EFFECTIVENESS OF THE NINTENDO® WII FIT™ GAMES ON THE BALANCE OF A COMMUNITY-DWELLING OLDER ADULT IN EASTERN NORTH CAROLINA

By

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June 2011

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Abstract

The aim of this study was to determine if the Nintendo® Wii Fit™ was an effective and motivating modality for fall prevention with an older adult who has MG and lives in Eastern North Carolina. With the increasing number of older adults, it is imperative for occupational therapists to address balance and fall-prevention. The Nintendo® Wii Fit™ is currently being implemented in occupational and physical therapy; however, there is limited research. There is limited research on this topic, as this is an innovative approach to balance rehabilitation. The current study aimed to provide additional evidence regarding the use of the Wii Fit™ to improve balance. The single-subject study selected an active community-dwelling older adult with Myasthenia Gravis for participation. The study consisted of three phases: phase one combined the Wii Fit™ balance games with walking outside, phase two consisted of the balance and stepping games on the Wii Fit™ only, and phase three consisted of walking only.

Motivation was measured with a Likert-scale and self-perception of occupational performance was measured through the Canadian Occupational Performance Measure (COPM). The Four Square Step Test (FSST) and Timed Get Up and Go Test (TGUG) were used to assess

the participant's balance, and risk for falling; the Survey of Activities and Fear of Falling in the Elderly (SAFE) determined the participant's fear of falling and activity restriction.

After the course of the study, the participant's balance scores, as measured by the FSST and TGUG, were analyzed to determine any change. There was a significant negative correlation between the participant's FSST score and each phase ($p=0.048$; $r=-0.712$); however, there was not a significant negative correlation between the participant's score on the TGUG and each phase ($p=0.107$; $r=-0.488$). These test scores indicate an improvement in dynamic balance and functional mobility. The participant reported the highest COPM and motivation scores for phase 3, walking outside only, indicating that he was not as motivated to complete the activities on the Wii Fit™. There was also a decrease in the participant's fear of falling score on the SAFE. The current study provides supporting evidence on the effectiveness of the Wii Fit™ for improving balance and reducing a risk for falling; however, the study exemplifies the need for additional research.

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A Thesis

Presented To

The Faculty of the Department of Occupational Therapy

East Carolina University

In Partial Fulfillment of the Requirements for the Degree

Masters of Science in Occupational Therapy

By

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July, 2011

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ACKNOWLEDGEMENTS:

The support from my family, friends, and academic professionals helped me to maintain focus and provided me with the encouragement to continue, especially during the difficult and overwhelming times of this thesis.

First, I would like to thank my thesis advisor, Dr. Jane Painter, for providing me with encouragement, feedback, and support throughout my thesis; with her guidance, I was able to develop a feasible study design and identify pertinent information to include in my thesis. Dr. Painter's guidance and professional expertise inspired me to expand my knowledge of fall prevention and the importance of this topic related to older adults. I would also like to acknowledge my thesis committee members, Dr. Leonard Trujillo and Dr. Carol Lust, for their patience and guidance to further develop my thesis. Additionally, Dr. Andrada Ivanescu was especially helpful during the data analysis and selection and interpretation of statistical analyses. Without the cooperation and flexibility of my research participant, this process would not have been possible. He remained motivated throughout the research study, and expressed a genuine interest and excitement about the Wii Fit™.

I cannot begin to express my gratitude for the support of my family throughout my thesis and study of occupational therapy. Through the inspiration, support, and encouragement from my loving family, I have been able to maintain a positive attitude, even during difficult times. It was an honor to return the love and support from my family to assist my grandmother after she sustained a fracture from falling; through this difficult experience, I was able to understand the serious implications of falling and the need to develop effective balance programs for older adults.

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LIST OF ABBREVIATIONS

TGUG: Timed Get Up and Go

SAFE: Survey and Activities of Fear of Falling in the Elderly

SAFER: The Safety Assessment of Function and the Environment for Rehabilitation Tool

FSST: Four Square Step Test

MMSE: Mini-Mental State Examination

FROP-Com: Fall Risk Assessment for Older People in the Community

COPM: Canadian Occupational Performance Measure

MG: Myasthenia Gravis

CHAPTER 1: INTRODUCTION

The risk of falling is a major concern for adults aged 65 and older. Studies suggest that 25-35 percent of adults aged 65 and older who live in communities fall at least once annually (Boulgarides, McGinty, Willet, & Barnes 2003; Centers for Disease Control [CDC], 2009; Chang & Ganz, 2007; Dite, GradDip & Temple, 2002; Perell, et al., 2001; Yoshida, 2007; World Health Organization Global Report on Falls Prevention in Older Age [WHOGRFPOA], 2007). There is evidence, however, that up to 60% of community-dwelling older adults fall annually (Rubenstein, & Josephson, 2002). The variation in these statistics is likely due to the fact that a number a falls go undetected (Chang & Ganz, 2007). Fall-related injuries have increased by 131% in the past 30 years and is predicted to increase by 100% by the year 2030 (WHOGRFPOA, 2007). These statistics are a significant concern for society because individuals aged 60 and older currently represent the fastest growing population worldwide and, by the year 2050, it is projected that there will be two billion people over the age of 60 (WHOGRFPOA, 2007). Thus, it is important for occupational therapists and other health care professional to addresses this issue now, to help reduce future injuries and fatalities from falls that could have been prevented.

CHAPTER 2: LITERATURE REVIEW

Definitions of a fall

Though there is not a universally-accepted definition of a fall (Yoshida, 2007), various suitable definitions have been established. The most precise definition of a fall is: "an event which results in a person coming to rest inadvertently on the ground or floor or other lower level" (World Health Organization, 2010). A more comprehensive definition of a fall is: "an unplanned descent to the floor (or extension of the floor, e.g. trash can or other equipment) with or without injury. All types of falls are included whether they result from psychological reasons or environmental reasons" (American Nurses Association, 2005, p. 26., as cited in Currie, n.d.). A third definition of a fall is: "inadvertently coming to rest on the ground, floor or other lower level, excluding intentional change in position to rest in furniture, wall, or other objects" (WHOGRFPOA, 2007, p. 1).

Physical Ramifications of falling

Approximately 20-30% of falls in older adults cause injury (WHOGRFPOA, 2007), and 5-11% of falls cause a serious injury, such as a fracture or head injury, that requires hospitalization (Chang & Ganz, 2007; Dite & Temple, 2002; Perell, et al., 2001; Josephson & Rubenstein, 2002; WHOGRFPOA, 2007). The majority of traumatic brain injuries in older adults occur because of a fall (CDC, 2009). Ninety percent of hip fractures occur in individuals over the age of 70 and are typically caused by a fall (Nazarko, 2008). Twenty-to-forty percent of individuals 65 and older have a detectable gait abnormality as a result from falling (Chang & Ganz, 2007). The average cost of hospitalization and other medical services from a fall is approximately $17,483 in the USA; however, a fall can cost as much as $40,000 from lost wages and reduced productivity of caregivers (WHOGRFPOA, 2007).

Fall-related injuries are the leading cause of death in adults over the age of 65 (Goldman et al., 2001; Hausdorff, 2001; Hornbrook, et. al., 1994; Lauritzen, 1996; Office of Statistics and Programming, 2005, as cited in Currie, 2006), and one in five fatal falls occur in nursing home residents who are 85 years and older (Josephson & Rubenstein, 2002). Thirty-to-fifty percent of individuals who live in a long-term care institution fall each year, with approximately 40% experiencing recurrent falls (WHOGRFPOA, 2007). Approximately 75-85% of fall-related deaths occur in adults 65 years and older (CDC, 2009; Nazarko, 2008; Josephson & Rubenstein, 2002). An older adult dies every five hours as a result of fall-related injuries (Nazarko, 2008), and for every 100 falls in adults 65 and older, approximately two result in death (Dite, et.al. 2002). A person's risk of experiencing a fatal fall increases with age, and individuals 85 years of age and older are at the highest risk (WHOGRFPOA, 2007).

Psychological Ramifications of Falling: Fear of Falling

In addition to the physical ramifications, there can also be detrimental psychological ramifications from falling that can limit a person's independence and increase his or her risk of experiencing additional falls. The most serious psychological ramification from falling is a psychological condition known as fear of falling, which is defined as "a lasting concern about falling that can lead an individual to avoid activities that he/she remains capable of performing." (Bandinelli, Deshpande, Ferrucci, Lauretani, Metter, and Windham, 2008, pg. 1). Furthermore, a person may be concerned that he or she will sustain a fall-related injury, be subjected to social embarrassment from falling, lose their independence, and/or have to move from their home after falling (WHOGRFPOA, 2007). Fear of falling has been identified in 55-to-60% of community-dwelling older adults (Brouwer, et al., 2003; Deschpande, et al., 2008), and tends to be higher in women, frail individuals, and older adults who have previously fallen (Deschpande, et al., 2008;

Vellas, Wayne, Romero, Baumgartner & Garry, 1997). Approximately 31-to-48% of older adults who have experienced a fall develop a fear of falling (Dite, et al, 2002; Perell, et al., 2001). However, an individual can develop a fear of falling even if he or she has never fallen (Deshpande, et al., 2008).

Fear of falling can cause an individual to use increased caution while participating in an activity. Fear of falling can also lead to activity restriction, which can result in a decrease in self-esteem, confidence, strength and balance, which increases the individual's risk of falling (Deschpande, et al., 2008; WHOGRFPOA, 2007). Individuals who have a fear of falling tend to be more anxious, depressed, and have less social support than those who do not have a fear of falling (Deschpande, et al., 2008); this may be caused because of activity restriction for a fear that a person may fall during a social activity (WHOGRFPOA, 2007).

A fear of falling can cause a decrease in mobility or reduce a person's ability to control balance, which increases one's risk of falling (Brouwer, Walker, Rydahl & Culham, 2003; Deshpande et al., 2008; WHOGRFPOA, 2007). Individuals who have a fear of falling lack confidence in preventing or managing falls, which also increases the person's risk of falling (WHOGRFPOA, 2007). Risk factors contributing to developing a fear of falling include: social isolation and depression, knowing an individual who has fallen, an individual's fall history (Brouwer et al., 2003) and an increase in age (Deschpande, et al., 2008). Fear of falling can be significantly reduced for older adults who participate in educational programs, which include discussions about falling, identification of risk factors and resources with additional information about topics discussed in the seminar (Brouwer, et al., 2003). If not addressed through therapy or education, fear of falling can become a long-lasting condition (Vellas, et al., 1997), thus it is important to engage older adults in educational programs to reduce this fear of falling, thus improving their quality of life.

Risk Factors for Falling

It is important for health care providers to identify and address an individual's risk factors for falling to help prevent falls. There are several risk factors for falling and an individual's probability of falling increases with the number of risk factors. Sixty-five percent to 100% of individuals who had three or more risk factors fell during a one-year time frame, compared to 8-to-12% fall rate for individuals who did not have any risk factors (Chang & Ganz, 2007).

Age

An increase in age is related to the likelihood that an individual will fall (Rogers, Fernadez, Bohlken, 2001; Rubenstein & Josephson, 2002). Approximately 75% of falls in the United States occur in adults 65 years and older (Rubenstein & Josephson, 2002), and an individual over the age of 80 is twice more likely to fall than younger individuals (Rubenstein & Josephson, 2002). Thus, it is important for health care providers to conduct screening for older adults to determine their fall risk factors, history of falling, and fear of falling.

Vision

The visual system is important for stabilizing balance by providing the nervous system information about the body's position in relation to the environment (Lord, 2003). The visual, proprioceptive, and somatosensory systems integrate information to determine where the body is in relation to space to maintain balance. If one of these systems is impaired, the body has an increased dependence on the intact systems to maintain stability (Lord, 2003). If the visual system is impaired, body sway increases by three-fold, which places the individual at an increased risk for falling (Black & Wood, 2005; Rubenstein & Josephson, 2002).

Older adults who have reduced visual acuity (clearness of objects) or reduced contrast sensitivity (the ability to distinguish an object from its background) are at an increased risk for falling and need to use adaptive techniques to safely move around their environment, such as walking slower than individuals without visual difficulties (Black & Wood, 2005; De Boer, et al., 2004, as cited in Lord, 2006). Impaired depth-perception (the ability to determine how far away an object is related to the environment) can also increase a person's risk for falling because he or she may have difficulties with accurately placing the foot while walking up or down stairs or maneuvering around obstacles in the environment (Black & Wood, 2005). Impaired depth-perception is the strongest visual factor that can cause an individual to experience multiple falls (Lord & Dayhew, 2001; Nevitt, et al., 1989, as cited in Lord, 2006).

Individuals who wear multifocal glasses are 35-to-50% more likely to have a fall, when compared to individuals who do not wear multifocal glasses (Black & Wood, 2005; Lord & Dayhew, 2001). Also, a visual field loss increases the risk of falling due to a decreased ability to detect potential hazards in the peripheral field of vision (Black & Wood, 2005; Ivers, et al., as cited in Lord, 2006; Klein et al., as cited in Lord 2006). Visual interventions can reduce falls up to 60% (Black & Wood, 2005). It is recommended that health professionals visually screen older adults to determine if their vision could contribute to falls and to provide interventions to help improve vision, thus reducing their risk of falling.

Gender and ethnicity

An individual's gender can also place a person at an increased risk for falling. Men are 46-49% more likely than women to have a fatal fall (CDC, 2009; Rubenstein and Josephson, 2002; Yoshida, 2007.), because men are more likely to have underlying health conditions, which may increase their risk of falling (WHOGRFPOA, 2007). However, women are 67% more likely to experience non-fatal fall-related injury and the majority of hip fractures occur in women (CDC, 2009; Schiller et al., 2007, as cited in Painter & Elliott, 2009; WHOGRFPOA, 2007). It is estimated that one-in-three women over the age of 70 will fall each year (Gillespie, et al., 2003 as cited in Flicker, et al., 2005), and women who are widows, frail due to age, or are not active are at an increased risk for falling (Yoshida, 2007). Also, Caucasians have an increased risk of falling and are two-to-four times more likely to be hospitalized from a fall than Hispanics and Asian/Pacific Islanders (WHOGRFPOA, 2007). It is important for health care professionals to consider their client's gender and ethnicity when assessing an individual for a risk of falling, as these factors may increase their risk of falling.

Vitamin D deficiency

Vitamin D deficiency is another fall-related risk factor. Individuals who have low levels of Vitamin D have an increase in body sway, weakness in the quadriceps, and abnormal motor patterns (Flicker, et al., 2005). Vitamin D and calcium can help reduce bone loss and fractures (Nieves, 2005, as cited in Currie, 2006). Researchers found a significant reduction in the fall rate for older adults who received a Vitamin D supplement of 700-800 IU/d (Flicker, et al., 2005; Nieves, 2005, as cited in Currie, 2006). In a study by Nieves, 2005, as cited in Currie, 2006, participants who received a high dose of Vitamin D supplementation of 700-800 IU/d, had a 26% reduction in fractures resulting from a fall, compared to no reduction in fall fractures for the individuals who received a smaller dose of Vitamin D supplementation of 400/IU/d (Nieves, 2005, as cited in Currie, 2006). Health care professionals should ensure clients are receiving adequate amounts of Vitamin D, to help prevent a fracture from falling.

Chronic pain

There is consistent evidence that chronic pain is associated with an increased risk for falling for community-dwelling older adults (Leveille, et al., 2009). Pain can lead to muscle weakness or a slower protective response to a fall, chronic pain may be distracting for the individual which causes him or her disregard cognitive activities that may prevent a fall, and/or the individual may develop an inappropriate gait because of pain (Leveille, et. al., 2009). Health care professionals should ensure clients do not have chronic pain or help clients manage their pain to help reduce their risk for falling.

Polypharmacy

Polypharmacy, or the use of four or more medications, increases an older adult's risk for falling (Boyle, Cumming, Naganathan, 2010, Ruddock, 2004; Ziere, Dieleman, Hofman, Pols, Cammen & Stricker, 2005). Individuals who take four or more medications daily are twice as likely to fall, compared with those who do not take any medication (Lai, et al., 2010). Also, individuals who take multiple medications are at an increased risk for sustaining a hip fracture from a fall, especially women who take five or more medications daily (Lai, et al., 2010). In a study by Ziere and colleagues (2005), approximately 72% of individuals were taking at least one drug and approximately 20% were taking four or more medications. An individual's risk of falling increased with the number of daily medications taken and individuals who took one medication were at a 25% risk of falling, whereas, those who took six or more medications were at a 60% risk of falling (Ziere, et al., 2005). Also, the use of four or more medications results in a nine-fold increased risk of cognitive impairment and individuals are more likely to have a fear of falling with an increase in medication use (Yoshida, 2007).

Various types of medication can increase an individual's risk for falling. Ziere and colleagues (2005) identified various risk drugs, which placed an individual at an increased risk for falling, these included: antiarrhymics, psyhotropic medications, diuretics, calcium preparations, potassium sparing diuretics, central acting antiobesity products, anilides, oxicams, quinine and derivatives, anxiolytics-benzodiazepine derivatives, and hypnotics-benzodiazepine derivatives. Medications that act on the central nervous system increase an older adult's risk of falling by 54% and are associated with recurrent falls (Boyle, Cumming, Naganathan, 2010). Medications that affect the central nervous system include: sedatives, benzodiazepines, and tranquilizers (Yoshida, 2007). Sedative medications, such as benzodiazepines, increase an individual's risk of falling by 51% and short-acting, high doses of benzodiazepines increase an individual's risk of falling by 90% (Boyle, et al., 2010). Antipsychotic medications increase an individual's risk of falling by 59% and increase an individual's risk of sustaining a hip fracture or recurrent falls (Boyle, et al., 2010). Antidepressants increase an individual's risk of falling by 61%, and selective serotonin reuptake inhibitors increase a risk for falling by 72% (Boyle, et al., 2010). Cardiovascular medications can increase an older adult's risk of falling due to the effect of postural blood pressure and cardiac arrhythmias; however, this risk various according to the type of cardiovascular medication; antihypertensive medications and diuretics have a modest increase risk for falling, whereas beta-blockers do not cause an increased risk for falling (Boyle, et al., 2010).

