

COMPARISON OF WII™ EXERGAMING AND MATTER OF BALANCE ON ASPECTS
OF BALANCE AND ACTIVITY ADHERENCE IN OLDER ADULTS

by

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November, 2011

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This study was conducted to determine the relative effect of fall prevention community-based education and video gaming-based exercise (exergaming), on measures of functional balance, fall-efficacy, activity adherence, and perceived enjoyment in community-dwelling older adults (N= 36). To quantify functional balance and fall- efficacy, the 8-foot Up-and-Go Test (UG), Multi-Directional Reach Test (MDRT), and Activities-specific Balance Confidence (ABC) Scale were used. Adherence was measured by recording attendance rate figures at each session and a modified Experience Questionnaire was used at posttest to assess enjoyment in exergaming. Repeated-measures MANOVA test indicated no statistically significant effects by treatment group across time mainly due to the small sample size. Trends in both treatment groups indicated slightly improved mean UG and MDRT scores, indicating improved functional balance performance when compared to control group. Post-study data also suggested that both treatment groups also demonstrated high levels of adherence and perceived enjoyment. Results support the effectiveness of the Nintendo Wii™ and the fall prevention education program as a generationally appropriate intervention for promoting enjoyable participation in routine physical activity and fall prevention for community-dwelling older adults.

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OF BALANCE AND ACTIVITY ADHERENCE IN OLDER ADULTS

A Thesis

Presented To the Faculty of the Department of Recreation and Leisure Studies

East Carolina University

In Partial Fulfillment of the Requirements for the Degree

Masters of Science in Recreational Therapy Administration

by

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November 2011

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Introduction

According to the National Centers for Disease Control and Prevention (CDC), falls are the leading cause of injury-related deaths in older adults over 65 years of age. Statistics on emerging baby-boomer population trends predict that adults ages 65 years and older will make up a vast majority of the population, as well as the healthcare consumer population, driving the demand of quality healthcare services (CDC, 2010). Falls are *not* a natural part of aging. Supporting research provides evidence that significant decreases in physical functioning, commonly associated with aging, are not due to the aging process itself but caused mainly by inactivity and disuse (Hawkins et al., 2009; Peterson, 1998). In fact, the majority of older adults drastically reduce their amount of physical activity believing it will lessen their likelihood of experiencing a fall, which has also been found to be highly correlated with lower levels of perceived balance confidence (Peterson, 1998). Evidence of the reciprocal relationship between fear of falling and quality of life was reported by Lachman et al. (1998), identifying that subjects who had greater fear of falling also had lower quality of life, as determined by both health and social indicators.

A study conducted by Brouwer, Walker, Rydahl, and Culham (2003) stated that “fear of falling in seniors has been identified as an independent risk factor for disability, loss of quality of life, and decreased mobility” (p. 829). Moreover, intentional activity restriction caused by fear of falling often decreases the quality of life in older adults, conversely increasing the risk of future falls (Newton, 2004; Vellas, Cayla, Bocquet, Depemille, & Albarde, 1987). Studies indicate that up to one-half of all community-dwelling older adults experience fear of falling (Howland et al., 1993; Tinetti, Mendes de Leon, Doucette, & Baker, 1994). The prevalence of elderly persons acknowledging fear of falling ranges from 40% to 73% among recent fallers compared to 20% to 46% among those not reporting recent falls (Tinetti, Speechley, & Ginter,

1988; Nevitt, Cummings, Kidd, & Black, 1989; Walker & Howland, 1991; Maki, Holiday, & Topper, 1991).

As people age and commonly adopt more sedentary lifestyles, physical and cognitive functions slowly begin to diminish due to disuse. Physical activity becomes increasingly important for the older adult population, especially in maintaining and prolonging functional independence (Rosenberg et al., 2010). Visual and cognitive deficits, as well as physical limitations secondary to osteoporosis, rheumatoid arthritis, and other age-related diseases that cause bone and joint deterioration, are more prevalent in adults over the age of 65 (American Academy of Orthopedic Surgeons Panel on Falls Prevention, 2001). Intrinsic factors associated with increased risk of falling among older people include, but are not limited to, reduced muscle strength and bone mass density, decreased reflex reaction time, and overall endurance. Slower walking time, impaired depth perception, and increased difficulty associated with dual-task performance have been reported as fall-risk factors among older adults (Keskin et al., 2008). According to the CDC, most intrinsic physical risk factors, such as decreased flexibility and range of motion (ROM), balance and gait pattern dysfunctions, and decreased strength and endurance, are responsive to change with physical exercise (2010). While it could be argued that limiting activity due to fear of falling limits opportunities for falling, it might also increase the risk for falling when activity such as reflex reaction, by necessity, occurs.

The benefits of physical activity most associated with active aging include fall prevention, ease in the ability to perform all instrumental activities of daily living (IADLs), such as bathing, feeding and toileting, improvements in cognition and psychosocial functioning, with the overarching goal of maintaining one's independence (United States Department of Health and Human Services [U.S. DHHS], 2006). Due to current health care trends, the length of

inpatient stay in health care facilities has dramatically decreased, discharging patients following disabling events much earlier than in the past. Too often, patients are returning to their homes and communities at lower levels of functioning, and with a significant need for continued rehabilitation (Holden, 2005). The evaluation of overall flexibility, dynamic balance, and postural stability are all fundamental parts of any physical performance assessment of older adults, especially those at risk for falls (Rose, Jones, & Lucchese, 2002). A number of researchers have determined that, even though predictors highly associated with falls are multifactorial and interactional in nature, there is still a demand for a clear and brief, cost-efficient and comprehensive measure of overall balance by healthcare providers, in order to effectively identify future fallers (Rubenstein, 2006; Shumway-Cook, Brauer, & Woollacott, 2000; Tinetti, Williams, & Mayewski, 1986).

Methods

This research study employed a quasi-experimental repeated measures design, with analysis of data obtained from an 8-week nonrandomized controlled trial to examine changes in (a) functional balance, (b) fall-efficacy, (c) activity adherence, and (d) perceived levels of enjoyment in community-dwelling older adults. This study, involving human subjects with no more than minimal risk involved, was approved by East Carolina University's University & Medical Center Institutional Review Board under expedited review (see Appendix A).

Sample Population

Approximately 45 participants voluntarily enrolled to participate in this study. Subjects (N=36) were non-randomly assigned to their respective experimental group based on voluntary enrollment in either a community education-based fall prevention program or a group-based video gaming program through their local senior center. Participants were selected from members of a non-profit Council on Aging organization that provides services to older adults, 60 years of age and older, as well as from residents of local independent living complexes, both located within an urban-rural city of Eastern North Carolina. The video gaming experimental group consisted of a total 4 males and 6 females, while the community education-based group had a total of 2 males and 11 females. The control group consisted of 10 females and 3 males, and completed only pretest and posttest balance screenings. A summary of all participant baseline measures by group are provided in Table 1. Eligibility for participation in the study was based on participants' desire to participate in either the community education-based program or progressive group-based exergaming program. A letter of support was obtained from the executive director and program coordinator of the participating senior center (see Appendix B).

Nonparametric convenience sampling was used to recruit individuals for the exergaming intervention group from individuals that regularly attend a weekly congregate meal program or other recreational group-based programs offered at their local senior center. An announcement was also placed in the senior center's monthly newsletter and advertised in the local newspaper in order to recruit any other interested members of the senior center or community interested in volunteering to participate in the study. Members of the congregate meal group required scheduled transportation assistance to and from the senior center, however, they still resided independently within the community. The community education-based experimental group consisted of residents from two independent-living complexes who voluntarily registered through the local senior center to participate in *A Matter of Balance (MOB)* evidence-based fall prevention program offered on-site at their complex.

Upon arrival to the initial session, participants were asked if they would like to complete an additional balance screening prior to starting the MOB class and at the end of the eight-week MOB program. After providing informed consent, all individuals interested in participating in the balance screening then completed two functional performance assessments, as well as two or three pen and paper questionnaires, depending on their respective intervention group.

Participants in the Nintendo WiiTM group were asked to complete an initial interest questionnaire (Appendix C), while participants in the MOB intervention group were administered a standard MOB first session survey (Appendix D) to record demographic information and baseline levels of physical activity behavior, as well as to generate an attendance sheet for each group. The control group participants only completed the pretest and posttest balance screenings.

Evidence-based MOB Intervention

A total of eight MOB sessions were conducted once a week, for approximately 120 minutes per session. Each session was led by two trained MOB coaches over the course of an eight-week period with the overall outcome of increasing falls self-efficacy of the participants (Peterson, 2003). In 1992, *A Matter of Balance* was supported by the CDC as an evidence-based falls management education program designed to reduce fear of falling and associated activity restriction in community-dwelling older adults (2010). The fear of falling community education intervention engaged participants in group discussions about their concerns regarding fear of falling, daily behaviors and habits that increase their risk of falling and rate of involvement in physical activity. Most of the topics discussed pertained to identifying and reducing risk factors of falls, promoting an increased awareness of environmental hazards in the home and community, the importance of proper nutrition and physical activity, how to get up after recovering from a fall, and how to safely perform low-intensity stretching exercises that focus on improving flexibility in muscles and joints specific to successful balance recovery (Brouwer et al., 2003). Physical activity through a 30 minute warm-up, stretching and cool-down routine was incorporated into five of the eight sessions and participants were required to attend five of the eight sessions in order to successfully complete the MOB training program and receive a certificate of completion. According to Peterson (2003), *A Matter of Balance*, which is based on cognitive-behavioral principles, has been shown to reduce fear of falling and improve some aspects of physical functioning among community-dwelling older adults. There is increasing evidence of the importance and benefits of physical activity in maintaining health status and slowing the rate of the aging process. Fear of falling may therefore have implications for the primary prevention of some chronic conditions. According to Howland, Peterson, & Lachman

(2001) with respect to secondary prevention, low balance confidence may in turn reduce overall compliance with rehabilitation.

Exergaming Intervention

For the purpose of this study, *exergaming* was defined as interactive video-gaming that incorporates whole-body movements and promotes increased levels of physical activity (Bogost, 2005). Utilizing the Nintendo Wii™ video gaming console, the exergaming intervention program included basic fitness components seen in typical senior exercise classes and consisted mainly of targeted stretching, as facilitated by the researcher, and progressive muscle strengthening exercises using the Nintendo Wii™ Sports package software.

A total of eight Nintendo Wii™ group sessions were conducted once a week for 60 minutes for a total duration of eight weeks. Training on how to use the gaming system, game instructions and therapeutic aims, and proper body mechanics during game play were provided to participants prior to and throughout the study by verbal and nonverbal cues from the researcher. The initial Nintendo Wii™ group involved a familiarization session that provided safety precautions and a basic introduction to using the gaming console and its associated equipment. All participants in the intervention group were required to use the wrist strap provided by Nintendo to anchor the remote to the wrist, ensuring participant safety and preventing the player from unintentionally dropping or throwing the Wii™ remote. The Nintendo Wii™ exergaming group sessions, overall, consisted of various activities ranging from low to moderate intensity stretching warm-ups, aerobic conditioning, strength, and balance training exercises. The Wii™ intervention incorporated whole-body movements coupled with dynamic standing activities that required weight-shifting, stepping, and reaching tasks while participants engaged in an interactive Wii™ Sports videogame via the Nintendo Wii™ in groups of up to four players.

Based on game preference responses from the initial interest survey, participants were divided into four groups of up to four people and participated in their sport of choice while sitting or standing, with or without the use of an assistive device throughout the 60-minute duration. The first and eighth Nintendo Wii™ sessions consisted of participants completing the UG, MDRT, and ABC scale. A modified pre-exercise screening and initial interest questionnaire were administered at pretest only, and the experience questionnaire was completed by subjects at posttest only. All instruments were provided by the researcher in large print versions for self-administration or completed with assistance, requiring the researcher to read questions aloud to participants as needed, secondary to visual deficits and/or variations in educational levels.

All Nintendo Wii™ groups began each session with a 5-minute warm-up stretching routine in preparation for physical activity with participants performing exercises from a seated or standing position as demonstrated by the researcher. Flexibility exercises included neck stretches, shoulder rolls, and diagonal arm presses across the body, which are all used in the exercises performed in *A Matter of Balance* class to improve range of motion (ROM) in the shoulders and upper back. Wrist and finger stretches, hip circles, toe raises, ankle rolls, leg lifts, and heel cord stretches were also incorporated into the warm-up. After completion of warm-up exercises, participants began playing the Nintendo Wii™ sports games specific to their group in pairs or as a group of up to three and four players for a total of 60 minutes.

The Nintendo Wii™ sports package software was utilized in this study secondary to arising evidence of its popularity with older adults in facilities such as community centers and nursing homes (Clark & Kraemer, 2009). Activities are programmed in the Nintendo Wii™ Sports package by allowing individuals to choose the option of playing the actual sports game or engaging in a sport-specific training mode. For example, according to Deutsch and Mirelman

(2007), the boxing game involves boxing matches that are played against a computer or an opponent, while boxing training sessions consist of punching a bag, dodging balls, or hitting the trainer's glove. The five Nintendo Wii™ sports games utilized in this study were tennis, bowling, golf, baseball, and boxing. Nintendo Wii™ bowling games and training events were more popular with female participants, and overall the sport of choice by all participants throughout the entire study. The Nintendo Wii™ golf game had the second highest rate of participation and more frequently chosen as the sport of choice by male participants.

The activity program sessions targeted major muscle groups of the legs and trunk, and incorporated upper extremity reaching and extension. Other physiological requirements incorporated in the sports games included maintenance of trunk control while rotating and reaching across the midline of the body with bilateral upper extremities, increased hand-eye coordination, attention, postural stability, and overall endurance levels (Deutsch & Mirelman, 2007). Each exergaming session progressively increased the amount of physical activity required by participants ranging from increasing the number of repetitions from five to ten when engaged in warm-up stretches to number of times participants chose to engage in specific sports per session. The overall aim of incorporating higher-level physical activity requirements through participation in Nintendo Wii™ sports was to promote increased levels of enjoyable, physical activity, and improve fall-efficacy to reduce fear of falling and associated activity restriction among participants.

Measurement and Instrumentation

The equipment used for this study included a Nintendo Wii™ video game console, including a total of four Wii™ remotes, sensor bar, and all the sports games included on the Nintendo Wii™ Sports Package software. The Wii™ nunchuk attachment, which plugs into the

Wii™ remote, was also utilized by participants who chose to engage in the Wii™ boxing game. Two Nintendo Wii™ videogame consoles were utilized in this study and connected to a 32-inch or 27-inch television, one housed in the activity room of the senior center, and the other stationed on a rolling cart, which was set up in the activity room during intervention sessions. A total of eight Nintendo Wii™ remotes were also provided with an additional four nunchuk attachments.

Dynamic balance, agility, and postural stability measures were conducted at pretest and posttest balance screenings through the administration of the *8-foot Up-and-Go Test (UG)* (Rikli & Jones, 2001) and the *Multi-Dimensional Reach Test (MDRT)* (Newton, 2001). Fall-efficacy was measured using the *Activities-specific Balance Confidence Scale (ABC)* developed by Powell and Myers (1995). Activity adherence was measured using compliance with both intervention protocols and calculated by recording group attendance rate figures at each session. To ensure participant safety, the *Physical Activity Readiness Questionnaire (PAR-Q and YOU)* (adapted from the revised version by the Canadian Society of Exercise Physiology, 1994) was administered to both intervention groups as a pre-exercise screening before beginning their respective activity program (Appendix E). The brief, check-list allowed participants to evaluate all potential health risks that could be associated with participation in the study and was modified by the researcher to address pacemaker and seizure precautions involved with using the Nintendo Wii™. The PAR-Q strongly recommends all individuals that checked “yes” to any of the items on the questionnaire to consult with their doctor before starting the program. Participants were also provided with an optional physician information form (see Appendix F), describing the physical requirements of the intervention program, to accompany the PAR-Q when consulting their doctor.

