International Journal of Research in Exercise Physiology

Original Research Article

Impact of Individual- vs. Functional-Based Exercise Training on Balance in Middle-aged and Older Adults

Megan Dobbertin[1*], Karli Chase-Jacobus[1], Katrina Peterson[1], Mikaela Burtis[1], Nik Shilts[1], and Saori Braun[1]

[1]Department of Kinesiology, University of Wisconsin-Eau Claire, WI, USA

Abstract

Introduction: The purpose of this short report was to examine the acute metabolic responses of **Purpose:** Purpose of the study was to compare the effectiveness of individual- vs. functional-based balance programs on functional balance score and confidence level in middle-aged and older adults. **Methods:** Twenty-nine participants (age range: 35-72 years) were gathered from the pre-established fitness program at the University. Participants were engaging in moderate-intensity physical activity at least 150 min/week or vigorous-intensity exercise at least 75 min/week. Participants were randomly assigned to either the Individual group or a functional exercise group incorporating Yoga (Functional group) over a 5-week period, twice a week with each session lasting for 15 minutes. The Berg Balance Scale, 30s Chair Test and the Activity Balance Confidence scale were administered at pre- and post-test to assess balance ability and confidence level among participants. Biodex Balance System was used as a training tool for the Individual group. Both groups attended training sessions twice a week. **Results:** Two-way repeated measures ANOVA indicated a significant group (Individual vs. Functional) x time interaction effect on Berg score. Simple effect tests indicated both groups displayed a significant increase in the score from pre- to post-test. For the Activity Balance Confidence scale, there was no interaction effect, but there was a significantly greater increase from pre- to post-test among Individual compared to Functional. Finally, the 30s-chair test resulted in no significant change from pre- to post- for both groups. **Conclusions:** The findings of the study suggest the importance of incorporating both individual- and functional-based balance exercises to increase confidence and functional balance in the aging population.

Key Words: Activity Balance Confidence, activities of daily living, Biodex Balance System, 30s-chair test, yoga

Introduction

Falls and unintentional injuries are the fifth leading cause of death in the geriatric population, and about 1 in 40 falls lead to hospitalization. Of this age group, only about half will be alive a year after being hospitalized from a fall[1]. As the geriatric population increases in size, including the baby boomer age group, there has been an increased awareness for the need of balance and stability in regards to fall prevention. Many therapists have seen an increasing number of falls among the older population and the growing need for balance training to be incorporated into their everyday lives to prevent injury and promote safer living[2]. Balance is a key component to all functional movements in our daily lives. It has been shown to be beneficial for improving joint stabilization, specifically dynamic stabilization for injury prevention. A significant decline in balance occurs with age. Over one third of people aged 65 years or older have fallen once or more times a year[2]. A decrease in balance can cause falls, which can result in disability, reduced independence, and a poor quality of life (QOL). Falls are also the leading cause of death from injury in older adults[3].

When looking at the aging population, there is a negative linear relationship between age and physical activity (PA). With the decrease in PA, there is a decrease in muscular strength and postural stability resulting in being unbalanced and at a greater risk for injury. Injuries often leave individuals unable to perform activities of daily living (ADLs) such as eating, bathing, dressing, or transferring on their own. When an individual is unable to perform ADLs, there is a higher probability that they will move to assisted living homes, causing greater dependence on others[2], which suggests the need for maintaining balance and postural stability among the elderly population

The literature on balance training is extensive, but it is also lacking in some areas. The majority of research studies compare one type of balance training with a control group of participants who are not participating in balance training. A study by Cug and Wikstrom (2014) explored the effectiveness of balance training and measured participants' single leg stance and a dual leg stance on the Biodex Balance System. This study showed improvements in balance from pre- to post-training; however, only one mode of balance assessment, which is not necessarily a true reflection of individuals' balance ability[4]. Another study done by Kumar, Singh, Pandey, and Shrivastava (2014) examined the impact of utilizing foam balance platforms as compared to utilizing stable ground on balance among older populations. Although both training modalities resulted in improvements in balance ability, there was a greater magnitude of increase in balance when

utilizing the foam platforms vs. the stable ground[5].

