THE EFFECT OF COUNTER-CLOCKWISE VIBRATION PLATFORM TRAINING IN THE GERIATRIC POPULATION ON POSTURAL SWAY

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Doctor of Physical Therapy

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APPROVAL SHEET

This Independent Research Project is submitted in partial

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The final copy of this Independent Research has been examined by the signatories, and we find that both the content and the form meet acceptable presentation standards of scholarly work in the above mentioned discipline.

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ABSTRACT

Introduction: This study analyzed the effects a counterclockwise oscillating vibration platform has on the community dwelling older adult's balance and postural sway. The current literature is mixed in regards to the effects that vibration platforms can have on improving balance and postural sway, however, there are no existing studies that look at the effects of a counterclockwise oscillating vibration platform. Previous studies investigated vertical and horizontal vibrations. **Methods:** A total of 34 subjects (mean age of 80 $\pm$ 7.57 years) completed the entire protocol. Each subject completed a Mini-Mental Evaluation, ABC Balance Confidence Scale, and the CDC4 SWAY Medical Balance Protocol prior to participating in the intervention for baseline measures. The intervention was over a five-week time period, which required subjects to stand on the vibration platform for five minutes a day, for four days a week. At the end of the five-week protocol, the ABC Balance Confidence Scale and the SWAY Medical Balance Protocol were re-measured. **Results:** The results showed a statistically significant difference for increase in the ABC Balance Confidence Scale. There was a numerical increase in postural sway, however it was not statistically significant. **Conclusion:** There was a statistically significant increase in balance confidence per the ABC Balance Confidence Scale. Average scores on the SWAY Balance test improved, but not to a statistically significant level. This is possibly due to brevity of protocol duration or high overall balance levels of those participating.

INTRODUCTION

The population demographics of the United States are shifting. There is a pronounced increase in the percentage of the population over the age of 65 and this number is projected to rapidly multiply over the next several years. Currently, more than 13% of the population is over the age of 65, accounting for over 33 million individuals. By the year 2050, the elderly population is expected to exceed 20% of all Americans,[2] with the greatest increase being in those aged 85 and older.[3] This redistribution of the age demographic will necessitate an increased focus on the health and well-being of the elderly population.

This population faces a unique set of challenges and obstacles as life progresses into its later years. Unfortunately, it is often accepted that the aging process is tied to loss of function and independence. These losses are often related to physiological changes brought upon by lack of activity or a sedentary lifestyle. There are several different physiological reasons that can make the aged individual at greater risk for falls. It is usually multifactorial disorders such as impaired vision, vestibular dysfunction, sensory loss, muscular weakness, or gait disorders that contribute to the more frequent falls experienced by the elderly.[4] By utilizing an effective intervention program, however, these physiological changes can be delayed or even reversed. The aging process is considered to have multiple components, and some of these variables are able to be manipulated by participation in exercise and regular physical activity. Balance, coordination, and strength are all abilities that can be improved with proper training. Regular participation in physical activity has been shown to limit many adverse effects associated with secondary aging processes, and can even prolong life expectancy.[5] It is hypothesized that the most significant underlying reason for weakness and atrophy in the older adult is actually muscle disuse and lack of activity, rather than the aging process itself.[6] This emphasizes the necessity of finding a technique that can improve function, foster patient compliance, and remain time and cost effective.

BALANCE

Results from a random survey of the elderly population conducted by Sheldon et al.[7] revealed that a history of falls was obtained from 24% of men and 44% of women who live at home. Statistics show that falls have become a major problem with today's elderly. Up to 5% of falls result in fractures and anywhere from 30% to 50% result in soft tissue damage that does not receive medical attention.[8] One of the leading causes of accidental falls among the elderly citizens is a lack of balance.[9] Balance can be defined as the ability to maintain the body's center of gravity over the base of support with minimal postural sway. Balance is primarily concerned with maintaining, attaining, or correcting the center of mass in relation to the base of support and is the second leading cause of all falls in the elderly.[10]

Balance and posture must be maintained in both static and dynamic activities. In a static posture the body segments are aligned and maintained in certain positions, such as standing, sitting, or kneeling. In the normal, static-standing position little to no visible acceleration or movement of the body occurs except for a swaying motion known as postural sway. This swaying motion occurs in response to internal inertial forces and acts as to maintain the center of gravity over the base of support. Dynamic balance must be maintained when the body or its segments are moving. Examples of dynamic balance situations are running, walking, or lifting.