To collect participant demographic information and baseline levels of current physical activity, an MOB first session survey or an initial interest survey was administered. At baseline, individuals were asked to indicate their current level or frequency of participation in regular exercise or walking on a six-point scale included as an item of the initial interest questionnaire or MOB first session survey. Participants indicating no current involvement in regular physical activity were further stratified by intent to start, identifying the number of individuals that, although currently did not engage in any form of regular exercise activity, were beginning the intervention program with the intention of incorporating regular walking or exercise into their lifestyle. A researcher-modified *Experience Questionnaire* (adapted from Broach, Dattilo, & McKenney, 2007) was used posttest to measure perceived levels of enjoyment in the exergaming group (Appendix G), while the MOB group completed a last session class evaluation survey (Appendix H).

The *Timed Up and Go Test (TUG)* was developed by Podsiadlo and Richardson (1991) as a basic tool for measuring functional mobility. By incorporating functional tasks such as sit to stand, walking, turning, and stand to sit, the TUG has been determined as an appropriate measure of static and dynamic balance in community-dwelling older adults (Podsiadlo & Richardson, 1991). A modified version of the TUG, the *8-foot Up-and-Go test (UG)*, was established by Rikli and Jones (2001) as a testing component of the Senior Fitness Test, to safely assess dynamic balance and agility of community-dwelling older adults within space-limited settings, such as participants' homes. Results obtained from this performance test may be compared to age-related normative values listed in the *Senior Fitness Test* manual, if the participant does not require the use of an assistive gait device (Rikli & Jones, 2001). Timed scores of more than 8.5

seconds are associated with high fall-risk in community-dwelling older adults, with the UG having an overall prediction rate of 82% (Rikli & Jones, 2001; U.S. DHHS, 2006).

The UG requires the use of a standard folding chair with 17-in. (43.18-cm) seat height, stopwatch, a small orange cone, tape measure, and a piece of masking tape to use as a floor marker. Each participant was provided with a demonstration and verbal explanation of how to perform the test by the researcher and then given one optional practice run and two timed trials. Both times were recorded to the nearest 1/10 and the lower of the two scores, or the fastest time, was used (Rikli & Jones, 2001). According to the research available on balance measurements and older adults, the *Berg Balance Scale (BBS)* and the TUG both have published reliability and validity with community-dwelling older adults (Holbein-Jenny, Billek-Sawhney, Beckman, & Smith, 2005; Steffen & Mollinger, 2005). The TUG has been identified as a sound tool for measuring gait speed during several functional tasks, which include standing up, walking, turning, and sitting down (Langley & Mackintosh, 2007).

The *Multi-Directional Reach Test (MDRT)* (Newton, 2001) is a modification of the *Functional Reach Test (FRT)* (Duncan, Weiner, Chandler, & Studenski, 1990) and designed to provide a quantifiable measure of a person's voluntary postural control, or margins of stability, which is a strong predictor of overall balance (Newton, 2001). The MDRT utilizes a yardstick or similar measuring tool to assess how far participants are able and/or willing to reach forward, right, left, and backward outside of their base of support in a static standing position (Newton, 2001). Although there is limited evidence on the validity and reliability of the MDRT with community-dwelling older adults, it was chosen over the FRT for use in this study simply due to the fact that older adults fall in all directions (Holbein-Jenny et al., 2005; Cummings & Nevitt, 1994). Supporting research has also found evidence that the measures of postural stability

required for the lateral right and left reach directions are important determinants of assessing an individual's overall postural control (Brauer, Burns, & Galley, 1999; DeWaard, Bentrup, Hollman, & Brasseur, 2002; Holbein & Chaffin, 1997; Holbein & Redfern, 1997; Ingemarsson, Frandin, Hellstrom, & Rundgren, 2000).

For this study, a measurement tool was constructed to assist in data collection. A yardstick replicated measuring tool made from PVC piping was securely positioned on a wall using tape and placed at the level of the participants' acromion process horizontal to the floor. Participants were instructed to stand with feet shoulder width apart and raise arms to shoulder height (90 degrees) parallel to floor with palm facing medially for initial reading. Participants were then asked to reach as far forward (forward reach), backward (backward reach), left (lateral reach left), and right (lateral reach right) as possible for three trials in each direction along the yardstick replicated measuring tool without making contact with the wall or yardstick and without taking a step or raising their feet from floor. Location of the tip of the middle finger was recorded in inches at the starting and ending positions of each trial and the "trial distance" (inches) was obtained by determining the difference between the two position numbers (Newton, 2001). Participants were given the option of completing one practice trial to ensure adequate comprehension of instructions followed by three recorded test trials. The average of all three test trials for each direction was recorded as the total distance reached or "measure of total hand excursion for each direction" (Lewis & Shaw, 2011, p. 6). If the participant's feet moved during any trial, then that trial was discarded. For measures of forward reach, participants were given the opportunity of choosing to use either their right or left arm, but had to stay consistent throughout the test.

While the FRT is highly correlated with the MDRT forward reach, a score below six inches has been found to predict recurrent falls in older adults and considers individuals at high risk for falling, while any score less than ten inches indicates individuals who are at moderate risk for falling (Duncan et al., 1990). According to Lewis and Shaw (2011), “when regression analysis was performed, scores on forward, right and left reach were influenced by activity level ($p < .004$) and scores on backward reach were influenced by fear of falling” (p. 6). Based on the functional ability of the participants and the minimal amount of risk involved in this study, the backwards reach was eliminated for use in the study secondary to participant safety. In a study conducted by Duncan, Studenski, Chandler, and Prescott (1992), the forward reach was found to predict frequent falling in a sample of community-dwelling older adult male veterans.

To measure perceived balance confidence of participants, the pen and paper *Activities-specific Balance Confidence (ABC) scale* was used (Powell & Myers, 1995). The ABC scale is a 16-item self-report assessment tool that can be self-administered or researcher administered via personal or telephone interview. As needed, the researcher read aloud the ABC scale to participants. Instructions for completion of the ABC scale asked participants to indicate their level of self-confidence in performing a specific activity without losing their balance or becoming unsteady, by choosing a corresponding percentage point on a scale from 0% to 100% (Powell & Myers, 1995). When calculating a participant’s score, ratings should consist of whole numbers (0-100) for each of the sixteen items (Powell & Myers, 1995). The scores across all 16 tasks were averaged and mean scores between groups were used in subsequent analyses.

Previous studies have determined that a score of 85% or less identifies older adults with impaired balance and a score of less than 67% indicates older adults that are at high risk for falling (Clark & Kraemer, 2009; Lajoie & Gallagher, 2004). In a study by Cho, Scarpace, and

Alexander (2004), lower scores represent lower levels of balance confidence and are associated with balance impairment. Along with a countless number of other factors such as home environmental hazards, community barriers and cognitive deficits, low balance confidence has been shown to be closely associated with falls in older adults (Cho, Scarpace, & Alexander, 2004; Northridge, Nevitt, Kelsey, & Link, 1995; Van Dijk, Meulenberg, Van de Sante, & Habbema, 1993; Lajoie & Gallagher, 2004; Schepens, Goldberg, & Wallace, 2010). When compared to related assessment tools, such as the *Falls Efficacy Scale (FES)*, the ABC Scale incorporated the assessment of a broader range of ADLs, those that were more difficult and performed outside of the home (Tinetti, Richman, & Powell, 1990). The FES includes 10 relatively basic ADLs that do not discriminate well among higher functioning community-dwelling seniors (Powell & Myers, 1995). According to Lachman and colleagues (1998), “Although the ADLs are basic and critical for independent living, the consequences of fear of falling may begin in more advanced activities, which may not be essential for independent functioning” (p. 44).

Lastly, to measure levels of enjoyment and perceived usefulness of participation in the activity program, a brief participant experience questionnaire or MOB last session class evaluation survey was completed by all experimental group participants at posttest. The Nintendo Wii™ group participants were asked to complete an experience questionnaire designed by the researcher, to specifically assess levels of perceived enjoyment, health value and usefulness of participation in the exergaming intervention program. Experiences were obtained from participants through a 20-item self-report questionnaire (adapted from Broach et al., 2007) that addressed items of participation including challenge-skill ratio, anxiety, boredom, levels of enjoyment, willingness and intent to participate, motivation to continue, and sociability value.

To increase physical activity participation and adherence, especially within the older adult population, it is necessary to create activities that are meaningful, intrinsically motivating and aid in improving self-efficacy. By providing the participants with feelings of control and self-confidence during treatment sessions, there is more likelihood that an outcome of desire to continue participation will be produced. To maintain test validity and reliability, consistent verbalization of instructions to all participants involved in the study were provided by the researcher, reinforcing individuals to do the best they could but not to push themselves to a point of overexertion or beyond what they felt was safe for them. Participant comments provided from either last session surveys in the MOB intervention group or the Nintendo Wii™ group experience questionnaires were used to evaluate perceived usefulness and health benefits of the interventions, social and individual aspects of enjoyment received from participation in interventions, and intent to maintain future adherence to flexibility and balance exercises or other novel alternatives (i.e., Nintendo Wii™) for increasing levels of physical activity.

Attendance sheets completed by the researcher throughout entire 8-week study, as well as attrition rates and barriers to study completion were compared across groups to examine compliance rates. In addition to the assessment instruments used for pretest and posttest, the researcher also gathered supplemental qualitative data and field observations from participants during the intervention sessions with both of the experimental groups. These included noting the participants' verbal and nonverbal communication during the sessions, expressions of positive emotions and/or self-statements regarding skills and abilities, comments of healthy competition toward other participants, and updates on noticeable improvements of various IADLs or ADLs. The length of time participants remained standing, visual improvements in physical functioning during stretching routines, as well as sports played and participants' weekly scores were also

documented during each group session. Types of assistive devices used, if any, during the completion of balance screenings and throughout the duration of both eight-week intervention programs were also documented by the researcher. Only one participant in the MOB intervention group was completely dependent on a wheelchair for mobility, secondary to recovering from recent unilateral lower extremity surgery status post experiencing a fall. However, participant was currently undergoing home-based physical therapy treatment once a week during eight-week MOB program, indicating motivation to return to functional independence. Participant comments provided from either last session surveys in the MOB intervention group or the Nintendo Wii™ group experience questionnaires were used to evaluate perceived usefulness and health benefits of the interventions, social and individual aspects of enjoyment received from participation in interventions, and intent to maintain future adherence to flexibility and balance exercises or other novel alternatives (i.e., Nintendo Wii™) for increasing levels of physical activity.

Data Analysis

All analyses were performed using SPSS statistical software version 19.0 (IBM® SPSS Inc., Chicago, IL) with statistical significance set at $p < .05$. The research design employed in this study was a general linear design of repeated measures, with time (pretest and posttest) assigned as the within-subject factor and the three independent grouping variables by type of intervention were assigned as between-subject factors. The three independent variables in this study were the Matter of Balance (MOB) intervention, the Nintendo Wii™ intervention and the control group and the five dependent variables were the changes (from pretest to posttest) in UG scores, MDRT forward reach scores, MDRT right reach scores, MDRT left reach scores, and in balance-confidence scores as measured by the ABC scale. Functional balance scores were

determined by analyzing mean changes in UG scores and MDRT (forward, right, and left reach) scores. Change in balance confidence scores were compared across all three intervention groups, from pretest to posttest, and analyzed to determine significant relationships between interventions or control on changes in fall-efficacy scores among participants. Nonparametric statistical analyses were used due to the small sample size; however, it has been noted that a total sample size of 30+ is required to determine significant relationships (Israel, 1992).

Baseline socio-demographic, fall-related behavior and non-behavior variables were compared across groups using chi-square tests for categorical data, and analysis of variance (ANOVA) tests for continuous scores, to detect significant group differences and control for covariates of age, gender and physical activity levels, as needed. Descriptive statistics were used to analyze and describe baseline participant characteristics among socio-demographic variables of age, gender, and race, and also current (pre-intervention) levels of physical activity participation (see Table 1).

To determine the relative intervention effect patterns over time on functional balance-related behavior and non-behavior measures, both ANOVAs and multivariate analysis of variance (MANOVA) tests with three between-subject factors (groups) and repeated measure of time (pretest and posttest) were performed. Baseline equivalency analysis of the dependent variables found that all five balance performance testing variables were moderately correlated, supporting the case for conducting repeated-measures MANOVAs to test intervention effects over time on the measures of functional balance, fall-efficacy, activity adherence and enjoyment. A repeated-measures MANOVA was used in this study to more efficiently address the multiple functional balance-related behaviors targeted by the two interventions, and because the dependent variables were not perfectly correlated. This approach creates a new dependent

variable maximizing group differences, in order to produce the most cohesive results possible while controlling for Type I error resulting from performing individual tests on multiple dependent variables. Estimated marginal means and measures of standard error were used to report group by time interaction effects among the UG, three MDRT directions, and the ABC scores (see Table 2) while providing scatter plot graphs to visualize the similarities and differences between group score changes from baseline to posttest (Figures 1-5). The effect of the intervention was measured by the interaction of Treatment and Time. Baseline scores were included to control for initial differences between groups. When demographic covariates of age and gender were included in the models, the results were not changed. Therefore, results of these models are not reported.

Participant comments provided from either last session surveys in the MOB intervention group or the Nintendo Wii™ group experience questionnaires were used to evaluate perceived usefulness and health benefits of the interventions, social and individual aspects of enjoyment received from participation in interventions, and intent to maintain future adherence to flexibility and balance exercises or other novel alternatives (i.e., Nintendo Wii™) for increasing levels of physical activity. Attendance sheets completed by the researcher throughout entire 8-week study, as well as attrition rates and barriers to study completion were compared across groups to examine compliance rates. A one-way analysis of variance (ANOVA) was conducted to compare the mean attendance scores between groups to determine substantial differences in attendance rates between participants in both intervention groups, to assess if either group had higher rates of attendance. Subjects who completed the MOB intervention or Nintendo Wii™ intervention programs were only included in this analysis, since compliance rates of intervention were a secondary outcome measure in this study.

Results

An analysis of data was expected to reveal that engagement in physical activity (PA) through the Nintendo Wii™ would produce similar participant balance performance scores on the UG, MDRT, and ABC, as those of participants from the Matter of Balance group. The functional balance and fall-efficacy scores of participants from the Nintendo Wii™ and MOB intervention groups were expected to demonstrate improvement at posttest when compared to the control group. Through evidence-based research, participation in routine stretching and physical activity coupled with fall prevention education and cognitive behavioral techniques has been proven to improve balance confidence and reduce fear of falling in community-dwelling older adults (Ory et al., 2010; CDC, 2010). Baseline participant characteristics among socio-demographic covariates of age, gender, and race, and current (pre-intervention) levels of physical activity participation by treatment group are shown on the following page in Table 1.

Table 1

Demographics of Participants by Group Allocation and Total Population

	Nintendo Wii™ (n= 10)		MOB (n = 13)		Control (n= 13)		Total (N= 36)	
	f	%	f	%	f	%	f	%
Gender								
Male	4	40.0	2	15.4	3	23.1	9	25.0
Female	6	60.0	11	84.6	10	76.9	27	75.0
Age (M/SD)	72.7/7.01		75.8/6.06		83.2/4.85		77.6/7.29	
Race								
African American	2	20.0	5	38.5	3	23.1	10	27.8
Caucasian	8	80.0	8	61.5	10	76.9	26	72.2
Current level of PA								
No PA, no intent to start	0	0.0	3	23.1	0	0.0	3	8.3
No PA, intent to start	2	20.0	4	30.8	3	23.1	9	25.0
Trying to start PA	0	0.0	2	15.4	0	0.0	2	5.6
PA infrequently /month	2	20.0	0	0.0	1	7.7	3	8.3
PA < 3 times/week	3	30.0	1	7.7	1	7.7	5	13.9
PA > 3 times/week	3	30.0	3	23.1	8	61.5	14	38.9

f = Frequency; % = Valid Percent; M = Mean; SD = Standard Deviation; PA = Physical Activity; N = Population; n = sample

The majority of the participants in this study were Caucasian (72%) older adult females (75%), with a mean age of 78 years (SD = 7.29). Unpredictably, participants in the control group were the oldest in age and most physically active, with six females and two males indicating regular engagement in moderate levels of exercise three or more times per week. Three participants in each experimental group indicated participation in moderate levels of exercise at least three or more days per week, while one male in the MOB and Nintendo Wii™ groups and a total of two females from the Nintendo Wii™ group reported exercising less than three times a week. A comparison of physical activity levels across groups tested, the control

group consisted of the largest amount of physically active older adults, with the Nintendo Wii™ participants making up the second most physically active group. The MOB group was 85% female and the least physically active, with three indicating no physical activity or intention to start. A one-way ANOVA comparison of the socio-demographic covariate of age, results indicated a significant between-group difference among covariate of age ($p < .001$). A one-way analysis of variance (ANOVA) was conducted to determine substantial differences in current (pre-intervention) levels of physical activity participation across all three groups.