Previous balance studies have focused on exercises that are segmental by only utilizing lower extremity movements. While these training programs may improve balance, there is still a need for functional-based training that involves multi-joint movements as most falls generally happen when individuals are distracted while performing daily tasks. One of the strong functional training methods which can be implemented in the balance training program may be Yoga, as it incorporates a multidimensional exercise that resembles ADLs that require whole body movements. In a study comparing Yoga and Tai Chi training in a residential care setting, individuals who engaged Yoga displayed a decrease in fall occurrence, and participants reported a reduction in average pain scores[6]. This Yoga and Tai Chi balance study suggested the possibility of effectively improving and maintaining balance ability to reduce the risk of falls by integrating functional training in the daily lives of older adults.

The purpose of this study was to examine the impact of functional-based vs. individual-based balance training programs for middle-aged and older adults. Additionally, this study was aimed to examine the change that occurred over the training period on participants' confidence

levels to engage in ADLs without a fear of falling.

Methods

Participants

The study protocol was approved by the Institutional Review Board of the University of Wisconsin-Eau Claire. Male and female participants of the middle-aged and older adult population (mean age= 59.88 ± 10.51 years) were recruited from the Community Fitness Program at the University of Wisconsin-Eau Claire. To be included in the study, participants must have met the American College of Sports Medicine guidelines of physical activity by accumulating 150 minutes per week of moderate-intensity physical activity or 75 minutes per week of vigorous intensity physical activity. A written informed consent was obtained from all participants prior to participating in the study.

Participants were randomly assigned to either a group that focused on balance training on the individual Biodex Balance System or in a group exercise class that incorporated functional balance exercises supplemented with Yoga poses. Each subject participated in a five-week balance training program, and sessions were held twice a week. The Functional group participants were required to attend classes on both Monday and Wednesday. The classes were offered during the normal community fitness hours, one at 5:40am and another at 6:40am. Both classes were

held in the same room, and the participant was given the option to attend one class per day. The subjects assigned to the individual group could sign up for a time on either Monday, Wednesday, or Friday. Attendance was taken at every session to assure program adherence throughout the entire data collection period of the study.

Testing Procedures

Berg Balance Scale

The Berg Balance Scale measures functional balance. This test takes participants through a series of functional tasks, and the investigator rates each activity on a scale of 0 to 4. This test is designed to help predict falls in older populations. In a study that examined the validity of the Berg Balance Scale in predicting fall risk, the cut off score of 45 out of a total of 56 was used to determine "increased fall risk," and they found that 58% of people who scored at or below a 45 cut point had fallen in the 1-year follow-up period, whereas 39% of people who scored above a 45 had fallen[7]. Accuracy of predicting fall risk increased using the Scale for older adults who experienced more than one fall in the 1-year timespan.

Activity Balance Confidence Scale (ABC)

The Activity-specific Balance Confidence Scale is a subjective measurement of balance. The scale is a questionnaire developed to assess older individuals' balance confidence in performing daily

activities. It asks an individual to indicate their level of confidence (0-100%) in doing a specific activity without losing his or her balance or becoming unsteady. A score of > 80% indicates that the high level of confidence. A score of 50%-80% indicates moderate level of confidence. A score of < 50% indicates low levels of confidence. The individuals are able to evaluate their perception of their balance while doing everyday activities such as walking up the stairs or walking down a ramp.

