IMPROVING BALANCE BY EDUCATION, WALKING AND THE WII™

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Abstract

Objective: To determine whether balance education, walking and the Wii™ improve balance confidence and reduce the risk for falls in older adults. **Method:** A pilot study was performed to investigate the effects of a balance intervention program on reducing fall risk in older adults sixty-five years and older. The program included education on fall prevention, a walking program, and Wii™ bowling. Balance examination occurred before and after the eight-week intervention program and at an 18 week follow-up session using three outcome measures: the Berg Balance Scale, the Timed "Up & Go", and the Activities-specific Balance Confidence Scale. **Results:** All three participants improved from the pre-test to post-test on the Berg Balance Scale according to the MDC value. Participant 1 and 2 maintained a clinically significant change on the BBS from post-test to 18 week follow-up. Participant 1 and 2 made clinically significant improvements from pre-test to post-test on the Timed "Up & Go" according to the MDC value. Participant 2 maintained a clinically significant change on the TUG from post-test to follow-up. All participants improved on the Activities-specific Balance Confidence Scale, however none showed a minimally detectable change from pre-test to post-test. Participant 2 maintained his score on the ABC scale from post-test to follow-up. **Conclusion:** A multi-factorial balance program including Wii™ bowling, walking and education may be an effective intervention to improve balance and decrease fall risk for older adults.

Key Words: balance, falls, older adults

Introduction

Falls are considered a major problem for older adults. Falls are the leading cause of a death related injury in adults over 65.[1] Each year 30-40% of people over 65 years old fall.[2,3,4] Falls in the geriatric population are associated with increased mortality, morbidity, loss of independence and disability which cause a significant increase in hospital stays.[5] It has been shown that 20-30% of those who fall can suffer from injuries such as lacerations, head traumas and hip fractures. Death rates from falls have increased dramatically over the past decade in both men and women.

Falls in the older adult population have been attributed to poor balance, decreased strength and decreased physical function in older adults. Adults sixty-five years and older can be identified if they are at risk for falls. The most prominent predictor of a fall is a previous fall.[1,6] Limited mobility, impaired balance, muscle weakness and gait deficits are also main risk factors for falls in older adults.[7] Additional risk factors that can increase one's risk for falling include age over 80, cognitive decline, visual deficits, use of an assistive device and depression.[1,4] Older adults taking four or more medications can significantly increase fall risk.[4,8] The more risk factors or predictors a person has the greater the likelihood a fall will occur.

Several studies have suggested prevention programs as a possible way of reducing fall risk in the older adult population. It is critical to recognize and identify people at risk prior to having an injury as well as implement interventions to reduce fall risk as early as possible.[5] Multi-factorial interventions have been noted as the most effective fall prevention strategies that are aimed at identifying risk factors along with exercise, balance training and educational programs.[4,9] Studies containing multi-factorial interventions have been shown to decrease fall risk factors in people's homes as well as community settings.[10] Exercise programs that include

walking and balance training are important fall prevention strategies for older adults.[1,3] According to Petridou et al, the implementation of fall prevention programs during the past decade have contributed to an overall 4% reduction in annual fall rates in the European Union level. It has been suggested that there is increased motivation for older adults to participate in programs that are fun and inspiring as well as those that involve another person or group of people.[6]

Walking programs have also been shown to improve balance scores in older adults who are active in the community.[11] Research has shown that walking programs are an enjoyable way to manage health problems as well as to provide physical and psychological affects to improve quality of life.[12] Slow gait velocity has been correlated with an increased risk of falls in older adults.[13] Shimada et al conducted a study to find out the relationship between quality of gait and falls. The study concluded that quality of gait is directly associated with falls; therefore, gait and mobility interventions should be included in exercise programs designed to reduce fall risk in older adults. When choosing whether to implement treadmill versus over ground walking in an intervention plan of care, over ground walking was shown to be more enjoyable to older adults. Participants walking over ground are able to walk faster and take long strides after the implementation of a walking program.[14] Music incorporated into walking exercise has been shown to encourage patients to walk along with the music (increase/decrease tempo or speed) better than if a metronome is used. Music is also considered an enjoyable item to add to a walking program.[15]

Recently, including the Nintendo Wii™ as part of an intervention program has become popular. In relation to balance, the Nintendo Wii™ has been shown to be beneficial in improving balance when used with physical therapy interventions.[16,17] It has been shown to

improve Berg Balance Scale (BBS) scores,[16,17,18,19] as well as other tests including the Timed Up and Go (TUG) and Activities-specific Balance Confidence Scale (ABC). Clark et al specifically showed improvements in BBS, TUG and ABC scores after 6 one-hour treatment sessions using WiiFit™ Bowling with one subject. Another study conducted by Yamada et al used the "Basic Step" and "Ski Slalom" to examine if the WiiFit™ game program could be used to assess fall risk in adults over 65. The games were modified so the participants could play in a seated position and results suggest that both games are reliable in assessing risk for falls.[20] Overall, the Nintendo Wii™ appears to be a useful addition to include as part of a fall prevention program.

