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The Effects of a Multi-Axis Balance Board Intervention Program in an Elderly Population

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This study indicates that use of the Indo Balance Board three times a week for ten minutes can significantly improve balance and potentially decrease the risk of falls.

Abstract

Balance is a major issue facing the geriatric population. Nine participants from a local community center for seniors completed a five-week study to assess improvement in balance. Measures of balance, performance times, and scores on the Berg Balance Scale (BBS) and the Wii Fit Age (WFA) were recorded before and after the entire intervention. An analysis of variance (ANOVA) with repeated measures was used to assess change in BBS and WFA scores. An analysis of covariance with repeated measures was used to assess the impact of possible contributing factors of age, gender, BMI and total balance board training time over the five-week period. The analysis indicated that use of the Indo Balance Board three times a week for ten minutes can significantly improve balance and potentially decrease the risk of falls, as measured by the BBS. Age was the only factor that significantly influenced balance (p = .006). These improvements are postulated to be due to an increase in subjects’ core and lower extremity muscle strength and improved proprioception; a result of balance board usage.

Introduction

Balance is a major issue facing the geriatric population. In the 65 and older population, one in every three persons will experience a significant fall. These falls contribute greatly to morbidity and are a leading cause of death in this population. Between 2001 and 2003, falls occurred at a rate of 51 episodes per 1,000 individuals among those 65 years and older. Data also shows falls increase with age and were higher for women than men. The falls are not only debilitating to the individual, but also are a large financial burden to the health care system. In 1994, the total cost of fall injuries was $27.3 billion for the concerned age group. In 2006 persons 65 and older numbered almost 500 million people worldwide, and that number is estimated to double by 2030, according of The National Institute on Aging. With this population increase, it is no surprise that within the next 10 years the cost of falls is projected to increase to $43.8 billion. Various
interventions targeting balance improvement have been shown to be effective in reducing the incidence and risk of falls.\textsuperscript{5-8} The cost that these injuries impose on quality of life and the health care systems reinforces the need for more scientifically proven fall-prevention interventions, including those that can translate into real-life contexts.\textsuperscript{9}

Balance is affected by deficits in both neurologic and musculoskeletal impairments. These balance components play a large role in postural control, proprioception, leg strength, and ankle mobility.\textsuperscript{7} Impairments in these components, which can be related to age, have proven to be the most common causes of falls in the elderly population.\textsuperscript{1} These components also play a large role in kinesthetic awareness, which is vital to maintaining stability and orientation during static and dynamic activities; the basis of postural control.\textsuperscript{10} Previous studies have shown that exercises targeting lower limb and core muscles can increase kinesthetic coordination and awareness along with musculoskeletal strength.\textsuperscript{11-13} Through improvement in balance, proprioception, and core strength within this target population, the incidence of falls can be decreased significantly.\textsuperscript{11-13}

Physical improvements of balance along with improved balance confidence have both been shown to have a negative correlation with the incidence of falls.\textsuperscript{16} Achievement of improved proprioception and stability can be accomplished through specific exercises integrating afferent input to the central nervous system (CNS) into the motor output response responsible for balance.\textsuperscript{17} This has been shown to have a protective effect on the risk of falling.\textsuperscript{5} Exercises aimed at improving quadriceps strength, reaction time, and neuromuscular control have shown improvement of the sensorimotor systems, which are the major contributors to balance and stability in the elderly.\textsuperscript{18} In addition, increased balance confidence augments better overall balance performance.\textsuperscript{16} Therefore, finding a cost and time effective exercise routine for elderly individuals to use is imperative with our aging society.