30-second sit to stand test

The 30-second sit-to-stand test was administered to examine individuals' lower extremity functional mobility. The test was designed to measure an individual's ability to stand up and sit down in a chair as many times as possible in the 30-second period of time[8]. Jones et al., tested the test-retest reliability among older men and women and reported high reliability coefficients of .84 for men and .92 for women. Additionally, Jones and colleagues demonstrated high correlation between the test results of the 30-second sit to stand test and maximum weight-adjusted leg press[8]. The individuals were asked to sit upright in the middle of a chair with their arms placed across their chest and their feet shoulder width apart. The same chair was used for every participant. Once the tester provided a "go" sign, the individual rose to an erect standing position and returned to the initial seated position as

many times as possible; the participants were instructed to be fully seated between each repetition. During this testing period, the tester counts the number of repetitions the participant is able to complete in 30-seconds without losing his or her balance.

Balance Training Procedures

Individual-based using Biodex Balance System

One of the instruments used for balance training was the Biodex Balance System 950-300 out of Shirley, New York. The effectiveness of the Biodex Balance System on an aging population was shown in Gusi and colleagues[9]. This study compared the use of interactive Biodex training and no balance training in a group of forty older adults who had a fear of falling. At the end of the twelve weeks they found that training on the Biodex Balance System significantly improved the fear of falling as well as isometric knee strength and dynamic balance as compared to no balance training.

Individualized Biodex Balance Training occurred two days a week for each participant and each session consisted of 15 minutes of individual training in the Human Performance Lab. The training was conducted in the mornings on Monday, Wednesday, and Friday during Community Fitness hours between 5:30am and 7:30am. The balance training programs used were

Postural Stability, Maze Control, and Random Target Control. To assure valid assessment for each of the tests, individual foot placement was recorded from the time of the first test, and used throughout all of the training days. During all the programs, the test would only be stopped if the individual were to place his or her hands on the Biodex handle bars, fall, or displace his or her feet on the balance platform.

Postural Stability. The first training exercise that was used for the Individual training group was a test called Postural Stability, in which the individual had to focus on keeping the balance cursor on top of a placed target to gain points. The target was placed in the center of the testing circle. During the test, the platform of the Biodex machine was altered by the tester starting from static (most stable) surface and moving to level one (most unstable) surface. Each level lasted 15 seconds and the entire test was 3 minutes and 15 seconds. The scoring for this test was determined by how much time was spent touching the blue placed target.

Maze Control. The second training exercise was called Maze Control; the easiest level of Maze Control was utilized. Level one consisted of one maze pattern with 14 large circles that the participants were required to touch with the black cursor. The participants started at the center of the circle and moved to the outer layer to

Dobbertin et al. (2017) *Int J Res Ex Phys*. **12(2):28-38.**

Sponsored by:
Exercise and Sport Science Program
Western State Colorado University

collect the dots. After working their way around the circle, participants held their weight to the left of the screen until the dots reappeared; participants were then challenged to return back to the center of the screen. While moving through the test, the individual had to concentrate on using slow, controlled movements in order to avoid the walls to sustain a high score percentage. The percentage score was based off the number of times the participant hit the solid blue walls on the screen. The number of times the wall was hit was subtracted from a total of 28 dots there were to collect with the cursor. Then the number obtained by that calculation was divided by 28 to compute the percentage of accuracy in hitting the dots. If the individual were to score more than 50% on test, they proceeded to the next level where the platform became less stable.

Random Target Control. The last training exercise completed by participants was the Random Target Control, in which the individual was instructed to follow a moving target circle around the screen, concentrating on keeping the balance cursor icon in the center of it. The target circle utilized was the middle size of the three circle size options, and it moved at the slowest speed. The score was based on the overall time spent inside the circle divided by the total time. Throughout this test, the platform was altered by the tester, moving from static (most stable) surface to level one (most unstable) every 15 seconds

for a total time of 3 minutes and 15 seconds.

Functional-based Balance Exercises Incorporating Yoga Movements

Participants in the Functional training group attended two sessions per week of balance training. The sessions were held in the group exercise room and were led by the same person for each daily session to keep the programs consistent. Each session lasted 15 to 20 minutes. The group exercise incorporated different modalities such as Bosu balls, unstable platforms or surfaces, and foam balance beam structures, supplemented with Yoga poses which focused on functional balance training in middle-aged and older individuals.

