Effectiveness of Gaming Systems on Balance in Older Individuals (2013)

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Abstract

Balance training using gaming systems, called exergaming, is a rising trend for reducing fall risk in older individuals. Previous studies have conducted research pertaining to gaming systems and traditional balance training, however there is a lack of comparison between gaming systems. This study was performed to determine the effectiveness of two gaming systems, the Wii Fit and Xbox Kinect, as compared to traditional balance training. This study was performed with subjects (N=5) over the age of 65, in good health, randomly placed in one of the three balance training groups: Wii Fit (n=2), Xbox Kinect (n=2), and Traditional balance training (n=1). Tests for balance were conducted before a six week control period, after the control period, and after a six week intervention period. The study showed decreased fall risk in subjects who performed exergaming balance training as compared to the individual who performed traditional balance training.

Introduction

Unintended falls are a major health concern, especially in older adults. A fall, by definition, is a "sudden, unintentional change in position causing an individual to land at a lower level, on an object, the floor, the ground or other surface" (Tinetti et al., 1997). Adults age 65 and over are prone to experiencing falls due to aging and decreased balance. Other causes of falls include muscle weakness, unsteady gait, confusion, and certain medications (Rubenstein, 2006). One-third of adults over the age of 65 experience a fall each year, and falls are the ninth leading cause of death and the leading cause of fatal and nonfatal injury in this age group (Hornbrook et al., 1994, Hausdorff et al., 2001). Previous work predicted that in 2010 alone the cost of injuries from falls would reach $30 billion, adjusted for inflation (Stevens et al., 2006).

Exercise has been shown to be the most effective form of balance intervention and can reduce fall risk by up to 40% in older individuals (Alburquerque-Sendin et al., 2012, Baik et al., 2012, Garcia et al., 2012). These balance intervention programs typically include fall risk assessment as well as exercises targeted to increase balance and stability (Rubenstein, 2006).

In recent years, exergaming has been introduced as a possible new balance intervention for older individuals. Exergames have been defined as "video games that provide physical activity or exercise through interactive play… and require the user to apply full body motion to participate…" (Mears and Hansen, 2009). Exergaming reached the public with the release of Konami's Dance Dance Revolution in the late 1990s, and has become more accessible and more affordable since then. Balance training that involves exergaming has been shown to increase enjoyment and motivation to train in older individuals (Garcia et al., 2012). Thus, exergaming could be a useful tool for the medical field, being included in regular physical therapy as well as used for rehabilitative purposes (Arntzen et al., 2011). This form of balance training allows patients to receive quantitative scores and affords them the ability to compare scores and track progress (Garcia et al., 2012). Regular use of exergaming can help older individuals maintain a basic level of physical activity while also having positive emotional effects (Gerling et al., 2012). The nature of exergaming requires physiological responses to visual and auditory stimuli, which increase fitness in both the physical and cognitive areas (Arntzen et al., 2011, Boulos, 2012).

Traditional balance exercises are often utilized by physical therapists to reduce fall risk. Physical activities which promote balance can be adapted for a geriatric group with much success (Alburquerque-Sendin et al., 2012). Studies have also shown that physical exercise regimens including a balance element help reduce fear of falls in older adults who had experienced a fall within the last year (Baik et al., 2012).

Kinect is a motion-sensing device used in conjunction with Xbox 360, which was launched by Microsoft in 2010 (Redmond, VA). Kinect differs from other exergaming systems because the player acts as the game controller (Boulos, 2012). Kinect’s camera system utilizes depth perception and skeletal tracking technology, allowing it to track the player more accurately than other systems (Arntzen et al., 2011). The system requires players to stand 1.2-3.5m from the sensor in order for the skeletal tracking to differentiate between players and other surrounding objects (Garcia et al., 2012). Players can see their avatar on the screen following their every move while playing Kinect games.

The hands-free control of the Kinect allows it to accommodate a variety of users, including older individuals who might not be well-practiced with video game controllers. By not having to focus on a controller, the players can focus more on the exercises they are performing

(Garcia et al., 2012). Because the Kinect sensor is detecting the entire skeleton, there is no way for players to "cheat" during the games.

Wii Fit was launched in 2008 and is an exergaming system used with the Nintendo Wii (Arntzen, 2011). Players using the Wii hold the wireless Wii remote controller in one hand while standing on the Wii balance board. The player must use the Wii remote to navigate around the menu screens and select games to play. The balance board's sensors determine shifts in weight across the board and connect those movements with the movements of the player's avatar (called a "Mii") on the screen. The objective when using the balance board is to avoid obstacles in the games by shifting weight (Garcia et al., 2012).

It has been found that the Wii Fit Balance Board system helps increase balance and functional strength to reduce falls in older adults when used as a form of balance training (Bradley et al., 2011). Wii Fit strengthens knees and ankles, two major components in balance (Arntzen, 2011). Studies using the Wii Fit as the only source of balance training show a general increase in balance and balance confidence (Bainbridge, 2011, Bradley, 2011). They also conclude that the Wii Fit is feasible as standard balance care in older individuals with a history of falls (Jenkinson et al., 2010). Although studies show that the Wii Fit balance board helps to increase balance when used as balance intervention, it could also be limiting to older adults who might require a wider range of freedom and therefore a wider base (Garcia et al., 2012).