Medications can increase an individual's risk of falling due to the side effects of the medications or physiological changes that occur with continued use of the medication. Older adults are at an increased risk for having these side effects due to physiological changes that occur with aging; such as: decreased lean body mass, decline of kidney and liver function, increased body fat, rate of absorption, and metabolism and elimination of medications (Yoshida, 2007). Various medications can cause side effects that significantly increase an older adult's risk for falling; diuretics can cause dizziness and increased ambulation, benzodiazepine derivatives can affect the central nervous system (Ziere, et al., 2005), beta blockers can cause postural hypotension and sedation, cardiac glycosides can cause lethargy and confusion (Yoshida, 2007), anticonvulsants can cause postural disturbances and neuroleptics can cause visual disturbances (Ruddock, 2004). The use of multiple medications increases the risk for side effects from medications, and increases drug interactions, electrolyte imbalance, decreased drug clearance rates and impaired balance (Lai, et al., 2010). It is important for health care professionals to be aware of any medications clients are taking and to educate clients on their increased risk for falling if taking multiple medications.

Neurological conditions

Individuals with a neurological condition, such as Parkinson's disease (PD), stroke, or multiple sclerosis (MS) are at an increased risk for falling. Sixty-two percent of patients with PD experienced a fall, 48% of individuals with polyneuropathy fell, 33% of people individuals with a motor neuron disease fell annually, and one-in-three patients with MS reported a fall in the year (Stolze, et al., 2004). Neurological diseases can lead to a fall due to disturbances in gait and stance. Thirty-four percent of individuals with motor neuron diseases fall each year and 55% of falls were caused due to a postural or gait disturbance (Stolze, et al., 2004). Individuals with a neurological condition in an inpatient hospital are twice as likely to fall, compared to community-dwelling older adults (Stolze, et al., 2004).

Individuals with Parkinson's disease are at an increased risk for sustaining fractures from falling and have decreased bone mass density around the hip area (Ashburn, Pickering, Stack, &

Ward, 2001). Also, individuals with PD have an increased fear-of-falling, compared to those who do not have PD (Bilclough, Bowron, Walker & Wood, 2002). Individuals with PD who experience a fall can be at an increased risk for admission into a nursing home and have increased dependency for basic needs (Bilclough, et al., 2002). In a study by Bilclough et al. (2002), 68% of individuals with PD reported one fall in the past year and 50.5% reported multiple falls in the past year. Various risk factors for falls in individuals with PD included: bradykinesia, dyskinesia, a history of previous falls, cognitive impairment, and/or wearing off phenomena (Bilclough, et al., 2002). In addition, impairments of postural reflexes reduces stability and increases difficulty with responding quickly to external challenges (Ashburn, et al., 2001). Individuals with PD were most likely to experience a peripheral traumata and symptoms of PD, such as freezing episodes, difficulties getting up from a chair and difficulties with turns increased an individual's risk for falling (Stolze, et al., 2004).

An average of 40% of individuals who have experienced a stroke experience falls while in the hospital and 73% of individuals who had a stroke in the past 6 months experience a fall at home (Batchelor, Hill, Mackintosh, & Said, 2010). In a one year follow-up study, 55% of individuals who have had a stroke experienced one falls, 42% had multiple falls, and 54% experienced near-falls (Ashburn, Harris, Hyndman, Pickering, Yardley, 2008). Seven-percent of falls were caused due to a sudden stroke (Stolze, et al., 2004). Common impairments that increase a stroke-survivor's risk for falling include: leg weakness, foot problems, sensory loss, visual problems, balance problems and continence problems (Batchelor, et al., 2010). Therapists should ensure individuals with neurological conditions receive proper intervention to reduce fall risk.

The Environment

The environment in which a person lives can also increase their risk for falling. Approximately 30-50% of all falls occur due to hazards in an individual's environment (Perell, et. al. 2001; Rubenstein & Josephson, 2002; WHOGRFPOA, 2007). Fifty-to-sixty percent of falls occur in an individual's home (WHOGRFPOA, 2007; American Geriatrics and British Geriatrics Society [AGBGS], 2010) and the majority of falls occur in the late morning or early afternoon (AGBGS, 2010). Older adults are more likely to fall inside of their homes because they feel more comfortable in this environment and exhibit less caution when moving around their house (Rubenstein & Josephson, 2002). Environment hazards can include: wet floors, poor bed height (Rubenstein & Josephson, 2002), throw rugs, high or narrow steps, uneven surfaces, loose electrical wires, poor-fitting handrails, slippery surfaces, or inadequate or excessive lighting (WHOGRFPOA, 2007). Fifty-to-seventy percent of falls occur because of tripping over something or slipping (Dite et al., 2002). It is important for health care professionals to identify and remove potential hazards in an individual's environment to reduce an individual's risk of falling in their home.

Additional risk factors

Additional risk factors include: muscle weakness, mental status alteration, musculoskeletal deficits, postural hypotension, impairments in one or more ADLs, incontinence, and a sensory impairment, such as a deficit in proprioception, vestibular, or tactile input (AGBGS, 2010; Colon-Emeric, Pieper, & Artz, 2002, as cited in Currie, 2006; Perell, et al., 2001; Rubenstein & Josephson, 2002). Also, an individual with a history of falling is three times more likely to have additional falls than an individual with no history of falling (Rubenstein & Josephson 2002). Health care professionals should consider any of these risk factors when assessing an individual's risk of falling, as this may place a person at an increased risk for falling.

Physical Activity and Older Adults

According to the United States Department of Health and Human Service recommendations, all capable, older adults should participate in at least 150 minutes per week of moderate-intensity physical activity, or 75 minutes a week of vigorous-intensity aerobic activity (United States Department of Health and Human Services, 2008). If an older adult is not able to achieve the 150 minutes of physical activity per week, he or she should participate in some form of exercise and avoid inactivity (United States Department of Health and Human Services, 2008). Regular physical activity has many health benefits for older adults, such as: improved cardiovascular health, reduced risk of obesity and osteoporosis, improvements in overall mood and mental health (United States Department of Health and Human Services, 2008). It is recommended for older adults to participate in muscle strengthening activities at least two days a week, and aerobic activities, at least three days a week (United States Department of Health and Human Services, 2008). Regular physical activity is safe for older adults who are at-risk for falling (United States Department of Health and Human Services, 2008) and exercise can reduce the risk of falling due to improvements in strength, flexibility, joint mobility, and reaction time (National Institute on Aging, 2000). In addition to strength and aerobic activities, older adults who are at-risk for falling should participate in balance training exercises at least three days a week (United States Department of Health and Human Services, 2008).

Components of a Successful Fall Prevention Program

Based on evidence-based research, there are five basic components to create a successful fall prevention program, these include: 1) education about falls, 2) medication review, 3) vision assessment, 4) home safety assessment, and 5) exercise (National Center for Injury and Prevention [NCIP], 2008). Also, the fall prevention program should address the benefits of participation, such as increasing independence, increasing confidence and having an active role in society (WHOGRFPOA, 2007). A successful fall prevention program should help raise public awareness about the risk for older adults falling and the benefits of interventions and programs that reduce fall risk (WHOGRFPOA, 2007).

A fall prevention program is most successful if it promotes positive beliefs about taking preventative action to reduce the risk of falling. Research shows older adults believe falls are an inevitable aspect of aging; this misconception may decrease a person's motivation to participate in a fall prevention program (WHOGRFPOA, 2007). Raising awareness and educating older adults can help motivate individuals to participate in the program and change their belief that falls are inevitable with aging (WHOGRFPOA, 2007). Educating older adults and their caregivers about fall risk is a fundamental component of a successful fall prevention program; falls can be prevented through this education about fall risk factors and ways to reduce fall risks (NCIP, 2008).

Medication review is another important component to a successful fall prevention program; medication review can help identify and eliminate possible side effects that can increase a risk for falling, such as drowsiness, dizziness, blurred vision, confusion, and sedation. Aging can increase sensitivity to the side effects of medication and an increase in age also affects the distribution, absorption, and elimination of medications (NCIP, 2008).

Vision exams and improvements in vision should also be included in a fall prevention program; changes in vision and vision loss increase an individual's risk for falling by disturbing balance and obscuring tripping and slipping hazards. Comprehensive vision examinations with specialized equipment should be conducted by a trained optometrist or ophthalmologist to ensure all types of vision problems are identified (NCIP, 2008).

Another component to a successful fall prevention program includes assessment of the home and home modifications; environmental hazards account for approximately half of falls that occur in the home. A home safety assessment can reduce a person’s risk for falling by identifying hazards in the environment. Home modifications can reduce a person’s risk for falling, these include: installation of bathroom grab bars, handicapped showers and ramps (NCIP, 2008).

Another important component to a successful fall prevention program is participation in effective exercises. Before beginning the exercise program, the professional must assess the participant’s balance, strength and fitness and the exercise classes should small, with no more than 15 participants (NCIP, 2008). Older adults have indicated they believe strength and balance training activities are important because these can help to maintain functional capabilities and reduce dependence, enhance one’s general health, appearance, and mobility. Additionally, older adults indicated the strength and balance exercises should be enjoyable, interesting and provide an opportunity for socialization (WHOGRFPOA, 2007).

A combination of strength, balance, and aerobic activities can improve strength and mobility among older adults, and reduce their risk for falling (Gardner, Buchner, Robertson, and Campbell, 2001; Robertson, Campbell, Gardner, & Delvin, 2002; Sherrington, et al., 2008; NCIP, 2008; 2008 guidelines). Participation in a weekly exercise group with supplemental home exercises reduced falls up to 40%, prevented injuries from falls, and improved balance for community-dwelling older adults (Barnett, Smith, Lord, Williams & Baumand, 2003). Exercise programs should be taught by a professional and tailored to meet the specific needs of older adults (Gardner, et al., 2001; NCIP, 2008). It is recommended for exercises to be performed at least twice a week and progress in difficulty throughout the program (NCIP, 2008). Additionally, a fall-prevention program should encompass dynamic balance exercises, as these activities transfer to improved balance during daily activities and are closely related to lifestyle and function (Gardner, et al., 2001).

In addition to the components discussed above, a fall prevention program should create a supportive partnership between the provider and participants. The program should help an individual develop a sense of self-confidence, build confidence by successfully completing fall prevention exercises, and promote the belief that the intervention is effective (WHOGRFPOA, 2007). To encourage participation and progress, the program should provide the participants with a contract of goals, give accurate and positive feedback on achieving these goals, help the participants develop skills to generate and maintain new behaviors, and should be tailored to meet the individual's needs, (WHOGRFPOA, 2007). Additionally, a fall prevention program that provides older adults with social support and social activities with others may decrease a person's risk for falling and motivate a person to stay socially active even after a fall. An important component to a successful fall prevention program is to change the beliefs, attitudes, and behaviors of older adults, health care providers, and the community (WHOGRFPOA, 2007). Research has shown people will only make a change if there are adequate resources to implement the change, if the person believes the change will be beneficial, and if the benefits outweigh the cost or efforts (WHOGRFPOA, 2007). When creating a fall prevention program, it is important to include the various components identified through evidence-based research; this will help to encourage participation in the program and can help to reduce falls.

Programs to Prevent Falls

The most effective fall-prevention programs for older adults involve a variety of tasks which challenge balance, such as multisensory balance training (Nitz & Choy, 2004; Rogers, Fernandez, & Bohlken, 2001; Steadman, et al., 2003), stepping programs (Nnodim et al., 2006; Rogers, Johnson, Martinez, Mille, & Hedman, 2003), and a combination of balance and aerobic activities (Gardner, et al., 2001; Robertson, Campbell, Gardner, & Delvin, 2002; Sherrington, et al., 2008; United States Department of Health and Human Services, 2008).

Multisensory balance programs

Programs which combine multisensory training and specific balance activities are more effective for improving balance when compared to traditional exercise programs that consist only of aerobics, strengthening, or flexibility exercises (Nitz & Choy, 2004; Rogers, Fernandez, & Bohlken, 2001; Steadman, et al., 2003).

In a study by Nitz & Choy, 2004, a multisensory balance program, which required participants to bend, reach, and turn, while maintaining balance on various surfaces, was compared to a traditional balance program, which consisted of typical balance activities, such as marching in place, arm circles, gentle stretching activities, and stepping to the side. The multisensory balance program provided additional vestibular stimulation and encouraged participants to increase their speed and size of movements to maintain balance, which resulted in increased strength, endurance, and reaction time. After the intervention, both groups had a significant reduction in falls and significant improvements on the TGUG; however, the multisensory balance group had more improvements in functional skills, measures of balance, and a reduced fear of falling.

In a similar study by Steadman, et al., 2003, a conventional therapy program, which consisted of various mobility skills, was compared to an enhanced balance program, which required participants to maintain a narrow base of support, while moving the center of gravity outside of the base of support.   The enhanced therapy program also consisted of repetition of graded balance activities and participants received visual feedback from the Balance Performance Monitor, which provided an objective measure of balance by measuring a participant's postural sway and overall balance. Both the convention balance group and the enhanced therapy group showed improvements in balance, quality of life, walking speed number of falls, independence for activities of daily living, and social participation; however the enhanced therapy group showed more improvements in walking speed, stability, and quality of life (Steadman, et al., 2003).

Stepping programs

When a person loses his or her balance, the individual must take a rapid and lengthy step in the direction of the loss of balance, to prevent falling (Lord & Fitzpatrick, 2001; Rogers, Johnson, Martinez, Mille, & Hedman, 2003; Schulz, Ashton-Miller, Alexander, 2007). A slow stepping response time is a strong predictor of a fall for older adults and impairments in stepping may be a contributing factor for falling (Lord & Fitzpatrick, 2001). Additionally, the person must maintain rapidly swing the foot, with a sufficient force to the group with the stepping leg and maintain postural stability (Schulz, et al., 2007). A person's ability to accurately and quickly take a step has been correlated with other measures of balance, and neurophysological functioning (Lord & Fitzpatrick, 2001). An individual's speed of stepping and length of stepping is related to a person's mobility, gait, and risk for falling (Cho, Scarpace, & Alexander, 2004).

Research indicates a person's speed of stepping and reaction time for taking a quick step decreases with age (Lord, et al., 2001; Rogers, et al., 2003; Schlutz, et al., 2005).

In a study by Rogers, et al., 2003, twenty adults participated in a stepping training program, which consisted of stepping on and off a platform in response to either a small forward waist-pull or an auditory cue. Each session comprised 53 trials, twice a week, for three weeks. Older adults had significant improvements in their speed of stepping, and a quicker reaction time for stepping (Rogers, et al., 2003); this suggests a stepping program can be beneficial for older adults by improving balance, enhancing the quality of life, and reducing falls among older people (Rogers, et al., 2003). Additionally, a stepping program indicated greater improvements in balance, functional mobility, and a decreased risk of falling, compared to a Tai Chi program (Nnodim et al., 2006).

Walking programs

According to the American Geriatrics Society, walking is the most common form of physical exercise for older adults (American Geriatrics Society, n.d.); however, there is a lack of research on interventions that can be implemented in the home and community (National Institute on Aging, 2000). Though walking has many health benefits and is safe for most older adults (United States Department of Health and Human Services, 2008), walking alone is not sufficient for reducing falls and improving balance (Audette, et al., 2006; Gardner, et al., 2001; Salbach, et al., 2005; Sherrington, et al., 2008; Yamada, Tanaka, Nagai, Aoyama, and Ichihashi, 2010). Research indicates Tai Chi exercises are more effective than brisk walking for improving lower extremity strength and balance (Audette, et al., 2006) and a walking program is only effective for balance self-efficacy related specifically to mobility, with no improvements in specific balance tasks (Salbach, et al., 2005). Additionally, a traditional walking program, was less effective for improving mobility and fall-risk than a trail-walking program, which required a combination of attention, short-term memory, balance, and multidirectional stepping (Yamada, et al., 2010).

Though the specific task of walking is not effective for reducing falls, it is recommended to include walking in a comprehensive strength and balance program to reduce a person's risk for falling (Gardner, et al., 2001; Sherrington, et al., 2008). Research indicates a reduction in falls when participating in a program that combines balance activities and muscle strengthening for 90 minutes a week, and walking for at least 60 minutes weekly (Gardner, et al., 2001; Robertson, Campbell, Gardner, & Delvin, 2002; United States Department of Health and Human Services, 2008). An individualized balance program that combines walking, balance, and strengthening exercises can reduce falls and fall-related injury up to 35% for community-dwelling older adults, and improve a person's balance, and reduce a fear-of-falling (Robertson, et al., 2002).

Virtual Reality and Video Games in Rehabilitation

With the expansion of new technology, such as video games and virtual reality, there has been an increase in the interest of using virtual reality in therapy. Virtual reality has been used therapeutically with a variety of populations, ranging from children to older adults, and in a variety of contexts (Das, Grimmer, Sparnon, McRae, & Thomas, 2005; Flynn, Lange, Yeh, & Rizzo, 2008; Lieberman, 2001, Wille, et al., 2009).

Das and colleges (2005) used virtual reality as a therapeutic means of helping reduce pain in children who had suffered from burns. Researchers concluded that virtual reality games, paired with analgesics were more effective in reducing pain in pediatric burn victims than using only analgesics (Das, et al., 2005). Also, caregivers and nurses reported the children were calmer and less distressed when playing the virtual reality games. This suggests that using a virtual reality game may help distract children from pain, allowing the child to be more cooperative and listen to doctors and other health professionals (Das, et al., 2005).