The programs for each session incorporated balance training exercises such as the one legged stand, toe to ankle rocking movement, T-Walk, and the heel to toe walk. Yoga movements that were included were chair pose, tree pose, warrior 1, and warrior 2. The programs consisted of a variety of exercises that allowed for variations and individualization for each participant because of the different levels of balance for each individual.

Study Design and Data Analysis

This study was an experimental design consisting of two groups: a group that

focused on functional exercise incorporating Yoga movements and an individual group that focused on individual balance training using the Biodex Balance System. The dependent variable in this experimental design was balance. Balance was tested using three different measurements for pre- and post- testing. The 30-second sit to stand test was tested by the number of repetitions between standing and sitting completed. The Berg Balance scale was tested by the score of success in a variation of static and dynamic balance tasks. Lastly, the ABC (Activity specific Balance Confidence Scale) was tested by the average percentage of overall confidence in daily activities.

Statistical analysis was carried out using SPSS version 19.0 with significance set at $p < .05$. The statistical method employed in the experimental design was using a two-way factorial repeated measures ANOVA test (group x time). To assess the effect of Individual training vs. Functional training, the pre- and post-test results were compared between each of the training methods (individual, group, and control) as well as the overall change in pre- and post-test results in each of the groups themselves.

Table 1. Means and standard deviations of balance tests by group and time.

	Individual Group		Functional Group	
	Pre-test	Post-test	Pre-test	Post-test
Berg scale	54.18 ± 2.14	55.36 ± 1.43	50.00 ± 5.22	54.64 ± 1.86
ABC test	95.97 ± 4.42	97.91 ± 2.41	89.04 ± 8.26	91.67 ± 5.89
30-sec chair	17.36 ± 3.26	18.09 ± 3.91	19.64 ± 6.67	18.73 ± 3.72

Note. Values are presented in means ± standard deviations; ABC = activity-specific balance confidence scale.

Results

In order to help increase adherence to the study, it was completed during the participants' normal community fitness hours. This allowed participants to come and perform in the study as well as meet the ACSM guidelines. At the beginning there were 29 participants, 15 in the functional training and 14 in the individual training. Among the initial 29 individuals, 79% of participants completed the 5-week training program. The functional-based training group had 2 participants drop due to scheduling conflicts. The individual-based

training group had 4 participants drop out of the study due to work conflicts. Among the Individual group, 5 participants completed all sessions, 2 participants missed 1 session, 2 participants missed 2 sessions, and 1 participant missed 3 sessions out of 10 sessions in total.

Berg Balance Scale

There was a significant interaction between Time (pre-test, post-test) and Group (Individual, Functional) on the Berg scores, $F(1,20)=6.13$, $p=.022$. As a result, simple effect independent samples t tests were used to compare Berg scores between the two groups at pre- and post-test separately. A Bonferroni-adjusted alpha of .025 was used to determine significance for each independent samples t test. The results indicated, at pre-test, Berg score was significantly lower in the Functional group (M=50.00; SD=5.22) compared to the Individual group (M=54.18; SD=2.14), $t(23)=2.33$, $p = .029$. At post-test, Berg score was similar between groups, $t(20)= 1.03$, $p = .316$. Paired-samples t tests with a Bonferroni-adjusted alpha of .025 was used to compare pre- to post-test change for each group. The results indicated, for Individual group, there was no change in Berg score from pre- (M=54.18; SD=2.14) to post- (M=55.36; SD=1.43), $t(10)= -2.08$, $p = .065$; whereas, a significant improvement in Berg score was seen in the Functional group from pre- (M=50.00; SD=5.22) to post-test (M=54.64; SD=1.86), $t(10)= -3.64$, $p = .005$.