The accessibility and affordability of both the Xbox Kinect and Wii Fit make them convenient options for balance training. The current study will analyze the effectiveness of traditional balance training, Xbox Kinect balance training, and Wii Fit balance board training programs in adults 65 and older in reducing the risk of falls by improving balance and functional ability. Although traditional balance training has been successful in improving balance, exergaming includes an element of fun and competitiveness that traditional training lacks. Although the Wii Fit balance board is not very wide and could limit the range of freedom of the tester, it requires the player to use weight-shifting more than stepping and arm motions (as in the Xbox Kinect) to maintain balance and complete tasks in the game. It is hypothesized that participants who train with the Wii Fit balance board will show significantly larger improvements in balance ability as compared to traditional balance training and Xbox Kinect balance training.

Methods

Subjects age 65 and older and in good health were recruited to participate in this study. Physician's approval was required for all participants (1). Subjects (n=5, mean age 71.2±5.67 years, range 67-81 years, 2 male, 3 female) began a series of baseline testing after signing an informed consent (2).

Baseline tests for balance include the Biodex Balance Tests, Timed "Up and Go" test (TUG), and Five Times Sit to Stand Test (FTSTS). The Biodex Balance Tests were performed on the Biodex Balance System SD, and included the Fall Risk test (FR) and the Limits of Stability test (LOS), both of which required the subject to shift his or her balance while performing tasks generated by the system. The TUG test measured the amount of time taken for the subject to stand up from a standard arm chair, walk 3 meters, turn, walk back to the chair, and sit back down. The Five Times Sit to Stand Test was performed in the same standard arm chair as the TUG test, and required the subject to stand up fully from a seated position (arms folded across chest, back against the chair, feet comfortably below them), and sit back down five times.

Baseline testing was conducted prior to a six-week control period in which the subjects were instructed to go about their daily routines without any new balance or exercise training. After this period, the subjects returned for a second round of testing, then were randomly assigned to one of three groups for balance training intervention: Traditional Balance Training, Wii Fit Balance Board, or Xbox Kinect. The Traditional Balance Training group was used as a reference to compare the effectiveness of Wii Fit Balance Board and Xbox Kinect. The Wii intervention group consisted of 2 male subjects (n=2), with mean age 74.5±9.19 years, mean height 1.705±0.06 meters, and mean weight 81.38±7.04 kilograms. The Xbox intervention group consisted of two female subjects (n=2), with mean age 68±1.41 years, mean height 1.475±0.13 meters, and mean weight 68.615±19.96 kilograms. The traditional intervention group consisted of one female subject (n=1), with age 71 years, height 1.59 meters, and weight 80.9 kilograms (Table 1).

Statistical analysis of variance (ANOVA) with repeated measures was conducted, with significance set at $p<0.05$. This test was used to determine significant differences within groups for each day of testing – baseline, post-control period, and post-training.

After the second round of testing, balance training was conducted over a six-week period, three days per week. In the first week, the first session of training was 20 minutes, the second session was 25 minutes, and third session was 30 minutes in duration. Training sessions during weeks 2-6 were 40 minutes each. After the six-week intervention period, the tests for balance were re-conducted and data was collected and analyzed for differences between the experimental groups and improvement in balance scores as compared to the 6 week control period.

The Traditional Balance Training group performed a collection of traditional balance exercises often used in physical therapy settings. Exercises consisted of Balance on One Foot, Heel Raise, Toe Raise, Three-Way Leg Swing, Place Alternating Feet on Step, Stand Unsupported with One Foot in Front of the Other, Balance Walk, Walking Heel to Toe, Heel Raise Unilateral, and Forward Lean. Study investigators determined the exercises and order of exercises to be performed for each training session, as well as the progression of the subject through levels of difficulty of exercises at the discretion of the study investigator. Balance on One Foot was performed by the subject balancing on each foot for 2 sets, progressing through goals of 15, 20, and 30 seconds. Further progression of the exercise included the subject performing Balance on One Foot with eyes closes, on a foam pad, and finally eyes closed while on a foam pad. Balance time was recorded for each condition. Heel Raise was performed by the subject standing with feet together and raising her heels off the ground, with control, and returning to normal standing position. Three sets of 15 repetitions each were performed. Toe Raise was performed by the subject standing with feet together and raising her toes off the ground, with control, and returning to normal standing position. Three sets of 15 repetitions each were performed. Three-Way Leg Swing was performed by subject standing on one foot, hands on hips, and raising the other leg three times to the front, side, and back. Progression included increasing to five, then 10 repetitions in each direction. Two sets were performed on each leg. Place Alternating feet on Step was performed by having the subject stand on foam pad and placing alternating feet on platform 6 inches from the ground. This task was completed with eight steps per set, and time to perform the task was recorded, with a goal time of 20 seconds.