Fall prevention programs may also include an educational component. Currently, there is minimal evidence that suggests the sole implementation of education or environmental modification programs have been effective in reducing fall risk.[9] However, including an educational component as part of the multi-factorial intervention has been shown to reduce fall risk.[9] These education programs include discussion on topics such as medication use, orthostatic blood pressure, environmental dangers, vision, balance, activities of daily living, and gait.[9] Other topics that can be addressed include aspects of diet, dwelling, movement, exercise, selecting suitable clothing and shoes, obtaining help after falling and proper use of assistive devices. These programs also encourage older adults to make environmental modifications to reduce fall risk in the household such as removing throw rugs, using non slip bath mats, raised toilet seats, proper stair hand rails as well as having adequate lighting in each room.[4]

Another important aspect that should be addressed in regard to the older adult population and falls is their fear of falling. Unfortunately, some older adults will not discuss risk of falling with their doctors even if they are fearful of falling.[3] The fear of falling can cause self-imposed functional limitations in older adult individuals and a loss in confidence.[1,4,6,21] Fear of falling can

develop even if a person has not fallen, and with that fear the person may restrict physical activity. Restricting physical activity will then increase risk of falling due to decreased physical fitness.[3] Some older adults view falling as a normal part of aging while others believe it to be shameful and embarrassing.[6]

Currently, to our knowledge there have been no other studies published that investigate balance improvement and fall reduction in an 8 week program involving Wii™ bowling, walking and balance education for older adults over 65. Similar studies have used many other programs on the Nintendo Wii™ and have also implemented the use of the Nintendo Wii™ balance board. Studies show that implementing the Nintendo Wii™ can clinically increase balance scores on the BBS as well as improve quality of life in patients with balance deficits.[17,22] These studies had participants complete twelve 20-30 minute sessions using the Wii™ over a 4-6 week period playing games such as the tightrope walk and table tilt. In the study performed by Tibbs et al, researchers noted that the participants enjoyed using the Nintendo Wii™ and they liked the increased socialization when using the Wii™ in a group treatment setting. Another similar study looked to decrease the fear of falling through education as well as exercising and balance activities.[23] The researchers had subjects discuss fears of falling, identify risk factors for falls and how to reduce these risks. Risk factor topics included proper footwear, nutrition, importance of activity, and environmental dangers in the home and out in the community. Brouwer et al concluded that education on falling as well as implementing an exercise program can significantly reduce the fear of falling. Other balance programs have comprised of exercise programs that include gait, balance and strengthening[1] in addition to home hazard modification,[4,24] education programs,[9] management of reduced vision[24] and the Nintendo WiiFit™;[17,25] however, none of these studies included all three components comparable to this

study. The aim of this study is to determine whether balance education, walking and the Wii™ improve balance confidence and reduce the risk for falls in older adults.

Methodology

Research Design

The research question is whether using the Nintendo Wii™ bowling game, performing a walking program and fall prevention education impacts the balance of a group of older adults as measured by the BBS, TUG and ABC. This quasi-experimental, pilot study utilized a single group, pretest–posttest design. The intervention phase consisted of each subject participating in the walking program, education, and the Wii™ bowling program for 20 minutes each for two sessions per week, over an 8 week period. A follow-up was conducted 18 weeks after the conclusion of the 8 week study. Participants and researchers were not blinded in this study. The Sage College's Institutional Review Board approved the study.

Participants

Participants consisted of a sample of convenience of the older adult population at a senior center in New York. To recruit participants for this study, we obtained a convenience sample from the facility via verbal communication, demonstrations of intervention, and promotional flyers. The study was to include between 12-15 participants. The procedures were explained to all subjects and an informed consent form was signed prior to the start of the study. Subjects were free to withdraw from the experiment at any time, simply by notifying the experimenter.

Inclusion Criteria

Individuals qualified for this study if they were 65 years of age or older and at risk for falls according to the BBS. People were considered at risk for falls if they had scores $\leq 45/56$ or

if they had fallen at least once in the past 6 months and a BBS score $\leq$ 50/56. The individual also had to have been able to walk 20 feet independently without an assistive device. Exclusion criteria for this study included if they had a blood pressure reading over 160/100 mmHg and if they needed physical assistance for standing and walking. Individuals were also excluded if they had unstable health, decreased mobility, or the inability to attend interventions sessions on a consistent basis.

Outcome Measures

The BBS, TUG, and ABC Scale were given prior to the intervention to select seniors with fall risk and to establish baseline data. First the participants were given the BBS to determine if their score met the inclusion criteria. If the inclusion criterion was met they were given the TUG and ABC scale.