Balance Systems

Balance deficits can be multifactorial and include issues with many separate but related body systems. These systems include the central and peripheral nervous systems, the vestibular system, the visual system, and the musculoskeletal system. Information from all of these systems is integrated in order to maintain proper balance. All of these systems need to be functioning optimally for the body to fully engage all of the necessary balance strategies used in daily life. Each of these related components provide a unique set of information regarding the movement and position of the body within space.

The vestibular system is an active part of maintaining balance and posture. This system involves the structures in the inner ear that monitor and sense various changes in the position of the head. This system can be separated into two divisions, with one monitoring static equilibrium and the other monitoring dynamic equilibrium. Receptors in the inner ear that are responsible for the monitoring of static equilibrium respond to linear head movements and head tilt, and respond only to changes in the velocity of head movement.[11] This means that they do not report unchanging head positions, making them an important part of the maintenance of normal head position. The receptors that are concerned with dynamic balance respond to changes in rotary movements of the head. The vestibular balance system does not directly or automatically compensate for forces acting on the body, rather it sends impulses to reflex centers in the brain. Impulses are either sent to the vestibular nuclei in the brainstem for integration with input from the visual and somatosensory systems, or to the cerebellum to coordinate skeletal muscle activity. These impulses are then integrated by the central nervous system in order to initiate the appropriate compensation for a disturbance in balance.

The visual system also plays an important role in balance. Reflexes mediated by input from the vestibular system effect how the eyes move relative to the position of the head. Every time the head rotates, the semicircular canals of the vestibular system send signals that cause the eyes to rotate in an equal and opposite direction to the rotation of the head.[12] This relationship between the vestibular system and visual system allows one to maintain a stable image on the retina while the head moves in space. Without this mechanism the eyes would not be able to remain fixed on an object long enough to obtain a clear image.

The somatosensory system is another critical component in balance. Proprioceptors in the neck and body send signals to the vestibular nuclei relaying information about the body’s position in space. This information is then sent to the cerebellum for modification of both static and dynamic balance. The joint receptors in the cervical region are of particular importance to the proper function of balance systems. These receptors help to keep one from feeling disequilibrium by transmitting signals that precisely oppose the signals sent by the vestibular apparatus.[12] This ensures that the signals being sent from the vestibular system are relaying appropriate information regarding the position of the head.

Balance strategies

Individuals use many different balance strategies in order to respond appropriately to a multitude of different situations that challenge the body to maintain posture and balance. Two of these strategies are reactive strategies and proactive strategies. Reactive strategies are used when there is an external force that alters the body's center of mass. Proactive strategies are used in anticipation of internally generated destabilizing forces that will shift the body's center of mass, such as reaching out the arms. [13] The elderly individual, however, often cannot integrate these strategies to correct for their lack of balance in time to prevent a fall. Decreased reaction speed and the inability to correct for a disturbance in balance is another factor that leads to the prevalence of falls in the elderly population. As individuals age, nerve conduction speed is reduced considerably. This decrease in conduction velocity means that both the signals being received by the sensory systems and the signals being sent out by the central nervous system are not reaching their destinations as quickly as they once had. While an individual either young or old may have an equally likely chance to trip over an unseen object, the younger individual has a better ability to regain balance and avoid a fall.

The body uses different muscle synergies to compensate for loss of balance of different magnitudes. There are three main strategies that the body uses in order to maintain or regain balance: ankle strategy, hip strategy, and stepping strategy. Ankle strategy and hip strategy are examples of fixed-support strategies, where the base of support remains fixed during perturbation and recovery. The ankle strategy is employed first, when there is a minor perturbation or disturbance in balance. The body will send quick bursts of activity in either the anterior or posterior aspect of the leg in order to prevent movement in the sagittal plane.[13] Important muscle groups involved in this strategy include the ankle plantarflexors and dorsiflexors, along with the abdominals and hip flexors. Muscles firing when the ankle strategy is utilized begin to fire distally and continue more proximally as the balance task becomes more difficult. Hip strategy is the next fixed-support strategy that is used when the ankle strategy is not sufficient to maintain or regain balance. Hip strategy generally initiates for larger perturbations, and operates in a proximal to distal muscle firing pattern. The muscles involved in this strategy include the quadriceps, hamstrings, abdominals, and paraspinals. If these two strategies fail, a third strategy is utilized: stepping strategy. This is technique is known as a change-in-support strategy, as opposed to the fixed-support strategies described earlier. In a change-in-support strategy the center of gravity moves too far from the base of support to maintain a fixed position. The body will react by stepping in a certain direction in order to move the center of gravity back over the base of support thereby regaining balance. This strategy is most effective when recovering from a large perturbation.[13]