Three sets were conducted. Stand Unsupported with One Foot in Front of the Other was performed by the subject placing the heel of one foot directly in front of the toes of the other foot, so that her feet were in a straight line, and holding the posture. This was timed, and the goal time was 30 seconds. Two sets were performed for both left and right foot forward. Progression included performing the exercise with eyes closed, on a foam pad, and eyes closed while on the foam pad. Balance Walk was performed by the subject walking and lifting the back leg and holding it up for one second before placing it down to take the next step. This task was completed by taking 20 steps in a straight line, alternating legs, for two sets. Walking Heel to Toe was performed by the subject walking with the heel of one foot placed directly in front of the toes of the other foot in a straight line for 20 steps. This was repeated for two sets. Heel Raise Unilateral was performed by the subject balancing on one foot and raising the heel of that foot to be balanced on the ball of the foot. This was repeated for three repetitions on each foot for 3 sets. Progression included increasing repetitions to five and ten repetitions. Once ten repetitions was achieved, further progression included performing the task with eyes close, on a foam pad, and with eyes closed on a foam pad. Forward Lean was performed by the subject standing on one foot, hands on hips, and bending forward at the hips as if to touch his or her forehead to the wall. The position was held for 20 seconds, and 2-3 sets were performed on each foot. Progression included holding the position for 30 seconds as well as performing the task with eyes closed, on a foam pad, and with eyes closed on a foam pad.

The Xbox Kinect group used the game Motion Explosion (Majesco Entertainment Co.) to perform three different balance training games. These games included Balance Beam, Dodge Ball, and Sack Hack. The avatar on the screen performed the tasks in conjunction with the movements of the subject picked up by the motion sensing camera. To play Balance Beam, the subjects caught falling shapes on a board and balanced them there while they also stepped to avoid bombs and to collect stars. Once the shapes were balanced on the board the player tilted the beam and dumped the shapes into buckets to earn points. To play Dodge Ball, the subjects hit either the balls shot at him or her by cannons or moved side to side to avoid them altogether. To play Sack Hack, the subjects kept a ball in the air and off the ground by hitting the ball with the body part (head, elbow, wrist, knee, or ankle) highlighted on the avatar on the screen.

The Wii Fit group used the balance board to perform three different balance training games. These exercises included Balance Bubble, Soccer Heading, and Penguin Slide. In each exercise, the Mii (the character on the screen) performed tasks while the subject adjusted his or her body weight on the Wii Fit Balance Board. The three games performed by each subject were Balance Bubble, Soccer Heading, and Penguin Slide. To play Balance Bubble, the subject navigated his or her Mii along a river lined with rocks and tried to avoid bumble bees along the course by shifting his or her weight forward, back, left, and right on the balance board. To play Soccer Heading, the subject shifted his or her weight to either side of the balance board to make the Mii hit the soccer balls with its head while avoiding other flying obstacles. To play Penguin Slide the subject shifted his or her weight to either side of the balance board to help the penguin Mii slide along an iceberg and catch fish without falling into the surrounding water.

Results

Descriptive statistics for each subject, including type of intervention, sex, age, height, weight, BMI, heart rate, blood pressure, number of medications, and fear of falling pre- and post-balance intervention are shown in Table 1. None of the subjects had experienced a fall in the past year, and none reported history of cardiovascular disease. Results of functional task tests for each day of testing for each subject are displayed in Table 2. Results of Biodex Balance Tests for each day of testing for each subject are displayed in Table 3. Results for each test for each subject are displayed in Figure 1. Results of each test for each day of testing for Wii (subjects 101,102), Xbox (subjects 103,104), and Traditional (subject 105) groups were determined for functional tasks (Table 4) as well as Biodex Balance Tests (Table 5). Two factor analysis of variance (ANOVA) without replication (95%CI, $p<0.05$) was conducted for each test between subjects in intervention groups over the three testing days. Two factor ANOVA without replication (95%CI, $p<0.05$) was also conducted for each test between groups over the three testing days.

Functional tasks tests consisted of the Timed "Up and Go" (TUG) test and the Five Times Sit to Stand (FTSTS) test. ANOVA was run between all subjects; subjects 102, 104, and 105 displayed a significant ($p=0.049$) decrease in time to complete the TUG test (Table 2, Figure 1). No subjects were determined to be at risk of falling, pre- or post-intervention, as outlined by Bohannon, 2006. Subjects 101, 102, 103, and 104 displayed a decrease, though not statistically significant ($p=0.079$), in time to complete FTSTS test, indicating a possible decreased fall risk (Table 2, Figure 1).

Functional tasks test significance was also determined between intervention groups. TUG test displayed significant difference ($p=0.002$) from baseline to post-intervention in Wii, Xbox, and Traditional balance training groups. Results for FTSTS test were not significant ($p=0.38$).

Biodex Balance Tests consisted of the Fall Risk (FR) index and the Limits of Stability (LOS) test, in which both score and time were recorded, and ANOVA was run between all subjects. Subjects 103, 104, and 105 displayed a decrease in FR score, indicating decreased fall risk (Table 2, Figure 1). Subjects 101, 102, and 105 displayed an increase in LOS score, indicating decreased fall risk (Table 2, Figure 1). Subjects 101, 102, and 104 displayed a decrease in LOS time to complete, indicating a decreased fall risk (Table 2, Figure 1). No results of the Biodex Balance Tests were significant on a 95% confidence interval.