Activity-specific Balance Confidence (ABC)

As for the ABC scores, the two-way repeated measure ANOVA indicated no significant interaction effect, $F(1,20) = 0.14$, $p =.709$. Time effect (pre-test, post-test) was significant, $F(1,20) = 6.39$, $p = .02$, and group effect was also significant, $F(1,20) = 8.66$, $p = .008$. ABC scores at post-test (M =94.79) was significantly greater than at pre-test (M=92.50). The Individual group (M=97.91) scored significantly higher than the Functional group (M=91.67) in the ABC test.

30-second Sit-to-Stand Chair Test

Using an alpha of .05, the two-way repeated measure ANOVA indicated Time (pre-test, post-test) and Group (Individual, Functional) were not significant predictors of 30-second chair test scores, $F(1,20)= 0.01$, $p = .922$, and $F(1,20)= 0.71$, $p = .410$, respectively. In addition, no significant interaction effect was examined, $F(1,20)=0.79$, $p = .384$.

Discussion

A decline in strength comes with aging, which can cause an individual to experience a loss of balance[10]. This loss of balance can affect many different aspects of daily living including performing activities of daily living, cognitive functioning, taking care of oneself, and living independently without assistance. Specific training for balance can help reduce the risk of falls and prevent injury among older adults. The aim of the present study was to explore the

effectiveness of a 10-session functional-based balance training program incorporating full-body movements vs. an individual-based balance training program to improve overall balance, confidence level to engage in daily activities, and lower extremity functional mobility among older adults.

Overall Functional Balance and Berg Balance Scale

The results of the study revealed improvements in Berg test scores for both groups, however, the Functional group showed greater score improvement from pre-test to post-test. This could be because the Functional group started with lower functional balance scores compared to the Individual group. This allowed more room for improvement in Berg test scores to occur among the Functional group. Previous research, such as a study completed by Katherine Berg and colleagues, had tested the validity of the Berg Balance Scale by examining its effectiveness of measuring balance capacity among older adults. Their research concluded that the Berg Balance Scale was a valid method of measuring functional balance and of predicting future falls based on an individual's baseline score[11]. The significant improvement in Berg scores with the Functional group could be because of the test itself consisting of similar movements/tasks performed in the Berg test were incorporated in the functional balance training vs. the Individual group

had undergone training sessions that occurred only on the platform of the Biodex Balance System.

Activity-specific Balance Confidence (ABC)

When analyzing the results of the ABC tests, participants in the Individual training group had a higher personal balance confidence score compared to the Functional training group. This could be due to the training method, such that the Biodex Balance System put the participants in situations that they might not encounter in their everyday life, such as standing on an unstable platform and trying to follow a circle around the testing screen. A study looking at the effects of balance training on foam platforms in the geriatric population completed by Kumar, Singh, Pandey, and Shrivastava in 2014 comparing a balance training program using a static surface versus a foam surface. The results showed that participants in the foam training group had a greater increase in balance than those in the training group on the static surface. Using foam platforms and balance beams may improve balance more effectively than using static surfaces alone[5], which can ultimately increase the confidence in individuals' balance ability.

Additionally, a study by Cug and Wikstrom in 2014 examined the effectiveness of single leg vs. dual leg stances on the Biodex Balance System and their findings suggested that individual balance training could be used to improve balance in the

middle-aged and older adult population[4]. Supplemental to regular physical activity, middle-aged to older adults should incorporate balance-specific exercises to decrease the risk of fall in the future. While speculative, individual balance training on the Biodex Balance System may have induced greater confidence among participants due to the amount of cognitive focus necessary to complete the training program successfully. More specifically, participants were able to see their scores on the screen and were provided with objective assessment of their improvements in balance from session to session. With an increase in individual's confidence level, there is an increased possibility for the aging population to engage in more frequent and various forms of daily activities, resulting in maintaining or attenuating the rate of a decrease in functional mobility.