Another study by Lieberman (2001) used interactive health games with pediatric patients who had chronic diseases. A variety of video games were used to address the children's diseases; a game addressing asthma self-management, a diabetes self-management game, and a smoking prevention game. The video games were engaging and appealing to the children, promoted positive health-related behaviors, improved their self-care skills and communication skills (Lieberman, 2001).

Wille, et al. (2009) conducted a study using a virtual-reality program with children who had motor deficits. After participating in the virtual-reality program, the majority of participants had improvements in arm function and a high motivation level. Participants reported they enjoyed the direct feedback provided by the virtual-reality program, the challenges of the games, and the competition of trying to beat the high score. The virtual reality program was cost-effective, helped clients have a better sense of self-sufficiency, and have control over their actions (Wille, et al., 2009).

Flynn, Lange, Yeh, and Rizzo (2008) conducted a study with individuals 49-to-69 years of age who had disabilities and use a variety of video game programs, including the Nintendo® Wii™, the Sony PlayStation® 2 Eyetoy™, and Novint® Falcon™. Participants reported they enjoyed feedback provided by the video games, were distracted from their disability, and wanted to use the games in therapy, as opposed to performing repetitive, boring exercises (Flynn, et al., 2008).

Video Games with Patients Who Have Neurological Disorders or Neurological Injuries

Researchers have used video games therapeutically with individuals who have neurological disorders or injuries. Due to the novelty of this area of interest, there is limited research; however, the research findings have demonstrated the effectiveness of using video games with this population and stress the importance for additional research.

Rand, Kizony, and Weiss (2008) conducted a study using the Sony® Eyetoy™ with a variety of adults with and without disabilities. There were three groups in the study: young adults without a disability, older adults without a disability, and older adults who were in various stages of stroke recovery. In all three groups, participants reported a high sense of enjoyment, which could influence performance and motivation to engage in an activity. For individuals who have had a stroke, the Sony® Eyetoy™ can be an alternative to a home program that uses repetitive, exercises that are not motivating or interesting for the individual. Also, the Sony® Eyetoy™ can be used in the home to encourage activity after an individual no longer needs rehabilitation. The Sony® Eyetoy™ is easy to operate, inexpensive, enjoyable, and encourages use of the upper extremities and trunk (Rand, Kizony, Weiss, 2008).

Betker, Desai, Nett, Kapadia, & Szturm (2007) conducted a study using a video game-based tool with adults who had traumatic brain injuries or chronic spinal cord injuries. Betker, et al. (2007) were interested in determining if video game-based exercises could improve sitting balance, and if participants were motivated and interested in performing the video game-based exercises. Betker, et al. (2007) developed a center-of-pressure mat that was placed in the individual's wheelchair, which measured weight shifting and registered the shifting of weight on a computer screen. There were a total of three games, each varying in difficulty and with various objectives; however, each game required the participant to shift his or her weight in a variety of positions. The difficulty levels of the games were adjustable so the participant did not become frustrated, but was challenged enough to remain interested (Betker, et al., 2007). All participants had a decrease in fall rates after playing the game and reported a high level of enjoyment of the game and all participants (Betker, et al., 2007).

Additional research on video games and balance found improvement in fall rate prevention and a high level of enjoyment reported by participants (Betker, Szturm, Moussavi, & Nett, 2006). Betker and colleagues (2006) used a questionnaire to inquire about the motivation level of participants and the games they preferred, and various stability measurements to determine if there were significant changes in sitting balance while participants played the games. Participants were motivated to play the games and all participants preferred the video games over traditional treatment (Betker, et al., 2006). Also, participants indicated they would like to continue playing the games after the study had been completed. In addition to the motivational factor of the video games, participants also had a decrease in falls, were able to accurately move towards the targets and the games, and were able to maintain short-sitting balance while performing tasks. Results indicate video game-based exercises may be motivating and can help individuals with brain injuries achieve goal-directed behaviors (Betker, et. al., 2006).

Video Games and Cognition of Older Adults

Video games can also be used to help improve cognitive function for older adults. Currently, research is being done to use software and other technology for cognitive remediation; a variety of programs, such as Brain Age™, by Nintendo DS® and the Brain Fitness Program™ are available. In one study by Vance, McNess and Menese (2009), older adults who used computer software had significant improvements in memory, attention, and speed of processing.

Though some adults may be reluctant to use technology because of a fear of limited knowledge, it is important to challenge the brain by learning and experiencing new things (Vance, et al., 2009). Research is currently being conducted to develop software programs that can be readily accessible, provide visual and auditory stimulation, and are enjoyable and engaging for older adults (Vance, et al., 2009).

The Gains Through Gaming Lab, at North Carolina State University, is currently conducting research to determine cognitive benefits for older adults after playing video games (Gains Through Gaming Lab, 2009). Researchers conducted a study with 14 older adults, aged 63-to-70 years, who were provided a video game to play for two weeks. Participants had significant improvements in executive functioning, speed of thinking, spatial ability, everyday memory and basic memory, as measured by various cognitive tests. Researchers found the older adults were motivated to play the video game and the clients who were most interested and engaged in playing the video game had the greatest gains (Gains Through Gaming Lab, 2009).

Additional studies indicate that older adults had significant improvements in executive control, reasoning skills, and the ability to switch tasks after playing a video game (Basak, Boot, Voss, and Kraemer, 2008). The most significant improvements in cognitive functioning were noted after 23.5 hours of playing the video game, over a five-week period (Basak, et al., 2008), which suggests the importance of allowing time for an individual to learn a new skill or adjust to a new task.

Nintendo® Wii™ and Therapy

The Nintendo® Wii™ is currently being used in various rehabilitation settings, such as private practices, hospitals and extended care facilities to improve balance and increase upper extremity strength (Coye, 2008). "WiiHab", and "Wiihabilitation" are unique terms that refer to the use of the Nintendo® Wii™ in rehabilitation (Cautions and Contraindications for Wii-Habilitation, 2009). However, there is little evidence-based research on the Nintendo® Wii™ since this is a relatively new modality to be implemented in rehabilitation.

The Nintendo® Wii™ is starting to be implemented in conjunction with physical and occupational therapy. At Weiss Memorial Hospital, occupational and physical therapists use the Nintendo® Wii™ in conjunction with traditional physical and occupational therapy. The first client to use the Wii™ was a 100-year-old woman who had difficulties with balance. After using the Wii™ in the first session, she wanted to continue playing and eventually progressed through the levels on the Wii™ game. The Nintendo® Wii™ is being used to improve balance skills, build endurance, build core muscle strength, and improve hand-eye coordination. Also, the Wii™ is motivational for clients and provides therapy sessions that have meaning and purpose for the client, (Wii-habilitation adds fun to physical and occupational therapy).

At Glenrose Rehabilitation Hospital, the Nintendo® Wii™ is being used in conjunction with occupational therapy to work on "client-centered goals". Specifically, the Wii™ helps to encourage active movement of the upper extremities and trunk, and clients report they had better focus on their affected limb while using the Wii™. Additionally, clients have more opportunities for social interaction and attend therapy for a longer period of time when playing the Wii™ during therapy (Halton, 2008).

Contraindications for using the Nintendo® Wii ™ in Therapy

The Nintendo® Wii™ can have many therapeutic benefits; however, before using the Nintendo® Wii™, it is important to consider contraindications and precautions to ensure that the client is safe and will benefit from using the Wii™. It is imperative to review the client's medical history prior to using the Nintendo® Wii™ to ensure it is safe. To avoid possible complications from using the Nintendo® Wii™, health care professionals should ensure the client does not sit or stand too close to the television screen, the Nintendo® Wii™ is played on a small television screen, and the client had an adequate amount of sleep the night before playing. It is also important to ensure the area is well-lit, and allow the client to take a 10-to-15 minute break every hour playing the Wii™. Additionally, the therapist should ensure there is adequate space to play the games (Jochem, 2008). Cautions and Contraindications for Wii-Habilitation, 2009). Playing the Nintendo® Wii™ for a prolonged period of time without taking a break may cause pain in the muscles or joints in the wrist (Wii Health and Safety Precautions, n.d.) which could result in tendinitis or carpal tunnel syndrome.

For clients who have difficulties with balance, gait belts should be used while playing the Nintendo® Wii™ (Jochem, 2008). The therapist should ensure the client wears the Wii™ remote wrist strap during all activities and that the wrist strap is fastened securely around the individual's wrist to avoid having the Wii™ remote thrown out of the person's hand (Herz, 2009).

If a client has a pacemaker or other implanted device, it is recommended for the therapist to consult the client's doctor before using the Nintendo® Wii™ in therapy (Wii Health and Safety Precautions, n.d.). While using the Nintendo® Wii™ with an individual who has a pacemaker, it is critical that the client stand at least nine inches from the Nintendo® Wii™ (Wii Health and Safety Precautions, n.d.), to avoid electrical interference.

Individuals who have a history of seizures or epilepsy should not use the Nintendo® Wii™ for therapeutic purposes. In rare cases, the video game may trigger a seizure, even for individuals who have no history of seizures (Wii Health and Safety Precautions, n.d., Cautions and Contraindications, n.d.). If an individual has symptoms of a seizure, such as eye twitching, convulsions, loss of awareness, involuntary movements, altered vision, or disorientation, (Wii Health and Safety Precautions, n.d.), the health care professional must contact emergency medical services, and the Nintendo® Wii™ should not be used in future sessions. Also, the Nintendo® Wii™ can also cause motion sickness or dizziness in some individuals (Wii Health and Safety Precautions, n.d.). Health care professionals should monitor clients for any signs of motion sickness and stop using the Nintendo® Wii™ if symptoms are present.

Populations That May Benefit from Using the Nintendo® Wii™

The Nintendo® Wii™ has the potential to be used with a variety of populations during occupational and physical therapy. The Nintendo® Wii™ can be used in either an individual therapy session or a group therapy session.

Individuals who have had a joint replacement can also benefit from using the Nintendo® Wii™ during therapy. The Wii™ can help motivate the individual to perform activities while standing and to begin weight-bearing on the affected extremity (after ensuring that the individual does not have weight-bearing precautions). The Wii™ can be used to increase the individual's standing balance, to help relax the person if he or she is experiencing anxiety or pain, and to help increase strength and flexibility (Glomstad, 2008). The Wii™ can be used with individuals who have osteoarthritis to help increase range of motion and muscle strength, and help with fatigue, anxiety or depression (Glomstad, 2008). Additionally, individuals who have cancer can benefit from using the Nintendo® Wii™ during therapy; the Wii™ can help to alleviate pain, anxiety, depression, cancer-related fatigue, and help increase muscle tone (Glomstad, 2008).

The Nintendo® Wii™ and Use for Forearm Injuries

Decker, Li, Losowyj, and Prakash (2009) used the Nintendo® Wii™ remote with individuals who have limited range of motion in the wrist due to a wrist injury, such as a fracture. Decker and colleagues (2009) devised a progressive gaming system that required participants to use range of motion to accomplish the goals of the game. As the participants progressed, the game adjusted to require greater range of motion to achieve the goals of the game. Decker, et al. (2009) concluded the Wii™ remote can be used to increase range of motion in the wrist and is an effective, inexpensive piece of equipment to be used in rehabilitation. Using the Wii™ remote and the video game provided an engaging activity for participants and could be an alternative to having patients perform repetitive, uninteresting range of motion activities that are sometimes used in traditional rehabilitation (Decker, et al., 2009).

Hidrian and Weyler (2008) conducted a study comparing the Cyriax cross friction massage technique to Nintendo® Wii™ for treatment of lateral epicondylitis. The Cyrix cross friction massage technique is a type of massage that is applied directly to the soft-tissue of the tendons; this type of massage technique is beneficial for pain relief and to heal damaged tissue. Researchers compared this type of massage to the Nintendo® Wii™ tennis game, which involves using the Nintendo® Wii™ remote as one would use a tennis racket. The movements of the wrist are registered by the remote and transmitted to the Nintendo® Wii™. There were a total of 10 participants in the study and 6 participants were assigned to the Wii™ treatment group, and 4 were assigned to the Cyriax massage group. After the six week study, results indicated the Nintendo® Wii™ group showed a significant improvement in pain reduction, and the massage group had no significant improvements. Researchers contributed a portion of the improvements to the motivational factor of using the Nintendo® Wii™ and participants were enthusiastic about the activities, which likely contributed to the success of the Wii™ program. Results from this study indicated the Nintendo® Wii™ was more motivating and showed more reduction in pain than using the Cyriax massage technique (Hidrian & Weyler, 2008).

Older Adults and the Nintendo® Wii™

The Nintendo® Wii™ and other video game systems are becoming increasingly popular among the older adult population, especially in nursing homes and assisted-living communities (Baig, 2009; Peltier, 2007). Older adults can use the Nintendo® Wii™ to simulate popular sports, such as bowling, golf, and tennis. At one retirement community, there is a Wii™ bowling league with over 200 older adults competing. The Wii™ league provides numerous opportunities for social interaction (Baig, 2009), and helps older adults remain active.

At another nursing home, the Nintendo ® Wii™ is incorporated into weekly therapy sessions (Peltier, 2007). Occupational therapists use the Wii™ to help older adults improve arm movements, eye-hand coordination, range of motion, and balance (Peltier, 2007). Therapists use the Wii™ with individuals who have limited mobility by modifying the activities to be played from a wheelchair (Peltier, 2007). Residents report the Wii™ provides therapeutic and recreational benefits; also, the Wii™ increased social interactions among residents, which helped improve their psychosocial functioning (Peltier, 2007).

Neurological Disorders or Injuries and Nintendo® Wii™ Usage

In addition to using the Nintendo® Wii™ in nursing homes and assisted living communities, researchers have conducted a variety of studies on the use of the Nintendo® Wii™ with individuals who have neurological disorders or have sustained a neurological injury. For individuals who have had a stroke, the Nintendo® Wii™ and Wii Fit™ can be used for standing while moving the affected extremity, improving strength, flexibility, balance, and responding to visual stimuli (McUsic, 2009).

Deutsch, Borbely, Filler, Huhn, and Guarrera-Bowlby (2008) conducted a study using the Nintendo® Wii™ with an adolescent who had Cerebral Palsy. Researchers were interested in determining if the Nintendo® Wii™ could be used as a low-cost, commercially available alternative to other gaming systems. The Nintendo® Wii™ was used in conjunction with physical therapy to help improve the participant's functional mobility, visual-perceptual processing, and postural control. At the conclusion of the study, the participant had improvements in visual-perceptual processing and figure-ground discrimination. Furthermore, the participant's weight distribution of his lower extremities became more symmetrical and he had a decrease in postural sway, indicating an increase in stance stability. Results from this study indicate the Nintendo® Wii™ can be used in conjunction with therapy to improve visual-perceptual processing, functional mobility, and postural control (Deutsch, et al., 2008).

Deutsch, Robbins, Morrison, and Guarrera-Bowlby (2009) conducted a study comparing the Nintendo® Wii™ to standard rehabilitation for two individuals in the chronic post-stroke phase. As a result of the stroke, both participants had balance difficulties and gait deficits. The first participant used the Nintendo® Wii™ Sports games and the Nintendo ® Wii Fit™ software. The Nintendo® Wii™ activities stimulated coordination, balance, strengthening, and bilateral upper extremity coordination. The second participant used a variety of standard balance and coordination activities, such as negotiating an obstacle course and using a paced metronome for sitting, stepping, and standing. Both individuals trained for a total of 12 hours, over a four-week course. The participant who played the Nintendo® Wii™ had greater improvements in balance than the participant in the standard program; however, the standard program showed better retention of improvements. Researchers identified potential advantages of using the Nintendo® Wii™ including: ease of administration, portability, rate of improvements in therapy, and engaging for the participant. Results from this study indicate the need for additional research and suggest the best intervention technique may involve a combination of standard care activities and the Nintendo® Wii™ (Deutsch, et. al., 2009).

Saposnik, et al., (2010) developed a trial program, Effectiveness of Virtual Reality Exercises in STroke (EVREST); this was the first double-blind randomized trial to use the Nintendo® Wii™ with individuals recovering from a stroke. The program is currently in the initial stages of development and researchers are evaluating the program for safety and feasibility (Saposnik, et. al., 2010). Though the program is still being developed, the research may provide evidence for using the Nintendo® Wii™ with individuals who have had a stroke in conjunction with traditional therapy.

The Nintendo® Wii™ has been used with individuals who have Parkinson’s disease to increase their endurance, balance, and fine motor coordination (Crompton, 2009; McUsic, 2009). In one study, participants were divided into a control group, which received a traditional occupational therapy intervention and without using the Wii™, and an experimental group, who received Wii™ therapy for eight-weeks, in addition to traditional occupational therapy (Michael J Fox Foundation for Parkinson's Research, 2008). The participants who received the Wii™ intervention had significant improvements in fine motor skills, rigidity, energy, and a decreased level of depression (Crompton, 2009). According to Dr. Herz, “The games require visual perception, eye-hand coordination, figure-ground relationships, and sequenced movement, so it’s a huge treatment tool from an occupational therapy perspective” (Nintendo® Wii™ May Enhance Parkinson’s Treatment, para 3, line: 5-9, pg 1). The formal results of Herz’s study have not yet been analyzed; however, the preliminary findings indicate the Nintendo® Wii™ could be helpful for individuals with Parkinson’s disease.

Use of the Nintendo® Wii™ for Balance Rehabilitation

Another important topic is the use of the Nintendo® Wii Fit™ for balance rehabilitation. The Nintendo® Wii Fit™ has been effective in improving balance with various populations; however, additional research is needed to evaluate the effectiveness of using the Wii™ in conjunction with other therapies.