The BBS is the gold standard for measuring balance.[26] The scale consists of 14 items that are based on a 0-4 scale; a 0 means that the person is unable to perform the activity, whereas 4 means that the person performs the activity independently. To calculate total score, all 14 items are added together for a global score calculated out of a possible 56 points. Participants were not able to use an assistive device during this assessment. Activities performed included transfers, static standing balance such as standing with eyes closed, and dynamic standing balance such as turning 360 degrees within 5 seconds. In addition, several studies indicate high validity and reliability ratings of the BBS.[27,28,29] The test re-test reliability for the BBS is .98 and the validity value is .76. [27] The sensitivity value for the BBS is 64% and the specificity value is 90%.[27]

The TUG is another measure of balance performed by walking, transitioning and turning.[30] The subject is timed with a stop watch from the moment that they rise from a chair, walk 3 meters, turn, walk back 3 meters and sit down. Participants were not allowed to use an

assistive device. Research states that a TUG time of greater than or equal to 14 seconds places an individual at a fall risk. The intratester and intertester reliability for the TUG is .99, and the validity value is .76. [27] The TUG was found to have a sensitivity and specificity of 87%.[27]

The ABC Scale[31] is a 16-item self-report scale where the person rates his/her confidence level on a scale of 0-100 where 0 is no confidence and 100 is complete confidence. The total score is the average of the 16 individual scores. The reliability value for the ABC scale is .92. [31] The validity is moderately positive with a linear correlation between the ABC total score and the BBS score. [31]

Intervention

The program consisted of an 8 week balance program at a local senior center which was performed twice a week that included education, Nintendo Wii™ bowling and a walking program each performed for 20 minutes.

The educational component included a presentation and discussion of the causes of falls and identifying solutions to reduce fall risk. Topics that were discussed included balance safety in the home, community, and environment. Proper footwear was discussed as well as being aware of all the side effects of medications that affect balance. Participants were given a night light, an extended grabber and a pedometer for them to use around their home to increase balance safety.

Next the participants engaged in Wii™ bowling which provided a balance intervention that simulated the TUG test as described by Clark and Kraemer.[25] The participants stood up from a chair, walked 3 meters, bowled, turned and walked back to the chair and sat down. The subjects repeated this sequence every time they bowled. Subjects were potentially at risk for falling during the balance testing and balance interventions and therefore were guarded by a

physical therapy student who was supervised by a physical therapist. Participants were not allowed to use an assistive device for the bowling intervention.

Lastly, the walking program was performed on an even surface at the subject's own pace with music playing in the background. The subjects walked around a large room with 100 feet measured out. Each time that the subject walked around the room a lap was recorded. Researchers walked along with the participants for safety and motivation. Participants were able to take breaks when needed and were allowed to use an assistive device. Participants were screened again at the end of the 8 weeks by the same 3 outcome measures to see if improvements were made. A follow-up session was performed 18 weeks following the end of the intervention using the same 3 outcome measures to assess carryover.

Data Analysis

Descriptive statistics were used to determine if there were improvements from pretest to posttest and post-test to follow-up. Results were also compared to established minimal detectable change (MDC) scores for the BBS: 5 points,[32] ABC: 18%,[33] and TUG: 4.09 seconds.[34]

Results

Twelve participants were initially recruited for this study. Of the 12 recruited participants, 6 participants arrived on the first day. Three of the initial 6 participants withdrew from the study due to lack of compliance and death of one participant. These participants were not included in the data due to their early withdrawal from the study. A follow-up study was conducted with participants 1 and 2 to determine the carry-over effects of our intervention. Participant 3 was unable to attend the follow-up session due to a recent hospitalization. Table 1 (see Appendix) describes the participant demographics of the 3 subjects who participated the entire duration of the study.

During the walking component of our intervention, the number of laps each participant completed around a 100 feet course was recorded during every session along with the amount of rest breaks needed. Each participant consistently increased in the number of laps that they completed over the course of the intervention. When comparing the number of laps completed from the first to the last day of the intervention the participants improved their walking distance as follows: participant 1 improved from 24 laps to 39 laps, participant 2 improved from 22 laps to 28 laps, participant 3 improved 8 laps to 16 laps. The amount of rest breaks needed by the participants during the walking intervention also improved. Participant 1 required 2 breaks during the first day and none the final day, participant 2 did not require a rest break during the first or last day, participant 3 required 3 breaks on the first day and 1 rest break the last day.

Berg Balance Scale

All three participants improved in the BBS from pre-test to post-test. The MDC value for the BBS is 5 points.[26] A clinical significant change occurred for all participants based on the MDC value. Participant 1 improved 19 points, participant 2 improved 6 points and participant 3 improved 5 points. Shumway-Cook et al stated a 1-point increase in the BBS indicates a 6% decrease in fall risk for individuals with BBS scores between 46 and 54. The participants decreased their fall risk by 30-114% with an average decrease of 60% in fall risk. From post-test to follow-up at 18 weeks, participant 1improved by 1 point and participant 2 declined by 2 points; however, both participants maintained a clinically significant change according to the MDC value. See Figure 1 and 4 (see Appendix).