Biodex Balance Tests significance was also determined between intervention groups. Results for all tests were not significant: FR score (p=0.30), LOS score (p=0.54), and LOS time to complete (p=0.37).

		Subject 101	Subject 102	Subject 103	Subject 104	Subject 105
	Intervention	Wii	Wii	Xbox	Xbox	Traditional
	Sex	M	M	F	F	F
	Age	81	68	67	69	71
	Height (m)	1.66	1.75	1.57	1.38	1.59
	No. Medications	4	4	5	3	11
	Fear of Falling, pre-intervention	No	No	No	No	Yes
	Fear of Falling, post-intervention	No	No	No	No	Yes
Baseline	**Weight (kg)**	76.4	86.36	82.73	54.5	80.9
	BMI (kg/m^2)	27.73	28.2	33.56	28.62	32
	Resting heart rate	76	56	76	56	88
	Resting blood pressure	136/80	126/76	118/74	112/70	176/90
Post-Control Period	**Weight (kg)**	75.4	85.46	81.36	55	82.27
	BMI (kg/m^2)	27.36	27.6	32.2	20.18	32.54
	Resting heart rate	76	60	76	52	92
	Resting blood pressure	136/86	116/70	126/70	132/70	172/94
Post - Intervention	**Weight (kg)**	77.27	83.64	79.09	54.55	81.82
	BMI (kg/m^2)	28.04	27	31.3	20	32.4
	Resting heart rate	68	60	68	72	100
	Resting blood pressure	144/80	110/70	136/80	112/64	186/96

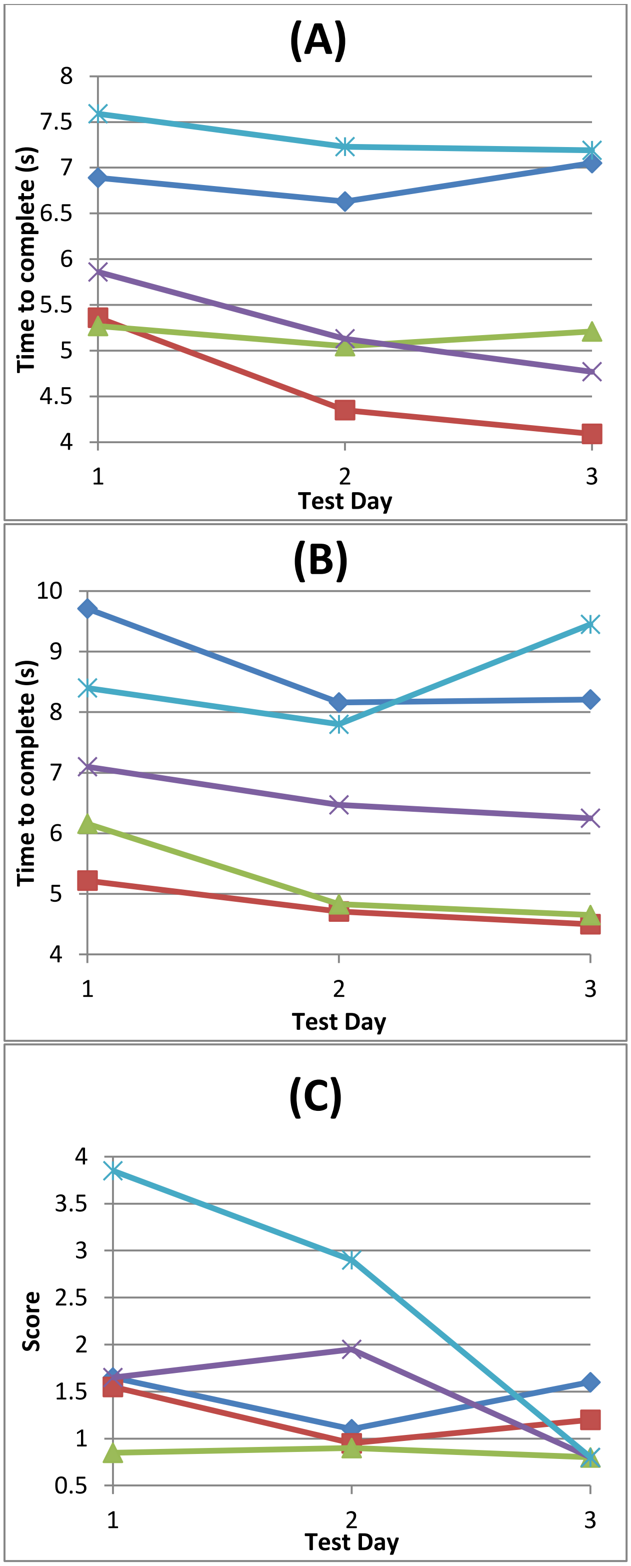
Table 1. Descriptive statistics for each subject, including type of intervention, sex, age, height, weight, BMI, resting heart rate, resting blood pressure, number of medications taken daily, and fear of falling pre- and post-balance intervention.