Balance and Strength

Diminishing balance is multifactorial, but several studies have shown that a lack of lower extremity strength is one of the common factors leading to decreased balance, and eventually falls.[14] The increased risk of falls in the elderly is closely related with the decrease in muscular strength typically experienced by this population, and can provide an additional deterrent to the functional independence of the older adult.[15] By age 40, muscle strength can be expected to decrease about 1% each year,[16] with these losses being exaggerated to up 3% per year in those over age 65.[3]

There are a few different specific muscles in the lower extremities that have been linked as key components of balance. Lord et al's.[17] findings on ankle dorsiflexion determined that increased strength has a direct relation to balance. With this in mind, Hess and Woollacott[14] concluded in their own study that strength is 1 of 3 variables significantly discriminating between older adults with a history of 0 to 1 falls to those with a history of multiple falls. Dorsiflexors (tibialis anterior) were extremely weak in those with multiple falls, which suggests that these muscles greatly contribute to poor balance. This showed that weak knee flexors (hamstrings), extensors (quadriceps), and plantar flexors (gastrocnemius and soleus) all had an effect on patients with multiple falls. Hess and Woollacott[14] further studied the four muscles listed above and found using the Berg Balance Scale, that the subjects increased balance with increased plantar flexor muscle strength. The TUG test was used as well and yielded similar results as the Berg Scale. The participants were asked to rate the perception of their balance using the ABC scale before and after the study. Those in the experimental group ranked over 26% higher than the control group at the end of the study. They noted that strength training can reduce fall risk anywhere from 5% to 20% in a 10 week program, while also increasing balance confidence.

Balance Boards and Vibration Platforms

Whole body vibration is a training method that exposes the entire body to mechanical vibrations or oscillations while standing on a platform. [18] The use of balance boards and vibration platforms in effort to improve balance is a novel concept that is growing in popularity and research. As research into this concept progresses, it is important to define the variables that are the most effective in producing the desired results in the patient.

Vibration boards have a number of different parameters including frequency, amplitude, and direction of the vibratory force. Frequency refers to the number of oscillations per second that are produced by the platform. The amplitude describes the magnitude of excursion of the platform. The direction of vibration of a conventional vibration platform is typically either side-to-side or vertical. A study conducted by Pollock et al. investigated the effects of different vibratory parameters on various outcomes using an elderly population. [19] Results demonstrated that higher frequencies in the range of 40 to 50 cycles per second produced the most muscle stimulation. The effect of frequency was also magnified as the amplitude of vibrations increased. However in a study conducted by Gusi et al.[20] participants reported significant results using a frequency range of 12.6 to 26 cycles per second. Higher amplitudes have been demonstrated to cause greater muscle activation, with a tendency for muscles nearest to the platform to be most active.

There are several different types of vibration platform, each using a different mechanism of vibration. A stochastic vibratory platform has separate platforms for each foot and vibrates in a random manner. A more conventional type of vibration platform has the user standing on a single platform. This type of platform generally operates using a sinusoidal wave and vibrating in either a side-to-side alternating or vertical direction.[4] A counter-clockwise oscillating vibration platform uses spirally formed oscillations that rotate in a counterclockwise direction. According to the inventor of the counter-clockwise oscillating vibration platform, "the gravitational force pulls the body down. The force is strengthened through the spiral dynamic of the platform due to the gravitational force. The levitation force pushes the body upwards and is enhanced by the oscillations. Therefore, both forces, the downward pull and the upward push, are being reinforced."[1] This is opposed to the conventional side-to-side or vertical whole body vibration platforms.

Vibration platform training causes rapid vertical and/or horizontal displacements with high levels of acceleration. This type of perturbation causes a disturbance of the user's motion and equilibrium. These perturbations can interfere with postural control, challenging the body to respond with appropriate balance correcting strategies. Perturbations are known to be an appropriate training stimulus to improve balance and balance confidence.[18] Bernhardt et al.[18] concluded that postural control was improved in a similar manner using either vibration board induced perturbations or a specific balance training protocol. Perturbations provide an input that challenges the balance systems to react to an external force. Balance strategies must be appropriately and sequentially executed in order to maintain the desired postural position.

