect behaviors of the elderly. For instance, Klima et al.[17] showed that balance confidence assessed with the Activities-specific Balance Confidence (ABC) scale in older men was moderately to highly positively correlated with the Berg Balance Scale (BBS; i.e., assessment of balance impairment). In addition, Portegijs et al.[18] also showed a high positive correlation between the ABC scale and BBS along with the Timed Up and Go (TUG) (i.e., functional balance performance test), level-walking speed and self-reported physical activity. Thus, not only are training programs for strength and reactive response improvements important, high balance confidence appears to be associated with increased mobility and balance performance.

The QuickBoard (The QuickBoard, LLC, Memphis, TN, USA) is often used in athletic settings as a tool for improving lower limb movement performance, such as movement speed, reaction time (RT), and agility which involves quick change of movement directions. The QuickBoard requires users to rapidly steps on specific ground targets in response to a visual stimulus and can be used for both training and testing purposes with a high test–retest reliability.[19] It allows individuals to work at their own effort and provides convenient knowledge of results (KR; performance feedback) to ensure maximal efforts in order to reach a particular goal. To date, no studies have investigated the effects of QuickBoard training on movement speed, RT and balance in a healthy elderly population.

The purpose of this preliminary study was to examine the effects of an 8-week QuickBoard training program on RT foot speed, static balance, and balance confidence in healthy older adults compared to an exercise control group during pre-, middle (4-week), post- and follow-up tests. It was hypothesized that the QuickBoard group would improve on QuickBoard RT foot speed, static balance, and balance confidence over the 8-week period and would show significantly greater improvements compared to the cycling control group. The larger improvements in QuickBoard RT and foot speed within the QuickBoard group are expected due to the specificity of these tests with the training group. Although previous research has confirmed these improvements in QuickBoard testing variables in healthy young men, this effect is unknown in healthy older adults.

2. Methods

2.1. Participants

Twenty-five healthy older adults were recruited from local community centers and from the university campus via recruitment flyers and emails to participate in the study. Participants were randomly assigned to a stationary cycling group ($n = 13$; 70.2 ± 6.0 years; 1.7 ± 0.1 m; 75.5 ± 17.0 kg; BMI: 26.0 ± 4.5 kg/m^2; 6 men and 7 women) and a QuickBoard group ($n = 12$; 71.0 ± 8.6 years; 1.6 ± 0.1 m; 66.7 ± 10.6 kg; BMI: 25.7 ± 3.6 kg/m^2; 6 men and 6 women). All participants met the inclusion criteria which included: no previous joint replacement surgeries, no current lower extremity joint injuries, no history of neurological disorders or health problems, able to perform sub-maximal physical activity, and able to follow instructions. All participants were screened for inclusion criteria via a phone interview. Participants had not had any agility or balance training prior to the start of the study. They completed a general health questionnaire and provided written informed consent approved by the Institutional Review Board for ethical human subject research before the participation in the study.

2.2. Instrumentation

The QuickBoard consists of a ground platform with five foot targets arranged with two targets at the front, one in the middle and two at the back of the board (Fig. 1A). The board is connected via cable to a control unit (Fig. 1B) that provides visual feedback for required task (i.e., stepping on a specific target) and confirms correct target contacts. The NeuroCom© VSR system (Neurocom International Inc., Clackamas, OR, USA) was used for all static balance tests. A stationary cycle ergometer was used for the warm-up and for training sessions in the cycling group (RevMaster; LeMond, Poway, CA, USA).

2.3. Procedures

Participants attended a familiarization session in the exercise intervention laboratory the week before the start of the training intervention. During this session, participants from both groups completed three trials of each of the three QuickBoard drills used in testing and researchers provided feedback to ensure proper technique. The balance tests using the NeuroCom© VSR system were also introduced and participants performed practice balance tests (i.e., double leg with eyes opened and closed) in barefoot to get familiar with the testing protocol. Finally, participants in the cycling group were familiarized with the cycle ergometer (i.e., workloads, seat adjustments).