An intervention that incorporates neuromuscular, musculoskeletal, and confidence improvement in the elderly population would make for an ideal method of balance improvement. Review of current literature has shown an abundance of research examining interventions aimed at improving these characteristics in the elderly; however, limited studies have investigated balance improvement using a single-axis balance board, and none using a multi-axis balance board. The authors of the present study attempted to formulate an exercise program that would fit these criteria. The objective of the study was to assess the balance and balance improvements in an active elderly population. Additionally, the validity of the Nintendo Wii balance board (WBB) in conjunction with the Wii Fit game as a balance assessment instrument was investigated. It is hypothesized that balance performance will improve as a result of multi-axis balance board training in the target population of 65 and older. Furthermore, in comparison to the Berg Balance Scale (BBS), the Wii balance board will be validated as a tool to measure balance improvement.

Research Design

Recruitment

Twenty-seven participants were recruited using flyers and direct contact at a local community center for seniors. Volunteers were screened and selected based on inclusion and exclusion criteria. Participants were eligible to participate in the study if they were 65 years or older, in good health, and obtained a score of 41 or higher on the BBS. Participants were excluded from participation if they did not meet the age requirement, were non-English speaking, scored less than 20/200 on the Snellen Vision Screen, and/or had health problems including history of stroke, prosthetic joint, amputation of any limb, daily
oxygen use and or any vestibular condition which affected balance. Subjects were also unable to participate if they had any previous experience with or current use of a balance board. Of the 27 individuals, 13 were eligible to participate and nine met the requirements for study completion (>50% attendance). Written consent was obtained from all participants. This study was approved by Kansas City University of Medicine and Biosciences’ Institutional Review Board.

Procedure

The intervention device used for balance training was the Indo Board Balance Trainer. It is a balance board that utilizes the IndoFLO® Balance Cushion as a multi-axial fulcrum. Participants trained on the balance board for a maximum of 10 continuous minutes per day, three times per week, for five consecutive weeks. Each training session was performed between a doorway with research assistants on either side of the participant to ensure safety. Participants were encouraged to balance as long as possible during the training session, with balance defined as no edges of the balance board in contact with the floor. (See Figures 2 & 3.)

The first day of data collection consisted of visual acuity screening, blood pressure and body mass index (BMI) measurements, muscle strength and deep tendon reflex testing. The BBS was administered to each participant and video recorded to determine baseline scores. Nintendo Wii Fit game and Wii balance board, were used to obtain baseline Wii fit balance age (WFA), the numerical value Nintendo uses to measure balance.

Shoes were worn during the duration of the training. Participants were allowed to use research assistants or the doorway if they felt unsteady. Every third visit, prior to balance board training, balance was re-evaluated with the BBS and WF. All BBS performances were video recorded and scored by three examiners. At the final session participants completed the ABC Confidence Scale as well as a study completion surveys.

Data Analysis

Intraclass correlation was used to estimate inter-rater reliability. To assess change in BBS and WFA values, an analysis of variance (ANOVA) with repeated measures was used. Due to inconsistent attendance, only the baseline and final BBS and WFA values were included in data analysis. An analysis of covariance with repeated measures was used to assess the impact of possible contributing factors: age, gender, BMI and total balance board training time over the five-week period.

Results

Initial recruitment for the study included 27 subjects and only nine subjects: (a) met all of the inclusion criteria; (b) did not meet the exclusionary criteria; and, (c) had completed at least 50% of the five-week training protocol. Descriptive statistics for the nine subjects are presented in Table 1. Intra-rater reliability for BBS scoring was determined with an ICC of .987.

Values for BBS and WBA are reported in Table 2. All data are reported in terms of mean and standard deviation. A significant increase was seen from baseline to final BBS, $F(1,8) = 8.417, p = .02$, partial $\eta^2 = 0.513$, and an improvement was shown from baseline WBA to final WBA. A low to moderate negative correlation exists between BBS and WBA for both initial and final measurements ($r = -.085, r = -.251$ respectively).

Of all possible contributing factors measured, only age showed significant influence on balance ($p = .006$), while
gender, BMI and total training time did not. Examination of the BBS data suggests that younger participants had a greater improvement in balance.

Two subjects were absent for both post-training questionnaires (N = 7). Although an increased trend was seen, it was not significant.