Torvinen et al.[21] have conducted multiple studies using a variety of balance boards and several different protocols, but these studies have returned mixed results. A twelve week study of middle aged women utilizing a side-alternating vibration platform training program demonstrated significant gains in isokinetic strength of the knee extensor musculature. A similar training program conducted with a younger population, however, did not demonstrate any significant knee extensor musculature gains. Another study that was conducted by Belavey et al.[22] concluded that vibration could minimize risk factors for falling by improving muscle strength and body balance. In a systematic review of 15 vibration platform studies, de Bruin et al.[4] concluded that side-alternating sinusoidal vibrations can have a beneficial effect on the dynamic balance of elderly individuals. Vertical sinusoidal vibrations, however, did not demonstrate these positive results. Of the fifteen studies reviewed, one third of them were not able to show beneficial results from the use of a vibration platform.

Several studies[4, 14, 18, 23-25] reporting the effects of whole-body vibration on the elderly have demonstrated adverse effects resulting from training. Complaints included erythema, itching of legs, headache, and groin pain. In a study conducted by Bogaerts et al.,[26] 9 out of 119 participants complained of knee pain after whole-body vibration training, however these reports were found to be related to degenerative changes from previous injuries. One of the common complaints among several studies was muscle soreness after the initial training session, but this can be expected when introducing a new training protocol. Lam et al.[23] note that prolonged exposure to whole-body vibration has also been shown to have adverse effects, however, it is unspecified as to what prolonged exposure may constitute. They also note the relatively short duration of training sessions in most studies, which eliminates this negative consequence. The low frequency of occurrence of adverse effects, and the fact that these effects have generally been mild and usually subsided soon after the completion of the training session indicates that whole-body vibration is well tolerated among older adults.[23]

It is clear that more investigation into the use of balance and vibration platforms as a tool to improve both static and dynamic balance is warranted by the disparity of results from previous studies. While several studies may be using the same type of balance board (i.e. side-alternating sinusoidal), other various parameters such as frequency or amplitude of vibration could be different. Studies[4, 18, 19, 21, 25] have also attempted to determine the most beneficial duration of training, ranging from an acute bout of vibration lasting only several minutes to a year-long training progression.

THEORETICAL FRAMEWORK

As the elderly population continues to increase in number, it is important that new and innovative ways to reduce the number of falls that lead to decreased quality of life are investigated. For an intervention to be maximally effective, it should be manageable from a time perspective, ensure flexibility in scheduling, and elicit the desired psychological and physiological effects. Participation in regular physical activity seems to be the only lifestyle modification identified to date, other than caloric restriction, that can favorably influence a broad range of physiological systems as well chronic disease patterns. Physical activity is also closely related to better mental health and social integration.[27]

The purpose of this study was to determine whether the counter-clockwise oscillating vibration platform has a significant effect on balance in a geriatric population.

METHODS

Study Design

This was a quantitative research study with a one group repeated measures (non-control) quasi-experimental design. The intervention was a 5-week treatment protocol using a counterclockwise oscillating vibration platform. Each participant completed an ABC Balance Confidence Scale and SWAY balance measurement prior to the 5-week protocol. Each participant was reassessed at the end of the 5-week protocol. The study was approved by the Institutional Review Board of Florida Gulf Coast University.

Sample

A non-probability convenience sampling strategy was used to gather participants. A Priori power analysis was conducted using an effect size of 0.4, power of 0.8, and 3 degrees of freedom, which determined that 30 participants were needed in the study. The researchers contacted local Independent Living Facilities in order to see if they felt their residents might have interest in participating in a study regarding balance. A Health Fair at Cypress Cove Independent Living Facility was attended, where the researchers gained interest from 54 participants over the age of 65 through flyers, face-to-face conversation, and word of mouth.