Kirk, Blasius, Cortright, Oumedian, and Solberg (2008) compared a traditional balance training program to the Nintendo® Wii Fit™ and Playstation® Dance-Dance Revolution™ video games to determine which was most effective for improving balance. The study consisted of 25 participants, 18-to-24 years of age. Both the Nintendo® Wii Fit™ and the Dance-Dance Revolution™ games require weight-bearing and physical activity to play the game (Kirk, et al., 2008). The Dance-Dance Revolution™ game consists of a game pad with four directional arrows (right, left, front and back) and the direction arrows appear on a television screen in a random sequence. The gaming participant must press each arrow as it appears on the television screen with his or her foot. The Wii Fit™ game consists of a plastic balance board, which registers weight-shifting of the participant and the gamer must weight-shift to the right, left, front, or back to play each game. Participants played either the Dance-Dance Revolution™ game, Wii Fit™ game, or participated in the balance program for three days a week for a total of four weeks (Kirk, et al., 2008).

Both the Dance-Dance Revolution™ study group and the Wii Fit™ group had significantly reduced anterior and posterior postural sway, and a reduced deviation from the center of pressure, which indicates an improvement in balance. The traditional balance program also had significant improvements; however, the traditional balance program had the lowest score for participant enjoyment and engagement (Kirk, et al., 2008). Qualitative reports from participants indicated the video game based balance programs were less difficult and more enjoyable and engaging than the traditional balance program, which may increase participant compliance, motivation, and lead to better results (Kirk, et al., 2008).

In a study by Williams, Doherty, Bender, Mattox, and Tibbs (2011), the Nintendo® Wii Fit™ was used with 22 older adults, who resided in independent retirement communities and skilled nursing facilities. The participants were "well-elderly", indicating they were independent and had no significant medical conditions or functional deficits (Williams, et al., 2011). The average age of participants was 84, with a range of 74-to-94 years of age. The intervention phase included the use of the Nintendo® Wii Fit™ for four weeks, three times per week. The duration of each session was 20 minutes, split equally between the balance games and aerobic games on the Nintendo® Wii Fit™ (Williams, et al., 2011).

Prior to the study, the Berg Balance Scale (BBS) was administered; participants scored an average of a 39.41/56, indicating impairments in balance, and an increased risk of falling. After the intervention, the BBS was administered to determine changes in balance. There was a statistically significant ($p < 0.01$) increase between the posttest BBS (mean: 48.55, SD: 4.58) and the pretest BBS (mean: 39.41, SD 6.28) (Williams, et al., 2011). This indicates an improvement in balance and a reduced risk for falling. After the study, there was a decrease in the need for using an assistive device for ambulation and a decreased need for additional balance rehabilitation. Overall, participants showed an average of 25.03% improvement in Berg Balance scores from pre-test to post-test (Williams, et al., 2011). Additionally, all participants reported they enjoyed playing the Wii Fit™ and several participants reported social benefits from the study, as the games were competitive and occurred in a group setting (Williams, et al., 2011).

These findings support the use of the Nintendo® Wii Fit™ in occupational therapy practice, as a client-centered and effective intervention for balance rehabilitation. The Wii Fit™ can be used to help address client deficits, such as standing tolerance, problem solving, motor planning, and visual-motor integration (Williams, et al., 2011). This study suggests occupational therapists who work with older-adults should consider utilizing the Wii Fit™ for balance rehabilitation, leading to increased independence for valued occupations (Williams, et al., 2011).

Clark and Kraemer (2009) conducted a study using the Nintendo® Wii™ with an older adult who had an unspecified balance disorder. The research participant was an 89-year-old woman who had been admitted into a skilled nursing facility and had an abnormal gait because of limited postural stability. Prior to the research study, the participant scored a 48/56 on the BBS, which indicated unsteadiness and difficulty placing one foot on a stool during single-leg stance. The participant scored a 19 on the Dynamic Gait Index (DGI), which indicates instability while ambulating and changing direction and while maneuvering around obstacles on the floor. Researchers used the Nintendo® Wii™ bowling game for six sessions, each lasting one hour. After the sessions using the Nintendo® Wii™, the participant's BBS score improved from 48 to 53, which indicates improved steadiness and a reduced risk for falling than her initial score. For the DGI, her score improved from 19 to 21, which indicates improvements in her ability to ambulate without requiring an assistive device, while making a pivot-turn. With the Timed Up and Go Test (TGUG), she improved from 14.9 seconds to 10.5 seconds, with indicates she was mostly independent with ambulation. These results suggest that the participant had a reduced risk of falling after participating in the research study (Clark & Kraemer, 2009).

In a similar study by Brown, Burstin, and Sugarman, (2009), the Nintendo® Wii Fit™ was used with an 86 year-old woman who had balance difficulties after having a stroke. She was not able to walk without close supervision and tended to fall. The participant used the Wii Fit™ for four training sessions in addition to physical therapy. She did not have any discomfort when using the Wii Fit™ program and reported that she greatly enjoyed using the Wii Fit™. Following the study, the participant had improvements in balance, was at a reduced risk for falling, and was able to ambulate using a walker with minimal assistance (Brown, Burstin, & Sugarman, 2009).

Andrews and Pigford, (2010) used the Nintendo® Wii Fit™ with an 87-year-old man who experienced multiple falls and required a rolling walker for ambulation. Prior to the study, the researchers used the Berg Balance Scale, the Timed Up and Go, and the Activities-Specific Balance Confidence Scale (ABC scale) to determine the participant's risk for falling. The participant scored a 13/56 on the BBS, which indicated he had impairments with dynamic standing balance activities that required a shift of weight in any direction, which places him at a high risk for falling (Andrews & Pigford, 2010). The participant completed the TUG in 62 seconds, indicating impaired mobility with a high risk for falling and scored a 32/100 in the ABC scale, indicating he had low confidence in his balance performance (Andrews & Pigford, 2010). The study took place over a two-week time frame and consisted of one hour sessions five days a week. The participant chose the following Nintendo ® Wii Fit™ games to play: Ski Slalom, Table Tilt, and Deep Breathing games. After completion of the study, the BBS, TUG and ABC scales were conducted again. The participant scored 25/56 on the BBS, a 12 point increase from the pre-test, indicating he was at medium risk for falling. The participant was able to complete the TUG test in 47 seconds, a 15 second improvement from the initial assessments, but still indicating impairments in mobility. The participant's ABC Scale score on the post-test assessment was 38%, compared to 32%, indicating that he had better confidence in his balance.

Six weeks after the study, the participant had not sustained any additional falls. The Nintendo® Wii Fit™ games were challenging, goal-based, and interactive for the participant. The participant indicated that he would prefer the Wii Fit™ activities over a traditional balance program and the participant was very motivated and had a positive experience with the Wii Fit™ (Andrews & Pigford, 2010).

Current study

Fall prevention is an important topic for occupational therapists to address; in order to fully participate in occupations, individuals must be able to move safely in their environment and not have a fear of falling. After a fall, a person may become more sedentary, which can decrease an individual's independence and affect their ability to complete valued occupations. The psychological stress of a fall can be detrimental to an individual's health, and decrease the number of meaningful occupations the person performs. Occupational therapists must be able to engage an individual in an activity that he or she finds meaningful and enjoyable, so the client is motivated to participate in the activity.

The purpose of this research study is to determine if the Nintendo® Wii Fit™ is an effective and motivating modality for fall prevention with an older adult who has MG and lives in Eastern North Carolina. The current study will address balance and fall prevention in an older adult, in an interactive way, through the use of the Nintendo® Wii Fit™.

CHAPTER 2: METHODS

Study Design

The current research study was a single-subject design, which was appropriate due to the in-depth nature of the study. The study design was A-B-A-C-A-D-A; with “A” representing the balance scores as indicated by the Four-Square-Step Test, and the Timed-Get-Up and Go test, “B” representing the first intervention phase (Nintendo® Wii Fit™ and walking), “C” representing the second intervention phase (Nintendo® Wii Fit™ only) and “D” representing the third intervention phase (walking only) (Kielhofner, 2006).

Inclusion/exclusion criteria

Due to the single-subject design of the research study, it was important to have clearly defined inclusion and exclusion criteria to ensure an ideal candidate was selected. The inclusion criteria were based on the location of the study and the population of interest. The inclusion criteria included: any individual who was over the age of 60 years, a resident of Pitt County, North Carolina, and an individual who had a neurological or medical condition which affected balance. The exclusion criteria included: any individual who did not speak English, any individual who was unable to follow simple directions, stand for at least 25 minutes, and/or any individual who had a serious fall in the past six months that required a hospitalization of more than three days, or resulted in a fracture. To ensure the participant was cognitively intact, any individual who scored 26 points or less on the Mini-Mental State Examination would not be selected for participation. The exclusion criteria were designed to ensure the potential participant was safe to participate in the study, and able to understand instructions, the purpose of the study, and potential risks.

Population

The study was a single-subject design; the participant was selected through convenience sampling. A faculty member of the Occupational Therapy Department at East Carolina University suggested her father would be an ideal candidate. The researcher contacted the faculty member's father to further discuss the research study and ensure he met the inclusion criteria. The candidate was interested, met the inclusion criteria, and was selected to be the participant for the study.

The participant, John (a pseudo-name) was 68 years of age and had recently retired. He was a very active older man, and walked approximately three miles a day. John stated he was a former marathon runner and he valued remaining active as he aged. John had never used the Nintendo® Wii™ or the Wii Fit™, but expressed interest in learning how to play the Wii Fit™.

John has a neurological condition, known as Myasthenia Gravis (MG). Though his condition is currently being managed by medication, he believes his balance definitely has worsened since his diagnosis of MG. At the time of the study, John stated he had fallen once in the past 12 months, when he tripped down the stairs in the garage while rushing to pack up the car before a vacation. He did not sustain an injury. John commented he was concerned he would fall again and used more caution when completing daily activities. The participant was at an increased risk for falling because he was taking four or more medications, was over the age of 60, had a neurological condition, and had a history of falling.

Myasthenia Gravis

Myasthenia Gravis is a rare condition, identified in two-to-four cases in one million and affects individuals between 20 and 40 years of age or between 60 and 80 years of age (Leonardi, et al., 2009). Myasthenia Gravis is an autoimmune neurological disease that causes a disruption in transmission of the neurotransmitter acetylcholine resulting in a decrease in acetylcholine receptors (Chau, McLoughlin, Sharma, 2000; Davidson, Hale, Mulligan, 2005). The decrease in receptors causes weak muscle contractions and less muscle cell depolarization (Davidson, Hale, Mulligan, 2005), which results in fluctuating weakness of the skeletal muscles and causes fatigue (Leonardi, et al., 2009). Myasthenia Gravis can also affect eyelid movement, chewing, swallowing, and facial expressions (Leonardi, et al., 2009; National Institute of Neurological Disorders and Stroke, 2009).

Individuals with MG typically have difficulties performing activities of daily living or working, due to decreased muscle endurance, pain, or fatigue (Leonardi et al., 2009). The limitation in activities can vary depending on the fluctuation of the disease, extent of muscle involvement, effectiveness of therapy, and the level of support from family or other individuals (Leonardi et al., 2009; Raggi et al., 2010). Individuals with severe MG have a decreased health-related quality of life and a higher level of disability (Raggi, et al., 2010).

Myasthenia Gravis and Falls

Myasthenia Gravis causes a decrease in functioning acetylcholine receptors and abnormalities with neuromuscular junction transmissions (Chau, McLoughlin, Sharma, 2000); which results in a fluctuation of distal and proximal muscle weakness (Horlings, Engelen, Allum & Bloem, 2008). These muscle fluctuations are often progressive and increase a risk-for-falling (Horlings, et al., 2008). Proximal muscle weakness can cause a person to fall because of an inability to correct balance after an initial loss of balance. Distal muscle weakness could contribute to a fall due to a weakness in the ankles, causing an inability to overcome an obstacle or an increase in stumbling or shuffling the feet (Horlings, et al., 2008). Additionally, muscle weakness can cause an abnormal postural alignment, which changes a person's center of mass and causes difficulty with balance (Horlings, et al., 2008). Also, MG can cause sensory impairments, in the visual or vestibular systems, which impair balance and can lead to a fall (Horlings, et al., 2008). It is recommended for health care professionals to screen individuals who have neurological conditions, provide interventions to help clients manage MG, and encourage clients to partake in strengthening exercises to reduce muscle weakness and help reduce an individual's risk for falling.

Myasthenia Gravis and Exercise

Exercise can be effective in managing MG and other neuromuscular diseases by maintaining an individual's muscle strength, which minimizes muscle atrophy (Davidson, Hale, & Mulligan, 2005). Various forms of exercise, such as flexibility, strengthening, aerobic, and balance exercises, can have specific benefits for individuals with neuromuscular disease, such as MG (Krivickas, 2003). Flexibility exercises help prevent muscle contractures. Strengthening exercises can improve muscle strength, without causing damage to the muscles, which can help the person maintain independence and performance of valued activities (Krivickas, 2003). Aerobic activities can improve quality of life, improve sleep patterns, increase independence in activities of daily living, and help prevent secondary diseases, such as heart disease, cancer, and diabetes (Krivickas, 2003). Balance is typically impaired for individuals with MG due to sensory neuropathy, spasticity, and muscle weakness, and balance exercises may help reduce falls (Krivickas, 2003).

Studies have indicated that exercise, such as low impact aerobics and lower extremity strengthening, can be effective in reducing fatigue and can increase the ability to participate in activities of choice among individuals with MG (Davidson, et al., 2005). Davidson and colleagues (2005) conducted a research case study with a 78-year-old male with MG, who initially reported a lack of muscle strength, unsteadiness while walking, and fatigue. After participating in a six-week exercise program, which consisted of a combination of aerobic activities and muscle endurance, the participant's endurance increased, and he was able to return to his activities of choice (Davidson et al., 2005).

Risks

It was anticipated this study would help improve the participant's balance; thus, reducing his risk of falling. There were no psychological, economic, social, legal, or dignitary risks to the participant, and no illegal information was revealed during the study. To reduce any potential embarrassment and maintain privacy, the researcher was not present while the participant completed the body mass index and weight measurements on the Nintendo® Wii Fit™. The study took place in the participant's home and only the participant and researcher were aware of progress made throughout the study. To reduce the risk of fatigue, the participant was encouraged to take breaks as frequently as needed; this time did not count towards the overall session. There were no requirements for breaks during each session; however, the informed consent document stated for the participant to stop playing the Wii Fit™ if he felt tired and to rest as long as needed.

Instruments

Timed Get Up and Go

The Timed Get Up and Go Test (TGUG) (Podsiadlo & Richardson, 1991) assesses functional mobility for community-dwelling older adults (see Appendix D). It is a simple and concise assessment, which requires minimal equipment, and can be used to measure change in functional mobility over time (Podsiadlo & Richardson, 1991). The TGUG measures the time required for an individual to stand up from an armchair, walk a distance of 10 feet, turn around, then walk back, and sit down (Podsiadlo & Richardson, 1991). Individuals who perform the TGUG in 10 seconds or less are identified as freely mobile (Podsiadlo & Richardson, 1991).

The TGUG score can provide information regarding an individual's risk for falling and functional capacity (Podsiadlo & Richardson, 1991). Older adults who complete the test in less than 20 seconds typically walk at a sufficient gait speed, and are usually independent for daily living activities, transferring in and out of the shower, climbing stairs, and crossing the street (Shumway-Cook, Brauer, & Woollacott, 2000; Podsiadlo & Richardson, 1991). In contrast, older adults who complete the TGUG test in 30 seconds or longer walk at a slower gait speed, require a walking aid for ambulation, and typically need assistance for activities of daily living, tub or shower transfers, crossing the street or climbing stairs (Shumway-Cook, Brauer, & Wollacott, 2000; Podsiadlo & Richardson, 1991). For community-dwelling older adults, a TGUG score of 13.5 seconds or greater indicates an increased risk for falling with a 90% prediction rate (Shumway, et al., 2000). However, a TGUG score of 11.1 seconds indicates an increased risk for falling in middle-to-old aged adults, (average age 60) who have a vestibular disorder (Whitney, Marchetti, Schade, Wrisley, 2004). In a study by Whitney et al., (2004), adults with a vestibular disorder who scored greater than 11.1 seconds on the TGUG were significantly more likely ($p= 0.001$) to have fallen in the past 6 months, compared with those who scored less than 11.1 seconds (Whitney, et al., 2004).

For community-dwelling older adults, the TGUG 13.5 second cut-off level had a sensitivity and specificity of 87% for correctly classifying individuals as fallers versus non-fallers (Shumway-Cook, Brauer, & Wollacott, 2000). For middle-to-old aged adults with a vestibular disorder, the 13.5 second cut-off value of the TGUG had a sensitivity of 46.7%; however, the 11.1 second cut-off level showed a sensitivity of 80% (Whitney, et al., 2004). This indicates the 11.1 second cut-off is more sensitive to classify a person with a vestibular disorder at-risk for falling (Whitney, et al., 2004).

The TGUG is strongly reliable with inter-tester reliability ranging from 0.99 to 0.97 and test-retest reliability of .99 (Podsiadlo & Richardson, 1991; Whitney, et al., 2004). This indicates small discrepancy of scoring between different testers, and consistency of the TGUG to provide a similar score over time with the same tester and client without an intervention (Podsiadlo & Richardson, 1991).

To confirm validity, scores on the TGUG were compared to other assessments of functional mobility, and balance (Cho, Scarpace, Alexander, 2004; Lin et al., 2004; Podsiadlo & Richardson, 1991). The TGUG was compared to the Berg Balance Scale (BBS) (Berg, Wood-Dauphinee, and Williams, 1989), Tinetti gait test (Tinetti, 1986), and the Activities-Specific Balance Confidence Scale (ABC) (Powell & Myers, 1995). There were negative correlations between the TGUG and the BBS (r= -0.81), Tinettti gait measure (r= -0.53) and ABC (r= -0.61) (Cho, Scarpace, Alexander, 2004; Lin et al., 2004; Podsiadlo & Richardson, 1991). This correlation was in the expected direction, as higher scores on the BBS, Tinnetti gait, and ABC indicate better balance, functional mobility, (Berg, et al., 1989; Tinetti, 1986), and greater balance confidence (Powell & Myers, 1995); whereas lower scores on the TGUG indicates better mobility (Podsiadlo & Richardson, 1991; Shumway-Cook, et al., 2000).