Functional Balance

A repeated-measures MANOVA test was conducted to test the intervention effect on functional balance scores over time (eight weeks) at pretest and posttest. A significant Box's M test ($p < .05$) indicated no homogeneity of variance and covariance matrices of the dependent variables across all three groups, so Pillai's trace multivariate test of within subjects and time by group interaction effects are reported. The results indicated that there were no substantial intervention effect interactions between the two intervention groups and control group on changes in UG, MDRT and ABC scores over time, $F(10, 60) = .96, p = .49, \eta_p^2 = .14$. Post-hoc test results were not reported because multivariate tests indicated no significant interaction effects by groups across time. Univariate tests also indicated there was no significant interaction effect of intervention by time on individual balance test scores, $F(2, 33) = .12, p = .88, \eta_p^2 = .01$ for UG, $F(2, 33) = .87, p = .43, \eta_p^2 = .05$ for MDRT forward reach, $F(2, 33) = 2.68, p = .08, \eta_p^2 = .14$ for MDRT right lateral reach, $F(2, 33) = .66, p = .52, \eta_p^2 = .04$ for MDRT left lateral reach, and $F(2, 33) = .14, p = .87, \eta_p^2 = .008$ for ABC scale. Table 2 displays results of MANOVA test for estimated marginal means and standard error of group by time interaction effect on all dependent variables. The direction of change between groups was not substantial, producing

similar or parallel patterns across groups, which indicated no significant intervention interaction effects on variables tested.

Table 2

Estimated Marginal Means of Balance-related measures by Group and Time

Measures	Nintendo Wii™ (n= 10)				MOB (n = 13)				Control (n= 13)			
	Pretest		Posttest		Pretest		Posttest		Pretest		Posttest	
	M	SE	M	SE	M	SE	M	SE	M	SE	M	SE
UG	7.91	1.16	7.41	1.33	11.18	1.02	10.95	1.17	9.12	1.02	8.94	1.17
MDRT_F	11.19	.963	12.72	2.71	5.60	3.11	7.19	3.26	10.21	3.14	10.72	3.34
MDRT_R	10.06	.867	10.47	2.49	5.75	2.90	6.78	3.42	8.97	3.11	7.86	2.51
MDRT_L	10.54	2.20	10.68	2.38	5.22	3.40	6.46	3.54	7.85	2.41	9.01	2.51
ABC	87.85	6.06	86.69	7.31	50.10	5.32	45.13	6.41	75.32	5.32	74.18	6.41

SE= Standard Error; n = sample

8-foot Up-and-Go Test (UG). The mean UG scores improved in all three of the groups tested over time (see Figure 1); however, the Nintendo Wii™ group demonstrated only a slightly larger improvement in dynamic balance performance scores. An overall improvement (or reduction in seconds) in mean UG scores of total sample population was found across time, from pretest (M = 9.53, SD = 3.82) to posttest (M = 9.24, SD = 4.33) with an average group improvement in mean UG scores of 0.29 seconds within all three groups. With a mean UG time of 7.91 seconds at baseline, the Nintendo Wii™ group was already below the cut-off levels indicating higher functional balance abilities of participants existed. The Nintendo Wii™ intervention demonstrated an average group improvement of 0.5 seconds over 8-weeks. When compared to the similar pattern of improvement in mean UG scores of the MOB intervention group, these results may suggest the effectiveness of the Nintendo Wii™ intervention in

improving functional balance scores in this population of community-dwelling older adults. Results also found that the average group improvement in mean UG time from pretest to posttest for the MOB intervention was 0.23 seconds and the mean control group improvement was 0.18 seconds. Estimated marginal means of MANOVA test indicated no statistical significance in the intervention interaction effects across all groups. Figure 1 provides a graphical display of the almost parallel pattern within groups across time, indicating the direction of improvement in scores was not substantially impacted by type of intervention. It should also be noted that the average MOB group and control group scores were above the cut-off threshold of 8.5 seconds, indicating that participants in both groups were at an increased risk for falls, when compared to participants in the Nintendo Wii™ group. According to the U.S. DHHS (2006), timed scores of more than 8.5 seconds on the UG are associated with high fall-risk in community-dwelling older adults, with the UG having an overall prediction rate of 82%.

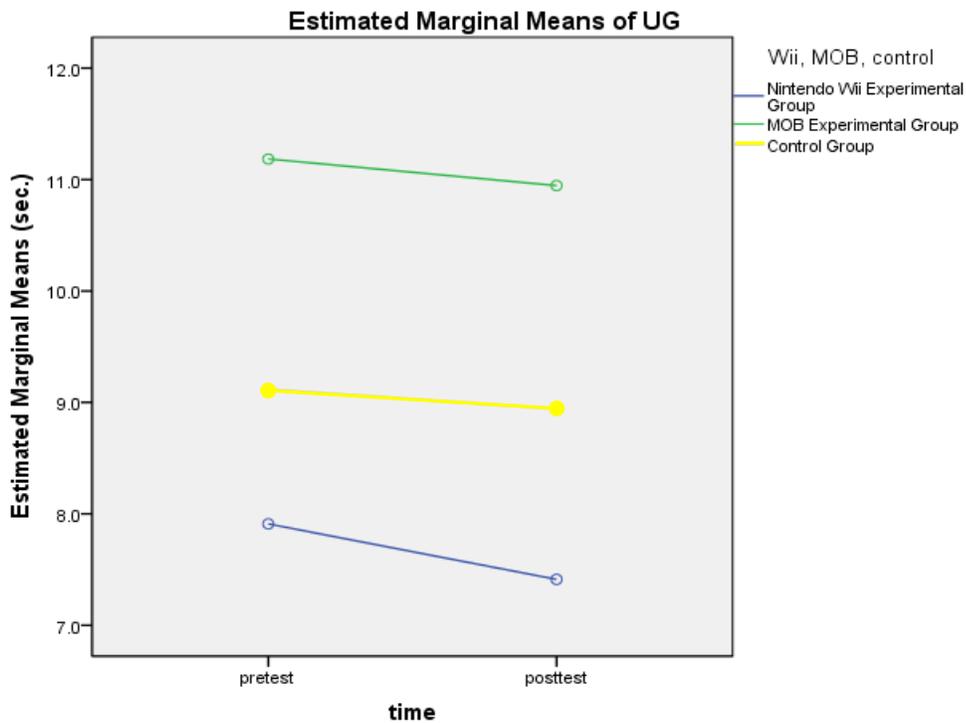


Figure 1. Change in UG scores over time across groups

Multi-Directional Reach Test (MDRT). The mean MDRT scores increased for all three groups in all directions except the right lateral reach score, which decreased by one inch in the control group. Table 3 displays mean pretest and posttest MDRT scores (in inches) for the forward reach, right, and left lateral reaches by intervention group. Figures 2 – 4 provide graphical displays of intervention effect patterns on the MDRT estimated marginal means in all directions, by group across time. Overall, the MOB and control groups recorded the smallest distances reached which has been identified as an indicator for decreased levels of postural stability (Newton, 2001). Both intervention groups demonstrated a slight improvement in mean MDRT scores in all three directions. Results found again, that scores on all trials completed by participants in the Nintendo Wii™ intervention group were notably higher at baseline and posttest than scores recorded in the MOB and control groups.

Table 3

Average MDRT Scores by Group and Time

MDRT reach	Nintendo Wii™ (n= 10)				MOB (n = 13)				Control (n= 13)			
	Pretest		Posttest		Pretest		Posttest		Pretest		Posttest	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Forward	11.19	2.82	12.72	2.71	5.60	3.11	7.19	3.26	10.21	3.14	10.72	3.34
Right	10.06	1.99	10.47	2.49	5.75	2.90	6.78	3.42	8.97	3.11	7.86	2.51
Left	10.54	2.20	10.68	2.38	5.22	3.40	6.46	3.54	7.85	2.41	9.01	2.51

SD = Standard Deviation; n = sample

Estimated marginal means of MDRT scores (in all directions) across time however, still demonstrated a similar effect pattern within the two intervention groups. A one-way analysis of variance was conducted to test for significance in the group differences between the MOB and

control group. Spinal flexibility and postural control are necessary to maintain throughout the lifespan and are identified as a preventative health measure toward prolonging independence by decreasing fall risk (Rikli & Jones, 2001). According to Duncan and colleagues (1990), a score below six inches has been found to predict recurrent falls in older adults and identifies individuals at high risk for falling, while any score less than ten inches indicates individuals who are at moderate risk for falling.

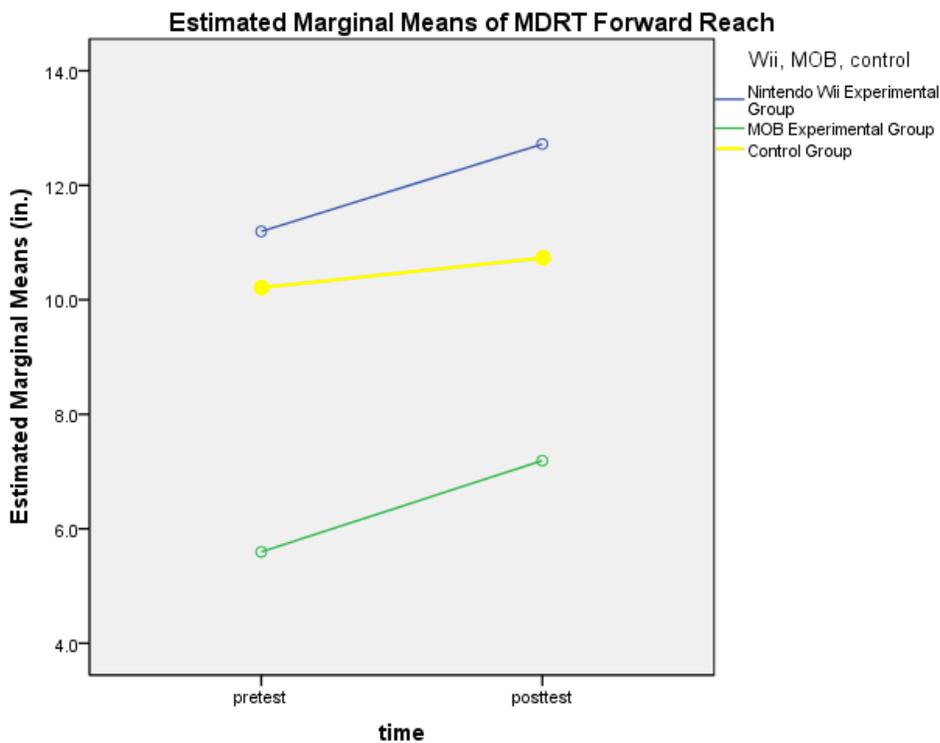


Figure 2. Change in MDRT Forward Reach over time across groups

After evaluation of all MANOVA test results, changes in average MDRT lateral right reach scores were similar between intervention groups but demonstrated opposite change patterns between the MOB intervention and control groups. Figure 3 provides a graphical display of the estimated marginal means of intervention effect patterns on change in mean MDRT right reach scores between groups across time. Results from ANOVA test indicated a

statistically significant decrease in the change of mean right reach scores from pretest to posttest between the MOB and control group, $F(1, 24) = 7.44, p < .05$. MOB participants scored much lower (3.22 inches) on right reach MDRT scores at pretest than control group participants, however improved at posttest increasing the mean total right reach distance scores by 1.03 inches while control group participants decreased the mean total distance reached to right by 1.11 inches. These results suggest that although participants in the MOB group were on average initially assessed at lower levels of functioning than the control group, with regular participation in low-intensity stretching exercises, levels of flexibility and postural control can be improved or maintained in community-dwelling older adults.

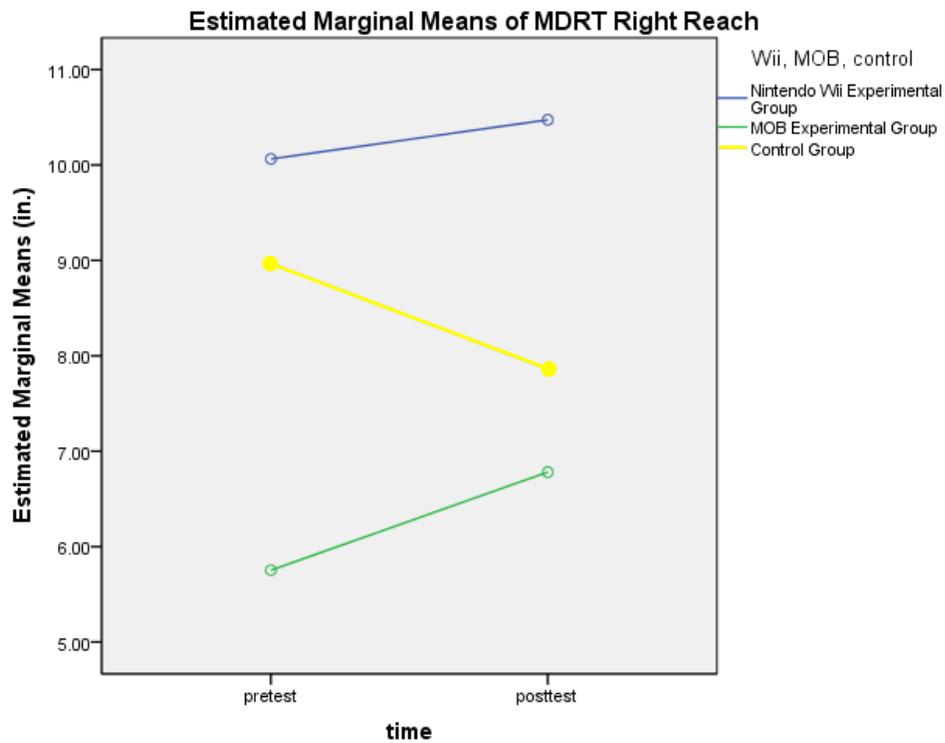


Figure 3. Change in MDRT Right Reach over time across groups

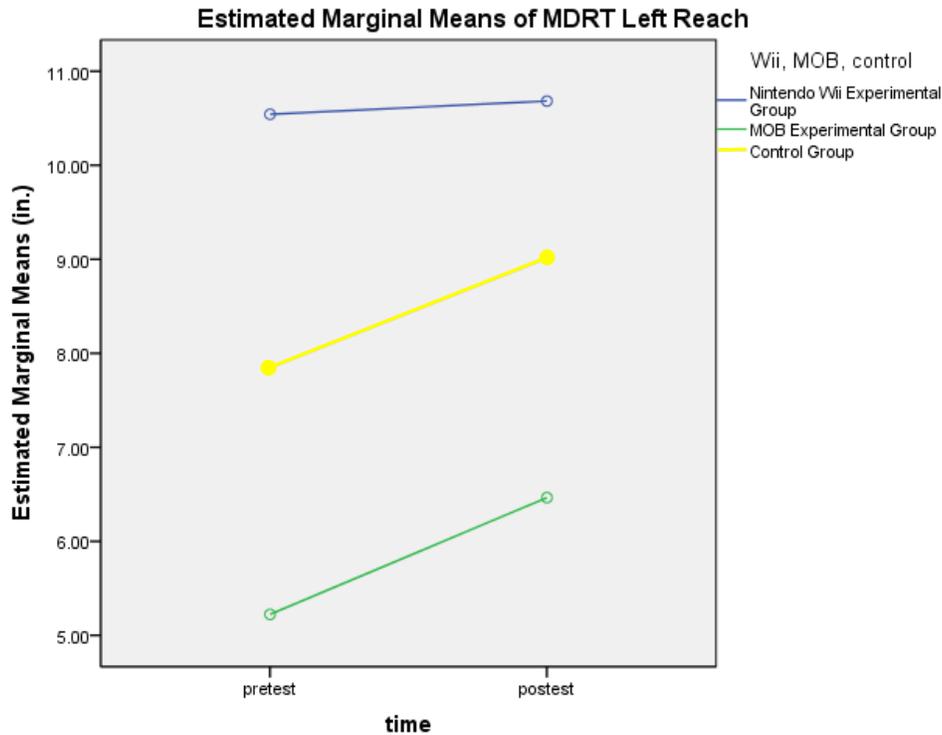


Figure 4. Change in MDRT Left Reach over time across groups

Fall-efficacy

Activities-specific Balance Confidence (ABC) Scale. Participants in the exergaming group had noticeably higher balance confidence scores both pretest ($M = 87.9\%$, $SD = 11.6$) and posttest ($M = 86.7\%$, $SD = 12.3$), as compared to both the MOB group pretest ($M = 50.1\%$, $SD = 25.8$) and posttest ($M = 45.1\%$, $SD = 32.6$) ABC scores, and the control group pretest ($M = 75.3\%$, $SD = 15.7$) and posttest ($M = 74.2\%$, $SD = 17.1$) scores. In summary, all three groups of participants indicated a slight (1.1%) decrease in their balance-confidence levels, and MOB having the largest decrease of 5% (see Figure 5). Previous studies have determined that a score of 85% or less identifies older adults with impaired balance and a score of less than 67% indicates older adults that are at high risk for falling (Clark & Kraemer, 2009; Lajoie &

Gallagher, 2004). In a study by Cho, Scarpace, and Alexander (2004), lower scores represent lower levels of balance confidence and are associated with balance impairment.