	Subject 101	Subject 102	Subject 103	Subject 104	Subject 105
Timed "Up and Go" (s)					
Baseline	6.89	5.36	5.27	5.86	7.59
Post-control period	6.63	4.35	5.05	5.13	7.23
Post-intervention	7.05	*4.09	5.21	*4.77	*7.19
Five Times Sit to Stand (s)					
Baseline	9.71	5.22	6.16	7.1	8.4
Post-control period	8.16	4.71	4.83	6.47	7.8
Post-intervention	8.21	4.5	4.65	6.25	9.45

Table 2. Averages of functional task test results for each subject at baseline, post-control period, and post-intervention data collection days. Asterisks denote significant difference (p=0.049) in time to complete Timed "Up and Go" test for post-intervention in subjects 102, 104, and 105.

	Subject 101	Subject 102	Subject 103	Subject 104	Subject 105
Fall Risk Index					
Baseline	1.65	1.55	0.85	1.65	3.85
Post-control period	1.1	0.95	0.9	1.95	2.9
Post-intervention	1.6	1.2	0.8	0.8	0.8
Limits of Stability Score					
Baseline	13	20.5	19.5	20.5	9.5
Post-control period	13	22.5	22	25	10
Post-intervention	27	26	20.5	19.5	10
Limits of Stability Time (s)					
Baseline	97	65.5	77	91.5	124.5
Post-control period	81	64.5	68	76	96.5
Post-intervention	44.5	59	71.5	71	127

Table 3. Averages of Biodex Balance Tests for each subject at baseline, post-control period, and post-intervention data collection days. No significant difference (p<0.05) was determined between tests days for subjects.


(A)
Time to complete (s)
8
7.5
7
6.5
6
5.5
5
4.5
4
1
2
3
Test Day
(B)
Time to complete (s)
10
9
8
7
6
5
4
1
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Test Day
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Test Day

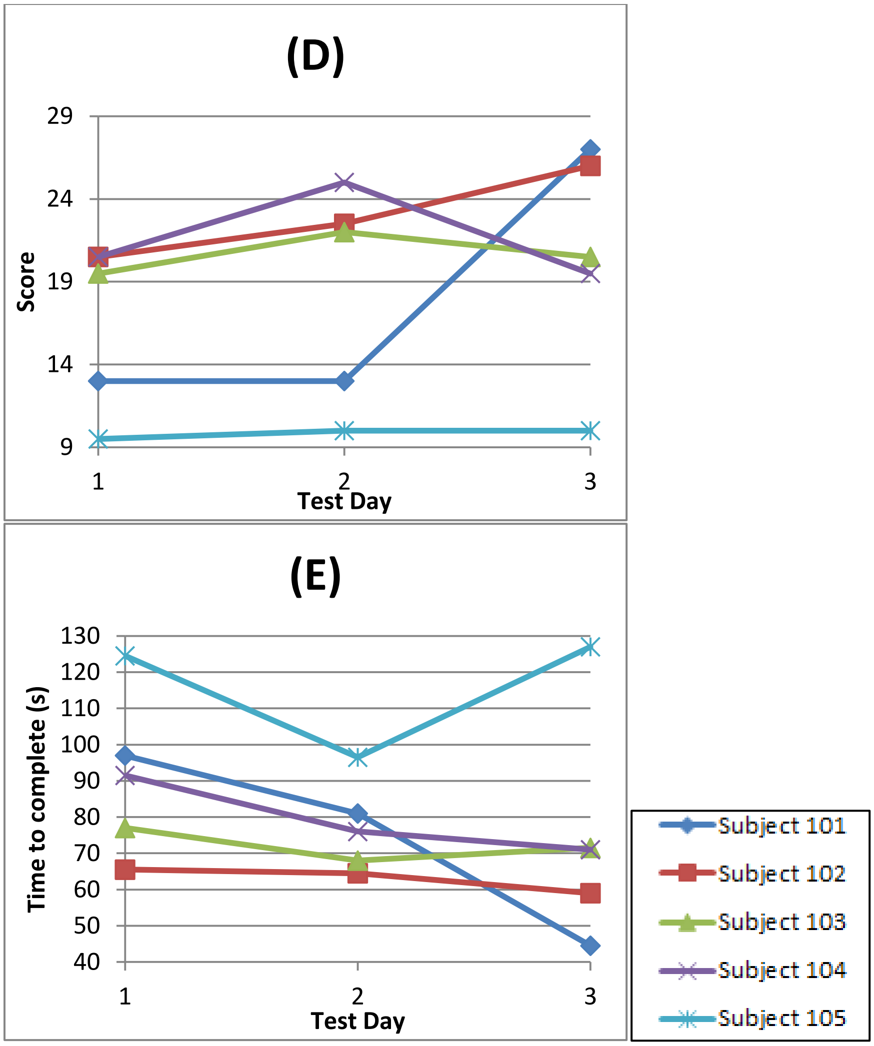

Figure 1. Graphs displaying tests results for each day of testing - Baseline (1), Post-control (2), and Post-intervention (3). A) Results of Timed "Up and Go" test, displaying decrease in time to complete after intervention period for subjects 102, 104, and 105, with significant decrease (p=0.049) denoted by an asterisk in each of those subjects. B) Results of Five Times Sit to Stand test, displaying decrease in time to complete after intervention period for subjects 101, 102, 103, and 104. C) Results of Fall Risk index, displaying decrease in fall risk after intervention period for subjects 103, 104, and 105. D) Results of Limits of Stability test scores, displaying increased score in subjects 101, 102, and 105. E) Results of Limits of Stability test times, displaying decreased time to complete test in subjects 101, 102, and 104.