Physical exclusionary criteria for the participants included:

1. Have an acute thrombosis

2. Any injury or existing inflammation
3. Recent fracture
4. Recent joint implant
5. Recent surgery
6. Having a rheumatic episode
7. Having a tumor of any sort

Instrumentation

The OSFLOW counterclockwise oscillation vibration platform was used for the intervention in this study. The platform frequency is adjustable, but can be set anywhere between 8 to 12 Hz by the manufacturer. For the purposes of this study, both machines used were calibrated to 10 Hz over the five-week course of the study. The dimensions of the platform are 31.5 inches in length, 15.75 inches in width, and 7.09 inches in height. The total weight of the platform is 29.99 pounds. The amplitude of the OSFLOW is set to 1-2 mm.[1]

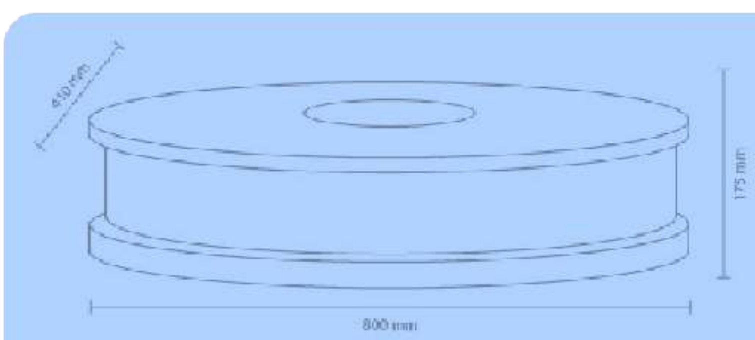

Figure 1. Vibration Platform Dimensions. Adapted from OSFLOW.[1]

Figure 2. OSFLOW Vibration Platform. Adapted from OSFLOW.[1]

The SWAY Medical Balance phone application was used to collect data on the subject's balance and postural sway. This App is an FDA approved medical device that is intended to assess postural sway as an indicator of balance. It is considered to be reliable with test-retest reliability (ICC(3,1) = 0.76; SEM = 5.39).[28] Research also indicates that it is highly comparable to the Balance Error Scoring System (BESS).[29] The CDC4 protocol was used for this research, as it was determined to be the most relevant to the study being conducted with the geriatric population than the other protocols that were available. The CDC4 protocol is exclusionary of reaction time, as the others are not.

Figure 3. SWAY Medical Balance App. Adapted from SWAY Medical.[29]

The Activities-Specific Balance Confidence Scale (ABC Scale) was used as a subjective measure of confidence for the community dwelling adult in performing various ambulatory activities without falling or a sense of unsteadiness. It is a 16 question, paper survey. A score of less than 67% is indicative of that subject being considered a fall risk. The test has excellent test-retest reliability in the elderly population ($r = 0.92$, $p < 0.001$), as well as excellent internal consistency for community dwelling older adults (Cronbach's alpha = 0.96).[30]

The Folstein Mini-Mental State Examination was used as a brief screening tool to provide a quantitative assessment of cognitive impairment. This assessment consists of 11 questions or tasks, grouped into 7 cognitive domains: orientation to time, orientation to place, registration of three words, attention and calculation, recall of three words, language, and visual construction.[30] Scoring a minimum of 24 out of the 30 possible points indicates that there is no level of impairment in cognition. All participants in this studied scored at least a 24. The Mini-Mental was used in order to ensure that the potential participants fully understood the potential risks that were involved with signing up for this study. It was also used by the researchers to ensure that the subjects that committed to participate were fully aware of the large time commitment that was involved to decrease odds of subject drop out.

Procedure

Potential participants attended an information session the day before the first intervention session was implemented. The Informed Consent form was gone over in detail at this time. Confirmed participants were then administered a Mini Mental

Evaluation, as well as given a Recent Health Survey to determine if they were fit both physically and mentally to participate. Potential participants needed a minimum of 24/30 to be considered eligible. Confirmed participants were then required to fill out an initial ABC Balance Confidence Scale for their baseline measurement.

The study lasted a time period of five weeks. Each participant was asked to attend four sessions a week for the five-week time period. The researchers were present six days a week, for a time period of three hours each day. Participants were able to attend any time during the allocated time block. A schedule of the times for the following week was provided at the end of each week. A weekly sign in sheet was set up at the front desk so that participants and researchers could keep track of the number of sessions attended for the week. Each participant was allocated a three session grace period for the entirety of the research process. If they missed more than three sessions, they were removed from the study.

On the first day, participants underwent an initial balance evaluation using the SWAY Medical Balance Application. All participants were asked to remove their shoes prior to the testing of their balance. The researchers measured the postural sway of each participant in each of the following seven positions:

1. Feet together
2. Semi tandem with right foot leading
3. Tandem with right foot leading
4. Single leg stance on left leg
5. Semi tandem with left foot leading

6. Tandem with left foot leading
7. Single leg stance on right leg

A gait belt was placed on each participant during the initial balance evaluation for safety, as well as to determine those that were at a greater fall risk.