Timed Up and Go

Two of the 3 participants improved on the TUG from pre-test to post-test. A clinical significant change occurred for participants 1 and 2 based on the MDC value of 4.09 seconds.[30]

Participant 1 improved by 7.72 seconds and participant 2 improved by 7.89 seconds, which are both a 41% improvement. Participant 3 did not improve from pre-test to post-test, decreasing by 25%, demonstrating a slowed gait speed. The participants improved on the TUG by an average of 3.84 seconds. Participant 1 and 2 had an increase in time at follow-up compared to post-test; however, this was not a significant decline for participant 2 according to the MDC value. See Figure 2 and 4 (see Appendix).

Activities-specific Balance Confidence Scale

All three participants improved in the ABC from pre-test to post-test. Participant 1 improved 16.56%, participant 2 improved 11.87% and participant 3 improved 16.9%. Participants 1 and 3 were approximately 1-2% shy of a significant change from pre-test to post-test according to the MDC value which is 18%.[31] The participants improved on the ABC scale by an average of 15.11%. Participant 1 had a decreased score on the ABC scale from post-test to follow-up, while participant 2 maintained the same score. See Figure 3 and 4 (see Appendix).

Discussion

Overall, improvements in balance were seen for all 3 participants throughout this study. All participants improved from pre-test to post-test on all outcome measures with the exception of participant 3 during the TUG post-test. All participants improved their BBS, the gold standard for balance, based on the MDC value by an average of 60%. It was noted that participant one decreased her fall risk by 114%, which is a 19 point improvement on the BBS. This is a strong indication of our intervention's success as the BBS is the gold standard for balance assessment. Two out of the 3 participants showed improvement on the TUG according to the MDC value. Participant 3 did not improve on the TUG which may be attributed to other co-founding factors that are further discussed below. The ABC scale is a subjective measure

which may indicate why the results were not clinically significant. This may not fully represent balance improvements that were gained from performing these interventions because the participants' perception may be different than their actual balance deficit. The outcome measures used were chosen because they are frequently used in the clinical setting to assess balance and fall risk.

At the start of our study, participant 1 presented with the highest fall risk out of all 3 participants as evidenced by her pre-test BBS score. She displayed generalized unsteadiness during gait and standing activities. It was evident that she had impaired balance through observation and her low BBS pre-test score. Throughout the intervention, she required contact guard assist especially during the Wii™ Bowling portion of our intervention. Participant 1 had increased difficulty with sit-to-stand transfers and transitioning from walking to static standing. However, during the walking sessions it was noted that she did not use her cane often and did not need more than supervision for assistance until she needed to slow her gait speed and come to a stop at the end of the session. At the end of our intervention, it was observed that Participant 1 had increased quality of gait and balance demonstrated through decreased swaying during standing, decreased assistance during sit-to-stand transfers (from contact guard to supervision), and increased stability with transitions from walking to standing. Improvements in balance were demonstrated by her drastic increase in her post-test BBS score, in which she decreased her fall risk by 114%. Participant 1 also increased in her TUG and ABC scores which further shows her decrease in fall risk. Participant 1 was very enthusiastic and proactive with the modifications in her home which she reported verbally, as well as the program overall.

Participant 2 presented with slow gait speed, decreased foot clearance, and short step length at the beginning of our program. Participant 2 required supervision for assistance

throughout the study. He benefited from the increased motivation of walking with a researcher as well as friendly competition during Wii™ bowling and walking. He reported verbally that he made environmental changes in his home during the education sessions. Participant 2 demonstrated improvement on his post-test outcome measure scores which shows that he decreased his fall risk and benefited from our program. Overall improvements were seen in gait quality, confidence, and safety. At the end of the study, participant 2 decreased his fall risk by 36% as demonstrated by his post-test BBS score.

Throughout the intervention, it was noted that participant 3 had increased hip pain with walking and also reported foot pain as a result of prior co-morbidities. These health issues may have limited the maximum gains that may have been achieved from the interventions. Participant 3 had decreased gait velocity due to hip pain and foot pain which may have affected her overall results of the outcome measures specifically the post-test TUG score. Despite her co-morbidities, participant 3 decreased her fall risk by 30% at the end of the study.