The TGUG was also compared to the Barthel Index of Activities of Daily Living (Barthel, Mahoney, 1965), a valid and reliable measure of an individual's functional capacity for self-care, continence, and mobility (Barthel & Mahoney, 1965). The TGUG correlated well with the Barthel Index (Pearson r= -0.78) (Podsiadlo & Richardson, 1991). This correlation was in the expected direction, as a higher score on the Barthel Index indicates greater independence

(Barthel & Mahoney, 1965) and a lower score on the TGUG indicates greater independence for mobility (Podsiadlo & Richardson, 1991).

Additional support of validity was confirmed by comparing TGUG scores with individuals who have fallen versus those who have not fallen (Whitney, et al., 2004). The TGUG scores were also compared to gait speed and distance for walking (Podsiadlo & Richardson, 1991). The TGUG showed a significant difference in scores between non-fallers versus fallers ($p < 0.02$) (Whitney, et al., 2004). There was also a negative correlation between a participant's score on the TGUG and his or her gait speed per second ($r= -0.61$) (Podsiadlo & Richardson, 1991) and distance for walking ($r= -0.752$) (Cho, Scarpace, Alexander, 2004).

The TGUG is a valid and reliable assessment of functional mobility, balance, fall-risk, and level of independence for community-dwelling older adults (Shumway-Cook, Brauer, & Wollacott, 2000, Lin, et al., 2004, Podsiadlo & Richardson, 1991).

Four Square Step Test

The Four Square Step Test (FSST) (Dite & Temple, 2002) is a clinical test which assesses an individual's ability to rapidly step in various directions over low obstacles placed on the floor (see Appendix E). The FSST requires minimal time, space, and equipment; it uses four canes, placed on the floor in a cross pattern, to create four squares (Dite & Temple, 2002). The current research study used four PVC pipes, which were connected in the middle to form four squares. Additionally, one side of the device was covered in black electrical tape, whereas the other side was white, to ensure contrast against a light or dark carpet or floor. The pieces of PVC pipe were cut to the appropriate length of 90 cm, as described in research by Dite and Temple, 2002 and were similar in height to a cane. The examiner records the time required for the participant to step in each square with both feet as fast as possible without touching the canes

(Dite & Temple, 2002). To complete the sequence, the participant has to step to the left, right, back, and front while facing forward and the sequence is completed in a clockwise direction, then a counterclockwise direction (Dite & Temple, 2002). If a participant loses balance, touches the canes, or is not able to complete the test, he or she is allowed another trial (Dite & Temple, 2002).

The FSST provides relevant information regarding an individual's ability to plan, step, and change directions (Blennerhassett & Jayalath, 2008). For community-dwelling older adults who have fallen, a score of greater than 15 seconds indicates an increased risk of falling (Dite & Temple, 2002); however, a cut-off score of 12 seconds is suggested for middle-to-older aged adults, with an average age of 64, who have a vestibular dysfunction are at-risk for falling (Whitney, Marchetti, Morris, Sparto, 2007).

The FSST has a sensitivity of 89% for correctly identifying multiple fallers and a specificity of 85% for correctly classifying non-multiple fallers, using the 15 second cut-off level (Dite & Temple, 2002). For community-dwelling older adults, the FSST has excellent reliability, with an inter-rater reliability of 0.99 and test-retest reliability of 0.98, indicating consistency of scores between testers and over time (Dite & Temple, 2002). The FSST is also reliable for those who have a vestibular dysfunction, with a test-retest reliability of 0.93 (Whitney, et al., 2007). There was a significant difference ($p < .01$) between the FSST scores for middle-aged adults at-risk for falling versus those who were not at-risk for falling (Whitney, et al., 2007). The 12 second cut-off showed a sensitivity of 80% and a specificity of 92% for correctly identifying middle-older adults who are at-risk for falling due to a vestibular dysfunction (Whitney, et al., 2007).

To determine the validity, the FSST was compared to other reliable and valid measures of balance, which included the Step Test (Hill, Bernhardt, McGann, Maltese, & Berkovits, 1996), the TGUG, and the Functional Reach Test (Duncan, Weiner, Candler, Studenski, 1990). A higher score on the Step Test or Functional Reach Test indicates better balance, stability, and a reduced risk for falling (Duncan, et al., 1990; Hill, et al., 1996). There was a strong negative correlation between the FSST and Step Test ($p= -0.83$) (Dite & Temple, 2002). There were significant correlations ($p< 0.01$) between the FSST and Functional Reach Test ($r= -0.47$), and the FSST and gait stability ($p= -0.51$) (Dite & Temple, 2002; Whitney, et al., 2007). These correlations indicate a lower score on the FSST correlates with a higher score on the Step Test or Functional Reach Test, and decreased gait stability (Dite & Temple, 2002; Whitney, et al., 2007). There was a strong positive correlation between the FSST and the TGUG ($r= 0.88$) (Dite & Temple, 2002), and a significant ($p< 0.01$) positive correlation between the FSST and gait speed ($p=0.65$) (Whitney, Marchetti, Morris, and Sparto, 2007). This indicates an increase in the time required to complete the FSST correlates with a slower gait and an increased time to complete the TGUG.

As confirmed through research, the FSST is a valid and reliable assessment of dynamic balance by measuring an individual's ability to rapidly step in various directions (Blennerhassett & Jayalath, 2008; Dite & Temple, 2002; Whitney, et al., 2007).

Survey of Activities and Fear of Falling in the Elderly

The Survey of Activities and Fear of Falling in the Elderly (SAFE) (Lachman, et al., 1998) is used to assess a fear of falling, and the impact of this fear in relation to activity restriction and a decreased quality of life (see Appendix F). The SAFE consists of 11 activities, which represent typical activities of daily living, instrumental activities of daily living, mobility, and social activities (Lachman, et al., 1998). It includes activities such as: taking a bath, going to the store, walking for exercise, getting out of a vehicle, visiting friends or going to events with crowds (Lachman, et al., 1998). The SAFE determines if an individual has a fear of falling while performing these activities, and any activity restriction resulting from this fear (Lachman, et al., 1998). The SAFE assumes a fear of falling is not problematic, unless it leads to sedentary behavior, activity restriction, affects good judgment, and/or causes a person to be preoccupied by worrying about a fall (Lachman, et al., 1998).

For each activity, an individual rates his or her fear of falling based on a Likert scale, ranging from one-to-four, with four indicating the person is "very worried" that he or she might fall when completing an activity. Additionally, the individual's activity restriction is measured by determining if the person avoids an activity for a fear of falling, or if he or she has other reasons for not completing an activity (Lachman, et al., 1998). The overall fear of falling score is averaged, with a range from 0-to-3, a higher score indicating a greater fear of falling. The activity restriction score is calculated by counting all the activities a person avoids due to a fear that he or she will fall, with a range from 0-to-11, a higher score indicating greater activity restriction (Lachman, et al., 1998).

The SAFE has excellent internal reliability of 0.91-0.95, indicating this assessment consistently measures fear of falling and activity restriction; and test-retest reliability of 0.95, indicating consistent test scores over time with multiple test administrations (Lachman, et al., 1998; Talley, Wyman, Gross, 2008).

To determine validity, the SAFE was compared with other measures of fear of falling and demographic information. There was a significant correlation between the SAFE and the Tinetti Falls Efficacy Scale (Tinetti, et al., 1990) (r= -0.76). This correlation was in the expected direction, as a lower score on the Tinetti Falls Efficacy Scale indicates a fear of falling, and a higher score on the SAFE indicates a fear of falling (Lachman, et al., 1998). There was a significant ($p < 0.001$) negative correlation between the SAFE and the ABC ($r = -0.65$). As confidence in balance increased, as measured by the ABC scale, there was a decrease in a fear of falling, measured by the SAFE (Talley, et al., 2008). There was also a significant ($p < 0.001$) negative correlation between the SAFE and Berg Balance Test ($r = -0.43$). This correlation was in the expected direction, as a higher score on the Berg indicates better balance and functional mobility, and a lower score on the SAFE indicates a decreased fear of falling (Talley, et al., 2008).

Empirical validity of the SAFE was supported by comparing SAFE scores to previous research that increases a person's fear of falling. There was a negative correlation between the SAFE, gait speed ($r = -0.36$), and assistive device use ($r = -0.36$); whereas there was a positive correlation between the SAFE scores and the TGUG ($r = 0.41$), Geriatric Depression Scale (Sheikh & Yesavage, 1986) ($r = 0.33$), and number of medical conditions ($r = 0.25$). These correlations were significant ($p < 0.001$) and consistent with previous research on fear of falling, as individuals with a fear of falling walk slower, use assistive devices, score higher on the TGUG, have a higher depression rating, and have more medical conditions (Talley, et al., 2008). Also, a higher SAFE score was found for individuals over the age of 76, women, and those with a history of falling, which is consistent with previous research (Lachman, et al., 1998). Also, a higher fear of falling score on the SAFE was correlated with a poorer quality of life, physical functioning, and mental health, and a decrease in leisure activities and social relationships (Lachman, et al., 1998).

Construct validity of the SAFE was confirmed through an appropriate correlation between a higher score on the SAFE and engagement in fewer activities (p= -0.57) and a reduction of activities over the past 5 years (p= -0.57) (Lachman, et al., 1998). This indicates the SAFE is able to accurately assess an individual's fear of falling and activity restriction. Furthermore, there was a significant difference between the groups of individuals who indicated no fear of falling and individuals who limited activities due to a fear of falling (Lachman, et al., 1998).

As confirmed through research, the SAFE is a valid and reliable assessment of fear of falling and activity restriction in older adults (Lachman, et al., 1998; Talley, et al., 2007).

Canadian Occupational Performance Measure

The Canadian Occupational Performance Measure (COPM) (Law, et al., 1994) is a semi-structured interview which determines a change in a client's self-perception of occupational performance after an occupational therapy intervention (see Appendix G). The COPM is individualized for the client, and the therapist and client collaborate to determine problems with occupational performance (Law, et al., 1994). The COPM can also be used to evaluate the effectiveness of an occupational therapy program (Law, et al., 1998). Most clients report the COPM helped to identify their specific problems, as opposed to typical problems related to their diagnosis or disability, and they found the instructions and ratings easy to understand (McColl, Paterson, Davies, Doubt, & Law, 2000). The COPM provides the therapist with pertinent information regarding a client's specific problems with occupational performance, which cannot be obtained with other standardized measures (Dedding, Cardol, Dekker & Beelen, 2004). Though originally established in Canada, the COPM has been recognized internationally, as an important assessment for client-centered occupational therapy intervention and outcomes (Dedding, et al., 2004; McColl, et al., 2000).

The COPM typically takes approximately 30-to-45 minutes to administer. The COPM is tyically conducted prior to occupational therapy intervention for identifying a client's problems, and after therapy, to determine changes in occupational performance (Law, et al., 1994). The COPM consists of four steps; step one involves identification of occupational performance problems, step two involves rating the importance of these occupations, step three is the scoring process, and step four is the re-assessment. For step one, the therapist asks the client to think about a typical day and identify valuable occupations in the areas of self-care, productivity and leisure. Then the client identifies the occupations that are most challenging or problematic to complete (Law, et al., 1994). For step two, the therapist asks the client to rate the importance of each occupation on a scale of 1-to-10; with one representing "not important at all" and ten representing "extremely important". The third step involves scoring the performance and satisfaction of the five most important occupations (Law, et al., 1994). The client rates his or her current levels of performance and satisfaction using a scale of 1-to-10, with one representing "not able to do it at all" and "not satisfied at all" and ten representing "able to do it extremely well" and "extremely satisfied" (Law, et al., 1994). These scores are used to determine the client's initial self-perception of occupational performance. Step four is the re-assessment phase, which is completed after the occupational therapy intervention, and the client rates his or her current level of performance and satisfaction, with the same 1-to-10 scale used previously. The occupational therapist calculates the difference between the initial scores and the scores on the re-assessment to determine the client's change in occupational performance (Law et al., 1994).

The test-retest reliability of the COPM is 0.63 for the performance measure and 0.84 for the satisfaction measure (Law, et al., 1994); this indicates good consistency for scoring after multiple trials. The inter-rater reliability for identifying problems was 0.80; however, the inter-rater reliably for identifying the most important problems was 0.66. This indicates consistent problem identification with multiple administrators, but a difference for identifying the most important problems. Though the inter-rater reliability is adequate, it is recommended for the same occupational therapist to administer the initial COPM and the COPM after therapy services (Eyssen, et al., 2005).

To determine validity, the initial scores of the COPM were compared to COPM scores after therapy; there was a significant difference between the scores (p= <0.0001). This supports the construct validity of the COPM to accurately measure a change in self-perception of occupational performance (Law, et al., 1994). The COPM was also compared to a simple 7-point Likert scale of a client's rating of occupational performance. The COPM scores were correlated with a client's rating of performance (p= 0.62) and satisfaction (p= 0.53) and the family's rating of performance (p= 0.55) and satisfaction (p=0.56). This supports the accuracy of the COPM for measuring a client's self-perception of occupational change or measuring a change in function when used with the client's family (Law, et al., 1994).

The COPM was more sensitive for detecting a change in the client's self-perception of occupational performance than the Structured Activities of Independent Living Scale (Mahurin, Bettignies & Pirozzolo, 1991) and the Older Adults Resource Scale (Fillenbaum, 1988) (Law, et al., 1994). Also, the COPM was more specific then the Sickness Impact Profile (SIP68) (Post, DeBruin, Witte, & Schrijvers, 1996) and the Disability and Impact Profile (DIP) (Lankhorst, Jelles, & Smith, 1996) for identifying occupational performance problems, with 81 problems identified with COPM, which were not included in the SIP68 or the DIP (Dedding, et al., 2004). There was a positive correlation between the COPM and the satisfaction with performance rating (SPSQ) (Yerxa, et al., 1988), reintegration to normal living (RNL) (Wood-Dauphinee, et al., 1988), and life satisfaction (LSS) (Michalos, 1980). However, these correlations were low-moderate, which indicates consistency of problem identification, but shows the unique quality of the COPM to measure occupational performance (McColl, et al., 2000).

As indicated by evidence from supporting research, the COPM was confirmed to be a valid and reliable measure of a client's self-perception of occupational performance within the community (Dedding, et al., 2004; Law, et al., 1994; McColl, et al., 2000).

Mini-Mental State Examination

The Mini-Mental State Examination (MMSE) (see Appendix H) is a quantified assessment of cognitive state, which provides an objective measure of cognition (Folstein, M, Folstein, S., & McHugh, 1975). The MMSE is a simple, concise assessment, and is presented at a second grade reading level, making it easy to understand (Nieuwenhuis-Mark, 2010). The MMSE is the only cognitive assessment that has been internationally accepted to assess cognition and dementia in older adults (Brayne, Chatfield, & Matthews, 2007). Though established nearly 36 years ago, the MMSE continues to be used as a screening tool for detecting dementia and cognitive changes (Nieuwenhuis-Mark, 2010). It contains 11 questions that relate to various cognitive components, and the maximum score is 30, indicating no cognitive impairment. The first section of the MMSE requires a verbal response from the participant and covers memory, attention and orientation; the second section of the MMSE involves writing a sentence, copying a complex shape, and following verbal and written instructions (Folstein, et al., 1975).

A score of 24 on the MMSE indicates an older adult has a cognitive impairment (O'Bryan, et al., 2008); however, a cutoff level of 27 has been recommended when detecting for mild cognitive impairments in highly educated older adults (O' Bryant, et al., 2008). Additionally, researchers determined the appropriate MMSE cut-off levels to use when classifying individuals into specific categories of cognitive impairment: a score of 30 indicates no dementia; scores ranging from 26-29 indicate questionable dementia; scores from 21-25 indicate mild dementia; scores of 11-20 indicate moderate dementia; and scores of 0-10 indicate severe dementia (Perneczky, et al., 2006).

The MMSE has an inter-rater reliability of 0.827, and test-retest reliability, ranging from 0.98 to 0.88, which indicates excellent consistency of scoring with multiple administrators and over multiple trials (Brayne, Chatfield, & Matthews, 2007; Folstein, et al., 1975).

The concurrent validity of the MMSE was confirmed by a statistically significant ($p < 0.001$) difference in the scores on the MMSE between older adults with normal cognition, and those with dementia (Folstein, et al., 1975). The MMSE accurately identified the presence of a cognitive impairment and the severity of impairment (Folstein, et al., 1975). The MMSE is most sensitive for accurately detecting severe dementia with a 95% detection rate (Borson, Scanlan, Watanabe, Tu, & Lessig, 2005) and an accuracy of 81-89% for detecting mild dementia (Borson, et al., 2005; O' Bryant, 2008).

The MMSE has a sensitivity of 87% and a specificity of 82%; indicating it is accurate for distinguishing between a cognitive impairment and normal cognition (Kilada, et al., 2005). The MMSE can be used in a variety of settings, such as, memory clinics, hospital settings, primary care, and community settings; however, the scores have different implications. When used in community settings, the MMSE has a negative predictive value of 95.7-98.5%, indicating it is most sensitive for determining those not-at-risk for dementia. When used in a specialty clinic, however, the MMSE is most sensitive in detecting those at-risk for developing dementia, with a positive predictive value of 94.6% (Mitchell, 2009). For use as a clinical measure, the MMSE is a valid measure for determining cognitive changes for individuals who are recovering from an injury that affects memory, or for individuals with dementia (Folstein, et al., 1975).