After the preliminary SWAY data had been collected, each participant was able to complete the five-week protocol. Each session that was attended, participants were asked if they had consumed any alcohol, as well as if they were experiencing any abnormal signs and symptoms. Once cleared, participants were asked to remove their shoes and partake in the intervention. The participants stepped onto the vibration platform, and the platform was turned on for five minutes. Each participant was instructed on how to appropriately position him or herself on the platform throughout the time period (feet shoulder width apart, chin up, and relaxed posture). The researchers were stand-by assist for the entirety of the intervention for each session within one foot proximity. For those who were deemed a fall risk by the researchers, a gait belt was used every session. Participants were considered a fall risk if they had lower than a 70 overall score on the SWAY pre-intervention, or lower than 67% on the ABC Scale, which is the cut-off score for fallers and non-fallers.[30] After the five minute time period was up, the participants were asked to stand on the platform for an additional minute to ensure their safety. Participants were able to leave after they were deemed safe to ambulate again.

After the five-week protocol was concluded, each participant selected a time slot to complete his or her final session. This included their final 5-minute intervention on the vibration platform, filling out a new ABC Balance Confidence Scale, and a final measurement of their balance using the SWAY Medical Balance Application. The same seven positions were tested, as stated above.

The Cypress Cove Health Center location was used for all data collection and interventions. It was used for participant accessibility and to ensure that sufficient participants were maintained throughout the research.

RESULTS

This study investigated the following research question: Does a counter-clockwise oscillating vibration platform have positive effects on balance in the elderly population? Of over 50 potential participants who expressed interest in being a part of the study at the Cypress Cove Health Fair, a total of 43 individuals returned to fill out the required forms for the study. These 43 people each filled out a Health History form, ABC Scale, and completed the Folstein Mini-Mental examination. Thus, a total of 43 participants were recruited at the beginning of the study. Of these 43, a total of 34 participants completed the entire protocol and were eligible to be re-tested using ABC Scale and Sway Balance app. The 9 people who were ineligible to be re-tested either did not complete the protocol in its entirety or had to drop out of the study for various reasons. Reasons for these 9 not meeting the inclusion criteria are as follows: one person sustained a fall and an injury which prevented them from returning, two people dropped out of the study after reporting that they could not make the time commitment, and 6 people did not meet the required total number of sessions to qualify for re-testing. A total of 34 participants completed the study through the entire five-week protocol after dropout. The group included 17 males and 17 females. The average age of the participants was 80 ± 7.57 years, with the youngest at 66, and the oldest at 96 years old.

The difference between pre-test and post-test scores was calculated for both the Activities Specific Balance Confidence Scale and the results of the SWAY balance application test. The statistics were analyzed by the IBM SPSS version 20 software. Descriptive statistics were used to provide information about the relevance and significance of the change in scores before and after the introduction of the five week protocol. To provide the most accurate and complete picture of the data collected a Paired T-Test was used to determine the significance of the change in balance confidence as well as the actual balance measure calculated by SWAY.

Using the Paired T-Test, two hypotheses were conceived for each balance measure. The null hypothesis for the ABC scale stated that there would be no difference between the pre and post-test marks. The working hypothesis stated that there would be a significant difference between the pre and post-test marks. The null hypothesis for the SWAY balance stated that there would be no difference between the pre and post-test marks using the average calculated from the test scores using both left and right foot scores. The working hypothesis stated that there would be a significant difference between the pre and post-test scores using the average calculated from the test scores using both left and right foot scores.

The relative change in Activities Specific Balance Confidence (ABC) Scale scores for the 34 participants was as follows: 20 participants had scores reflecting an increase in balance confidence, 9 had scores reflecting a decrease in confidence, and 5 had scores reflecting no change. Descriptive statistics for the results of the ABC Scale were calculated using the SPSS software and the results are displayed in Tables 1 and 2. Table 1 demonstrates the average scores on the ABC scale tested prior to performing the five-week protocol and on the final day of the protocol.