		Wii	Xbox	Traditional
Timed "Up and Go" Test (s)	**Baseline**	6.13	5.57	7.59
	Post-control	5.49	5.09	7.23
	Post-intervention	*5.57	*4.99	*7.19
Five Times Sit to Stand (s)	**Baseline**	7.47	6.63	8.4
	Post-control	6.44	5.65	7.8

	Post-intervention	6.36	5.45	9.45

Table 4. Averages of functional task test results for each test group at baseline, post-control period, and post-intervention data collection days. Significant difference in time to complete Timed "Up and Go" test (p=0.002) is denoted by an asterisk in each group (Wii, Xbox, Traditional) post-intervention.

		Wii	Xbox	Traditional
Fall Risk Index	**Baseline**	1.6	1.25	3.85
	Post-control	1.03	1.43	2.9
	Post-intervention	1.4	0.8	0.8
Limits of Stability Score	**Baseline**	16.75	20	9.5
	Post-control	17.75	23.5	10
	Post-intervention	26.5	20	10
Limits of Stability Time (s)	**Baseline**	81.25	84.25	124.5
	Post-control	72.75	72	96.5
	Post-intervention	51.75	71.25	127

Table 5. Averages of Biodex Balance Tests for each test group at baseline, post-control period, and post-intervention data collection days. No significant difference ($p<0.05$) was determined between test days for groups.

Discussion

The results of this study indicate that participants in both the Wii Fit balance intervention group and the Xbox balance intervention group generally had most improved balance as compared to the individual who performed traditional balance intervention. Balance training is an important tool for reducing fall risk in adults over the age of 65 (Hornbrook et al., 1994). All groups (Wii Fit, Xbox Kinect, and Traditional) displayed significant improvement in TUG tests(Table 4). However, the Wii Fit and Xbox Kinect groups showed general improvement in more tests than the Traditional (Tables 4, 5). Analysis of subjects within the groups also supports that Wii Fit and Xbox Kinect improved fall risk more than Traditional (Tables 1, 2, Figure 1). The small sample size (n=5), uneven distribution of males and females, and lack of significance in all but one functional tasks test do not allow for a decisive conclusion as to which form of balance intervention is the most effective.

These results coincide with results of previous studies determining the effectiveness of exergaming as a form of balance intervention training. Brumels et al. (2008) performed a study comparing exergames with traditional balance training and determined that exergames are a more effective balance training intervention, and they had a higher satisfaction rating among subjects. Bainbridge et al. (2011) determined that Wii Fit balance board was an effective tool for balance training in older adults in a pilot study of eight community-dwelling adults over the age of 65 with a perceived decline in balance. Bateni (2012) studied the effectiveness of Wii Fit balance board as compared to a physical therapy intervention, similar to the traditional balance intervention conducted in this study. Bateni also studied a group performing both Wii Fit exercieses and physical therapy intervention, and determined that this form of intervention was the most effective. Boulos (2012) performed a study determining Xbox Kinect as an effective form of balance training intervention, and even suggested that it may be superior to other forms of exergaming. Garcia et al. (2012) performed a study determining that a Kinect-based balance training is an effective form of balance intervention, and that exergaming intervention in general could be viewed as more effective than traditional balance intervention because they are easily performed at home and have a higher "enjoyment factor". A higher level of enjoyment could lead to the subjects being more willing to continue the training: as opposed to seeing balance training as a task to be completed, they could instead perform the training exercises for fun.

This study differs from other studies in that it includes two forms of exergaming intervention being compared to traditional balance intervention. Other studies often tested either the Wii Fit or the Xbox Kinect as compared to traditional balance intervention effectiveness. Bateni (2012), Bradley et al. (2011), and Jenkinson et al. (2010) all tested the Wii Fit as compared to traditional balance intervention training, whereas Boulos (2012), Garcia et al.

(2012) and Gerling et al. (2012) compared Xbox Kinect and its full-motion sensing balance training to traditional balance training intervention. Bainbridge et al. (2011) differs from this study in that it lacked a control group or comparison to any other form of balance training intervention. Other studies on balance training intervention in older individuals focus solely on traditional balance trainging intervention, as seen in Baik et al. (2012), Alburquerque-Sendin et al. (2012), Hornbrook et al. (1994), and Tinetti et al. (1997). By comparing three different forms of balance training intervention, results (in a larger study which demonstrates significance) would be more indicative of which form of balance training intervention (Wii Fit, Xbox Kinect, Traditional) is most effective, as opposed to only one gaming system compared to traditional balance training intervention.