To determine construct validity, the MMSE was compared to the Clinical Dementia Rating (CDR), which is a valid and reliable assessment of cognitive impairment (Sheikh, Yesavage, 1986). A Cohen kappa measure was used to determine the agreement of between the MMSE score and the CDR stage, with a higher score representing better agreement (Perneczkly, et al., 2006). There was substantial agreement between the MMSE and CDR for detecting mild dementia ($k= 0.62$), moderate dementia ($k= 0.69$), or severe dementia ($k= 0.76$); however, the agreement was fair ($k= 0.28$) for detecting questionable dementia (Perneczky, et al., 2006). This confirms the construct validity of the MMSE to accurately classify an individual as having mild, moderate, or severe dementia (Perneczky, et al., 2006). Also, the MMSE was compared to the Wechsler Adult Intelligence Scale (Wechsler, 1955), a standard test of cognition. There were positive correlations between the MMSE and the Wechsler Adult Intelligence Scale Verbal IQ ($r= 0.776$; $p < 0.0001$) and the Wechsler Adult Intelligence Scale Performance IQ ($r= 0.660$; $p< 0.001$), indicating the MMSE is a valid test of cognition (Folstein, et al., 1975).

Based on research, the MMSE is a valid and reliable assessment to determine cognitive function, and is the most common assessment used to screen for dementia in older adults (Folstein, et al., 1976; Hughes, Berg, & Danziger, 1982; Kilada, et al.,2005; Mitchell, 2009; Perneczky, et al., 2006).

Fall Risk for Older People in the Community Assessment

The Fall Risk for Older People in the Community Assessment (FROP-Com) (National Ageing Research Institute, 2005; Russell, Hill, Blackberry, Day, & Dharmage, 2008) is a 26 question survey, which assesses a person's risk for falling, based on the severity and number of fall risk-factors (see Appendix I). The FROP-Com has simple instructions for administration and scoring, requires no equipment or specialized knowledge and can be administered in 10-15 minutes by health professionals in a variety of settings (Russell, et al., 2008). The FROP-Com is a comprehensive measure of fall risk, and includes 13 fall risk factors, such as: fall history, mobility, medical conditions, cognitive status, level of physical activity, and number of medications. Each question is scored on a scale of 0-to-3, with a higher score indicating an increased risk for falling (Russell, et al., 2008). The overall risk for falling is determined by adding all the question scores, with the total score ranging from 0-to-63 (Russell, et al., 2008). Based on this total score, an individual is classified into a low, moderate, or high risk for falling and guidelines are provided for interventions depending on an individual's fall risk (Russell, Hill, Blackberry, Day, Dharmage, 2008). A score of 0-to-15 indicates low fall risk, 16-to-24 indicates mild to moderate fall risk, and a score greater than 24 indicates a high fall risk. The FROP-Com recommends health professionals to address fall risk-factors and implement programs to help prevent development of additional risk factors (National Ageing Research Institute, 2005). The FROP-Com is easy to access and available for download at the National Aging Research Institute Website.

The FROP-Com has excellent reliability; with a test-retest reliability of 0.93, indicating consistent test scores over multiple trials, and an inter-rater reliability of 0.81, which supports consistency of test scoring with multiple test administrators (Russell, et al., 2008). The FROP-

Com has a specificity of 56.1% and sensitivity of 71.3%, indicating the FROP-Com is able to distinguish between individuals at-risk for falling and those who are not at-risk (Russell, et al., 2008). The FROP-Com successfully classified a group of older adults who required emergency department services after falling as high fall risk (Murray, Hill, Phillips, & Waterson, 2005). There was a significant difference in FROP-Com scores for fallers versus non-fallers ($p < 0.001$), with fallers scoring an average of 25.6 and non-fallers an average of 8.2 (Murray, et al., 2005).

The FROP-Com is significantly correlated with the Functional Reach Test ($r=0.50$; $p< 0.001$) and the TGUG ($p=0.62$; $p< 0.001$) (Russell, et al., 2008); indicating the FROP-Com is consistent with other assessments of balance and fall-risk. Higher scores on the TGUG, Functional Reach Test, and FROP-Com indicate an increased risk for falling. Also, there was a significant correlation ($r= 0.68$; $p< 0.001$) between the FROP-Com and the Human Activity Profile (Fix and Daughton, 1988) and the FROP-Com and the Modified Falls Efficacy Scale (Hill, Schwarz & Kalogeropoulous, 1996) ($p=0.54$; $p< 0.001$) (Russell, et al., 2008). Additionally, the FROP-Com, Functional Reach Test, TGUG, Human Activity Profile and Modified Falls Efficacy Scale showed significant differences between scores for fallers versus non-fallers (Murray, et al., 2005).

The FROP-Com has been confirmed as a valid and reliable measure of determining a person’s risk for falling (Murray, et al., 2005; Russell, et al., 2008).

Safety Assessment of Function and the Environment for Rehabilitation Tool

The Safety Assessment of Function and the Environment for Rehabilitation Tool (SAFER Tool) (Community Occupational Therapists and Associates, 1991) evaluates an older adult’s ability to safely participate in functional activities within their home environment (Letts & Marshall, 1995) (see Appendix J). The SAFER Tool is presented in a checklist format, which contains 97 items, which cover 14 domains of home safety, such as the general living situation, mobility of the environment, fire hazards, and the bathroom environment (Letts, Scott, Burtney, Marshall, & McKean, 1998). The SAFER Tool is typically administered during a home assessment by a therapist, who checks off each item, based on three categories: "addressed", "not applicable", or "problem". "Addressed" is checked off after each item has been reviewed by the therapist, and all items should be addressed during the SAFER administration. "Not applicable" is checked off if the item does not apply to the client's home, or living environment, and the "problem" category is checked if the therapist judges an item to be a potential safety concern for the client (Letts, et al., 1998). Additionally, there is an area for the therapist to record comments regarding additional information about the environment (Letts, et al., 1998). Health professionals can use the SAFER Tool to identify hazards in a person's home and provide recommendations to improve the overall safety of the home to prevent potential accidents (Letts & Marshall, 1995).

Inter-rater reliability was established by comparing scores between two therapists who administered the SAFER to a client. There was excellent agreement (k=0.80-to-1.00) for 53 items, substantial agreement (k=0.79-to-0.63) for 25 items, moderate agreement (k=0.41-to-0.62) for 14 items, and unacceptable agreement (k=0-to-0.40) for 5 items (Letts, et al., 1998). The items with unacceptable agreement for identifying problems were determined to be clinically important for assessing home safety (Letts, et al., 1998). Test-retest reliability was established by comparing scores between two administrations with the same therapist and client. There was excellent agreement (k=0.80-to-1.00) between the two scores for 59 items, substantial agreement (k=0.61-to-0.79) for 21 items, moderate agreement (k=0.41-to-0.60) for 10 items, and unacceptable agreement (k<0.40) for 10 items (Letts, et al., 1998). Overall, the inter-rater and test-retest reliability was sufficient; indicating the SAFER Tool is a reliable measure of an individual's safety within the home environment (Letts, et al., 1998).

The SAFER Tool has excellent internal validity with a score of 0.83, indicating it accurately evaluates items of importance for safety functioning within the home environment (Letts & Marshall, 1995). There was acceptable correlation ($r = -0.41$) between a cognitive impairment and more problems identified on the SAFE (Letts, et al., 1998). There was not an acceptable correlation ($r < 0.40$) between a person's SAFER score and independence for activities of daily living (Letts, et al., 1998). There were not significant differences between a person's SAFER score and living situation (Letts & Marshall, 1995).

Though there are some inconsistencies with measures of validity and reliability, the SAFER was confirmed to be a valid and reliable measure of older adults' ability to safely function within their home environment (Letts & Marshall, 1995; Letts, et al., 1998). Additionally, the SAFER provides a structured and comprehensive measure of home safety (Letts & Marshall, 1995).

Nintendo® Wii Fit™ balance board

There is limited supporting evidence on the Nintendo® Wii Fit™ for use as a balance test; however, research indicates the Nintendo® Wii Fit™ balance board may be a valid measure of standing balance (Bennell, et al., 2009; Yamada, et al., 2011). Bennell and colleagues (2009) compared a laboratory-grade force platform to the Nintendo® Wii Fit™ for measuring the center of pressure in young adults. Researchers found the Wii Fit ™ balance board has excellent test-retest reliability and has concurrent validity with the force platform (Bennell, et al., 2009). The Nintendo® Wii Fit™ balance board can be especially beneficial for measuring standing balance and center of pressure for individuals who have movement disorders or are recovering from lower extremity surgery. The Nintendo® Wii™ balance board has the potential to monitor a change in balance over a period of time to determine the effectiveness of a therapy intervention (Bennell, et. al., 2009). The Nintendo® Wii™ can provide specific information regarding a client's balance, which cannot be determined by a typical balance assessment (Bennell, et. al., 2009).

In a study by Yamada, et al. (2011), the Nintendo® Wii Fit™ was compared to other measures of balance. The "basic step" and "ski slalom" games on the Wii Fit™ were selected, as these games could be played from a sitting position. Both games had acceptable test-retest reliability, with 0.78 for the basic step and 0.61 for the ski slalom. Additionally, there was a significant difference ($p < 0.001$) between scores on the basic step for fallers versus non-fallers. A score of 111 points on the basic step correctly distinguished between fallers and non-fallers with an 88.6% accuracy (Yamada, et al., 2011). Researchers indicated the basic step has good generality for community-dwelling older adults and the basic step is a feasible measure of fall-risk (Yamada, et al., 2011).

Equipment

The Occupational Therapy Department of East Carolina University loaned the participant with a Nintendo® Wii™ gaming console, including Wii™ remotes, the Wii™ Sports basic game, and a Wii Fit™ balance board and game for the duration of the study. The Nintendo® Wii™ gaming console retails for $199.99 and the Nintendo® Wii Fit™ retails for $99.99. The participant's own television was hooked up to the Nintendo Wii™ gaming console.

Nintendo® Wii™

The Nintendo® Wii™ was first publically released on November 19, 2006. The system was designed to interest all populations and ages. It has a unique wireless remote controller, which detects the user's movements and registers these movements to the Nintendo® Wii™ console (Wii, 2011). The Wii™ remote uses a combination of accelerometers and infrared detection to determine its position in space when pointed at the sensor bar. This unique design allows the user to control the game through physical arm gestures and using traditional buttons on the remote (Wii, 2011).

Nintendo® Wii Fit ™

The Nintendo® Wii Fit™ is an exercise-based video game that consists of various activities, such as strength training, balance games, aerobics and yoga. The Wii balance board™ is utilized while playing the Wii Fit™, and the technology registers an individual's shift in weight, then communicates this to the Wii™ system. The user controls the video game through weight-shift, balance, and other means, and the virtual character in the video game responds to these changes registered by the Wii™ balance board (Wii, 2011). For example, if an individual shifts his or her weight to the right, the virtual character moves to the right. The Wii balance board™, along with the Wii Fit™ game, can be used to determine the user's weight, body mass index, Wii Fit™ age, and balance score (Wii, 2011).

Procedure

The study began after IRB permission was granted from the University and Medical Center Institutional Review Board (see Appendix A). Prior to the study, informed consent was obtained from the participant (see Appendix B) and the researcher addressed the participant's questions regarding the study. The participant also signed a consent document that gave permission for him to be photographed or videotaped during the research study (see Appendix C). These consent documents were gathered in the privacy of the participant's home, with his wife serving as the witness. The participant received a copy of the informed consent document for his records, with the researcher's contact information. The researcher provided the participant with an in-depth explanation of the research study and discussed any possible risks. The researcher explained to the participant he was not obligated to participate in the study and could quit at any time, if he desired. The researcher also explained he was not obligated to complete a session if he was not feeling well or felt fatigued, dizzy, or off-balance.

Prior to the first session, the researcher conducted the MMSE to ensure the participant was cognitively intact and did not have any dementia or memory impairments. The participant scored a 30/30 on the MMSE, indicating he did not have any cognitive impairments (Green, Knight, McMahon, & Skeaff, 2006).

In order to ensure a safe environment for the research study, the researcher completed the "Living Situation" portion of the SAFER tool. After completing the SAFER assessment and examining the home environment, the researcher concluded there were no home safety problems in the participant's house and no home modifications were needed to be made. The researcher determined the living room of the participant's house was an ideal location for the research study with adequate space and lighting.

The first session of the study consisted of determining the baseline scores for balance and fear of falling. The researcher conducted the balance pre-assessments, which included: the FSST, the TGUG test, and the "balance test" on the Nintendo® Wii Fit™. To help prevent a fall, the participant wore a gait belt during these assessments. These three balance assessments served as a baseline to determine the participant's balance and risk for falling prior to the research study. The TGUG and FSST were also administered at the end of the research study. The balance assessments involved some physical activity and the participant was allowed to take a break between each of the assessments. Following the balance assessments, the researcher conducted the FROP-Com tool and the SAFE to determine the participant's risk for falling and his fear of falling. These two assessments are in a questionnaire format and did not involve any physical activity. The two questionnaires were completed prior to the study to serve as pre-assessments and were completed after the study, as post-assessments. Lastly, the COPM was completed, to determine the participant's motivation and satisfaction with walking. The COPM was administered prior to each phase and at the conclusions of each phase.

After completion of the assessments, the researcher set-up the Nintendo® Wii Fit™, on the participant's living room television. The researcher educated the participant on the use of the Nintendo® Wii Fit™ and demonstrated each of the balance games. The participant practiced the balance games, and the researcher addressed the participant's questions regarding how to play the games.

There were a total of three phases to the research study; phase 1 represented the first intervention, with two variables: 1) playing the Nintendo® Wii Fit™ games; and 2) walking outside. Phase 2 represented the second intervention, with only one variable: playing the Nintendo® Wii Fit™ games. Phase 3 represented the control: only walking outside and not playing any Nintendo® Wii Fit™ games. The research study took place in the privacy of the participant's home and the researcher did not need to be present during the individual sessions of the study, to allow flexibility in terms of playing the Nintendo® Wii Fit™ games. The researcher requested the participant to always have a phone within reach when he played the Nintendo® Wii Fit™ games and to carry his cell phone while walking, in case of an emergency.

Phase 1

During phase 1, the participant walked outside, for his typical duration of 60 minutes, and played the Nintendo® Wii Fit™ games. Originally, the researcher stated the participant would play the Wii Fit™ games for 15 minutes during each session; however, when communicating with the participant regarding his weekly progress, the participant commented he found 15 minutes not an adequate time to play the Wii Fit™ games. After consulting with the researcher's advisor, it was agreed the participant could play the Wii Fit™ games for up to 60 minutes each session, taking breaks as needed. There were a total of 30 sessions in phase 1, and the participant played the Wii Fit™ games for five days a week, over a time frame of two consecutive months. For each session, the participant recorded the date, and time spent playing the balance games, the score for the games played, and qualitative information regarding how he felt about each session (see appendix K). The researcher contacted the participant weekly to ensure the research study was going well and to address any questions or concerns. Prior to each gaming session, the balance test on the Nintendo® Wii Fit™ was conducted and the participant recorded the results.

The participant could play the Nintendo® Wii Fit™ games any time of the day, and there were no requirements as to the order of the games or the specific games the participant played. The flexibility of study was designed so the Wii Fit™ could be a feasible addition to the participant's routine and to avoid boredom from having a specific protocol for the games that were played. Each of the balance games required the participant to quickly shift his weight to the left, right, front, or back to achieve the goals of the game; however, the games varied in difficulty level and physical demands. Some games required only a lateral weight shift, whereas other games required an anterior weight shift in addition to a medial or later shift in weight. As the participant played the games, the level of difficulty of the games increased and more advanced, challenging levels could be played.

The participant also needed good visual-motor skills to visually-attend to the items on the television screen and respond accordingly. The ability to attend to a variety of stimuli was also required; the participant had to be able to disregard extraneous distractions in the environment and respond to visual and auditory stimuli in the video game. Typically, the participant played each balance game multiple times during each session.

The participant had a choice between the following basic balance games: “soccer heading”, “ski slalom,” “ski jump,” “table tilt,” “tightrope walk,” and the following advanced games: “balance bubble,” “penguin slide,” and “snowboard slalom.” The advanced games were unlocked after playing the basic games. The only balance game the participant did not play was the “lotus focus” game, as it does not require standing balance or weight shift.

Soccer heading game

The “soccer heading” game required the participant to quickly shift his weight to the right and left to hit the soccer balls and to avoid hitting the cleat-shoes or panda bears. If the participant hit one of the items that was not a ball, such as a shoe, the participant lost points. This game required an ability to differentiate between the soccer balls and panda bear heads (which are the same color and shape as the soccer balls), and to quickly shift the weight in the desired direction.

Ski slalom game

The “ski slalom” game required the participant to shift his weight to the front, back, left and right. The participant stood on the balance board and had to shift his weight to the right or left, for his character to ski through the various flags on the screen. The participant gained points if he successfully skied through the flags, and lost points if he missed the flags. By shifting his weight to the front of his body (placing more weight on the balls of his feet), the avatar on the television screen traveled more quickly down the ski slope.

Ski jump

The "ski jump" game required the participant to lean forward, with both knees bent and arms extended while moving quickly down a steep hill. If the participant shifted his weight to the balls of his feet, the Wii™ character moved more quickly down the slope. When the character on the television screen reached the end of the hill, the participant had to quickly extend both knees and stand still while the virtual character flew through the air, reaching the end of the ski slope. The participant had to stand still and not shift weight in order to obtain a high score. If the participant was too unsteady, he received a low score. If the participant extended his knees too quickly and did not "jump" at the correct time, he scores 0 points.