Table 1. ABC Paired Sample Statistics

	Mean	N	Std. Deviation	Std. Error Mean
Pre-Intervention	13.1906	34	2.86756	0.50692
Post-Intervention	13.8038	34	2.44764	0.43269

The average score of the group before the intervention was 13.19 out of a possible 16 points. The average score of the group after the protocol had been completed 13.80 out of a possible 16 points. These scores represent percentage scores of 82.44% and 86.27%, respectively. The difference between these two scores was 0.61. This represents the mean change between the test scores before and after the intervention period. Results of the Paired T-test calculated by the SPSS software are displayed in Table 2. The Paired T-test demonstrated that there is a significant difference between the ABC Scale scores in the pre and post-test groups ($p = .044$).

Table 2. ABC Paired Samples Test

	Mean	Std. Deviation	Std. Error Mean	95% CI Lower	95% CI Upper	t	Sig. (2-tailed)
Pre-Post Paired	.61313	1.65297	.29221	0.01717	1.20908	2.098	.044

Descriptive statistics for the results of SWAY Balance test were also calculated using the SPSS software and the results are displayed in Tables 3 and 4. Table 3 demonstrates the average balance scores of the group taken prior to beginning the 5 week protocol and then again after completion of the protocol.

Table 3. SWAY Averages Paired Sample Statistics

	Mean	N	Std. Deviation	Std. Error Mean
Pre-Intervention	81.6027	34	12.12175	2.11013
Post-Intervention	83.2439	34	11.66608	2.03080

This average score represents the mean score of three different balance tests performed on each foot. These tests include postural sway measured with the participant standing stationary with their feet together, feet in tandem stance, and then finally when standing on one foot. From these scores the SWAY application calculated an overall balance score for the left and the right. These two averages were then used to calculate a final overall balance score that included both the left and right. The average score of the group before the intervention was 81.60 out of a possible 100 points. The average score of the group after the protocol had been completed 83.24 out of a possible 100 points. The difference between these two scores was 1.64. This represents the mean change between the test scores before and after the intervention period. Results of the Paired T-test calculated by the SPSS software are displayed in Table 4. The Paired T-test demonstrated that there is no significant difference between the SWAY Balance scores in the pre and post-test groups.

Table 4. SWAY Averages Paired Samples Test

	Mean	Std. Deviation	Std. Error Mean	95% CI Lower	95% CI Upper	t	Sig. (2-tailed)
Pre-Post Paired	1.64121	8.42952	1.46739	-1.34776	4.63019	1.1118	.272

DISCUSSION

No adverse side effects were reported by anyone who completed the 5 week protocol. Several participants noted a transient feeling described as "getting off of a boat" or "feeling unsteady". These effects all subsided within the 1-minute waiting period after turning off the vibration platform. Of the 34 participants who completed the protocol there was a 100% overall adherence rate.

Results from the SPSS descriptive statistical analysis demonstrate a significant change in Activities Specific Balance Confidence score after completion of the protocol. The average pre-test ABC score was 13.19, which represents a percentage score of 82.44%. This figure is significantly higher than the average for this age population. The average balance confidence score after the completion of the protocol was 13.80, which represents a percentage score of 86.27%. This demonstrates a 3.83% increase from baseline scoring. Despite the fact that the pre-intervention ABC scores were higher than the mean score for this age demographic (leaving a narrower margin for improvement) there was a statistically significant increase in balance confidence. While there is not an established value for the minimally clinically important difference for this test, statistically significant improvements in balance confidence have been linked improvements in function and possible decrease in fall risk.

Of the 34 participants who completed an ABC survey before and after the protocol 26.5% reported a decrease in their balance confidence. This decrease in balance confidence had a significant impact on the mean score for the post-intervention group. There are several possible explanations for this decrease in balance confidence, as the SWAY balance measures did not reflect this same decrease in overall balance. Prior to beginning the protocol none of the participants had any experience with a vibration platform. Furthermore, the balance measures tested by the SWAY application included positions (tandem stance and single leg stance) that the participants did not frequently assume in their daily lives. After completion of the initial balance testing many participants verbalized that they had not been aware of their balance deficiencies. This may have led to post-protocol scores that were more reflective of actual balance scores, as the initial balance confidence scores reflected an inflated sense of ability.

The results of the SPSS descriptive statistical analysis did not demonstrate significant improvement in the scores of the SWAY balance test from pre-intervention to post-intervention. These results did not support the hypothesis that the counter-clockwise oscillating vibration platform would have positive effects on postural sway. While there was a numerical increase in the scores after completion of the five-week protocol, it was not enough to be considered statistically significant. There are several possible explanations for the lack of positive effects.