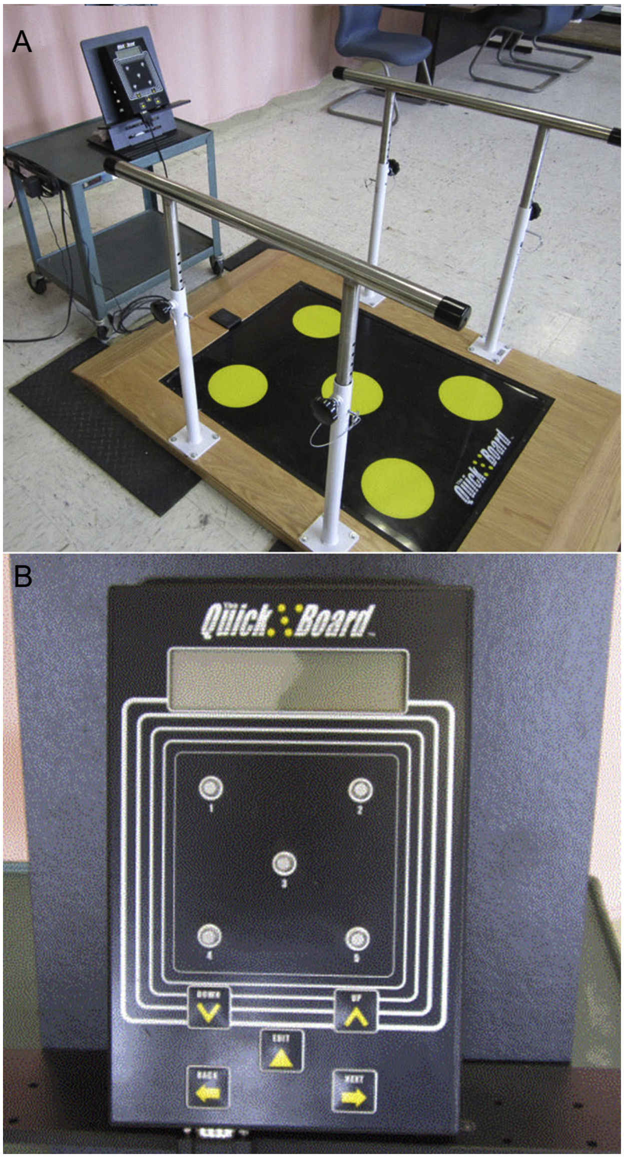

Fig. 1. Illustration of (A) the QuickBoard and support bars, and (B) the control unit with lights representing each target on the ground platform of the QuickBoard.

2.3.1. Training

Participants in each group completed an 8-week intervention that included two 30-min training sessions per week. This training session length was chosen to accommodate the schedules of our participants and to ensure that the training was not fatiguing as we intended the training dose to be light to moderate. Both groups had an average training adherence rate of 100%. At the start of each training session, participants performed a 5-min warm-up on the stationary cycle ergometer. During training, the QuickBoard group performed the QuickBoard reaction drill (RT), and forward (FFS) and backward foot speed (BFS) drills. Participants completed three sets of 20 touches for RT, FFS, and BFS. The three-set sequence for all three drills was completed twice for a total of six sets per QuickBoard drill during each session. Participants received a 1-min rest break between sets and a 3-min rest break after the completion of the first three sets of the training protocol.

During the RT, participants stood with both feet on either side of the middle target and were asked to respond to the randomly cued light trigger on the control unit by stepping on the corresponding foot target on the board as quickly as possible. Participants were asked to step on the right and left targets (front and back) with the corresponding foot (i.e., no cross-over was allowed) but could choose to step on the middle target with the left or right foot. The FFS and BFS required participants to step as fast as possible on the front or back two targets starting with both feet on either side of the middle target with alternating foot step patterns and returning to the start position.[19] The cycling group performed four sets of 5-min intervals at a self-selected workload with 2-min rest breaks on the cycle ergometer during each session. Participants were instructed to select a comfortable workload which they could maintain for 5 min. Both groups trained in their own athletic footwear throughout the training program.

2.3.2. Testing

Measures of static balance and QuickBoard RT, FFS, and BFS were obtained for all participants during the first training session of week 1 (baseline test), of week 5 (4-week test), during a lab visit in the 9th week (8-week test) and during a lab visit 4 weeks after the completion of the training intervention (4-week follow-up test). Static balance was measured on the NeuroCom© VSR system using average center of pressure (COP) sway velocity during a 20-s quiet standing with double feet with eyes open and closed.[20] Participants were instructed to stand as still as possible (as per the system's instruction manual) and static balance tests were performed barefoot. Participants were provided with practice trials before the testing trial during each testing session. During the same testing sessions, time to completion of 20 touches for RT, FFS, and BFS was measured by taking the average of two trials for each test. All QuickBoard tests were performed in the participants' own athletic footwear. During all testing sessions, none of the participants fell or tripped. In addition, each participant completed the ABC questionnaire at baseline, 8-week, and 4-week follow-up to obtain self-reported balance confidence during daily activities.[17,18]