Table tilt

The "table tilt" game required the participant to shift his weight to the right, left, front, or back, to place a ball into a hole on a table surface. As the participant shifted his weight, the table moved in the direction of the weight shift; if the participant shifted his weight too much to one side and was not able to re-correct his balance, the ball fell off the table and the participant scored 0 points. This required a specific amount of graded balance to achieve the goals of the game. As the participant successfully completed each level of the "table tilt" game, the difficulty increased and the participant had to maneuver his virtual character around blocks on the table surface and up inclines to reach the hole.

Tightrope walk

The "tightrope walk" game required the participant to shift his weight to the left and right to "walk" across a tightrope. The participant had to avoid obstacles, such as blockages on the tightrope and had to jump over these blockages to continue the game. In order to jump, the participant had to bend his knees, then quickly extend both knees to jump over the obstacles. Other obstacles included wind, which caused the participant to shift his weight further away to avoid being blown off the tightrope.

Balance bubble

The “balance bubble” game required the participant to maneuver his virtual character in a bubble through a river, with obstacles, which need to be avoided. The participant had to shift his weight to the left or right, to avoid the sharp edges and other obstacles. By shifting the weight forward, the bubble traveled more quickly down the river and the participant scored higher.

Penguin slide

In the “penguin slide” game, the participant had to shift his weight to the right or left, which caused an iceberg to tilt in the direction of the weight shift. As the iceberg tilted, the penguins slid; however, the participant had to shift his weight quickly in the opposite direction to avoid having the penguins fall off the iceberg.

Snowboard slalom

In the “snowboard slalom” game, the Nintendo® Wii Fit™ balance board is placed vertically to the television screen, as opposed to the typical horizontal placement. The participant stood on the Wii Fit ™ balance board had to lean to the front, back, left, or right to maneuver down the snowboard slope. The participant had to maneuver the snowboard to the right or left of the various flags to successfully complete the course. If the participant missed a flag, he lost points on the game.

Phase 2

Due to scheduling with the winter holidays, there was a three week break between phases 1 and 2. During this time, John did not play Nintendo® Wii™, but continued with his typical daily activities. Prior to phase 2, the FSST and TGUG were administered to determine a change in balance, and COPM was administered to determine the participant's self-perceived ratings of performance, satisfaction, and importance for stepping. Phase 2 of the research study eliminated the extraneous variable of walking outside, and the participant's daily walk was replaced with completing the stepping activities on the Nintendo® Wii Fit™ for 3 weeks. John performed the stepping activities for the duration of his typical walk (60 minutes). The participant had a choice between any of the stepping activities on the Nintendo® Wii Fit™, which included: basic step, advanced step, and free step. Each of the stepping games consisted of the participant placing both feet on the Wii Fit™ balance board and stepping one or both feet off the board, onto the ground, as the game indicated.

In the basic stepping game, John stepped on and off the balance board, with the rhythm of the game. The rhythm of the basic step was relatively slow, allowing ample time to move the foot off the balance board. The advanced stepping game had a quicker rhythm and the participant stepped on and off the balance board at a quicker pace. The advanced stepping game also included different moves, such as stepping to the left or right of the balance board or kicking with one foot. These moves were indicated on the television screen, as the participant stepped with the beat of the music of the Wii Fit™ game. The free step could be played without watching the television. The participant held the Wii™ remote in his hand and the remote made a "beep" at a selected time interval to indicate the participant is to step off the balance board.

During phase 2, the participant was able to play any of the Nintendo® Wii Fit™ games as he desired, in addition to the stepping games on the Wii Fit™. The participant recorded the duration of the stepping activities, his score on the stepping activities, how many times he stepped, and any other Wii Fit™ games he played. The participant's level of motivation was measured, using a 6- point Likert-scale, ranging from 0-to-5. A score of 0 indicated "not motivated at all and no interest in the activity" and 5 indicated "extremely motivated and extremely interested in the activity and extremely excited to complete" (See appendix L). This motivation scale was adapted from a similar scale used in research by Brown, Sugarman, and Burstin, 2009. After phase 2, the COPM, FSST, and TGUG tests were conducted, to be compared with the pre-phase 2 scores.

Phase 3

Phase 3 began immediately after phase 2. Prior to phase 3, the researcher completed the COPM with the participant to determine his self-perception for importance, performance, and satisfaction of walking outside. The researcher also conducted the FSST and TGUG prior to phase 3. Phase 3 served as the control phase, with no intervention and occurred over three consecutive weeks, for a total of 15 sessions. The participant resumed his daily activity of walking outside and did not play any of the Nintendo® Wii Fit™ games. For each day, the participant recorded the time he walked, how many miles he walked (using the participant's GPS walking device), how motivated he was to walk on a scale of 0 to 5 (using the same motivation level as phase 2), and any additional activities he completed during the day (see appendix M). Following phase 3, the researcher conducted the FSST, TGUG, Frop-Com, SAFE, and COPM tests, which were compared to the baseline scores and the scores for phases 1 and 2.

Hypotheses

The main hypothesis was: after participation in the study, there would be improvements in balance, as measured by the FSST and TGUG. The researcher hypothesized the Nintendo® Wii Fit™ would help improve the participant's balance, and these improvements would remain evident during phase 3, when the participant was walking outside only. The secondary hypothesis was the Nintendo® Wii Fit™ would be more motivating than walking outside only. The researcher also anticipated to find higher COPM test scores for phases 1 and 2, which would support satisfaction and importance of using the Nintendo® Wii Fit™.

CHATPER 4: RESULTS

Data Analysis

To determine any changes in balance over the course of the study, Spearman's Rho and Pearson Correlation tests were performed. The FSST and TGUG scores were compared between the three phases and baseline. The results from these balance tests were used to determine a correlation between the participant's balance and the three phases. The SAFE and FROP scores were compared from the baseline to post-test after the study. These two assessments measured the participant's risk of falling and his activity restriction due to a fear of falling. Occupational performance, as measured by the COPM, was used to determine any qualitative changes throughout the three phases.

Four Square Step Test

The results from the FSST were measured at baseline, post-phase 1, post-phase 2, and post-phase 3. For each FSST, there were two trials, which were averaged to determine the participant's score for each phase and change over the course of the study (see Figure 1). At baseline, the participant scored 11.28 seconds for trial one, and 7.02 seconds for trial two, for an average of 9.15 seconds for the baseline score. Post-phase 1, the participant scored 8.03 seconds for the first trial and 7.02 for the second trial, for an average of 7.52 seconds after phase 1. Post-phase 2, the participant scored 7.36 for the first trial and 6.53 for the second trial, for an average of 6.95 after phase 2. Post-phase 3, the participant scored 6.65 for the first trial and 6.42 for the second trial, for an average of 6.54 after phase 3 (see Table 1).

Figure 1: Mean FSST test scores for each phase

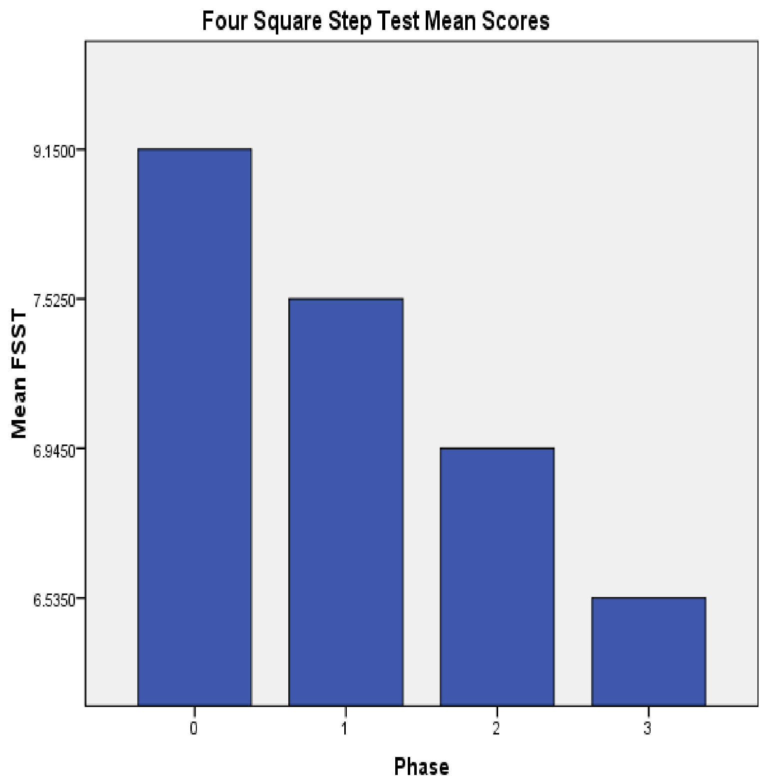

Table 1: Trials and average FSST scores for each phase

Phase	Trial 1	Trial 2	Average (mean)
Baseline (phase 0)	11.28 seconds	7.02 seconds	9.15 seconds
Post-Phase 1	8.03 seconds	7.02 seconds	7.52 seconds
Post-Phase 2	7.36 seconds	6.53 seconds	6.95 seconds
Post-Phase 3	6.65 seconds	6.42 seconds	6.54 seconds

To determine a correlation between the FSST scores and the three phases, a Spearman's Rho Test was performed. There was a significant (p=0.048) correlation between the FSST scores and each phase (A. Ivanescu, personal communication, April 9, 2010). This was a moderate-to-good (Kielhofner, 2006) negative correlation (r=-0.712), indicating a correlation between the phases and a lowered score on the FSST (see table 2 and figure 1).

Table 2: Spearman's Rho correlation for FSST scores over all 3 phases and baseline

Correlations

			Phase	FSST
Spearman's rho	Phase	Correlation Coefficient	1.000	-0.712*
		Sig. (2-tailed)	.	0.048
		N	12	8
	FSST	Correlation Coefficient	-0.712*	1.000
		Sig. (2-tailed)	0.048	.
		N	8	8

*Correlation is significant at the 0.05 level (2-tailed).

Timed Get Up and Go

The TGUG was performed at baseline, after phase 1, after phase 2, and after phase 3. For the TGUG test, there were three trials each time the test was performed. The trials were averaged to determine any change in the TGUG scores related to each phase (see Figure 2). For the three trials at baseline, the participant scored 6.52 seconds, 6.23 seconds, and 5.55 seconds, respectively, for an average of 6.10 seconds at the baseline assessment. For the three trials post-phase 1, the participant scored 5.59 seconds, 5.71 seconds, and 5.38 seconds, respectively, for an average of 5.56 seconds for post-phase 1. For the three trials post-phase 2, the participant scored 5.43 seconds, 5.20 seconds, and 5.23 seconds, respectively, for an average of 5.29 seconds for post-phase 2. For the three trials post-phase 3, the participant scored 5.78 seconds, 5.63 seconds, and 5.55 seconds, respectively for an average of 5.65 seconds for post-phase 3 (see Table 2).

Figure 2: Mean TGUG scores for each phase

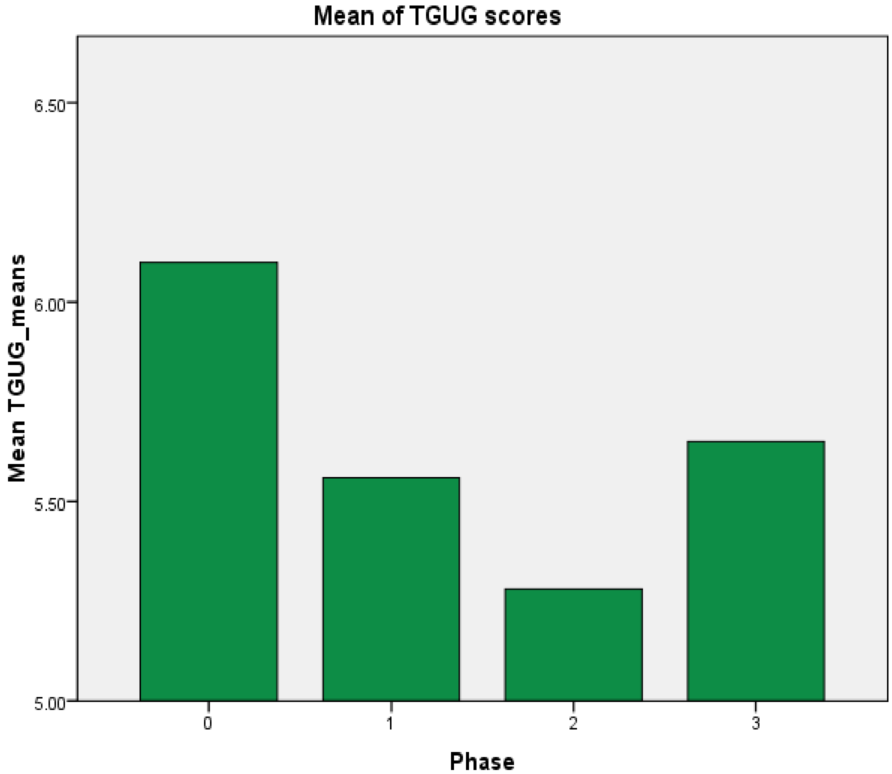

Table 3: Trials and averages TGUG scores for each phase

Phase	Trial 1	Trial 2	Trial 3	Average (mean)
Baseline (phase 0)	6.52	6.23	5.55	6.10
Post-phase 1	5.59	5.71	5.38	5.56
Post-phase 2	5.43	5.20	5.23	5.29
Post-phase 3	5.78	5.63	5.55	5.65

A Pearson's correlation test was used to determine a correlation between the TGUG scores and each phase of the study. Over the course of the study the correlation was not significant (p=0.107) (A. Ivanescu, personal communication, April 9, 2010). However, there was a significant correlation (p= 0.012) (Ivanescu, 2009) between the baseline TGUG scores and phases 1 and 2 (see Table 3). There was a fair-to-moderate (Kielhofner, 2006) negative correlation between the participant's TGUG score and each phase (r=-0.488), indicating an overall slight decrease in the TGUG score over the course of the study. Excluding phase 3, there was a moderate-to-good (Kielhofner, 2006) negative correlation (r=-0.785) between the baseline TGUG score and phases 1 and 2, indicating a decrease in the time required to complete the TGUG for phases 1 and 2.

Table 4: Pearson's correlation for TGUG test scores over all 3 phases and baseline

Correlations

		Phase	TGUG
Phase	Pearson Correlation	1	-0.488
	Sig. (2-tailed)		0.107
	N	12	12
TGUG	Pearson Correlation	-0.488	1
	Sig. (2-tailed)	0.107	
	N	12	12

Table 5: Pearson's correlation for TGUG test scores for baseline, phase 1, and phase 2

Correlations

		Phase	TGUG_0_1_2
Phase	Pearson Correlation	1	-0.785*
	Sig. (2-tailed)		0.012
	N	12	9
TGUG_0_1_2	Pearson Correlation	-0.785*	1
	Sig. (2-tailed)	0.012	
	N	9	9

*Correlation is significant at the 0.05 level (2-tailed)

Survey of Activities and Fear of Falling in the Elderly

The SAFE was completed before the study began and after the study was finished. There was a 51% improvement between the participant's first SAFE score and his second SAFE score. The participant's fear of falling score at baseline was 0.81, indicating a moderate degree of fear of falling. After the study was completed, the participant's fear of falling rating was 0.30, indicating a low degree of fear of falling. For individual questions, there were improvements in the participant's rating of fear of falling. For the question: "When you get out of bed, how worried are you that you might fall?" the participant rated somewhat worried on the pre-test and not at all worried at the post-test. For the question: "When you bend down to get something, how worried are you that you might fall?" the participant rated somewhat worried on the pre-test and a little worried on the post-test. The participant's activity restriction score indicated he did not avoid activities due to a fear of falling; this score remained stable over the course of the study.

Fall Risks for Older People—Community Setting

The FROP-COM was used to assess the participant's fall risk factors; he scored a 7/63 on the baseline assessment, indicating he was at a low risk for falling; however, the FROP-COM recommends implementation of health promotion behaviors, such as increased physical activity, to minimize future risk (National Aging Research Institute, 2005). John was independent for completing daily activities, was cognitively intact, had no sensory loss, and was very active. However, he had some risk factors for falling: he had experienced one fall in the past 12 months prior to the research study, was taking five medications, had a neurological condition, and was minimally unsteady while walking and turning. His score remained consistent throughout the research study, as the risk factors were primarily medically-based, and he did not experience any additional falls or other factors that could increase his fall risk.

Canadian Occupational Performance Measure

The current study also considered the participant's self-perception for the Wii Fit™ and walking, as measured by the Canadian Occupational Performance Measure. For phase 1, the participant rated 8/10 for performance, 8/10 for satisfaction, and 7/10 for importance. For phase 2, the participant rated 8/10 for performance, 7/10 for satisfaction, and 7/10 for importance. For phase 3, the participant rated 8/10 for performance, 9/10 for satisfaction and a 10/10 for importance. The participant had the highest satisfaction and importance rating for phase 3, walking outside only and not playing Nintendo® Wii Fit™ games.

Table 6: COPM ratings for the three phases

Phase	Performance rating	Satisfaction rating	Importance rating
Phase 1 (Wii Fit™ games and walking)	8/10	8/10	7/10
Phase 2 (Wii Fit™ games only)	8/10	7/10	7/10
Phase 3 (walking only)	8/10	9/10	10/10

Summary of results

There was a significant negative correlation between the participant's FSST score and each phase of the research study (p=0.048; r=-0.712). There was a negative correlation (r=-0.488) between the participant's TGUG score and each phase; however, this correlation was not significant (p=0.107). Over the course of the study, the participant had improvements in his fear-of-falling, as measured by the SAFE. The participant rated walking as more important and satisfying than playing the Wii Fit™.