We expected to see a carry-over of our interventions at the 18 week follow-up as measured by the participants' maintenance of outcome measure scores. A clinically significant score was maintained from post-test to follow-up on the BBS by participant 1 and 2. Participant 1 did not maintain a clinically significant change from post-test to 18 week follow-up on the TUG; however, her follow-up TUG score was still improved from pre-test by 3 seconds. Participant 2 had an increased time on the TUG from post-test to 18 week follow-up; however, this decline was not clinically significant. Participant 1 had a decreased score on the ABC scale from post-test to 18 week follow-up while participant 2 maintained his score from post-test to follow-up. We attribute the improvements seen by participant 1 on the BBS at the 18 week follow-up to her reporting that she continued a walking program and engaged in exercises classes

on her own since the conclusion of our study. Participant 2 maintained his ABC scale score from post-test to 18 week follow-up indicating that his confidence level regarding balance has not declined. Participant 2 did not report continuing a walking/exercise program following the study which may indicate why his BBS and TUG scores slightly decreased although these declines were not clinically significant. Participants 1 and 2 both reported not having any falls since the conclusion of our study indicating our intervention had lasting carryover effects regarding balance and fall risk.

Education was chosen as part of our intervention because current research by Weatherall et al[9] has shown that including an educational portion in addition to other balance interventions can reduce fall risk. Each week a new topic was discussed and followed up with questions and discussion. During the first session of every week a new topic was introduced and the second session was a follow up of the modifications we suggested and any concerns the participants had. All participants were provided with instruments to aid in decreasing fall risk around their home and environment including a reaching grabber, night light, programmable light timer, pedometer and nutritious food. Nutritious food was an added topic to the education program because it was apparent that the participants weren't eating a wholesome diet. It was evident that the participants would benefit from a discussion on essential foods to incorporate into their diet and healthy foods to have in their home. Participants reported which modifications they made in the home as well. These discussions allowed participants to become more aware of changes that could be made to decrease their fall risk and increase safety in the home and environment.

Wii™ bowling was chosen in order to simulate the TUG so that the participants would be able to practice the challenging balance transitions. We attribute improvements seen in balance due to the repetitive sit to stand transfers, ambulating to the intended target, performing a

dynamic balance activity (swinging upper extremity), pivoting 180° and ambulating back to the starting position. As the study progressed, Wii™ bowling became a fun, motivating and challenging activity for the participants. Our findings supporting the use of the Wii™ Fit for older adults with balance deficits are consistent with the results of Bainbridge et al[17] and Williams et al.[18]

A walking program was included because it has been shown to improve balance scores in older adults.[11] Improvements in walking distance were seen in all participants as measured by number of laps completed each session. Each participant walked laps with a researcher for safety and additional encouragement. Music was played in the background to increase motivation and enjoyment while walking. Participants were allowed rest breaks as needed. Participant 3 required more rest breaks due to hip pain. Assistive devices were allowed during this portion of the intervention. Participant 1 used a cane but none of the other participants used an assistive device. Current research suggests that including a walking program in a balance intervention can decrease fall risk.

We attribute improvements in balance seen in our participants to the multi-factorial interventions used in this study. This study provides a practical, simple and cost-effective intervention for clinicians to use with older adults to decrease fall risk. It can be performed in a community or clinical setting while providing a fun and social way to improve balance. The procedure was kept consistent with all patients who also had similar demographics. Limitations of this study include small sample size, attrition, no control group, no blinding, and no randomization. Future research should include a larger sample size to be able to generalize the findings to older adults who have balance impairments. Currently our study is being continued by other researchers with 7 new participants at a senior retirement community.

Conclusion

The results of this study suggest that a multi-factorial program may be an effective intervention to improve balance and decrease fall risk for older adults. Although further research is needed, the improvements seen in our participants indicate that a balance program that includes Wii™ bowling, walking and an education component is a promising intervention for improving balance in older adults.

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APPENDIX

Table 1. Participant Demographics

Participant	Age	Gender	Assistive Device	Falls Within 6 months (Y/N)	Initial Scores
1	83	F	Straight Cane	Y	BBS 33/56 TUG 18.78s ABC 68.75%
2	90	M	None	Y	BBS 45/56 TUG 18.95s ABC 75%
3	80	F	None	N	BBS 44/56 TUG 16.22s ABC 65%