2.4. Data analyses

A two-way (Group $\times$ Time) mixed design analysis of variance (ANOVA), with time as the within-subject factor and group as the between-subjects factor, was used to evaluate QuickBoard drills, static balance, and ABC data (SPSS, Chicago, IL, USA). Mauchly's Test of Sphericity was used in order to test the assumption of sphericity. When the assumption of sphericity was not met (i.e., $p < 0.05$), the Greenhouse-Geisser adjustment was used to assess within subject differences. When interactions were observed, paired sample t tests were used to compare means within groups and independent t tests were used to compare means between groups. When main or interaction effects were observed, Cohen's d effect

Table 1
Average center of pressure sway velocity (cm/s) during double feet quiet standing with eyes open and closed for 20 s for the QuickBoard (QB) and cycle groups at baseline, 4-week, 8-week, and 4-week follow-up (mean ± SD).

	Testing time				*p* value		
	Baseline	4-week	8-week	Follow-up	Group	Time	Interaction effect
Open							
QB	0.55 ± 0.21	0.51 ± 0.18	0.49 ± 0.16	0.48 ± 0.13	0.71	0.76	0.27
Cycle	0.52 ± 0.13	0.55 ± 0.15	0.53 ± 0.16	0.55 ± 0.17			
Closed							
QB	0.99 ± 0.60	0.85 ± 0.18	0.82 ± 0.23	0.85 ± 0.33	0.90	0.27	0.42
Cycle	1.06 ± 0.41	0.92 ± 0.35	0.96 ± 0.36	1.06 ± 0.56			

sizes were reported for mean differences with ≤0.20 representing a small effect, >0.20 and <0.80 representing a moderate effect, and ≥0.80 representing a large effect.[21] Significance was set at an α level of 0.05.

3. Results

3.1. Static balance

The average COP sway velocity during static standing on double feet with eyes open and closed did not reveal main or interaction effects ($p > 0.05$; Table 1). Although non-statistically significant ($p > 0.05$), there is a clear trend for reductions in sway velocity in the eyes closed condition in both groups (Table 1).

3.2. ABC

The ABC scores revealed a significant interaction effect ($p = 0.046$; Fig. 2). The paired *t* tests showed no statistical difference in the ABC scores between testing times for the QuickBoard ($p > 0.05$) group with small effect sizes at 8-week (92.5 ± 6.3 s; ES: 0.20) and 4-week follow-up (92.3 ± 7.1 s; ES: 0.25) compared to baseline (90.4 ± 8.7 s). The paired *t* tests also showed no statistical difference in the ABC scores between testing times for the cycling group ($p > 0.05$) with moderate effect sizes at 8-week (87.8 ± 12.3 s; ES: −0.52) and 4-week follow-up (89.7 ± 8.7 s; ES: −0.41) compared to baseline (93.0 ± 4.8 s). In addition, the *post-hoc* independent *t* tests showed no statistically significant differences between groups ($p > 0.05$) but moderate effect sizes of −0.32, 0.51, and 0.35 at baseline, 8-week, and follow-up, respectively, were found between group means where balance confidence was higher in QuickBoard compared to cycling.

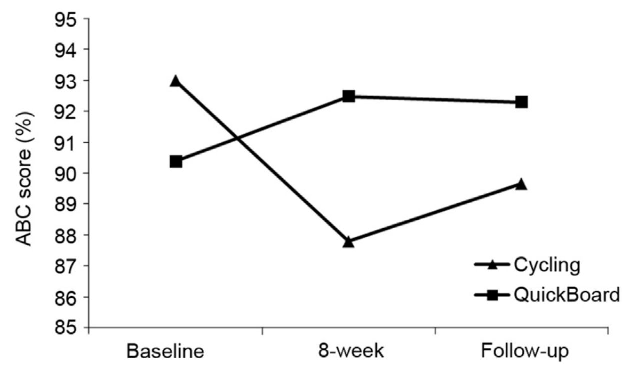

Fig. 2. Activity-specific Balance Confidence (ABC) questionnaire (out of 100) overall results for both groups at baseline, 8-week, and 4-week follow-up.