The traditional balance training intervention consisted of only one individual. The groups would ideally each have the same number of subjects, with varying health conditions. Subject 105 had overall worst health, indicated by her number of medications (11), high blood pressure compared to the rest of the test subjects, and high resting heart rate compared to the rest of the test subjects (Table 1). She was also the only subject in the study who reported a fear of falling pre-intervention. However, the type of intervention training was randomized, and the small sample size (n=5) did not allow for diversity of subjects within groups. The random group assignment and lack of diversity also affected the Wii Fit and Xbox Kinect intervention groups. The Wii Fit group consisted of two males, and the Xbox Kinect group consisted of two females. A larger group size and a more even distribution of males/females in each group would allow for a truer representation of which form of balance intervention is more effective.

The differences in platform size may have been a contributing factor to effectiveness of balance intervention training between balance interventions. The individual who performed traditional balance training and the Xbox Kinect intervention group both had the floor to stand on, which allowed for movement in all directions. The Wii Fit, however, has a relatively small balance board for the subject to stand on to perform balance intervention exercises. This small board has been shown to decrease the range of freedom of the individual performing the balance training, and could therefore be less effective than a form of balance training with a wider base (Garcia et al., 2012).

A larger sample size, with a more even distribution of males and females of varying health, which displays significance in more baseline tests would be a better indicator of which type of intervention – Wii Fit balance board, Xbox Kinect, or Traditional balance training – is most effective in reducing fall risk in adults over the age of 65. Continuation of this study will generate results that are a better indicator of which form of balance training intervention is most effective in reducing fall risk. For future studies a satisfaction survey could be performed at the end of balance training intervention, ranking the enjoyment and percieved effectiveness of the intervention by the subject. Also, another group, which goes through functional tasks testing as well as Biodex Balance tests with no balance training intervention, could be added to the study. This would allow for comparison between adults age 65 and over who do not perform balance training intervention and adults age 65 and over who perform balance training intervention, and then determine which form of balance training intervention is most effective.

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Appendix

1.

COASTAL CAROLINA UNIVERSITY

COLLEGE OF SCIENCE
Department of Kinesiology, Recreation, and Sport Studies

A study to look at the effects of multisensory gaming (e.g. Wii Fit Balance Board) on functional performance, balance, cognitive function, and aerobic capacity is currently being undertaken by the Department of Kinesiology, Recreation, and Sport Studies (KRSS) at Coastal Carolina University (CCU). All aspects of this study will take place at CCU. Your patient has volunteered to participate in the study, which will last approximately 12 weeks (6 week control period and 6 weeks of traditional balance training or 6 weeks of multisensory gaming). The following exclusion criteria have been employed to screen participants who may experience unwanted complications:

1) A functional capacity less than 5 METS (can't walk about ~4 mph on a treadmill); are color blind; do not exhibit basic cognitive function

2) Resting systolic BP > 140mmHg, resting diastolic BP > 90mmHg, or orthostatic hypotension

3) Are not at least 12 weeks post MI, CABG, PTCA, or other cardiovascular-related events or surgeries

4) Compromised by CHF, unstable signs, symptoms or heart rhythms (arrhythmias or heart blocks, ischemia);

5) Uncontrolled pulmonary disease or diabetes; neuropathy or neuromuscular disorders that negatively affect balance

6) Orthopedic problems which prohibit the ability to play multisensory games

The protocol for the study will include baseline testing of cognitive function, aerobic capacity, balance performance, and functional performance (timed up and go, sit-to-stand test). After the 6 week control period, participants will be randomly assigned to perform either traditional balance exercises or multisensory gaming three days per week for 6 weeks. Each testing and training session will be directly supervised by at least two faculty members from the department. All faculty members are currently certified in CPR and have access to an AED.

Although your patient has volunteered, provided written informed consent, and has qualified for our study based upon the previously mentioned exclusion criteria, we would greatly appreciate any questions or concerns you might have with your patients' participation. Please indicate any concerns you may have for this patient performing moderate to vigorous physical activity in the form of multisensory gaming (Wii Fit Balance Board or Xbox Kinect). A copy of the study protocol has been submitted to and approved by the CCU Institutional Review Board. Any questions you may have can be addressed to Dr. Greg Martel, Department of KRSS at (843)-349-2957 or Mrs. Stacey Beam at (843)-349-2807.

Sincerely,

Gregory F. Martel

Patient Name____

1. Are there specific concerns or considerations our staff should be aware of before this individual engages in exercise/physical activity at our facility? **Yes / No**
If yes, please specify:

____

____

2. If this individual has completed an exercise test, please provide the following:

a. Date of test: ________________
b. A copy of the final exercise test report and interpretation
c. Your specific recommendations for exercise training, including heart rate limits during exercise: ______________________________________

3. _______ **I AGREE** to the participation of this individual in exercise/physical activity at your facility.

_______ **I DO NOT AGREE** that this individual is a candidate to exercise or be physically active at your facility because:

____

____

Please provide the following information so that we may contact you if we have any further questions.
Physician's signature ____

Physician's name ____

Address ____

Telephone/Fax ____

2.