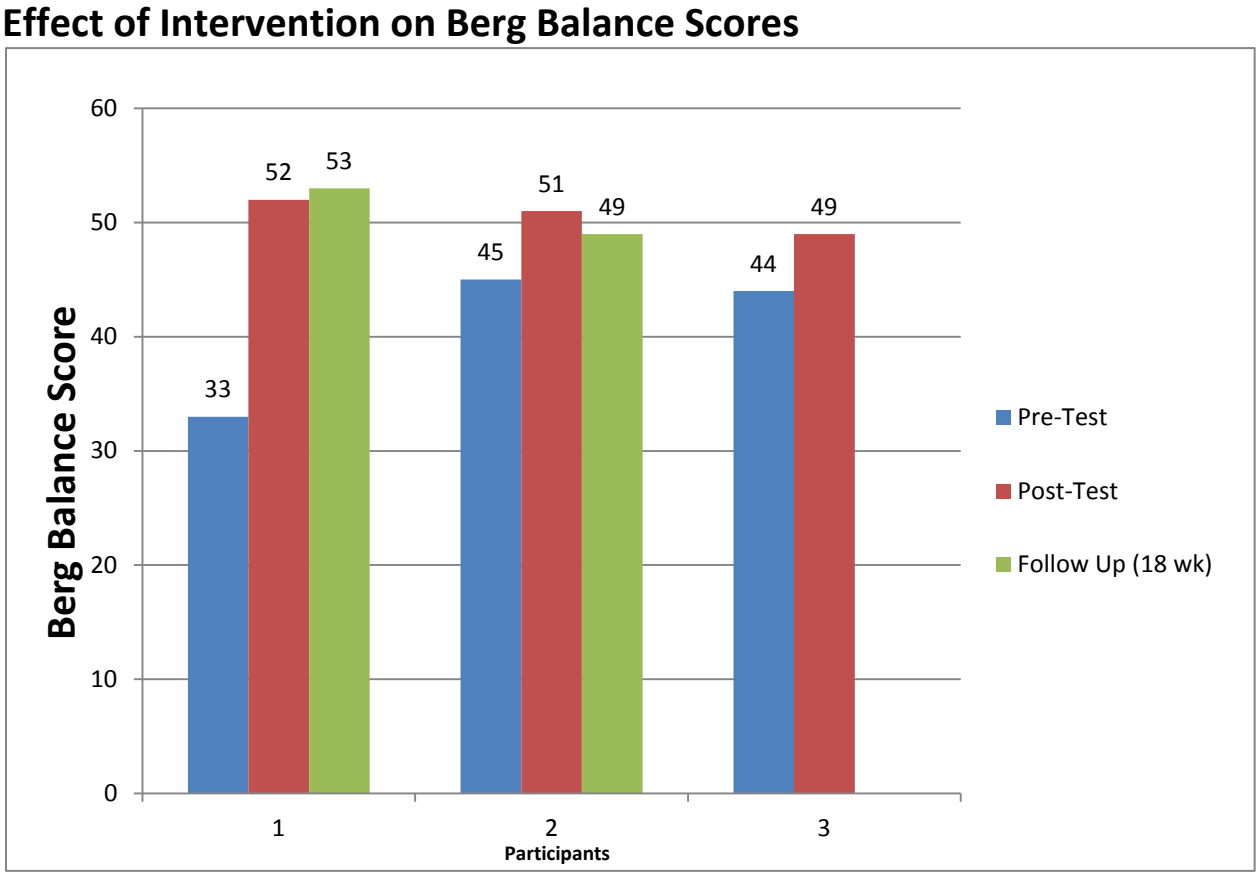

Figure 1. A clinically significant change occurred for all participants based on the MDC value of 5 points for the BBS from pre-test to post test. Participants 1 and 2 maintained their scores from post-test to follow-up.