3.3. RT and foot speed

The QuickBoard tests were obtained at baseline, 4-week, 8-week, and 4-week follow-up. RT showed an interaction effect (Table 2). *Post-hoc* paired *t* tests showed that RT was

Table 2
Average QuickBoard (QB) reaction time (RT) (s), forward foot speed (FFS) (s), backward foot speed (BFS) (s) to complete 20 touches for the QB and cycle groups at baseline, 4-week, 8-week, and 4-week follow-up (mean ± SD).

Variable	Testing time				*p* value		
	Baseline	4-week	8-week	Follow-up	Group	Time	Interaction effect
RT[a,b,c]							
QB	10.1 ± 1.7	8.7 ± 0.9[#]	8.4 ± 1.1[*#]	8.4 ± 0.9[#]	0.29	<0.001	0.029
Cycle	9.6 ± 11.5	9.3 ± 1.2	9.3 ± 1.1	9.2 ± 1.4			
FFS[a,b,c]							
QB	11.9 ± 2.7	8.8 ± 2.3[#]	8.3 ± 2.0[#&]	8.4 ± 2.1[#]	0.39	<0.001	0.005
Cycle	11.4 ± 3.3	10.0 ± 2.3[#]	9.6 ± 2.6[#]	9.9 ± 3.1[#]			
BFS[a,b,c]							
QB	12.1 ± 3.0	8.6 ± 1.8[#]	8.3 ± 2.0[#]	8.4 ± 2.0[#]	0.45	<0.001	<0.001
Cycle	11.0 ± 3.0	9.9 ± 2.1[#]	9.7 ± 2.6[#]	9.8 ± 2.9[#]			

Notes: Time effect: [a]difference between baseline and 4-week; [b]difference between baseline and 8-week; [c]difference between baseline and follow-up.
Time-by-Group effect: *different compared to cycle group; [#]different compared to baseline within group; [&]different compared to 4-week within group.

improved from baseline to 4-week ($p = 0.005$; ES: 1.08), 8-week ($p = 0.001$; ES: 1.25) and follow-up ($p = 0.001$; ES: 1.32) for the QuickBoard group. The *post-hoc* independent *t* test showed a faster RT in QuickBoard compared to the cycle group at 8-week ($p = 0.046$; ES: -0.67). RT also showed a time main effect where RT at 4-week ($p = 0.005$), 8-week ($p = 0.002$), and follow-up ($p = 0.001$) was improved compared to baseline.

The FFS also showed an interaction effect (Table 2). *Post-hoc* paired *t* tests showed that FFS was improved from baseline to 4-week ($p = 0.011$; ES: 0.52), 8-week ($p = 0.002$; ES: 0.64), and follow-up ($p = 0.003$; ES: 0.49) in the cycle group. FFS was improved from baseline to 4-week ($p < 0.001$; ES: 1.30), 8-week ($p < 0.001$; ES: 1.60), and follow-up ($p < 0.001$; ES: 1.53) and, from 4-week to 8-week ($p < 0.049$; ES: 0.24) in the QuickBoard group. FFS was not different between groups. The *post-hoc* independent *t* test showed a time main effect where FFS was improved at 4-week ($p < 0.001$), 8-week ($p < 0.001$), and follow-up ($p < 0.001$) compared to baseline in both groups, and improved at 8-week compared to 4-week ($p = 0.022$) in the QuickBoard group.

The BFS also showed an interaction effect (Table 2). *Post-hoc* paired *t* tests showed that BFS was improved from baseline to 4-week ($p = 0.025$; ES: 0.45), 8-week ($p = 0.012$; ES: 0.49), and follow-up ($p = 0.005$; ES: 0.43) in the cycle group. BFS was also improved from baseline to 4-week ($p < 0.001$; ES: 1.49), 8-week ($p < 0.001$; ES: 1.57), and follow-up ($p < 0.001$; ES: 1.51) in the QuickBoard group. BFS was not different between groups. The *post-hoc* independent *t* test showed a time main effect where BFS was improved at 4-week ($p < 0.001$), 8-week ($p < 0.001$), and follow-up ($p < 0.001$) compared to baseline in both groups.