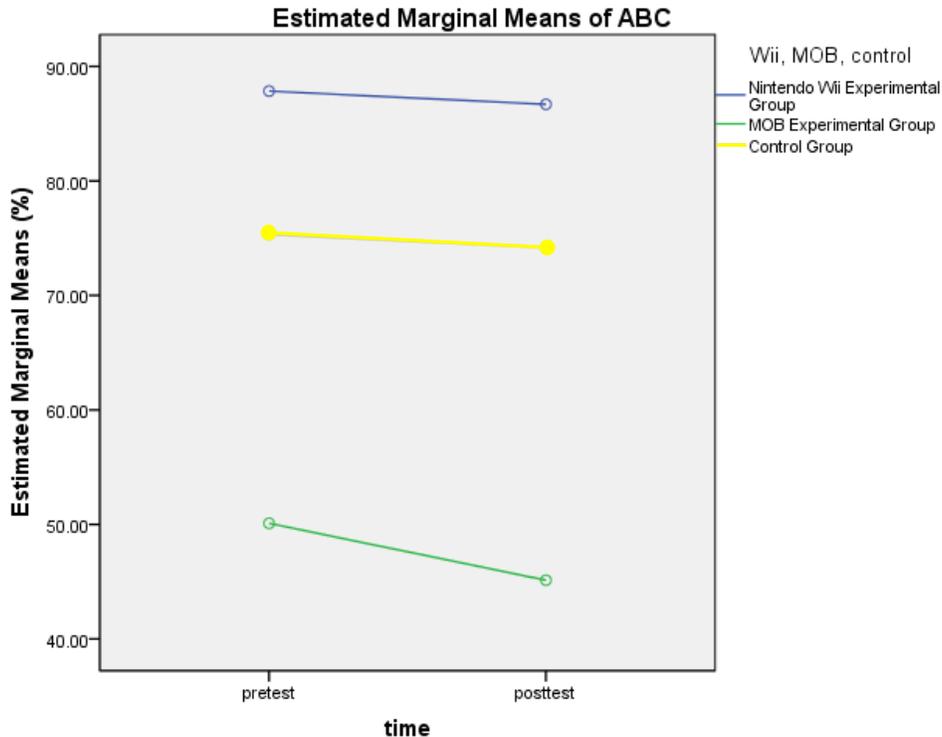


Figure 5. Change in Balance Confidence over time across groups

Additional research has also found that scores of 80% or higher indicates high levels of physical functioning, scores ranging from 50% to 80% indicate moderate levels and scores of < 50% have been found to identify individuals at low levels of physical functioning (Myers, Fletcher, Myers, & Sherk, 1998). The decline in fall efficacy of MOB participants could be attributed to increased safety awareness, resulting in more accurate and conservative scores by individual's at posttest. For example, at initial baseline testing MOB participants more frequently indicated scores for tasks such as standing on a chair to reach an object above head or walking on icy surfaces, than participants in the Nintendo Wii™ and control groups. Whereas

after the eight-week fall management education program, the same MOB participants reported much lower scores or a score of 0% indicating they did not engage in the high fall-risk behavior.

Enjoyment

Modified Experience Questionnaire. To evaluate various aspects associated with overall participant experience and levels of perceived enjoyment and satisfaction they received from participation in the exergaming-specific activities. At post-intervention balance screenings, the Nintendo Wii™ group participants were asked to complete an experience questionnaire designed by the researcher to specifically assess levels of perceived enjoyment, health value, and usefulness of participation in the exergaming intervention program. Please refer to Appendix G for specifically defined items used in questionnaire. Experience ratings were obtained from participants through completion of a 20-item self-report questionnaire (adapted from Broach et al., 2007) developed for this study to address items of participation including challenge-skill ratio, anxiety, boredom, levels of enjoyment, willingness and intent to participate, motivation to continue, and sociability value.

Scores on the first section of experience questionnaire, evaluating overall experience of intervention, corresponded to the following: (1) not at all, (2) slightly, (3) some, (4) a lot. The mean scores for the various components of the enjoyment questionnaire for the Nintendo Wii™ intervention group are as follows: A) challenge/skill ratio (M = 3.2, SD = 0.92), B) focused attention (M = 3.8, SD = 0.63), C) boredom (M = 1.1, SD = 0.32), D) desire to engage in different activity (M = 1.0, SD = 0.00), E) enjoyment of activity (M = 3.7, SD = 0.95), F) desire to continue activity (M = 3.7, SD = 0.95), and G) anxiety during activity participation (M = 1.9, SD = 1.20). For the second section of the experience questionnaire, participants were asked to answer a series of questions measuring their perceived ease of use of Nintendo Wii™ gaming

system ($M = 1.9$, $SD = 1.29$), perceived health value ($M = 3.1$, $SD = 1.60$), perceived usefulness of intervention ($M = 2.3$, $SD = 0.95$), perceived affective responses received through participation in activity ($M = 3.7$, $SD = 1.42$), perceived sociability value ($M = 3.4$, $SD = 1.90$), and overall perceived levels of enjoyment in intervention ($M = 2.6$, $SD = 0.84$).

The final section of the questionnaire evaluated participant's behavioral intent of continued participation post intervention based on their overall experiences with the Nintendo Wii™, by asking participants to answer seven additional items corresponded to the following: (1) not at all likely, (2) somewhat likely, (3) likely, (4) very likely, and (5) extremely likely. Items asked A) likelihood to use the Nintendo Wii™ to increase amount of daily physical activity ($M = 4.0$, $SD = 1.25$), B) likelihood to use the Nintendo Wii™ to improve your overall health ($M = 4.2$, $SD = 1.03$), C) likelihood to use the Nintendo Wii™ to increase social interaction ($M = 4.0$, $SD = 0.67$), D) likelihood to use the Nintendo Wii™ for entertainment ($M = 4.2$, $SD = 0.79$), E) likelihood to purchase the Nintendo Wii™ for personal use within home ($M = 4.0$, $SD = 1.25$), F) if already owned Nintendo Wii™ likelihood to use at home at least once a week ($M = 4.5$, $SD = 0.53$), and G) if already owned Nintendo Wii™ likelihood to use at home more than once a week ($M = 4.4$, $SD = 0.97$).

Overall results indicated all participants involved in Nintendo Wii™ intervention enjoyed the overall experience, and indicated that they would use exergaming to improve overall health and increase physical activity levels. This indicates an important relationship between engagement in enjoyable activity and continued adherence to activity supported in previous research.

Activity Adherence

Attendance frequency. It was hypothesized by the researcher that because the Nintendo Wii™ promotes enjoyment, participants would be more likely to adhere to the exergaming than the MOB more traditional education group. When comparing the effect of type of intervention on attendance rates, results from the Levene's test indicated no significant differences between both MOB and Nintendo Wii™ group participants, assuming equal variances between intervention groups ($p > .05$). Twenty-three participants completed the Nintendo Wii™ (n=10) and MOB (n=13) intervention programs, with a mean attendance rate of 83.7%. All participants in the Nintendo Wii™ group attended at least 5 of the 8 sessions, with half of the group missing only one session. Two participants, one male and one female, had perfect attendance (M = 83.8%, SD = 13.2). Eleven out of the 13 total participants in the MOB intervention group also displayed high attendance rates ($\geq 75\%$), with 4 females recorded at perfect attendance for participation in all eight of the group education sessions (M = 83.7%, SD = 15.6).

Within the initial familiarization session, verbal instruction (as needed), and the gaming system manual were available to participants allowing them to independently engage in exergames of choice and sustain gameplay throughout the 60-minute sessions. According to Rosenberg and colleagues (2010), there are several positive attributes associated with exergaming that may support activity adherence in this population. Reducing environmental barriers to exercise, the Nintendo Wii™ gaming console is low-cost and commercially available allowing for ease of use in personal home-based environments. They allow for self-directed choices and control among activities, which has been associated with sustained attention and an increased sense of autonomy (Rosenberg et al., 2010). Immediate visual and auditory feedback provided by the VR-based gaming system throughout gameplay also incorporates positive

reinforcement, with routine exercise adherence being reported as highly related to satisfaction and enjoyment with the activity at-hand (Rothman, 2000).

Supplemental Data

Supplemental qualitative data gathered by the researcher in a research journal during each session, in both experimental groups, demonstrated supportive findings in the areas of perceived enjoyment, self-efficacy, social relationships, and overall quality of life. From the exergaming groups, participants verbalized supportive self-statements and provided sincere encouragement to others in group. One participant brought her granddaughter to a Wii™ Sports session, promoting the intergenerational benefits of the Nintendo Wii™; this individual was also observed utilizing increased levels of physical exertion during gameplay. Another female participant verbalized noticeable improvements in her endurance levels and ease in her ability to complete yard work, simply from doing the ankle rolls that were incorporated into the stretching routines of both intervention groups. Participants in the MOB intervention group reported positive progress and healthy behavior or environmental changes at almost every group session.

Discussion

Results from this study were aimed at providing more evidence-based research on the use of a 2-dimensional interactive video gaming intervention to promote an increase in levels of physical activity among community-dwelling older adults with the overarching goal of reducing their risk of falls. The use of the Nintendo Wii™ in a variety of healthcare settings for clinical purposes is consistently increasing (Rosenberg et al., 2010). No significant differences were found between the two intervention groups, with regard to UG and MDRT scores, suggesting that they both measured very similar aspects of the construct of functional balance. No significant changes were found between the UG and MDRT pretest and posttest performance scores of both intervention groups, which may suggest the acceptability of using the Nintendo Wii™ to promote an overall increase in the average physical activity levels of older adults that subsequently may result in a decreased risk of falls.

This research study was specifically designed and implemented to support the field of Recreational Therapy and efforts toward increasing efficacy research among the profession, specifically in the area of geriatric healthcare. Findings estimate that fear of falling can be reduced in community-dwelling older adults through the participation in fall prevention education and physical activity group-based programs. Risk factors for disease morbidity and mortality increase as physical activity decreases (U.S. DHHS, 2006). Many older adults remain physically inactive even though research supports that regular physical activity can improve one's general well-being, muscle strength, overall endurance, functional balance, and the ability to effectively perform regular activities of daily living (ADLs) (Shephard, 1994). According to the Centers for Disease Control and Prevention (CDC), physical inactivity is highest among individuals 65 years of age and older (2010). By increasing physical activity among older adults

in a community-based setting, the physical functioning and functional balance levels of these individuals may advance, leading to improvements in the ability to maintain performance of ADLs, increased independence, and overall quality of life (QOL), as well as a decreased risk of experiencing falls and/or institutionalization (Yeom, Keller, & Fleury, 2009).

Variance in the range of baseline scores between the MOB, Nintendo Wii™, and control group participants could be attributed to several factors related to socio-demographic variables such as gender, age, location of residence, and accessibility of the residential neighborhood or complex. Different income levels could affect amount of accessibility and utilization of available community resources. Different income levels could determine increased participant accessibility of available community resources. According to Spiraduso and colleagues (2005), “Those now living are predominately Caucasian females, with approximately 50% of them living in their homes rather than institutions, most have very low incomes and 75% are native-born Americans” (p. 7-8). The Census Bureau projects that in 2050, 61% of those over 85 will be women (Spiraduso, Francis, & MacRae, 2005). As compared to individuals who lived in the independent living complexes, community-dwelling older adults may have higher physical or cognitive levels of function and in turn, be less affected by age-related declines in flexibility, balance and ROM (Holbein-Jenny et al., 2005). Results indicated that out of all three groups, the control group contained the largest number of physically active older adults with the Nintendo Wii™ participants making up the second most active group of participants. Substantially lower performance scores of participants in the MOB group on all balance assessments, compared to participant scores in the Nintendo Wii™ and control groups, may be partially due to the residents’ difficulty in performing and comprehending the tests, rather than truly poorer balance.

Fear of falling while performing the UG and MDRT may also contribute to underestimated balance capabilities of the MOB participants.

Deutsch and Mirelman (2007) determined that although there is positive feedback and longevity specifically in the use of VR-based systems to improve ambulation in older adults poststroke, evidence-based practices and new technologies are constantly being developed which demonstrate the need for more research to be conducted before the clinical use of VR with community-dwelling older adults can be validated. Opponents of VR argue that the Nintendo Wii™ and other VR-based video gaming systems and technologies are not marketed toward the older adult population, assuming uncertainty and disinterest in the elderly. However, alternative ideas and findings suggest that in reality, the emerging “baby boomer” generation adapts to innovative technology increasingly more. From all research studies reviewed, it is evident that more documented evidence of VR-based technology and its effects on promoting physical activity in older adults is needed. Few studies have examined interactive balance training exercises in older adults as an intervention to improve postural control and reduce the risk of falls. Diminished ability to maintain static balance is often associated with an increased risk of falling.

The Nintendo Wii™ has been proven beneficial to the older adult patient population as a way to increase cognitive functioning, interpersonal interaction, and overall health-related QOL (Rosenberg et al., 2010). The results from this study support these findings and the implications for using the Nintendo Wii™ video gaming console with older adults to improve levels of regular physical activity. Participants from both experimental groups commonly verbalized expressions of positive and negative emotions, self-statements regarding skills and abilities,

comments indicating healthy competition and support toward others, and self-statements regarding noticeable functional improvements throughout the entire eight-week study.

Limitations

Limitations to this study included small sample size, subject dropout, and participant confusion exhibited during the pretest and posttest balance screenings. As with any research study conducted with human subjects, various individualized limitations may arise. The small sample size could have been a contributing factor to the data being skewed and generalizability of these results is limited due to the small sample size. It was anticipated that sample sizes for all three groups would be equitable at 15 for participation in this study. A larger study incorporating residents from various independent living complexes and senior centers would improve the generalizability of these results, as the location and services provided at various facilities may create variance in the performance and attendance rates of participants.

Throughout the balance screening pre-testing procedure, several participants were not fully able to comprehend and respond accurately to the Activity-specific Balance (ABC) Scale secondary to the decreased ability to read or write. Visual deficits required several of the participant's surveys and self-assessments to be read aloud by the researcher. Other factors that could be attributed to the variance in testing scores include: taller/shorter height, gender, body weight, impaired cognition, motivation levels, medication side effects, and oxygen supplementation. One participant was unable to complete the final Nintendo Wii™ sports session and post-test balance screening secondary to being diagnosed with COPD during active participation in the eight-week study.

According to Holbein-Jenny and colleagues (2005), there is limited research available on the reliability and validity on the use of the ABC scale and MDRT with community-dwelling

older adults. Throughout this research study, the administration of the ABC scale to this population proved to be challenging. Many of the older adults in the MOB intervention group were more inactive than participants from the Nintendo Wii™ and control group population and often indicated several tasks on the ABC scale that they never performed, such as getting onto or off of an escalator or walking outside on icy surfaces. This created a challenge for them being able to accurately rate their levels of confidence on specific tasks.