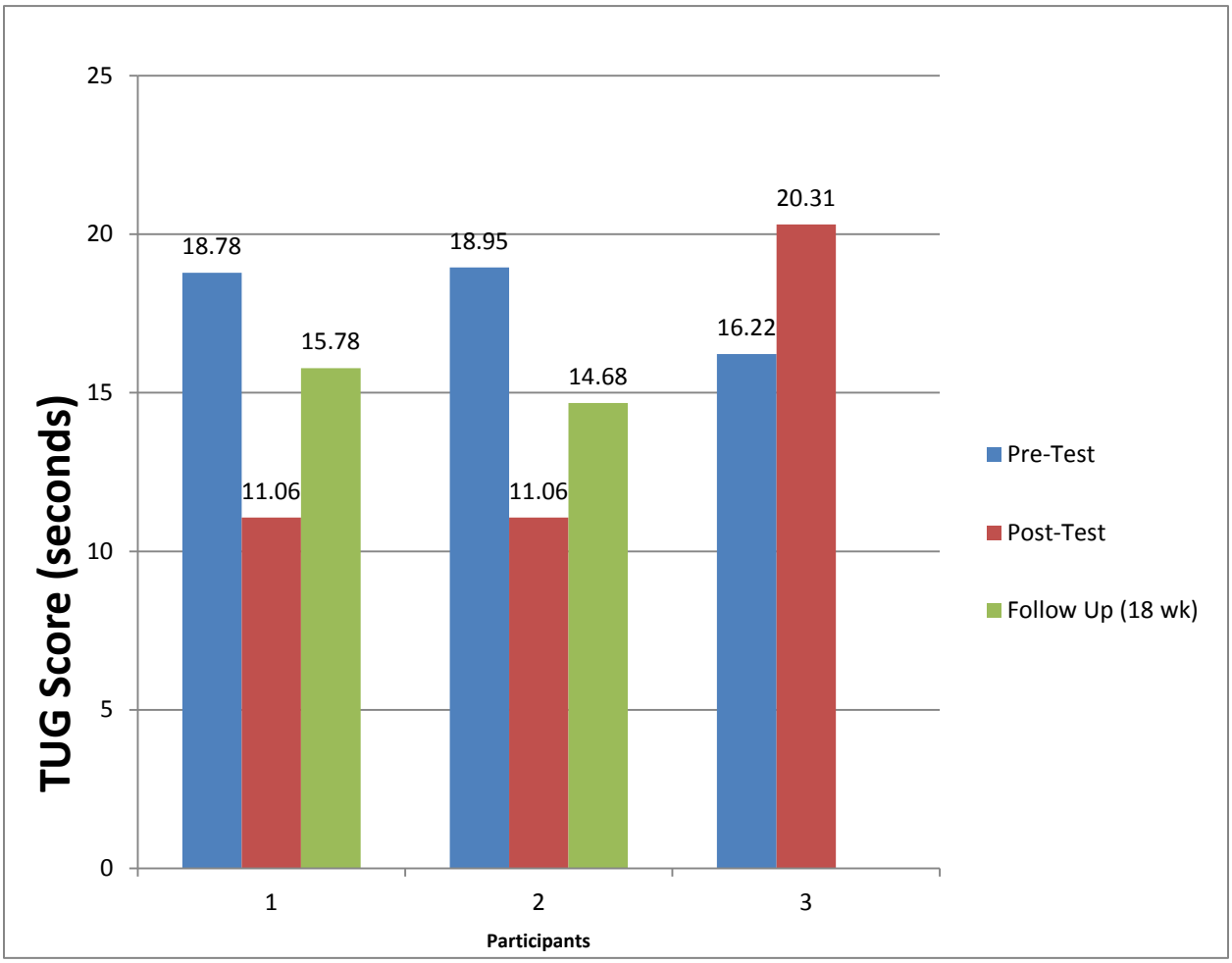

Figure 2. A clinically significant change occurred for Participants 1 and 2 based on the MDC value of 4.09 seconds for the TUG from pre-test to post-test. Participant 3 had an increased time on the TUG from pre-test to post-test. Participants 1 and 2 had increased TUG scores from post-test to follow-up; however, only participant 2 maintained a clinically significant change.