First, the protocol itself required the participant to stand stationary on the vibration platform with their feet shoulder-width apart and their lower-extremities in a comfortably relaxed position. While this is an appropriate posture that one assumes in every-day life, it was not a posture that was directly measured by the SWAY app. Of the three tests measured by the SWAY application the one closest to the position described in the protocol was "standing with the feet together". This position is inherently more challenging as it narrows the base of support in relation to standing with the feet at shoulder-width. The other two testing scenarios include standing with the feet in tandem and standing on one foot, both of which are also significantly more challenging than the position used in the protocol. The principle of specificity of adaptations also demonstrates that the adaptations that the body makes are specific to the challenges imposed upon it. This means that any balance adaptations made may have been directly related to standing stationary with the feet shoulder-width apart on a vibration platform and not translated to the three specific testing scenarios.

Another possible explanation for the lack of positive results is the fact that the protocol called for the participant to remain static during the 5 minute period while standing on the vibration platform. In order for the body to improve in its balance strategies the systems must be challenged beyond their normal abilities. For many participants the protocol itself may not have appropriately challenged the balance systems enough to elicit any positive adaptations. If participants had been challenged to a level reflecting their own personal abilities rather than using a uniform static protocol results may have reflected larger improvements in postural sway.

While there was no statistical significance found between the pre-test and post-test scores taken by the SWAY application, many of the participants verbalized anecdotal differences throughout the course of the protocol. The most frequently noted improvement was in posture. Many of the participants described a feeling that their posture was improving, noting that they felt it easier to stand erect with their shoulders back and cervical spine in a neutral position. This finding may reflect the instructions and postural cuing that each participant received from the principle researchers each time that they stood on the platform. Participants were encouraged to stand in proper posture with a slight bend in the knees so that the total-body effects of the vibrations could be maximized. Others reported feeling that they had made improvements in their sleep patterns, decreased joint pain, or increased sense of energy. Overall, the participants very much enjoyed participating in this research and found it all very interesting.

Recommendations for Future Studies

The results of the current study supported the proposed hypothesis relative to balance confidence. However, it did not support the hypothesis relative to increase in postural sway as measured by the SWAY balance application. As this is a pilot study, much was gleaned to improve the quality of future studies. One recommendation for future studies is that participants be given a more challenging protocol consisting of a series of active movements. The stationary nature of the protocol in this study may not have been challenging enough for the participants to elicit adaptations in balance strategies. Future protocols should incorporate functional movement patterns that can be performed on the platform such as squatting or reaching. These movements provide a challenge to the participant's musculoskeletal system. Hess & Woollacott describes a relationship between balance and strength.[14] Specific muscles mentioned that have a particular impact on balance include the ankle stabilizers, knee extensors/flexors, and the muscles surrounding the hips.[14] All of these muscle groups have the potential to be trained using a counter-clockwise oscillating vibration platform if a dynamic protocol is used for intervention.

Another recommendation for future studies wishing to investigate the impact of a vibration platform on postural sway is to include outcome measures that more closely replicate the intervention performed in the protocol. The protocol used in the current study had the participant standing with their feet shoulder-width apart, while the outcome measure used to determine the participants' balance had them stand in a series of postures that were much more challenging. Future studies would benefit from using a measurement device that replicated the exact posture that the participant was trained throughout the intervention protocol. This will ensure that any balance adaptations made throughout the protocol are measured in a way that replicates the protocol itself.

It is recommended that future studies develop a protocol that persists for a time period significantly beyond 5 weeks. The five week protocol developed in the current study was a combination of time constraints imposed by research deadlines and the feasibility of gathering a group of participants willing to make a significant time contribution of their own. The protocol conducted by the current study may not have allowed a significant amount of time to induce training benefits or balance adaptations. The same could be said for if the participants received the intervention 6 days a week, versus the 4 received in this study. Receiving additional time on the platform may allow for differing results. However, the lack of time paired with the relatively stationary nature of the participants' posture may not have been sufficient to challenge the participants enough to elicit the positive results that would have supported our hypothesis.

CONCLUSION

The results of this study demonstrated a statistically significant increase in the Activities Specific Balance Confidence Scale. The SWAY balance application scores demonstrated a numerical increase after completion of the five week study, but there was no statistically significant different between the pre and post-intervention measures. Future research needs to be conducted to investigate the further benefits of a counter-clockwise oscillating vibration platform on balance in the elderly population that includes a lower level population and a longer training time in addition to the recommendations previously.

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