Implications for Practice and Research

The results of this research support the similar effectiveness of utilizing the Nintendo Wii™ to promote participation of routine physical activity in community-dwelling older adults as other group-based fall prevention programs. Future subsequent studies and evidence-based research should be aimed at utilizing more specific, standardized assessment tools that are in better alignment with the aims of the study. Other recommendations to improve generalizability include studying a larger sample size, investigating gender differences on balance performance and fall-efficacy in this population, and also utilizing more structured methods to gather and analyze qualitative data. Additional time required for warm-up and cool-down stretching should be incorporated into every intervention session and adequate time allotted for various rates and levels of functioning. Future studies incorporating the use of the Nintendo Wii™ with the older adult population are recommended to increase the rate of gaming sessions to twice a week, as well as create a structured gaming intervention protocol to increase standardization and efficacy. Establishing evidence of the overall physical and social benefits of playing the Nintendo Wii™ could have a broad impact on the older adult population that correlates to higher levels of balance-confidence and enjoyment in physical activity adherence levels and overall health-related QOL.

Subsequent research should consider developing or utilizing a more standardized assessment tool for measuring levels of enjoyment and should also be applied across all groups measured within the total sample population. Additionally, the implementation of a thorough cognitive screening of all participants and utilization of an alternative fall-efficacy measure, or the short-version of the ABC scale, the ABC-6 scale, are other recommendations. According to Frick, Kung, Parrish, & Narrett (2010), “Future studies can focus on whether there are other opportunities for synergistic efforts of multiple interventions that can be combined” (p. 140). The incorporation of measuring attendance rates in organized community programs that combine recreation and physical activity in similar studies may aid in increasing the development of novel exercise-promotion programs for community-dwelling older adults.

Conclusion

In summary, the evidence laid out demonstrates that although some exercise interventions with balance and muscle strengthening components have been shown to reduce falls, it is not known which elements, or combination of elements, of exercise interventions are most effective for improving balance in older adults. Overall results from multivariate tests showed no intervention effects on variables of functional balance and fall-efficacy. Between group comparisons indicate no conclusion that one intervention group is more effective than the other at improving functional balance and balance confidence in community-dwelling older adults. When compared to the control group, the MOB intervention group indicated an opposite interaction effect over time in the average group MDRT right reach scores.

Supporting the need for more future evidence-based research on VR-based gaming technology, Merians, Poizner, Grigore, and Adamovich (2006) emphasize the importance of having a large pool of poststroke rehabilitation interventions focused on improved function and

strength in weakened limbs because the effects of a stroke are a leading cause of physical disability. Their study indicated that the movements required in the performance of VR-simulated activities does carry over into real-life experiences, suggesting significant improvements in the preparation process patients receive before transitioning back into the community and home. It is hypothesized that the use of interactive exergaming to improve physical activity and functional balance in older adults can provide an appropriate interactive, challenging, and encouraging environment where a patient or participant can repetitively practice tasks required through guided and rewarding systematic feedback. A recreational therapy intervention was presented in this study that provided opportunities for enjoyable physical activity through game play using an interactive simulated balance exercise gaming on the Nintendo Wii™ home-based VR video gaming system.

As an individual ages, decreases in levels of physical activity put older adults at a much higher risk for falls (Nevitt et al., 1989). Vellas and colleagues (1987) noted that 41% of fallers and 23% of non-fallers experienced activity restriction over a 6-month period. Statistics also indicate that approximately 46% of the older adult male population is more likely to die from a fall-related injury than the female population, suggesting the need for more strategies to increase male involvement in fall prevention programs (CDC, 2010). The Nintendo Wii™ exergaming group had the highest participation rate by males, when compared to the MOB and control groups. This research is on the forefront of many more studies on virtual rehabilitation and gaming technology and its use with various populations as a means of creating increased enjoyment in exercise, thus motivation and adherence to regular physical activity. Older adults prefer to remain independent for as long as possible, creating a demand for novel technologies to assist with healthy active aging in place (Rantz, Skubic, Miller, & Krampe, 2008). The need for

interactive, home-based interventions and exercise programs focused on improving overall endurance, strength, and flexibility and promote enjoyable, valued physical activity, is necessary to increase and maintain the healthy functioning and independence of our aging older adult population.

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Extended Literature Review

According to the National Centers for Disease Control and Prevention (CDC), falls are the leading cause of injury-related deaths in older adults over 65 years of age, as well as the most frequent cause of nonfatal injuries and inpatient hospital admissions for trauma such as fractured joints, broken bones, and traumatic brain injuries, in the United States (CDC, 2010). Statistics on emerging baby-boomer population trends predict that in the year 2011 alone, the first of approximately 70 million baby boomers will be turning 65 years old (Sedensky, 2011). There is no doubt that adults ages 65 years and older will make up a vast majority of the healthcare consumer population, driving the demand of quality healthcare services as they experience rising medical costs associated with chronic diseases or disability (CDC, 2010). Supporting research indicates that greater rates of inactivity among this age-cohort also result in greater medical costs. In 2000, the fall-rate among older adults cost the U.S. health care system over 19 billion dollars (CDC, 2010). With the population aging, both the frequency of falls and the costs to treat fall-related injuries are projected to increase. Carroll and colleagues (2005) found that “among community-dwelling older adults, fall-related injury is one of the most expensive medical conditions” (p. 308). Additionally, higher rates of hospitalized older adults will create a need for more doctors with the clinical expertise to provide effective healthcare services to older adult populations. The American Geriatrics Society indicates that today there is roughly one geriatrician for every 2,600 people 75 years of age and older (Sedensky, 2011).

There are significant decreases in levels of physical activity during aging (Hawkins et al., 2009). In fact, the majority of older adults will drastically reduce their amount of physical activity thinking it will reduce their chances of a future fall, which is usually associated with lower levels of perceived balance confidence (Peterson, 1998). Brouwer and colleagues (2003)

report that “fear of falling in seniors has been identified as an independent risk factor for disability, loss of quality of life, and decreased mobility” (p. 829). Moreover, activity restriction associated with fear of falling will decrease the quality of life in older adults and increases the risk of future falls (Newton, 2004). An individual, who experiences a high rate of falls, is more likely to lose their independence and increase their risk of early death (Alexander, Rivara, & Wolf, 1992). The benefits of physical activity most associated with healthy aging include fall prevention, ease in the ability to perform all instrumental activities of daily living (IADLs), such as bathing, feeding and toileting, improved cognition and overall functional health, with the overarching goal of maintaining one’s independence (United States Department of Health and Human Services, 2006). Seniors prefer to remain independent for as long as possible, creating a demand for novel technologies to assist with healthy successful aging in place (Rantz et al., 2008).

Due to current health care trends, the length of inpatient stay in health care facilities has dramatically decreased, discharging patients following disabling events much earlier than in the past. Too often, patients are returning to their homes and communities at lower levels of functioning, and with a significant need for continued rehabilitation (Holden, 2005). The evaluation of flexibility, dynamic balance, and postural stability is a fundamental part of any physical performance assessment of older adults, especially those at risk for falls (Rose et al., 2002).

Statement of the Problem

While the U.S. population is aging at an unprecedented rate, upcoming health care professionals need to produce more evidence-based research on the causes, risk factors, and preventative measures for injuries, as well as learn more about the most effective strategies to

reduce the consequences of those who are injured. A number of researchers have determined that even though predictors highly associated with falls are multifactorial and interactional in nature, there is still a demand for a clear and brief cost-efficient and comprehensive measure of overall balance by healthcare providers in order to effectively and efficiently identify future fallers (Rubenstein, 2006; Tinetti et al., 1986; Shumway-Cook et al., 2000; Rantz et al., 2008). The new wave of active older adults are continuously emphasizing their increased desire to maintain their independence for as long as possible creating a demand for novel technologies that assist with healthy, active aging in place (Rantz et al., 2008). The need for interactive home-based interventions and exercise programs focused on improving overall endurance, strength, flexibility, while promoting enjoyable, valued physical activity necessary to increase and maintain the healthy functioning and independence of our aging older adult population.

There is growing evidence that the opportunity to experience enhanced feedback and guided practice in a virtual environment (VE) is, in some instances, superior to learning in real-life settings where motions may be hesitant due to fear of injury or pain (Todorov, Shadmehr, & Bizzi, 1997; Brooks et al., 1999). Virtual environments can be developed to incorporate game-like elements that may improve patient motivation to participate in therapy, and may be used for self-guided independent training for continued practice after discharge from rehabilitation (Holden et al., 2005). The use of the Nintendo Wii™ to promote physical activity in people of all ages is promising. The popularity of the Wii™ provides greater access to exercise-themed videogames, more recently coined “exergames”, which allows for interventions to be developed that could reach larger age-populations. Innovative advancements in technology have also resulted in a shift toward implementing less traditional forms of physical rehabilitation interventions through the use of virtual reality-based technology (Holden et al., 2005).

The goal of this literature review is to identify and highlight the published research evaluating the use of the VR-based Nintendo Wii™ video gaming technology with various populations, while presenting the best evidence available for the effectiveness of a novel Nintendo Wii™ exergaming intervention as an alternative fall prevention strategy aimed to improve functional balance, fall-efficacy and promote increased involvement in physical activity levels of community-dwelling seniors. Older adults are particularly at risk of fall-related fractures, and therefore, fall prevention studies in this population are urgently required.

The Effects of Aging on Balance

For the purpose of this literature review, Rose's (2010) definition of balance will be used: "the process of controlling the body's center of mass (COM) with respect to its base of support, whether the body is stationary or moving" (p. 4). Balance impairments are a major contributor of falls among adults over the age of 65, which often result in severe injury, secondary disabilities, loss of functional independence, and early death (Schepens et al., 2010). As people age, physical and cognitive functions slowly begin to diminish and physical activity becomes increasingly important in the older adult population to accommodate such diminishing capacities (Rosenberg et al., 2010). According to Carter and colleagues, "Involutional changes in sensory and musculoskeletal structure and function among older people render them at increased risk of falls and injuries" (2001, p. 435). Physical decline is also linked to decreased clinical performance on balance testing (Clark & Kraemer, 2009). Carter et al. (2001) concluded that the increased incidence of falls in older adults is caused, in part, "by age-related deterioration of the 3 sensory systems that control posture: vestibular, visual and somatosensory" (p. 428). The somatosensory system receives and processes sensory input from the organs in the skin, ligaments, joints, and muscles of the body (Mosby's Medical Dictionary, 2006). In fact,

where most research supports an increase in physical activity within any age group, it is particularly evident in elderly populations that regular physical activity can lead to reductions in risk factors for chronic disease and disability (Warburton et al., 2006).

Visual and cognitive deficits, as well as physical limitations secondary to osteoporosis, rheumatoid arthritis, and other age-related diseases that cause bone and joint deterioration, are more prevalent in adults over the age of 65 (American Academy of Orthopedic Surgeons Panel on Falls Prevention, 2001). Intrinsic factors associated with increased risk of falling among older people include, but are not limited to, reduced muscle strength, reflex reaction, and endurance. These limitations often have a direct impact on risk factors for falls in older people living in the community and in nursing homes such as slower walking time, impaired balance and gait (Keskin et al., 2008). Matsumura and Ambrose (2006) state that as an individual ages, visual acuity and physical reactive responses, such as joint reaction responses, tend to become less proficient, which proves to be an underlying issue of increased risk for experiencing falls. Decreased muscle strength, range of motion (ROM), physical activity, and recreation participation can all increase a person's chance of experiencing a fall during normal activities of daily living. Other common factors associated with falls among older adults include, but are not limited to, postural hypotension, the use of an assistive device, medication side effects, depression, environmental hazards, and being over 80 years of age (American Geriatrics Society, American Academy of Orthopedic Surgeons Panel on Falls Prevention, 2001).

After experiencing a fall, along with physical injuries, many individuals may develop psychological consequences related to falls in the form of decreased balance confidence and fear of falling causing them to limit their activities of daily living (Powell & Myers, 1995; Keskin et al., 2008). Lack of balance confidence has also been linked to the restriction of activities and

overall physical functioning in older adults (Clark & Kraemer, 2009). According to Powell and Myers (1995), individuals who manifest a fear of falling also report scoring lower on balance tests.

Evidence indicates that falls can have a detrimental effect on the overall health, well-being, and quality of life (QOL) of elderly adults. In a study of 890 community-dwelling elderly, the prevalence of fear of falling increased with age and was greater in women. After adjustment for age and gender, being moderately fearful of falling was associated with decreased satisfaction with life, increased frailty, depressed mood, and recent experience of falls. Being very fearful of falling was associated with all of the above plus decreased mobility and social activities. In that study, 2.9% expressed a fear of falling; 9% of the total sample reported that they were very fearful of falling (Arfken, Lach, Birge, & Miller, 1994). According to Brouwer and colleagues (2003), “an older adult’s fear of falling is most often association with physical deconditioning as individuals adopt more-sedentary lifestyles. Fear of falling in older adults, regardless of fall history, leads to a deterioration in one’s perceived health status and is associated with impaired social function that, as a result, threatens an individual’s autonomy and quality of life (Brouwer et al., 2003; Howland et al., 1998). As limitations in functioning increase with age, injury and/or disability, balance impairments and other fall-related risks, such as decreased PA, depression, postural instability and decreased core strength, become crucial areas of concern for the successful aging of older adults (Arfken et al., 1994).

Falls and Older Adults

The National Council on Aging (NCOA) and other worldwide health initiatives have emphasized the adverse effects on the overall health of older U.S. populations due to poor nutrition, sedentary lifestyles, and increased rates of obesity. These warnings have led to an

increased public awareness and concern, especially among the aging population, for improving and maintaining one's health and overall well-being. Engagement in physical activity (PA) has been identified as a major contributor to improving and maintaining balance and preventing falls (Shephard, 1994; Yeom, Keller, & Fleury, 2009). Lee and Stokic (2008) found that mid-aged people with stroke and amputation, worse cognitive functions, and greater medical complexity are at a higher risk for falling than other populations. According to Pyöriä et al. (2004), difficulty with weight distribution and postural control are common in patients poststroke, with stepping and grasping gross motor movements of the upper and lower extremities playing a huge role in the maintenance of upright core and trunk posture and stability. Similarly, avoidance of participation in activities, secondary to fear of falling, can often advance the decline in balance functioning as one ages. In addition to balance training, fear of falling and associated activity restriction should also be addressed in therapeutic interventions designed to improve functional balance (Myers, Fletcher, Myers, & Sherk, 1998).

Recovery and improvement of function following an unanticipated fall-related injury vary considerably during the first year after experiencing a fall. The need for interactive, home-based interventions and exercise programs focused on improving standing (static) and dynamic balance that promote light physical activity is necessary to increase and maintain healthy functioning in aging older adults. Interventions have mainly focused on improving balance and fall prevention by providing seniors with programs that allow the opportunity for increased physical activity and improvements in overall functional mobility. The goal is to promote independence and improved health-related quality of life so that people can live in their homes as long as possible.

Traditional Interventions for Improving Functional Balance

According to a study conducted by Joo and colleagues (2010), repetitive movements are crucial to the progress of stroke patients in physical rehabilitation who are experiencing upper and lower extremity weaknesses, but provide no cognitive stimulation or social interaction. Similarly, Dunning et al. (2008) stated that repetitive practice, also referred to as “traditional rehabilitation”, is associated with an improvement in physical functioning and cortical plasticity. Aspects incorporated into traditional rehabilitation treatment usually includes balance re-training, muscle and motor function re-training, and training in areas of safe ambulation, gait and overall mobility (Holden, 2005). With older adults, the ability to compensate for loss of balance requires muscle strength and endurance in both bilateral upper extremities (B UEs) and lower extremities (LEs) (Shumway-Cook & Woollacott, 1995). Although strength training and muscle movement re-training may be monotonous and provide no stimulation other than physical, they have been proven as effective modalities to implement in the physical rehabilitation and recovery of fall-related injuries in older adults (Holden, 2005; Deutsch & Mirelman, 2007). The majority of interventions utilized for improving functional balance and preventing falls in older adults incorporate walking programs, balance training, aerobic exercise programs, resistance training, flexibility, and strength training exercises (Costello & Edelstein, 2008; Yeom, Keller, & Fleury, 2009).