Study Completion Survey results show five out of seven participants felt their balance improved as a result of balance board use; with two reporting indifference. Six of the seven felt safe while using the balance board and enjoyed training on it, while one neither agreed nor disagreed with the statements. In addition, six of the seven participants would consider using the Indo Board Balance Trainer as a tool for balance improvement if they owned or had access to one. All participants found use of the Wii Fit enjoyable and felt safe while using it.

**Discussion**

The study findings indicate that use of the Indo Balance Board three times a week for ten minutes can significantly improve balance and potentially decrease the risk of falls, as measured by the BBS.

As hypothesized, the WFA for each subject decreased, however this decrease was not significant. A negative correlation between the WFA and the BBS was anticipated, but was found to be low to moderate and negative. Although participants enjoyed using the Wii Fit, this study showed that it is not a statistically reliable means of measuring balance when compared to the BBS. Attempts to gather information on how the WFA is calculated by the Wii Fit software were unsuccessful. It is assumed that the participants' actual ages are factors in determining WFA; however, without knowledge of how WFA is calculated, the analysis could not be assumed to be reliable. The Wii Fit should not be disregarded as a potential method of balance measurement or improvement as it was found to be a tool that participants enjoyed using and may have enhanced participation in this study.

The study populations showed a significant improvement in BBS scores between the initial and the final measures. These improvements are postulated to be due to an increase in subjects' core and lower extremity muscle strength and improved proprioception; a result of balance board usage. These two improvements allowed subjects to become more stable, which theoretically lead to their objective and subjective improvements in balance. The only other study found that investigated balance board intervention in an elderly population was done by Nordt et al. They reported similar findings in overall balance improvement in both objective and subjective components. In contrast to the current study, Nordt and colleagues utilized a single-axis balance board intervention over a thirty-day training period.

The presumed advantage of a multi-axis balance board includes recruiting more muscle groups anssubjective improvement as well. The ABC confidence scales completed at the beginning and end of the exercise protocol demonstrated an upwards trend, indicating participants confidence in their balance abilities improved. Verbal statements were made by participants regarding how much safer they felt on their feet from day to day since beginning the exercise protocol. One subject stated they were now able to shower without the use hand rails. She was also able to ambulate further and stand for longer periods of time without sitting down or using assistance she previously required. Another subject noted the ability to get out of bed in the morning without any period of instability.

This study was limited by the small number of participants who successfully completed the exercise.
protocol. The strict inclusion and exclusion criteria limited the number of potential participants. As this was a pilot study to demonstrate the safety and efficacy of the Indo Board Balance Trainer, the target population was healthy elderly with low fall risk. In the future, the expansion of the inclusion criteria to contain participants with a larger range of balance ability is recommended. This would help increase the sample size, as well as give a more accurate depiction of balance board responses by those of varied fall risks. Another factor contributing to the small sample size was conducting the research in a community-based senior center. It was difficult to account for illness, lack of transportation, etc., which played a role in attendance, as only 64% of those eligible met study completion criteria. Conducting the study in a facility in which participants reside may increase the likelihood of full attendance.

The lack of a control group did not allow for consideration of any improvement stemming from socialization and the physical activity required to commute and to stand for periods of time. Furthermore, a familiarity may have developed from repeating the BBS and the WF at the end of each week.

When measuring potential contributing components to balance outcomes, it was found that total time of balance board training did not significantly influence participants’ balance. It would be expected that more time spent on the balance board would result in greater balance improvement. However, a ceiling effect was encountered with the assessment tool. As the majority of the participants started out with a high baseline BBS score (≥ 54), there was minimal space for improvement, as the scale caps at 56. In a population with lower baseline BBS scores, the ceiling effect would play less of a role. In addition, the participants who maximized the BBS scores were those that spent the most time training. The ceiling effect may also have minimized the increase seen in the mean BBS scores from initial to final assessment.

References

Disclosure
None reported.

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