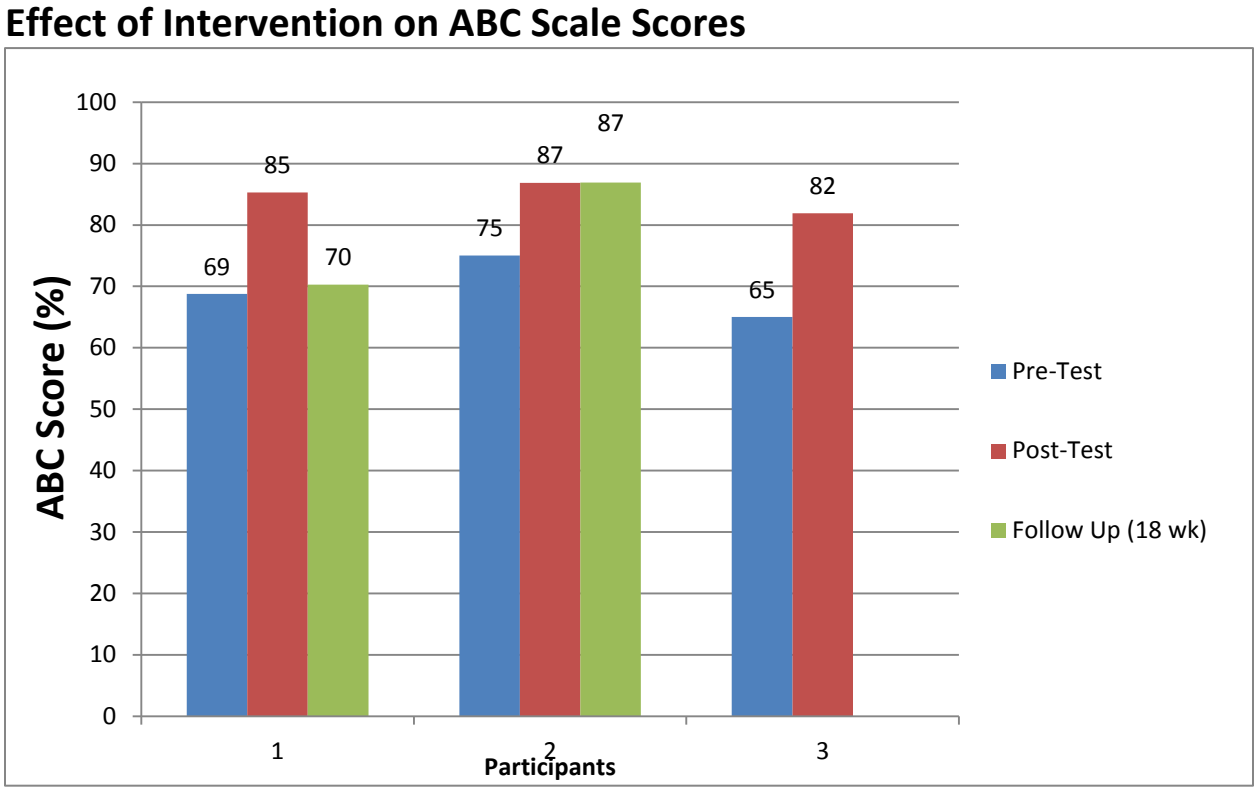

Figure 3. All subjects improved although none showed a clinically significant change based on the MDC value of 18% for the ABC Scale from pre-test to post-test. Participant 2 maintained his score from post-test to follow-up whereas participant 1 did not.

Average Improvement of Scores for Outcome Measure

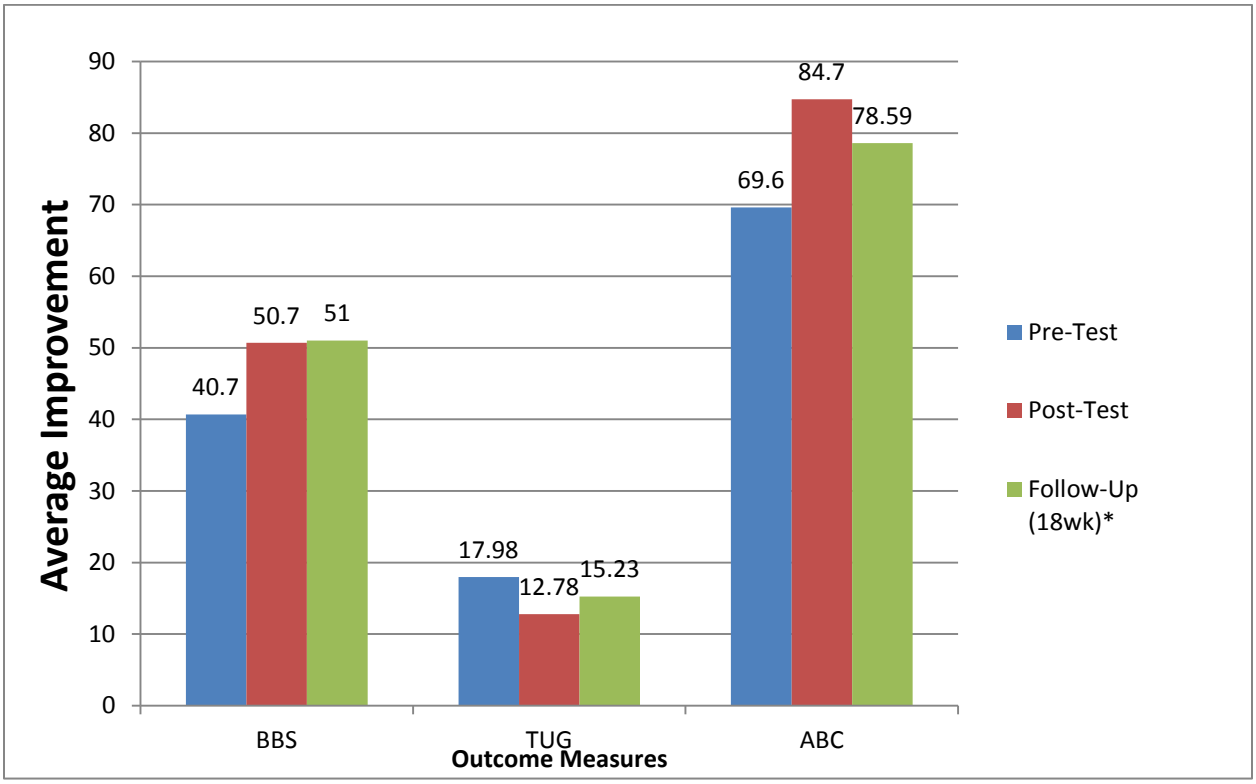

Figure 4. Average improvement from pre-test to post-test on the BBS, TUG and ABC scale. Subjects improved on the BBS by an average of 60%, or 10 points. Subjects improved on the TUG by an average of 3.84 seconds, or 35.66%. Subjects improved on the ABC scale by an average of 15.11%. *Note: The average of the outcome measures for the follow-up session were only performed with participant 1 and 2. From post-test to follow-up the TUG and ABC average scores declined, while there was a slight improvement on the BBS.