Individuals with balance dysfunctions constitute a vast majority of the rehabilitation, neurological, and geriatric patient population. Functional balance is not a remote quality, but is a necessary component of an individual’s ability to engage in a wide range of tasks that make up activities of daily living (ADLs). The successful performance of all ADLs, require effective balance control while the body is at rest or when moving from one position to another (Berg et

al., 1989a; Huxham et al., 2001). Normal balance requires control of both gravitational forces to maintain posture and acceleration forces to maintain equilibrium (Massion & Woollacott, 1996). Maintenance of balance requires the coordination of sensory, neural, and musculoskeletal systems for postural control, which naturally decline as part of the aging process (Berg, 1989b; Alexander, 1994). In 1992, A *Matter of Balance* (MOB) training was proven by the CDC as an evidence-based fall prevention program for older adults designed to reduce fear of falling and associated activity restriction (CDC, 2010). A randomized controlled trial by Tennstedt and colleagues (1998) produced efficacy-based research supporting the use of MOB in improving fall efficacy in community-dwelling older adults. Group-based physical activity has also been shown to have a positive impact on mobility, especially for older adult participating in community-based exercise programs (Kammerlind, Hakansson, & Skogsberg, 2001; King, Pruitt, Phillips, Oka, Rosenberg, & Haskell, 2000; King, Whipple, Gruman, Judge, Schmdt, & Wolfson, 2002).

Virtual Reality Technology and Physical Rehabilitation

The popularity of using virtual reality (VR) technology via video gaming systems in rehabilitation and functional improvement within clinical and community-based settings, although still relatively new, has substantially increased due to its ability to simulate real-life virtual environments (VEs) (Holden et al., 2005). Available research on the use of VR-based gaming for physical rehabilitation in health care and community-based settings includes studies on VR involving immersion, computer-based systems, and home-based systems (Flynn, Palma, & Bender, 2007). These virtual reality-based interventions provide the opportunity for users to practice a range of physical tasks in a safe, non-threatening, and controlled virtual environment (VE).

Deutsch and Mirelman (2007) state, “The demand for early active, intensive, and repetitive training has facilitated the development of new technology for gait training” (p. 45). As a result, various new approaches to using virtual reality technology and exergames are being incorporated into the physical rehabilitation of older adults post-stroke. But too often the traditional forms of physical therapy, including gait training, standing endurance, and balance interventions are redundant and may not be as functional as virtual environments (Holden, 2005). Virtual environments and virtual reality technology can provide self-controlled, safe real-life practice of daily tasks for patients (Rosenberg et al., 2010). Conventional repetition tasks become monotonous and require moderate assistance from the therapist, while VR technology not only allows participants to complete multiple repetitions related to achieving a specific goal, it also provides a sense of self-determination, while still being therapeutic in nature. The authors describe and evaluate four separate studies, all using different types of VR technology systems that have been developed to improve gait function in older adults. Traditional balance training was most commonly compared with VR-based exercises in the research studies reviewed.

A majority of people in the United States now have access to technology through personally owned equipment, work equipment, or public use equipment. Longitudinal studies have found that the use of technology could theoretically provide greater access to physical activity interventions and may be the most efficient technique for promoting and implementing future home-based interventions (Hillier, 2008; Dunn et al., 1998). Research has already begun to examine the use of technology as a physical activity tool, for example the use of active video gaming systems such as *Dance Dance RevolutionTM* and more recently the Nintendo WiiTM gaming console has shown promising results (Sell et al., 2008; Tan et al., 2002; Graves et al., 2008). Innovative advancements in technology have also resulted in a shift toward implementing

less traditional forms of physical rehabilitation interventions through the use of novel virtual reality-based technology.

As recreation-based activities have been shown to be a motivating means of PA leading to improvements in overall balance, mobility and physical function, interventions incorporating the use of VR-based video game technology may be a beneficial means towards functional improvement by providing a fun, motivating means of implementing physical activity in older adults (Chen et al., 2009; Clark & Kraemer, 2009). By utilizing the low-cost, commercially available Nintendo Wii™ computer gaming console during inpatient rehabilitation, therapists can familiarize participants with the operation and equipment of the system, which may increase their willingness to purchase and utilize the system post discharge. As a result, this would be expected to assist in the promotion and maintenance of continuous engagement in physical activity and recreation participation after inpatient rehabilitation. Studies completed by physical therapy have reported immediate results in patient compliance and the proactive transition to a home-based program implementing the Nintendo Wii™ (Holden, 2005).

Nintendo Wii™ Gaming Technology.

The Nintendo Wii™ has been proven effective in increasing physical activity (PA) and mild to moderate energy expenditure (EE) in various age groups with specific Wii™ video games, such as Wii™ aerobics. However, there is limited research available on the effects of the Nintendo Wii™ on functional balance in the older adult population. Clark and Kraemer's (2009) study indicated that the effectiveness and quality of VR training environments have been enhanced by the addition of interactive video games, by increasing enjoyment and motivation. Betker and colleagues (2006) determined from their study that a video-game based exercise program motivated patients to increase their amount of practice and attention span, which

indicated that novel video gaming had a positive effect on the static and dynamic balance of their older adult subjects. Tasks such as Nintendo Wii™ bowling were used in studies examining the Wii™, and were selected because of their related movements to activities of daily living such as crouching for gardening or home tasks.

It is important to note that, the majority of published evidence-based research on the use of the Nintendo Wii™ in rehabilitation is focused on supporting its feasibility in upper limb (UL) physical rehabilitation. Henderson, Korner-Bitensky, and Levin (2007) conducted a comprehensive research review of available data collected on the benefits of VR for upper extremity motor recovery. It seems there is a consensus among researchers that virtual reality is unique in that it provides users with a non-threatening virtual environment (VE) that promotes safe, positive learning experiences, while being entertaining and motivating at the same time. VR can be augmented to meet the needs of any individual, for example, by providing programs that are task-specific or meaningful to the participant, and that have been shown to be important in maximizing motor learning.

In a similar study conducted by Joo and colleagues (2010), the practicability of utilizing the Nintendo Wii™ gaming system as an adjunct to traditional interventions was evaluated in the post-stroke rehab of patients presenting with upper extremity weakness. According to the authors, the repetitive movements of motor retraining and strengthening are crucial to the effectiveness of functional progress in physical rehabilitation therapies, but provide no stimulation or social interaction with other patients. This research study also examined the specific use of the commercial off-the-shelf computer gaming system (COTS), the Nintendo Wii™, and its effects on upper limb recovery. Using the Nintendo Wii™ gaming console's unique motion-sensitive controller, the interactive Wii™ video games require body movements

similar to conventional therapies, but incorporate games that help to create an inner competitiveness to encourage participants repetitively to improve their performance. The wireless lightweight Wii™ controller is used as a hand-held pointing device, detects acceleration and orientation in three dimensions. According to Yong et al. (2010), “Nintendo Wii’s fun and interactive approach may motivate patients to increase participation and, ultimately may lead to better therapy results” (p.42). The study concluded that the VR-based Nintendo Wii™ video gaming console was proven to be an acceptable alternative to the monotonous repetition of traditional forms of physical rehabilitation exercises. The Wii™ also provides an adjustable skill level and a variety of programs that can be easily tailored to specific individual interests to increase levels of enjoyment in participation.

Implications of VR-based Gaming

The past decade has witnessed a growing interest in the popularity and utilization of virtual reality-based technology for assessment and treatment of rehabilitation patients (Holden et al., 2005). Virtual reality (VR) technology in rehabilitation settings presents opportunities for patients to practice simulated tasks that incorporate naturalistic challenges and are highly relevant to real-life experiences. VR-based video gaming technology, specifically the Nintendo Wii™, provides participants with immediate feedback via desired sensory modalities, such as audition or vision.

Following the development and launch of the Nintendo Wii™ in 2006, community-based, long-term care, and rehabilitation facilities have been incorporating its use in their programs. Current evidence-based research on the use of the Nintendo Wii™ with the older adult population has been promising and includes studies on VR involving immersion, computer-based systems, and home based gaming systems. The Nintendo Wii™ has been proven

beneficial to the older adult patient population as a way to increase cognitive functioning, interpersonal interaction, and overall health-related quality of life (QOL) (Rosenberg et al., 2010). By focusing on the balance element of physical functioning, empirical data can be identified in order to support the meager body of evidence-based research available on the effects of the Nintendo Wii™ on balance in the older adult, baby boomer population. The data from a research study by Merians and colleagues (2006) add support to the proposal to explore novel technologies for incorporation into current practice.

The idea of VR-based, computerized exercise systems leads one to speculate about the importance of developing lower cost, home-based therapy systems. Patients would be able to practice more frequently for longer periods of time, and for extended durations post discharge from inpatient rehabilitation. It would then provide patients the opportunity to immediately put their strengths and gains in rehab into functional activities of daily living, which ultimately results in an improved quality of life. By examining criteria performance measures, such as the average length of standing endurance during a treatment session, this study plans to demonstrate how novel, interactive treatment modalities, coupled with the foundations of traditional balance training and exercise techniques, can improve physical functioning and reduce fall risk factors in community-dwelling older adults.

With the increased need for more outpatient and home-based physical rehabilitation programs, therapists are constantly searching for motivating, functional intervention techniques and self-sustainable, exercise programs to incorporate into patient treatment plans. Virtual Reality (VR) and its simulated virtual environments (VEs) are unique in that they allow patients the opportunity to practice physical and cognitive tasks in a safe environment, with many programs allowing self-directed engagement. Engaging in active Nintendo Wii™ video gaming

will have a significant and positive relationship on the overall functional balance of older adults. Nintendo Wii™ exergaming, combined with one's self-efficacy and determination, will improve overall functional balance in community-dwelling older adults.

Deutsch and Mirelman (2007) determined that although there is positive feedback and longevity, specifically in the use of VR-based systems to improve ambulation in older adults poststroke. Evidence-based practices and new technologies are constantly being developed which demonstrate the need for more research to be conducted before the clinical use of VR with community-dwelling older adults can be validated. Opponents of VR argue that the Nintendo Wii™ and other VR-based video gaming systems and technologies are not marketed toward the older adult population, assuming uncertainty and disinterest in the elderly. However, alternative ideas and findings suggest that in reality, the emerging “baby boomer” generation adapts to innovative technology increasingly more. While diminished ability to maintain static balance is often associated with an increased risk of falling, few studies have examined interactive dynamic balance exercises in older adults as an intervention to improve postural control and reduce the risk of falls. From all research studies reviewed, it is evident that more research on VR-based technology and its clinical implications and applications in rehabilitation is required.

In summary, the evidence laid out demonstrates that although some exercise interventions with balance and muscle strengthening components have been shown to reduce falls, it is not known which elements, or combination of elements, of exercise interventions are most effective for improving balance in older adults. Supporting the need for more future evidence-based research on VR-based gaming technology, Merians and colleagues (2006) emphasize the importance of having a large pool of poststroke rehabilitation interventions focused on improved function and strength in weakened limbs, “because the effects of a stroke are a leading cause of

physical disability” (p. 252). Their study indicated that the movements required in the performance of VR-simulated activities does carry over into real-life experiences, suggesting significant improvements in the preparation process patients receive before transitioning back into the community and home.

In this study, it was hypothesized that the use of interactive exergaming to improve physical activity and functional balance in older adults is a technology that can provide an appropriate interactive, challenging, and encouraging environment where a patient can repetitively practice tasks required through guided and rewarding systematic feedback. A recreation therapy intervention is presented in this study that provides opportunities for enjoyable physical activity through game play using an interactive simulated balance exercise gaming on the Nintendo Wii™, a home-based VR video gaming system. The results of this research identify the safety and effectiveness of utilizing the Nintendo Wii™ to promote the physical exercise adherence of older adults and maintain the highest level of independence while “aging in place”.

Conceptual Framework for Exergaming Balance Interventions

Gentile’s taxonomy of tasks, specifically functional balance, offers a framework for the implementation of VR-based video gaming technology in rehabilitation settings, as well as in physical activity programming for older adults. The taxonomy of tasks provides a theoretical foundation on how VR-based video games can promote key factors of functional improvement, such as motivation and immediate feedback, by providing the opportunity for involvement in activities that support feelings of competence, motivation, inner competitiveness, and enjoyment, as well as continued participation in activities. According to Deci and Ryan (2000), immediate, positive feedback provided during activity participation can ultimately lead to increased

competence and intrinsic motivation. The higher an individual's self-confidence, the more likely one is to continue to engage in routine physical activity. Rothman (2000) indicated that maintenance of exercise has been reported as being strongly related to satisfaction with activity.

Aging is associated with loss of perceived control, or self-efficacy. Evidence suggests that participation in physical activity improves self-efficacy or an individual's confidence in their own ability to perform a specific action or satisfy situation-specific demands (Bandura, 1994). A similar theoretical approach to examining the impact of fear of falling on physical activity restriction in aging adults is Bandura's theory of self-efficacy (Bandura, 1977). According to Bandura, people with a strong sense of self-efficacy develop a deeper interest in the activities in which they participate and also form a stronger sense of commitment to their interests and activities. People with low self-efficacy tend to avoid challenges, believe that difficult tasks are beyond their capability, and quickly lose confidence in their personal abilities (Bandura, 1994). The Activities-Specific Balance (ABC) Scale (Powell & Myers, 1995) assesses the confidence that one can engage in a wider range of ADLs and instrumental ADLs (IADLs) (Lachman et al., 1998). "The ABC uses the more standard self-efficacy assessment (Bandura, 1977), with a 0 (no confidence) to 100% (complete confidence) rating scale.

As Bandura and other researchers have demonstrated, self-efficacy can have an impact on everything from psychological states to behavior to motivation. Bandura believed that self-efficacy was a primary mechanism of exercise behavior change in older adults, influencing not only persistence when faced with challenges but also amount of effort and choice of activity (i.e. rowing versus gardening) (1992). He conceptualized a cyclical relationship between physical activity and self-efficacy, believing that involvement in an intervention targeting physical activity-related self-efficacy would improve an individual's overall self-efficacy, and in turn

create better adherence to regular physical activity (1994). This relationship has been found to be true across the lifespan, with a particularly strong relationship among older adults. Because exergaming can provide that immediate feedback and motivation for self-efficacy to participate, the need to further examine exergaming as a viable intervention for improving balance among older adults is warranted.

Conclusion

In summary, the evidence laid out demonstrates that although some exercise interventions with balance and muscle strengthening components have been shown to reduce falls, it is not known which elements, or combination of elements, of exercise interventions are most effective for improving balance in older adults. Supporting the need for more future evidence-based research on VR-based gaming technology, Merians, Poizner, Grigore, and Adamovich, (2006) emphasize the importance of having a large pool of poststroke rehabilitation interventions focused on improved function and strength in weakened limbs, “because the effects of a stroke are a leading cause of physical disability” (p. 252). Their study indicated that the movements required in the performance of VR-simulated activities does carry over into real-life experiences, suggesting significant improvements in the preparation process patients receive before transitioning back into the community and home.

It was hypothesized in this study, that the use of interactive exergaming to improve physical activity and functional balance in older adults can provide an appropriate interactive, challenging, and encouraging environment where a patient or participant can repetitively practice tasks required through guided and rewarding systematic feedback. A recreational therapy intervention was presented in this study that provided opportunities for enjoyable physical

activity through game play using an interactive simulated balance exercise gaming on the Nintendo Wii™ home-based VR video gaming system.

As an individual ages, decreases in levels of physical activity put older adults at a much higher risk for falls (Nevitt et al., 1989). Vellas and colleagues (1987) noted that 41% of fallers and 23% of non-fallers experienced activity restriction over a 6-month period. Statistics also indicate that approximately 46% of the older adult male population is more likely to die from a fall-related injury than the female population, suggesting the need for more strategies to increase male involvement in fall prevention programs (CDC, 2010). The Nintendo Wii™ exergaming group had the highest participation rate by males, when compared to the MOB and control groups.