Coastal Carolina University
Department of Kinesiology, Recreation, and Sport Studies
Smith Exercise Science Laboratory

INFORMED CONSENT

I, ____, state that I am over 18 years of age and wish to participate in a program of research being conducted by Drs. Greg Martel and Lisa Barella of the Coastal Carolina University Department of Kinesiology, Recreation, and Sport Studies (KRSS).

TITLE OF RESEARCH PROJECT: The Effects of Different Balance Interventions on Fall Risk and Cognitive Function in Older Adults.

PURPOSE: The purpose of this study is to compare the effects of a traditional balance exercise training program to two different multisensory gaming systems (Xbox Kinect vs. Wii Fit Balance Board) in older men and women.

PROCEDURES: As part of the project, volunteers will be asked to report to Coastal Carolina University's Department of Kinesiology, Recreation, and Sport Studies three days a week for six weeks to participate in one of three forms of balance training: traditional balance exercises, using the Wii Fit Balance Board, or using the Xbox Kinect. Each balance training session will last between 20 and 40 minutes. Volunteers will be randomly placed into one of the balance training group. Volunteers will also be asked to report to the Smith Exercise Science Laboratory (also on campus) for up to 6 separate occasions for testing, each lasting approximately one hour.

On the first day of testing, any questions regarding the study will be answered, and the health history of volunteers will be reviewed. The investigators will need to know about certain aspects of volunteer health such as age, weight, medications, past surgeries, and current and past exercise habits. The investigators will also need each volunteer to have their physician approve of their participation in the study. Volunteers will then be asked to complete an exercise test on a stationary cycle. Volunteers will first have their resting heart rate and blood pressures measured, followed by pedaling at increasingly harder levels for approximately 9-12 minutes. Heart rate and blood pressure will be measured approximately every three minutes. The test will be stopped when the volunteer finishes three or four stages or when their heart rate reaches about 85% of their maximum predicted heart rate. After the cycle test, volunteers will have their balance measured on a computerized balance platform. They will then be asked to perform a series of tasks that will require them to stand up and walk around a cone, and stand up from and sit on a chair as quickly as possible. This first testing session should last approximately one hour.

During the second testing visit, volunteers will complete a series of tests involving one's memory, attention, and ability to think and solve problems. This session should last about one hour.

The third and fourth testing visits will occur six weeks after the second testing visit. During these 3rd and 4th testing visits, volunteers will perform the same cognitive tests, balance tests, and sit-to-stand tasks as they did during the first and second testing sessions. After this 4th testing session, volunteers will be randomly assigned to perform traditional balance exercises, or use the Wii Fit or Xbox Kinect for six weeks as described above. After six weeks of balance training, each volunteer will undergo the same tests (cognitive, balance, etc.) as performed previously to see if there was any change as a result of the training.

CONFIDENTIALITY: All information collected in the study is confidential. Neither your name nor any identifying information will be revealed to anyone outside of this study for any reason, unless specifically requested by you to do so. Some of your health-related information (for example, your age, weight, medications, etc.) is necessary for research and safety purposes, but this information will be presented in a way that will now allow for the identification of any specific person. All data and information related to this study will be kept in locked offices at all times.

RISKS: There is a risk of injury as a result of participating in any type of physical activity. However, we will reduce the risk of injury as much as possible by directly supervising all aspects of the study, and by carefully screening the information provided in the health history questionnaires that you will complete. Information about your health status or previous experiences with heart-related symptoms with physical effort will affect the safety of your participation in this study. Your prompt reporting of any unusual feelings with effort during the study, such as chest pain, shortness of breath, increasing fatigue, indigestion, heart burn, ear or neck pain, dizziness, unusual heart palpitations, or severe headaches is of utmost importance. Despite all these efforts, the possibility of injury, cardiovascular problems, and even death are still possible, although very rare. The investigators have current CPR certification and Automated External Defibrillator (AED) certification; the staff also has access to portable AED devices in the building should the need arise.

In the event of physical injury resulting from participation in the study, immediate medical treatment is available at the Conway Medical Center. However, Coastal Carolina University does not provide any medical or hospitalization insurance coverage for participants in the research study nor will Coastal Carolina University provide any compensation for any injury sustained as a result of participation in this research study except as required by law. The investigators, however, will immediately assist you to the best of their ability in obtaining emergency medical attention if needed.

BENEFITS: Although the study is not designed to help you personally, the investigators hope to learn more about how different types of balance training affect balance ability, fall risk, and cognitive function. The investigators also hope that the volunteers will learn more about the benefits of regular physical activity, including balance exercises, especially as it relates to balance and the risk of falling.

FREEDOM TO WITHDRAW AND ASK QUESTIONS: You are free to ask questions and to withdraw from any aspect of this study at any time. If you have any questions or concerns regarding the study, you may contact Drs. Martel or Barella using the information below. If you have any questions regarding your rights as a research subject, you may contact Ms. Bruxanne Hein, the Director of the Office of Research Services at (843) 349-2918.

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Printed Name of Research Volunteer

________________ ____
Date Signature of Research Volunteer

________________ ____
Date Signature of Witness