4. Discussion

The purpose of this preliminary investigation was to examine the effects of an 8-week QuickBoard reactive balance training program on QuickBoard RT and foot speed and, static balance and balance confidence in healthy older adults compared to an exercise control group. The sample population in this study included elderly self-reported highly functional individuals and none had postural or cognitive impairments. Thus, the results from this study cannot be generalized to elderly populations with low function and physical or cognitive impairments. No changes in static balance were observed following training or between groups. Static balance was assessed with average COP sway velocity while standing with two feet together with eyes open and closed. Computerized platform posturography (e.g., NeuroCom© Balance Manager) is a common method to quantify postural stability during quiet standing.[20,22–24] Research shows that older women who have fallen at least once in a 1-year period have higher mean postural sway velocities during quiet standing compared to non-fallers[25] and, older adults who are recurrent fallers (i.e., more than two falls in previous year) show reduced postural control (i.e., mean COP position and area of 95% confidence ellipse) compared to non-faller.[23] Further, reductions in active postural control through corrective processes (i.e., COP velocity control) are also observed in older individuals with mild cognitive impairment compared to healthy controls.[26] Our study population included healthy elderly individuals and before the start of the study, although we aimed to recruit participants with no history of falling or cognitive impairments, we did not expect to enroll older adults with such high physical function. Our training session lengths of 30 min may have not been long enough to elicit changes in postural control. Had it been possible to anticipate such a highly functional group of participants, longer training sessions would have been included in the training intervention to increase the training dose for this group. Lai et al.[27] reported baseline values of COP sway velocity between 0.94 and 1.1 cm/s during double feet stance with eyes open and, between 1.3 and 1.4 cm/s during double feet stance with eyes closed in healthy older adults. Their eyes open COP sway velocity values were nearly twice as large (i.e., 0.94−1.1° cm/s) the values in the current study (i.e., 0.52−0.55 cm/s). This suggests that our participant, compared to their population, had much better baseline postural control. In addition, even with the relatively large COP sway velocities, their 12-week interactive video game based intervention yielded no changes in COP sway velocity with eyes open and closed during double feet stance. Thus, it is unsurprising that sway velocity was unchanged throughout the current intervention considering the low baseline COP sway velocity values. Further, although not statistically significant, sway velocity in the eyes closed condition clearly showed a trend for reduced velocity from baseline throughout the interventions. Further, at 4-week follow-up, the sway velocity remained lower in the QuickBoard group while it increased back to baseline value in the cycling control group (Table 1). The small sample size and high variability in the data appears to be responsible for this lack of statistical significance and these trends warrant further investigation on the effectiveness of reactive response training on postural control.

Research has focused on identifying exercise training modalities to improve effectiveness of sensory information processing in older adults in order to improve postural control as a mechanism for fall prevention.[8,9,11–15,28,29] Hagedorn and Holm[16] found increased performance of the Modified Clinical Test of Sensory Interaction and Balance test (i.e., time to loss of balance in single leg and tandem stance on different surfaces) before and after a traditional static balance intervention but no changes were observed in a visual computer feedback balance training group (i.e., weight shifting in response to visual feedback) over a 12-week period in frail elderly patients. Suárez et al.[28] showed that balance training on a virtual-reality system targeting changes in sensory information (i.e., visual, vestibular, and somatosensory) reduced postural sway velocities during quiet standing in older adults at a high risk of falling. The QuickBoard, similar to other integrative training tools (e.g., virtual-reality systems, Nintendo™ Wii Fit Balance), requires sensory integration to rapidly react to a random visual stimulus. Thus, we expected similar improvements in postural sway velocities with eyes open and closed. However, postural sway velocities with eyes open and closed were unchanged following both training interventions. The highly dynamic nature of the QuickBoard may not be optimal to improve static postural control in older adults and instead, may be more effective for improving agility and speed as shown by previous research in healthy young men.[19] Further, the immediate knowledge of results for each task and high foot speed requirements of the QuickBoard promotes maximal performance for trainees and could be useful to improve dynamic balance during more complex tasks and fall recovery following postural perturbations. We intend to further evaluate the effectiveness of the QuickBoard as a tool to improve fall recovery following perturbation and functional mobility. In addition, the large variability in the sway velocity may be largely responsible for the lack of significant differences. Although all participants met the inclusion criteria, differences in physical abilities and fitness within this highly functional group of healthy older adults may have caused the large variability in the static balance data. Based on our findings of static balance and previous literature, it appears that differences in older adult subject populations (e.g., frail, high risk of falling, healthy) could explain different findings following balance-specific training interventions.