This research is on the forefront of many more studies on virtual rehabilitation and gaming technology and its use with various populations as a means of creating increased enjoyment in exercise, thus motivation and adherence to regular physical activity. Older adults prefer to remain independent for as long as possible, creating a demand for novel technologies to assist with healthy active aging in place (Rantz, Skubic, Miller, & Krampe, 2008). The need for interactive, home-based interventions and exercise programs focused on improving overall endurance, strength, and flexibility and promote enjoyable, valued physical activity, is necessary to increase and maintain the healthy functioning and independence of our aging older adult population.

Extended Discussion

Results from this study were aimed at providing more evidence-based research on the use of a 2-dimensional, interactive video gaming intervention to promote an increase in levels of physical activity among community-dwelling older adults, with the overarching goal of reducing their risk of falls. The use of the Nintendo Wii™ in a variety of healthcare settings for clinical purposes is consistently increasing. This research study was specifically designed and implemented to support the field of Recreational Therapy and its efforts toward increasing efficacy research among the profession, specifically in the area of geriatric healthcare. Findings estimate that fear of falling can be reduced in community-dwelling older adults, through the participation in fall prevention education and physical activity group-based programs. Overall, this study suggests that exergames are feasible and acceptable to community-dwelling older adults and may represent a novel route in decreasing fall-risk factors in seniors.

Risk factors for disease morbidity and mortality increase as physical activity decreases (U.S. DHHS, 2006). Many older adults remain physically inactive even though research supports that regular physical activity can improve one's general well-being, muscle strength, overall endurance, functional balance, and the ability to effectively perform regular activities of daily living (ADLs) (Shephard, 1994).

According to the Centers for Disease Control and Prevention (CDC), physical inactivity is highest among individuals 65 years of age and older (CDC, 2010). By increasing physical activity among older adults in a community-based setting, the physical functioning, and function balance levels, while also reducing chronic disease-related symptoms of these individuals may advance, leading to improvements in the ability to maintain performance of ADLs, increased

independence and overall quality of life (QOL), as well as a decreased risk of experiencing falls and/or institutionalization (Yeom, Keller, & Fleury, 2009).

Variance in the range of baseline scores between the MOB, Nintendo Wii™, and control group participants could be attributed to several factors related socio-demographic variables such as gender, age, location of residence, and accessibility of the residential neighborhood or complex. Age, gender, and income level could have an effect on the ease of accessibility or the frequency of use of available community resources. According to Spiraduso and colleagues (2005), “Those now living are predominately Caucasian females, with approximately 50% of them living in their homes rather than institutions, most have very low incomes and 75% are native-born Americans” (p. 7-8). In a study of 890 community-dwelling elderly, the prevalence of fear of falling increased with age and was greater in women (Arfken, et al., 1994). “The aging rate is different in men and women” (Spiraduso et al., 2005). “The rate at which males age slows monotonically with time, whereas females age at a slower rate between 45 to 60 years of age than they do between 70 to 80 years of age” (p. 5).

As compared to individuals who lived in the independent living complexes, community-dwelling older adults may have higher physical or cognitive levels of function and in turn, be less affected by age-related declines in flexibility, balance and ROM (Holbein-Jenny et al., 2005). Results indicated that out of all three groups, the control group contained the largest amount of physically active older adults, with the Nintendo Wii™ participants making up the second most active group of participants. Substantially lower performance scores of participants in the MOB group on all balance assessments, compared to participant scores in the Nintendo Wii™ and control groups, may be partially due to the residents’ difficulty in performing and comprehending the tests, rather than truly poorer balance. Fear of falling while performing the

UG and MDRT may also contribute to underestimated balance capabilities of the MOB participants.

The Nintendo Wii has been proven beneficial to the older adult patient population as a means of increasing cognitive functioning, interpersonal interaction, and overall health-related QOL (Rosenberg et al., 2010). The results from this study support these findings and the implications for using the Nintendo Wii™ video gaming console with older adults to improve levels of regular physical activity. Participants from both experimental groups commonly verbalized expressions of positive and negative emotions, self-statements regarding skills and abilities, comments indicating healthy competition and support toward others, and self-statements regarding noticeable functional improvements throughout the entire eight-week study.

Limitations

The primary limitations of this study is that it was a small, nonrandomized controlled trial indicating that possible effects of social contact and expectancy bias cannot be excluded.

Additional limitations to this study include subject dropout, treatment adherence and levels of perceived enjoyment were not measured with an objective assessment tool, nor was the amount of energy expenditure associated with specific Nintendo Wii™ sports games used in this research study. Confusion demonstrated by participants in both treatment and control groups was also a limitation, as the balance-confidence scores in all groups decreased over time.

As with any research study conducted on human subjects, various individualized limitations may arise. The researcher agrees that the small sample size could have been a contributing factor to the data being skewed and generalizability of these results is limited due to the small sample size. It was anticipated that sample sizes for all three groups would be equitable at 15 for participation in this study. A larger study incorporating residents from

various independent living complexes and senior centers would improve the generalizability of these results, as the location and services provided at various facilities may create variance in the performance and attendance rates of participants.

Throughout the balance screening pre-testing procedure, several participants were not fully able to comprehend and respond accurately to the Activity-specific Balance (ABC) Scale secondary to the decreased ability to read or write. Visual deficits required several of the participant's surveys and self-assessments to be read aloud by the researcher. Other factors that could be attributed to the variance in testing scores include: taller/shorter height, gender, body weight, impaired cognition, motivation levels, medication side effects, and oxygen supplementation. One participant was unable to complete the final Nintendo Wii™ sports session and post-test balance screening secondary to being diagnosed with COPD during active participation in the eight-week study.

According to Holbein-Jenny and colleagues (2005), there is limited research available on the reliability and validity on the use of the ABC scale and MDRT with community-dwelling older adults. Throughout this research study, the administration of the ABC scale to this population proved to be challenging. Many of the older adults in the MOB intervention group were more inactive than participants from the Nintendo Wii™ and control group population, and often indicated several tasks on the ABC scale that they never performed, such as getting onto or off of an escalator or walking outside on icy surfaces. This created difficulty for them being able to accurately rate their levels of confidence on specific tasks. According to Powell and Meyers (1995), the ABC scale has demonstrated high retest reliability with its use in various studies related to falls and balance in community-dwelling older adults (Myers et al., 1998; Lajoie & Gallagher, 2004; Whitney et al., 1999; Myers et al., 1996).

Implications for Practice

The results of this research support the similar effectiveness of utilizing the Nintendo Wii™ to promote participation of routine physical activity in community-dwelling older adults as other group-based fall prevention programs. Future subsequent studies and evidence-based research should be aimed at utilizing more specific, standardized assessment tools that are in better alignment with the aims of the study. Other recommendations to improve generalizability include studying a larger sample size, which would then allow for the investigation of specific age or gender-related differences on balance performance and fall-efficacy in this population, and also utilizing more structured methods to gather and analyze qualitative data. Additional time required for warm-up and cool-down stretching should be incorporated into every intervention session and adequate time allotted for various rates and levels of functioning.

Future studies incorporating the use of the Nintendo Wii™ with the older adult population are recommended to increase the rate of gaming sessions to twice a week, as well as create a structured gaming intervention protocol to increase standardization and efficacy. Establishing evidence of the overall physical and social benefits of playing the Nintendo Wii™ could have a broad impact on the older adult population that correlates to higher levels of balance-confidence and enjoyment in physical activity adherence levels and overall health-related QOL. Subsequent research should consider developing or utilizing a more standardized assessment tool for measuring levels of enjoyment and should also be applied across all groups measured within the total sample population. Additionally, the implementation of a thorough cognitive screening of all participants and utilization of an alternative fall-efficacy measure, or the short-version of the ABC scale, the ABC-6 scale, are other recommendations.

According to Frick and colleagues, “Future studies can focus on whether there are other opportunities for synergistic efforts of multiple interventions that can be combined” (2010, p. 140). The incorporation of measuring attendance rates in organized community programs that combine leisure and physical activity in similar studies, may aid in increasing the development of novel exercise-promotion programs for community-dwelling older adults.

Conclusion

In summary, the evidence laid out demonstrates that although some exercise interventions with balance and muscle strengthening components have been shown to reduce falls, it is not known which elements, or combination of elements, of exercise interventions are most effective for improving balance in older adults. Supporting the need for more future evidence-based research on VR-based gaming technology, Merians and colleagues (2006) emphasize the importance of having a large pool of poststroke rehabilitation interventions focused on improved function and strength in weakened limbs, “because the effects of a stroke are a leading cause of physical disability” (p. 252). Their study indicated that the movements required in the performance of VR-simulated activities does carry over into real-life experiences, suggesting significant improvements in the preparation process patients receive before transitioning back into the community and home. It was hypothesized that the use of interactive exergaming to improve physical activity and functional balance in older adults, is that this technology can provide an appropriate interactive, challenging, and encouraging environment where a patient can repetitively practice tasks required through guided and rewarding systematic feedback. A recreational therapy intervention is presented that provides opportunities for enjoyable physical activity through game play using an interactive simulated balance exercise gaming on the Nintendo Wii™, a home-based VR video gaming system.

As an individual ages, decreases in levels of physical activity put older adults at a much higher risk for falls. Statistics also show that approximately 46% of the older adult male population is more likely to die from a fall-related injury than the female population, suggesting the need for more strategies to increase male involvement in fall prevention programs (CDC, 2010). This research is on the forefront of many more studies on virtual rehabilitation and gaming technology and its use with various populations as a means of creating increased enjoyment in exercise, thus motivation and adherence to regular physical activity. Older adults prefer to remain independent for as long as possible, creating a demand for novel technologies to assist with healthy active aging in place (Rantz et al., 2008). The need for interactive, home-based interventions and exercise programs focused on improving overall endurance, strength, and flexibility and promote enjoyable, valued physical activity, is necessary to increase and maintain the healthy functioning and independence of our aging older adult population.

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APPENDIX A: ECU UMCIRB APPROVAL FORM



EAST CAROLINA UNIVERSITY

University & Medical Center Institutional Review Board Office
1L-09 Brody Medical Sciences Building • 600 Moye Boulevard • Greenville, NC 27834
Office 252-744-2914 • Fax 252-744-2284 • www.ecu.edu/irb

TO: Whitney Sauter, Graduate Student, 1680 Wimbledon Dr. Apt. 9, Greenville, NC 27858

FROM: UMCIRB *WCK*

DATE: July 7, 2011

RE: Expedited Category Research Study

TITLE: "A Comparison of Wii™ Exergaming and Matter of Balance on Aspects of Balance and Activity Adherence in Older Adults"

UMCIRB #11-0435

This research study has undergone review and approval using expedited review on 7.5.11. This research study is eligible for review under an expedited category number 7 Which includes research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies. (NOTE: Some research in this category may be exempt from the HHS regulations for the protection of human subjects. 45 CFR 46.101(b)(2) and (b)(3). This listing refers only to research that is not exempt.)

The Chairperson (or designee) deemed this **unfunded** study **no more than minimal risk** requiring a continuing review in **12 months**. Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The investigator must adhere to all reporting requirements for this study.

The above referenced research study has been given approval for the period of **7.5.11 to 7.4.12**. The approval includes the following items:

- Internal Processing Form (dated 6.27.11)
- Informed Consent (dated 6.30.11)
- Letter of Support (dated 6.31.11)
- Newsletter
- Physician Information Form Folstein Mini-Mental State Examination
- Participant Interest Survey
- Experience Questionnaire
- Test 3: ABC Scale
- MDRT
- 8-Foot UG Test
- PAR-Q and You

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

The UMCIRB applies 45 CFR 46, Subparts A-D, to all research reviewed by the UMCIRB regardless of the funding source. 21 CFR 50 and 21 CFR 56 are applied to all research studies under the Food and Drug Administration regulation. The UMCIRB follows applicable International Conference on Harmonisation Good Clinical Practice guidelines.

IRB00000705 East Carolina U IRB #1 (Biomedical) IORG0000418
IRB00003781 East Carolina U IRB #2 (Behavioral/SS) IORG0000418
IRB00004973 East Carolina U IRB #4 (Behavioral/SS Summer) IORG0000418
Version 3-5-07

UMCIRB #11-0435
Page 1 of 1

APPENDIX B: LETTER OF SUPPORT



Pitt County Council on Aging, Inc.
CENTER FOR ACTIVE AGING

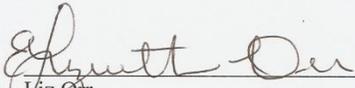
DIANE SKALKO
EXECUTIVE DIRECTOR

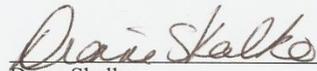
FRANK CASSIANO
CHAIRMAN, BOARD OF DIRECTORS

4551 County Home Road
Greenville, NC 27858
Telephone: 252.752.1717
Fax: 252.752.9365

May 31, 2011

I understand that Whitney Sauter will be conducting research with the Pitt County Council on Aging as part of thesis requirements at East Carolina University. The research will take place at one or more of the six senior centers operated by Pitt County Council on Aging. The purpose of this research is to compare the effects of a videogame-based exercise training program, using the Nintendo Wii™, on overall balance, confidence in engaging in physical activity, and perceived enjoyment levels with the effects of an evidence based program, Matter of Balance, with older adults living in the community. Participation of the study will consist of either participating in the exercise training program, using the Nintendo Wii™, or attending the Matter of Balance training program. The Nintendo Wii™ training program will be conducted by Whitney Sauter and will involve one hour group sessions of playing a video sports game, once a week. Each group will consist of four participants per group. Participants will be assessed using two different balance assessments, one general interest assessment, and a perceived confidence scale. I understand that this study is planned to take place over a six week period.


Liz Orr
Program Coordinator


Diane Skalko
Executive Director



SENIOR CENTER OF EXCELLENCE



APPENDIX C: INITIAL INTEREST QUESTIONNAIRE

Nintendo Wii™ Participant Interest Survey

Today's Date: ____/____/____

Your Name: _____

The following questions will provide us with background information.

1. What is your date of birth? ____/____/____
2. Are you: Female Male
3. Do you have a fear of falling? Yes No
4. Have you ever played the Nintendo Wii™? Yes No
5. Have you ever attended A Matter of Balance fall prevention education class?
 Yes No
6. What is your race? (Mark all that apply):
 American Indian or Alaska Native
 Asian or Asian-American
 Black or African-American
 Hawaiian Native or Pacific Islander
 White or Caucasian
 Other
7. Please rank the following sports in order of interest in participation, with one as your first preference and five, as your last choice:

__ Golf __ Tennis __ Bowling __ Baseball __ Boxing

Please mark the circle that tells us how sure you are that you can do the following activities.

How sure are you that...

	Very	Sure	Somewhat	Not at all
1. It will be easy for you to use the Wii™	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. Using the Wii™ can increase your physical activity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. Using the Wii™ will improve your balance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. Using the Wii™ will improve your overall health	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. Using the Wii™ will help you spend more time with friends/family	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. You can become more fit using the Wii™	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. You will enjoy exercise using the Wii™	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Mark **ONLY ONE CIRCLE** to tell us how much you are walking or exercising now.

I do not exercise or walk regularly now, and I do not intend to start.

I do not exercise or walk regularly, but I have been thinking of starting.

I am trying to start to exercise or walk.

I have exercised or walked infrequently for over a month.

I am doing moderate exercise less than 3 times per week.

I have been doing moderate exercise 3 or more times per week.

APPENDIX D: MOB FIRST SESSION SURVEY



A MATTER OF
BALANCE

MANAGING CONCERNS ABOUT FALLS



Lesley Richmond
Older Adult Specialist
2250 Perimeter Park Drive,
Suite 120
Morrisville, NC 27560
Phone (919) 287-7006
Fax (919) 287-7001

First Session Survey

Training Location:

Today's Date: ____/____/____

Your Name: _____

The following questions will provide us with background information.

8. What is your date of birth? ____/____/____
9. What is your zip code? _____
10. Today, how many people live in your household (including yourself)? _____
11. Are you: Female Male
12. Are you of Hispanic, Latino, or Spanish origin? Yes No Unknown
13. What is your race? (Mark all that apply):
 - American Indian or Alaska Native
 - Asian or Asian-American
 - Black or African-American
 - Hawaiian Native or Pacific Islander
 - White or Caucasian
 - Other

Please turn this paper over and fill out the other side.