30-second Sit-to-Stand Chair Test
Finally, the 30-second sit to stand test showed no improvement from pre-testing to post-testing. This test was designed towards older adults with a lower level of functioning[8], but every participant in this study had a higher level of functioning due to the regular participation in the exercise program, as demonstrated by their baseline scores of 30-second sit-to-stand test. The results from the previous study showed that highly active individuals, those who performed moderate exercise at least three times a week had a mean score of 13.3 sit-to-stand repetitions. The participants in this study, who could also be considered highly active, had a mean score of 17.36 repetitions at pre-test, which suggested a higher level of functioning compared to participants in the previous study.

Conclusions

The results of the study suggest the use of both individual-based and group-based balance exercise sessions to increase confidence in engaging in activities of daily living and to increase balance ability among middle-aged to older males and females. The use of unstable platform, such as Biodex Balance System, may also allow individuals to be exposed to conditions that mimic real life situation that potentially lead to falls. As Biodex Balance System focuses on only lower extremity control, it is as well recommended to incorporation whole body movements (both lower body and upper body), such as Yoga, into a group-based balance session as preventive methods for reducing the risk of falls among the aging population.

Address for correspondence
Dobbertin, M. University of Wisconsin-Eau Claire, 105 Garfield Ave. Eau Claire, WI, 54702, USA; Phone: 715-836-3774; FAX: 715-836-4074; Email: Dobbermn3110@uwec.edu.

References

1. Rubenstein LZ. (2006). Falls in older people: epidemiology, risk factors and strategies for prevention. *Age Ageing*, 35(suppl 2), ii37-ii41.
2. Yim-Chiplis P, Talbot L. (2000). Defining and measuring balance in adults. *Biol Res Nurs*, 1, 321-331.
3. Avin KG, Hanke TA, Kirk-Sanche N, McDonough CM, Shubert TE, Hardage J, Hartley G. (2015). Management of falls in community- dwelling older adults: Clinical guidance statement from the academy of geriatric physical therapy of the American Physical Therapy Association. *Phys Ther*, 95, 815-834.
4. Cug M, Wikstrom EA. (2014). Learning effects associated with the least stable level of the Biodex stability system during dual and single limb stance. *J Sports Sci Med*, 13, 387-392.
5. Kumar S, Singh M, Pandey A, Shrivastava S. (2014). Effect of balance training on foam platform in geriatric population. *Indian J Physiother Occup Ther*, 7, 77-85.
6. Saravanakumar P, Higgins IJ, van der Riet PJ, Marquez J, Sibbritt D. (2014). The influence of tai chi and yoga on balance and falls in a residential care setting: A randomised controlled trial. *Contemp Nurse*, 48, 76-87.
7. Muri SW, Berg K, Chesworth B, Speechly M. (2008). Use of the berg balance scale for predicting multiple falls in community-dwelling elderly people: A prospective study. *Phys Ther*, 88, 449-459.
8. Jones CJ, Rikli RE, Beam WC. (1999). A 30-s chair-stand test as a measure of lower body strength in community-residing older adults. *Res Q Exerc Sport*, 70, 113-119.
9. Gusi N, Adsuar JC, Corzo H, del Pozo-Cruz B, Olivares PR, Parraca JA. (2012). Balance training reduces fear of falling and improves dynamic balance and isometric strength in institutionalised older people: A randomised trial. *J Physiother*, 58, 97-104.
10. Ni M, Mooney K, Richards L, Balachandran A, Sun M, Harriell K, . . . Signorile JF. (2014). Comparative impacts of Tai Chi, balance training, and a specially-designed yoga program on balance in older fallers. *Arch Phys Med Rehabil*, 95, 1620-1628.
11. Berg K, Wood-Dauphinee S, Williams J, Maki B. (1992). Measuring balance in the elderly: Validation of an instrument. *Can J Public Health,* 83, S7-S11.