Balance confidence in the current study showed no statistical differences between testing times or groups ($p > 0.05$) but moderate effect sizes suggest greater ABC scores in QuickBoard compared to cycling group at 8-week and 4-week follow-up even though confidence scores were moderately higher in cycling group at baseline. A recent case study showed improved balance confidence assessed with the ABC questionnaire in two older adults post traumatic transfemoral amputation following a Nintendo™ Wii Fit Balance and gait retraining.[12] Further, unstable surface training has previously been shown to improve ABC scores in healthy older adults following a 5-week intervention.[30] However, due to the unchanged measures of balance and function, the authors suggested that although ABC scores were increased, their training program may not be adequate for older adults with no balance impairments. Similar to what was suggested by Schilling et al.,[30] the unchanged balance measures were likely attributed to the high level of baseline function and balance confidence and potentially, high balance variability in our healthy older participants. Finally, balance confidence has been positively correlated with the BBS and the TUG functional mobility test.[17,18] Thus, moderate improvements in balance confidence could suggest improvements in functional mobility and balance. However, our preliminary findings of balance confidence only suggest the potential effectiveness of reactive response training to maintain balance confidence and functional mobility compared to non-balance training (e.g., cycling) in healthy older adults. It is evident that the effects of such training tools on functional balance during daily tasks should be further studied.

The results also showed that both training groups improved QuickBoard RT and foot speed with expected greater improvements in QuickBoard RT and BFS for the QuickBoard group compared to the cycle group. These findings suggest that QuickBoard foot speed can be improved following both QuickBoard and cycling training, but that QuickBoard foot RT is only improved with QuickBoard training. These results are consistent with previous findings that young healthy adults improved their QuickBoard RT and FFS[19] following a 4-week QuickBoard training program. In our study, it was expected that older adults training on the QuickBoard would improve their QuickBoard drills as they were exposed to the movements each week throughout the intervention. From our findings, it is difficult to speculate on the applicability of these improvements during daily tasks requiring reactive responses. Galpin et al.[19] showed that along with improvements in QuickBoard RT and FFS, young healthy adults also improved on a change of direction test indicating a potential transfer of skills from these QuickBoard tests to other tasks. The transferability of QuickBoard performance to functional mobility task performance, however, clearly warrants further investigations in older adults.

Further, Grabiner et al.[14] have shown that fall-specific training reduces the number of falls during laboratory-induced trips. The benefits of fall-specific training in reducing falls and trips are consistent with previous literature in healthy and frail older adults.[31,32] The natural muscle strength reductions and changes in tendinous tissue associated with aging are well documented and contribute to slower RT.[33,34] In fact, Pai et al.[35] attributed greater fall incidence in older adults to insufficient knee extensor support following a trip. Along with muscle strength decline, research shows reductions in neural control (i.e., rate of muscle activation) in the elderly which could negatively impact trip recovery strategies and lead to falls.[36] Training interventions such as the QuickBoard that improve rapid foot movements and reactive responses (i.e., RT) may not only be beneficial for stimulating neural responses to external stimuli (i.e., unexpected obstacles in the travel path) but could potentially simulate tripping responses through rapid stepping and eccentric lower limb extensor muscle involvement. However, although our results confirm that QuickBoard training can improve foot speed and reactive response, we did not assess potential improvements in eccentric muscle strength. Based on previous literature, the combination of lower extremity strength training along with movement tasks requiring reactive neural control may be useful for preventing falls from unexpected trips in older individuals.

It is difficult to generalize our results to a broad older adult population as the participants in our study were healthy and highly functional and, our sample size was relatively small ($n = 25$). In addition, the short training sessions (i.e., 30 min) may not have been long enough for this highly functional group of healthy older adults and thus, a larger training study with this type of agility training should include training sessions to appropriate to the training groups. Finally, our control training intervention of stationary cycling is an aerobic activity and does not require reactive postural control. It would be insightful to compare the efficacy of QuickBoard training with other reactive control training tool (e.g., virtual-reality system, Nintendo™ Wii Fit Balance Plus) to identify the most effective training for improving foot RT and speed. The limitations of this pilot study will be simple to address in future training studies.

5. Conclusion

The results from this study suggest that QuickBoard and cycling training improved RT and foot speed, with greater improvements in RT and BFS from QuickBoard training compared to the cycling. No statistically significant changes in static balance or balance confidence were observed throughout the intervention or between training groups but balance confidence was moderately greater in QuickBoard compared to cycling group at 8-week and 4-week follow-up. However, the implications of the current findings on RT improvements for trip avoidance and performance of common daily tasks are currently unknown. Further, the participants in the current study were highly functional with no known postural or cognitive impairments. Future studies should not only investigate the effectiveness of reactive response training on performance of daily tasks and trip and fall prevention, but also in elderly populations with cognitive and/or postural impairments and with other dynamic balance training methods.

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