A Matter of Balance Volunteer Lay Leader Model, Maine Health's Partnership for Healthy Aging. Used and adapted by permission of Boston University.

Please mark the circle that tells us how sure you are that you can do the following activities.

How sure are you that:	Very sure	Sure	Somewhat sure	Not at all sure
8. I can find a way to get up if I fall	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. I can find a way to reduce falls	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. I can protect myself if I fall	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. I can increase my physical strength	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12. I can become more steady on my feet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

During the last 4 weeks, to what extent has your concern about falling interfered with your normal social activities with family, friends, neighbors, or groups?

Extremely Quite a bit Moderately Slightly Not at all

Mark ONLY ONE CIRCLE to tell us how much you are walking or exercising now.

I do not exercise or walk regularly now, and I do not intend to start.

I do not exercise or walk regularly, but I have been thinking of starting.

I am trying to start to exercise or walk.

I have exercised or walked infrequently for over a month.

I am doing moderate exercise less than 3 times per week.

I have been doing moderate exercise 3 or more times per week.

APPENDIX E: PHYSICAL ACTIVITY READINESS QUESTIONNAIRE (PAR-Q AND YOU)

PHYSICAL ACTIVITY READINESS QUESTIONNAIRE (PAR-Q AND YOU)

(This is a self-evaluation. Please keep for your records.)

Introduction: Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming more physically active. If you are planning to become much more physically active than you are now, start by answering the seven questions below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not accustomed to being very active, check with your doctor.

Directions: Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly, check YES or NO.

YES NO

- | | | |
|--------------------------|--------------------------|---|
| <input type="checkbox"/> | <input type="checkbox"/> | 1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor? |
| <input type="checkbox"/> | <input type="checkbox"/> | 2. Do you feel pain in your chest when you do physical activity? |
| <input type="checkbox"/> | <input type="checkbox"/> | 3. In the past month, have you had chest pain when you were not doing physical activity? |
| <input type="checkbox"/> | <input type="checkbox"/> | 4. Do you lose your balance because of dizziness or do you ever lose consciousness? |
| <input type="checkbox"/> | <input type="checkbox"/> | 5. Do you have a bone or joint problem (for example, arthritis, osteoporosis, etc.) that could be made worse by a change in your physical activity? |
| <input type="checkbox"/> | <input type="checkbox"/> | 6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition? |
| <input type="checkbox"/> | <input type="checkbox"/> | 7. Do you know of any other reason why you should not do physical activity? |
| <input type="checkbox"/> | <input type="checkbox"/> | 8. Do you currently use a cardiac pacemaker or any other implanted medical device? |
| <input type="checkbox"/> | <input type="checkbox"/> | 9. Have you ever experienced a seizure or other symptom associated with an epileptic condition? |

If you answered YES to one or more questions - Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want - as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those that are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

If you answered NO to all PAR-Q questions, you can be reasonably sure that you can:

- Start becoming much more physically active-begin slowly and build up gradually. This is the safest and easiest way to go.
- Take part in a fitness appraisal-this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively.

Delay becoming much more active:

- If you are not feeling well because of a temporary illness such as a cold or a fever-wait until you feel better.

Please note: If your health changes so that you then answer YES to any of the questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

**Adapted from the 1994-revised version on the Physical Activity Readiness Questionnaire (PAR-Q and YOU). The PAR-Q and YOU is a copyrighted, pre-exercise screen owned by the Canadian Society of Exercise Physiology.

APPENDIX F: PHYSICIAN INFORMATION FORM

Physician Information Form

To: [PHYSICIAN'S NAME}

From:

Date:

RE: [PARTICIPANT'S NAME]

Your patient, _____, a client at the Pitt County Senior Center (location at Pitt County Council on Aging off of County Home Road), has the opportunity to participate in a strengthening exercise program starting in July 2011. The program has been approved by East Carolina University's Institutional Review Board. The patient, _____, has given voluntary consent to participate in the program and has also given us permission to contact you regarding the inclusion of this person in the program.

The main objective of the program is to provide participants with an opportunity for physical activity and expression. Research on the effects of the activity components of video game-based exercise have demonstrated positive outcomes for senior in the following areas: improved balance, postural stability, fall prevention, cardiovascular enhancement, reduced pain, stress, and anxiety, improved fall efficacy, enjoyment and other improvements in quality of life indicators. We expect that this program will provide physical and cognitive benefits, improved affect, increased physical activity within the environment, and a more active overall lifestyle.

Before we include your patient in the program, we want to know if there are any limitations that would preclude the person from participating either fully or partially in the program. If there are any limitations that require accommodation during the program, please list them below. Such limitations could include, but are not limited to, anyone who has experienced a seizure or other symptom associated with an epileptic condition. The Nintendo Wii™ console and Wii™ remote can emit radio waves that interfere with the normal operation of nearby electronics. If your patient has a cardiac pacemaker or other implanted medical device, they are not recommended for participation in this study. If your patient has a medical history of chronic muscle or joint pain or decreased endurance levels, (patient must be able to tolerate 30 to 60 minutes of low-intensity physical activity while sitting or standing), please note below. Also list any assistive devices your patient uses, or may use as needed, for physical mobility. Please sign the form in the space provided.

Thank you for your time.

Patient Limitations:

Signature

Date

APPENDIX G: EXPERIENCE QUESTIONNAIRE

Experience Questionnaire

Test 5: Perceived Usefulness and Enjoyment Post-test Questionnaire**:

Administration: This questionnaire can be self-administered or researcher-administered via personal interview as needed, secondary to visual impairments. An enlarged version of the assessment tool and rating scale should be utilized for self-administration.

Instructions to Participants: These statements relate to the thoughts and feelings you may experience during the program you have just completed. There are no correct or incorrect answers, just answer each question as carefully and accurately as possible by placing a check in the appropriate box.

Think about how you felt during this program and complete the questionnaire using the form below by checking ONE box for each item:

Not at all Slightly Somewhat Very Much

While playing the Nintendo Wii™ sports program:

1. My skills were matched with the challenge.				
2. I felt proud of myself.				
3. The activity had my full attention while engaged.				
4. At times, I was bored during the activity.				
5. I had fun and enjoyed the activity.				
6. I felt challenged during activity participation.				
7. I felt anxious or nervous during participation.				

Check **ALL** that apply:

Perceived Ease of Use:

- Learning to use the Wii™ was easy for me.
- Using the Wii™ did **not** require a lot of my mental effort.
- Using the Wii™ did **not** require a lot of my physical energy.
- Learning to use the Wii™ was **not** easy for me.

Perceived Health Value:

Using the Nintendo Wii™ helps me to:

- avoid tension
- stay healthy longer
- enjoy life more
- stay physically fit
- spend more time with my family/friends

Perceived Usefulness:

Using the Nintendo Wii™:

- Would improve my overall health.
- Would increase my overall participation in regular physical activity.
- Would improve my social interaction.
- Is a good entertainment option.

Perceived Affective Responses:

When interacting with the Nintendo Wii™, I feel:

- excited
- happy
- energized
- eager to play
- nervous
- challenged

APPENDIX H: MOB LAST SESSION SURVEY



A MATTER OF BALANCE

MANAGING CONCERNS ABOUT FALLS



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Phone (919) 287-7006
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Last Session Survey

Training Location: _____

Today's Date: ____/____/____

Your Name: _____

Please mark the circle that tells us how sure you are that you can do the following activities.

How sure are you that:	Very sure	Sure	Somewhat	Not at all sure
13. I can find a way to get up if I fall	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14. I can find a way to reduce falls	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15. I can protect myself if I fall	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16. I can increase my physical strength	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17. I can become more steady on my feet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

During the last 4 weeks, to what extent has your concern about falling interfered with your normal social activities with family, friends, neighbors or groups?

Extremely Quite a bit Moderately Slightly Not at all

Mark ONLY ONE CIRCLE to tell us how much you are walking or exercising now.

I do not exercise or walk regularly now, and I do not intend to start.

I do not exercise or walk regularly, but I have been thinking of starting.

I am trying to start to exercise or walk.

I have exercised or walked infrequently for over a month.

I am doing moderate exercise less than 3 times per week.

I have been doing moderate exercise 3 or more times per week.

APPENDIX I: UG ASSESSMENT TOOL

8-Foot Up-and-Go (UG) Test:

Test 1: 8-Foot Up-and-Go (UG):**

1. Equipment: standard folding chair with 17-in. (43.18-cm) seat height, tape measure, tape, small orange cone, stopwatch.
2. Position chair securely with back against the wall facing a cone marker exactly 8 feet (2.44 meters) away. Place tape measure against front edge of the chair and mark 8-foot line with tape, then place a small orange cone centered inside the tape marker.
3. Procedure: Instruct the participant to sit with torso slightly leaning forwards toward edge of the chair with back straight, hands on thighs, and their feet flat on the floor, positioned either shoulder width apart or one foot slightly in front the other. On the word “go”, the participant gets up from the chair, walks as quickly as possible around either side of the cone, and sits back down in the chair. Be sure to start the stopwatch timer on the word “go” whether or not the participant has started to move and stop the timer at the exact instant the participant sits back down on the chair.
4. After the researcher provides one demonstration of the proper form and desired pace of the test, allow the participant to have one practice trial and then administer two timed test trials. Record both times to the nearest tenth of a second and circle the fastest time.
5. While administering the UG, stand on side between the chair and cone to assist participants in case they lose their balance. With the frail older adult, watch that he or she stands up and sits down safely.
6. The participant wears their regular footwear, and if needed may use any assistive device that they would normally use during ambulation, but may not be assisted by another person. If individual uses assistive device to complete test, scores should not be compared to norms and type of device used should be noted in the comment section of scorecard.
7. It is also recommended to measure participant’s height and weight in order to determine their body mass index (BMI). For weight on a standard scale with shoes on, subtract 1-2 lbs. using best judgment.
8. Results correlate with gait speed, dynamic balance, agility, and functional status of older adults. Performance on the up-and-go (UG) test have also been found to discriminate between various functional categories in older adults across age groups and is responsive to changes over time as a result of increased levels of physical activity (Podsiadlo & Richardson, 1991; Rikli & Jones, 2001).

9. Interpretation: Results obtained with this test may be compared to age-related normative values listed in the Senior Fitness Test manual (Rikli & Jones, 2001). Normal range of scores is defined as the middle 50 percent of each age group. Scores above the range would be considered “above average” for the age group and those below the range would be considered “below average”. According the Senior Fitness Test by Rikli and Jones (2001), a score of more than 8.5 seconds is associated with high fall-risk in community-dwelling older adults.

Normal Range of Scores for 8-foot Up-and-Go Test

	FEMALES	MALES
AGE GROUPS		
60-64	6.0-4.4	5.6-3.8
65-69	6.4-4.8	5.9-4.3
70-74	7.1-4.9	6.2-4.4
75-79	7.4-5.2	7.2-4.6
80-84	8.7-5.7	7.6-5.2
85-89	9.6-6.2	8.9-5.5
90-94	11.5-7.3	10.0-6.2

*Podsiadlo D, Richardson S. *The Timed "Up and Go": A Test of Basic Functional Mobility for Frail Elderly Persons*. Journal of the American Geriatrics Society 1991; 39(2): 142-148

**Rikli RE, Jones CJ. *Senior Fitness Test Manual*. Champaign, IL: Human Kinetics 2001. Refer to www.humankinetics.com for purchasing information

APPENDIX J: MDRT ASSESSMENT TOOL

Multi-Directional Reach Test (MDRT)

Test 2: Multi-Directional Reach Test (MDRT)**:

1. Equipment: yardstick, tape to secure yardstick.
2. Securely position a fixed yardstick on the wall, using tape, at the level of the participants' acromion process and horizontal to the floor.
3. Procedure: Instruct participant to stand with feet shoulder width apart and raise arm to shoulder height (90 degrees) parallel to floor with palm facing medially for initial reading. The participant is then instructed to reach as far forward (forward reach), backward (backward reach), left (lateral reach left) and right (lateral reach right) as possible for two trials in each direction, along the yardstick without making contact with the wall or yardstick and without taking a step or raising the feet from floor. Location of the tip of the middle finger is recorded in inches at the starting and ending positions of each trial and the "trial distance" (in inches) is obtained by determining the difference between the two position numbers.
4. Participants are given one practice trial to ensure comprehension of instructions followed by three recorded test trials. The average of all three test trials is recorded as the "total distance reached" for each direction.
5. If feet were moved during any trial then that trial was discarded. Start and stop of index finger was recorded and difference was the total reach for that direction. Participants could use whatever arm they choose but had to stay consistent throughout the test.

*Newton, R. Validity of the Multi-Directional Reach test: A Practical Measure for Limits of Stability in Older Adults. *Journal of Gerontology* 2001; 56A (4): M248-M252.

**<http://podiatry.temple.edu/gaitlab/facilities/mdrt.html>

APPENDIX K: ABC SCALE

Activities-specific Balance Confidence Scale (ABC Scale)

Test 3: Activities-specific Balance Confidence (ABC) Scale**:

Administration: This questionnaire can be self-administered or researcher-administered via personal interview as needed, secondary to visual impairments. An enlarged version of the assessment tool and rating scale should be utilized for self-administration.

Instructions to Participants: For each of the following, please indicate your level of confidence in doing the activity without losing your balance or becoming unsteady from choosing one of the percentage points on the scale from 0% to 100%.

If you do not currently do the activity in question, try and imagine how confident you would be if you had to do the activity. If you normally use a walking aid to do the activity or hold onto someone, rate your confidence as it you were using these supports. If you have any questions about answering any of these items, please ask the administrator.

For each of the following activities, please indicate your level of self-confidence by choosing a corresponding number from the following rating scale:

0% 10 20 30 40 50 60 70 80 90 100%
no confidence **completely confident**

“How confident are you that you will not lose your balance or become unsteady when you...

1. ...walk around the house? ____%
2. ...walk up or down stairs? ____%
3. ...bend over and pick up a slipper from the front of a closet floor ____%
4. ...reach for a small can off a shelf at eye level? ____%
5. ...stand on your tiptoes and reach for something above your head? ____%
6. ...stand on a chair and reach for something? ____%
7. ...sweep the floor? ____%
8. ...walk outside the house to a car parked in the driveway? ____%
9. ...get into or out of a car? ____%
10. ...walk across a parking lot to the mall? ____%
11. ...walk up or down a ramp? ____%
12. ...walk in a crowded mall where people rapidly walk past you? ____%
13. ...are bumped into by people as you walk through the mall? ____%
14. ... step onto or off an escalator while you are holding onto a railing? ____%
15. ... step onto or off an escalator while holding onto packages such that you cannot hold onto the railing? ____%
16. ...walk outside on icy sidewalks? ____%

Instructions for Scoring: The ABC is an 11-point scale and ratings should consist of whole numbers (0-100) for each item. A sum total of all the ratings (possible range 0 to 1600) is calculated and then divided by the total number of test items (16) to determine the participant's ABC score. NOTE: if a participant qualifies his/her response to items #2, #9, #11, #14 or #15 (different ratings for "up" versus "down" or "onto" versus "off"), solicit separate ratings and use the lowest confidence of the two (as this will limit the entire activity, for instance the likelihood of using the stairs or an escalator).

Interpretation:

80% = high level of physical functioning

50% - 80% = moderate level of physical functioning

< 50% = low level of physical functioning (Myers, 1998)

< 67% = older adults at risk for falling; predictive of future fall (LaJoie, 2004)

*Powell, LE & Myers AM. The Activities-specific Balance Confidence (ABC) Scale. *J Gerontol Med Sci* 1995; 50(1): M28-34

*Myers AM, Fletcher PC, Myers AN, Sherk W. Discriminative and evaluative properties of the ABC scale. *J Gerontol A Biol Sci Med Sci.* 1998; 53: M287-294

*LaJoie Y, Gallagher SP. Predicting falls within the elderly community: Comparison of postural sway, reaction time, the Berg balance scale, and ABC scale for comparing fallers and non-fallers. *Arch Gerontol Geriatr.* 2004; 38: 11-26

**http://www.pacificbalancecenter.com/forms/abc_scale.pdf