CHAPTER 5: DISCUSSION

The current research study investigated the impact of the Nintendo® Wii Fit™ on the motivation and balance of a 68 year-old community-dwelling older adult who had Myasthenia Gravis. To determine any improvements in balance and motivation, the participant's balance scores and self-perception for performance were assessed throughout the three phases (phase 1: Nintendo® Wii Fit™ and walking; phase 2: Nintendo® Wii Fit™ only; and phase 3: walking only). It was anticipated there would be a decrease in the amount of time required to perform the FSST and TGUG, indicating an improvement in balance, after using the Nintendo® Wii Fit™. Additionally, the participant, John, recorded his level of motivation for phases 2 and 3. It was anticipated his motivation level would be higher for the Wii Fit™ activities in phase 2 than walking outside during phase 3. Also, John's perceptions of occupational performance were measured using the COPM. It was anticipated phases 1 and 2 would have the highest COPM ratings. The participant's fear of falling and activity restriction were assessed with the Survey SAFE and his fall risk was assessed by FROP-Com. For John's safety, the MMSE was conducted to ensure he had no cognitive limitations, and the SAFER was used to determine John's home was a safe and hazard-free environment for the study.

Balance assessments

The FSST and TGUG scores were compared over the course of the study to determine a change in test scores related to each phase. Overall, from baseline to post-phase 3, the participant's FSST test score decreased by 2.61 seconds, indicating an improvement for stepping in various directions. John was able to complete the FSST in less than 15 seconds for all three phases, indicating he was at a reduced risk for experiencing multiple falls (Dite and Temple, 2002). Though John initially had a good score on the FSST, this assessment was appropriate due to its challenging nature and evidence that it can be used with those who have mild balance impairments (Dite & Temple, 2002).

There was a significant (p=0.048) negative correlation (r=-0.712) between the phases and the participant's FSST score, indicating a correlation between the phases and a lower score on the FSST (see table 2 and figure 1). The FSST scores were expected to decrease over the course of the study because it was anticipated John would have an improvement in dynamic balance after using the Nintendo® Wii Fit™. Also, both the balance games on the Nintendo® Wii Fit™ and the FSST required John to shift his weight to the right, left, front, or back.

The negative correlation between the FSST score and the various phases of the study, indicated improvements in the participant's dynamic balance, evidenced by a decrease in the time required for John to rapidly step in multiple directions. The improvements in dynamic balance, support the hypothesis the Nintendo® Wii Fit™ was effective in improving the participant's dynamic balance. The current study supports previous research by Andrews and Pigford (2010), who used the Nintendo® Wii Fit™ with an older adult for a total of ten sessions, over two weeks. After the Wii Fit™ intervention, the participant had improvements in dynamic standing balance, functional mobility, and a reduced risk for falling, as indicated improvements on the BBS and TGUG (Andrews & Pigford, 2010). Though Andrew and Pigford (2010) used the BBS and TGUG, as opposed to the FSST, these three assessments are used to determine a person's risk for falling based on balance. The FSST and BBS both assess dynamic balance, which requires a person to shift his or her weight in various directions. Additionally, the scores on the TGUG and FSST are strongly correlated (Dite & Temple, 2002), which suggests scores on the TGUG can be applied to a FSST score. Based on the similarities between these three assessments, the findings from Andrews and Pigford can be applied to the significant improvements in FSST indicated in the current study.

John's improved FSST scores indicated a reduced risk for falling, because the time required to complete the FSST is correlated with an increased risk for falling (Dite & Temple, 2002). Also, the ability to rapidly step in various directions, and clear obstacles placed on the floor is correlated with a decreased fall risk and better mobility (Nnodim et al., 2006). There was a significant negative correlation between the FSST scores and phases 1, 2, and 3. The current study represented a combination of balance and stepping activities, through the use of the Wii Fit™, and walking outside. As indicated in previous research, programs that combine multisensory balance training, such as the Wii Fit™, with traditional balance activities are most effective for improving balance (Rogers, et al., 2001; Campbell, et al., 2006; Deutsch, et al., 2009). Phase 2 used stepping activities; previous research indicates a stepping program shows greater improvements in stepping speed for healthy older adults, compared to a Tai Chi program (Nnodim, et al., 2006).

The average TGUG test scores for each phase were compared to determine any change in test scores related to each phase. Overall, from baseline to post-phase 3, the participant's TGUG score decreased by 0.54 seconds. The participant scored below 10 seconds for each phase, indicating he was freely independent for physical mobility, and was not at a high risk for falling (Podsiadlo & Richardson, 1991).

The correlation between the participant's TGUG score and the phases of the study was not significant ($p=0.107$); however, there was a negative correlation between the participant's TGUG score and each phase ($r=-0.488$). This indicates a slight decrease in the participant's TGUG score over the course of the study. There was an overall decrease in the TGUG scores for baseline (mean= 6.10 seconds), compared to post-phase 3 (mean= 5.65 seconds). Excluding phase 3, there was a significant negative correlation between the baseline TGUG score and phases 1 and 2 ($p=0.012$; $r=-0.785$), indicating a decrease in the participant's TGUG score for the phases which involved the use of the Wii Fit™.

John's ability to complete the TGUG in less time indicated a reduced risk for falling and improvements in functional mobility, as an increase in the time required to complete the TGUG increases the probability of a fall (Shumway-Cook, et al., 2000). In a study by Thigpen, Light, Creel, and Flynn (2000), individuals who required more time to complete the TGUG were less stable when making a turn and tended to take additional steps to maintain balance; John's improved TGUG scores indicate more stability while walking and turning.

The correlation between a lower score on the TGUG and phases 1 and 2 is consistent with previous research regarding improved TGUG scores for older adults after using the Wii™ (Andrews & Pigford, 2010; Clark & Kraemer, 2009). After using the Wii™, participants had a reduced risk for falling and improved functional mobility, as measured by the TGUG (Andrews & Pigford, 2010; Clark & Kraemer, 2009). There are some differences between these two studies and the current study. The participants in the studies by Andrews and Pigford (2010) and Clark and Kraemer (2009) were approximately 18 years older than the participant in the current study. Also, the participant in the current study was initially at a low risk for falling, whereas the participant in Andrews and Pigford's study was at a high risk for falling and the participant in Clark and Kraemer's study was at a moderate risk for falling. Despite these differences, there were improvements in the TGUG scores when using the Wii Fit™. Additional research indicates improvements in functional mobility after using the Wii Fit™ (Borbely, et al., 2008; Brown, et al., 2009).

When phase 3 (walking outside only) was included in the analysis, the correlation was not significant, which does not support the hypothesis that the participant's TGUG score would decrease over the course of the study. His increased TGUG score in phase 3 was surprising, as phase 3 involved walking only and the TGUG is an assessment of functional mobility. As indicated by the increase in the TGUG score for phase 3, the balance improvements from Nintendo® Wii Fit™ did not appear to be retained, after he was no longer using Wii Fit™. This finding supports previous research findings that the Nintendo® Wii™ shows improvements in balance, but these improvements are not retained (Deutsch, et al., 2009). In order to maintain improvements, balance activities need to be continued on a regular basis (Gardner, et al., 2001; Nitz & Choy, 2004). However, Andrews and Pigford, 2010, found maintained improvements in functional mobility six weeks after the participant used the Wii Fit™ (Andrews & Pigford, 2010). The decreased TGUG score in phase 3 indicates the Wii Fit™ could be used on a continuous basis to improve functional mobility. Additionally, research indicates walking alone is not sufficient for improving balance and reducing a person's risk-for-falling (Audette, et al., 2006; Gardner, et al., 2001; Salbach, et al., 2005; Sherrington, et al., 2008; Yamada, Tanaka, Nagai, Aoyama, and Ichihashi, 2010).

As indicated by a significant correlation between the FSST over the course of the study, and the TGUG scores for phases 1 and 2, the Nintendo® Wii Fit™ appeared to be effective for improving the participant's balance. The findings from the current study support previous research that the Nintendo® Wii Fit™ was effective for reducing fall risk and improving the balance of older adults (Andrews & Pigford, 2010; Brown, et al., 2009). However, the studies by Andrews and Pigford, 2010, and Brown, et al., 2009 were single-subject and the results cannot be generalized to other individuals.

There is currently only one study which used multiple participants to determine the feasibility of utilizing the Wii Fit™ for fall prevention with older adults (Williams, et al., 2011). The Wii Fit™ balance games and aerobic activities were used with 22 healthy, older adults. After using the Wii Fit™ three times a week for four weeks, researchers found qualitative and quantitative support for improvements in balance after using the Wii Fit™ (Williams, et al., 2011). There was a statistically significant improvement in the Berg Balance Scale (BBS) scores from pre-test to post-test, indicating an improvement in balance, functional mobility, and a reduced risk for falling (Williams, et al., 2011). Overall, participants had a 25 % improvement on the BBS and 21 out of the 22 participants showed an improvement in their BBS score after the study (Williams, et al., 20111). This provides supporting evidence for occupational therapists who work with older adults to consider utilizing the Nintendo® Wii Fit™ as an evidenced-based intervention to improve a client's balance and mobility, thus reducing a risk for falling (Williams, et al., 2011). These previous research findings are encouraging and support the use of the Wii Fit™ with older adults; however, additional research is needed to determine the effectiveness of the Nintendo® Wii Fit™ with other populations and ages.

Motivation and Self-Perception of Performance

The COPM was utilized to determine the participant's performance, satisfaction, and importance for each phase. The participant rated phase 1 (balance games and walking outside) 8/10 for performance, 8/10 for satisfaction, and 7/10 for importance. For phase 2 (stepping games, no walking outside), the participant rated 8/10 for performance, 7/10 for satisfaction, and 7/10 for importance. The participant commented the stepping activity was not as interesting as walking outside, due to the repetitive nature of stepping. For phase 3 (walking outside and no Wii™ games), the participant rated performance 8/10, satisfaction 9/10, and importance 10/10.

As indicated by the COPM, the participant valued walking outside and found walking more satisfying than the Nintendo® Wii Fit™. Using the COPM as a measure for a client's self-perception of performance, satisfaction, and importance provides new evidence for the use of the Wii Fit™ in therapy. There are no current studies that use the COPM in relation to the Wii Fit™ for fall prevention; however, other measures have been used to determine a participant's level of satisfaction and performance. The majority of studies conducted on the therapeutic use of video games with various populations, report participants find the video games to be engaging, interesting, and motivating (Kirk, et al., 2008; Lieberman, 2001; Rand, et al., 2008; Wille, et al., 2009). Participants enjoyed the direct feedback provided from the games, and the challenging and competitive nature of the games and preferred the video games as opposed to traditional therapy activities (Andrews & Pigford, 2010; Betcker, et al., 2006; Decker, et al., 2009; Flynn, et al., 2008; Hidrian & Weyler, 2008; Wille, et al., 2009). Specifically, when the Wii Fit™ is used with older adults to improve balance, participants reported a high level of enjoyment and interest in the Wii™ (Andrews & Pigford, 2010; Brown, et al., 2009; Williams, et al., 2011).

John's performance scores were consistent for all three phases, indicating he felt as though he was able to perform these activities well. Though John's satisfaction and importance scores were higher for walking outside than playing the Nintendo® Wii Fit™, his scores for performance, satisfaction, and importance still indicated that he was satisfied with the Wii Fit™ and felt as though these activities were important.

In addition to the COPM, qualitative measures were also recorded to determine his motivation level. The participant rated his overall motivation level for performing the Nintendo® Wii Fit™ activities 3.5/5; however, he rated walking outside a 4.5/5. These scores indicated walking was more motivating for the participant, than the stepping and balance games on the Nintendo® Wii Fit™. The qualitative measures do not support previous research findings, which indicate participants typically are more motivated to play interactive video games and prefer this over traditional activities (Andrews & Pigford, 2010; Betker, et al., 2006; Kirk, et al., 2008; Decker, et. al., 2009; Hidrian & Weyler, 2008).

The participant's lower motivation score for the Wii Fit™ activities could be explained because the daily walk was an important aspect to John's routine and was more familiar and habitual than the Wii Fit™ activities. Also, he commented the Wii Fit™ stepping activities became boring and less interesting due to the repetitive nature of stepping. Though the stepping activities increased in difficulty the more the participant played the game, the basic task of stepping on and off the Wii™ board remained consistent.

An additional compounding variable which could explain the participant's increased motivation for walking was the weather. Phase 2 occurred during December and January, when temperatures are typically cold, with severe weather; whereas phase 3 occurred during late January and February, with overall warmer temperatures. The participant may have been more motivated to walk outside as the weather became milder.

Fear of falling

John's baseline SAFE score was 0.81, which is categorized as a moderate degree of fear of falling (Lachman, et al., 1998); however, following the study, his score improved to 0.31, which indicates a low degree of fear of falling (Lachman, et al., 1998). His initial SAFE score indicated John was worried he would fall when completing activities, such as getting out of bed in the morning. An improved SAFE score signifies John was more confident in his balance during daily activities, was less likely to avoid activities due to a fear that he would fall, and was at a decreased risk for falling. Fear of falling increases an individual's risk for falling due to decreased mobility, difficulty controlling balance, and a lack of confidence for managing or preventing falls (Brouwer, Walker, Rydahl & Culham, 2003; Deshpande et al., 2008; WHOGRFPOA, 2007). John had previously fallen, which placed him at a greater risk for developing a fear of falling (Dite, et al, 2002; Perell, et al., 2001). Though John's fear of falling score decreased throughout the study, he did not have any activity restrictions from the onset of the study, which indicates his fear of falling did not limit his daily activities.

There is limited research on the specific fear of falling component and use of the Wii Fit™; however, multiple studies support the Wii Fit™ is an effective intervention for improving balance, and reducing a person's risk for falling (Andrews & Pigford, 2010; Brown, et al., 2009; Williams, et al., 2011). As a fear of falling increases a person's risk for falling, the Wii Fit™ can reduce a person's fear of falling by improving balance. If not addressed through therapy and balance interventions, a fear of falling can become a lasting condition (Brouwer, et al., 2003; Vellas, et al., 1997). A balance program, which combines walking, balance activities, and strengthening exercises can increase a person's confidence for performing activities without falling, thus reducing a fear of falling (Campbell, et al., 2002). As this study combined walking, and balance and strengthening exercises, the participant's fear of falling decreased; however, it is difficult to determine which specific aspect of the study decreased this fear.

Limitations

A major limitation of the research study was the single-subject design. The findings can only be applied to the individual who participated in the study and cannot be generalized to other individuals or populations. The research study supported the hypothesis the Nintendo® Wii Fit™ can improve balance; however, there is a need for additional research to determine if the results are significant for other populations.

Based on the participant's initial scores on the FSST, TGUG, and FROP-COM, John was not at a high risk for falling; however, he had the following fall risk-factors: polypharmacy, a history of falling, and a neurological condition which affected his balance. John was likely able to score well on the TGUG and FSST assessments because of his activity level and competitive nature. The participant was very active and walked approximately 3-to-5 miles daily; an uncommon level of physical activity for most older adults. Research indicates an estimated 34% of adults aged 50 and older are sedentary (National Institute on Aging, 2000). John was an appropriate participant for this study, because the Nintendo® Wii Fit™ requires good static and dynamic balance.

Another limitation was the period of three weeks between phase 1 and phase 2. During this time, both the participant and the researcher were on vacation for December holidays. The participant did not play the Nintendo® Wii Fit™ during this period of time, but resumed the Wii Fit™ during phase 2.

Additionally, the time of the year in which the phases occurred may have been a contributing factor to the participant's motivation. The participant's increased motivation for walking, during phase 3, could be explained because of the warmer weather and increased interest in participating in outdoor activities.

Future research

The current research study provides supporting evidence for the use of the Nintendo® Wii Fit™ with older adults to improve balance; however, the hypothesis of increased motivation with the Wii Fit™ was not supported. Due to the single-subject nature of the current study and similar studies (Andrews & Pigford, 2010; Brown, Burstin, and Sugarman, 2009; Clark & Kraemer, 2009), and limited studies regarding a group of older adults (Williams, et al., 2011), additional research with various populations and ages is needed to determine if the Nintendo® Wii Fit™ is appropriate for other populations. One suggestion for future research would involve two groups of approximately 10 people; one group would be the control, who would only walk outside and not play the Wii Fit™, and the other group would be the experimental group, who would play the Wii Fit™. The same baseline tests would be performed for both groups prior to the study, then these results would be compared after the study to determine if the Nintendo® Wii Fit™ is more effective than walking outside to prevent falls.

Also, the Nintendo® Wii Fit™ could be used with a variety of populations that have other neurological impairments, such as Parkinson's disease, Huntington's disease, or multiple sclerosis to determine if the Wii Fit™ proves effective in reducing fall risk for this population. Having a small group of approximately 15 individuals with a neurological impairment would provide additional evidence regarding the effectiveness of the Nintendo® Wii Fit™ with individuals who have a neurological impairment.

Another area for future research would be the use of the Nintendo® Wii Fit™ with a group of older adults in a community setting or senior center. A variety of factors could be considered, such as: social interactions, balance, motivation, or active aging. Qualitative and quantitative measures could be used to determine if the Nintendo® Wii Fit™ is effective with a larger population. Other games on the Wii Fit™, such as the yoga and aerobic games could be used to improve balance.

Lastly the Nintendo® Wii Fit™ could be used with young adults and children who have various conditions, such as: attention-deficit disorder, learning disorders, Asperser's disease, or developmental delays to improve balance or attention. The Wii Fit™ could be used in conjunction with physical or occupational therapy to help clients meet specific goals.

CHAPTER 6: CONCLUSION

The use of the Nintendo® Wii Fit™ to improve balance and prevent falls with a community-dwelling older adult was supported. There were improvements in the participant's balance and a decrease in fear of falling after using the Wii Fit™. There was a significant negative correlation between the participant's FSST score and each phase ($p=0.048$; $r=-0.712$); however, there was not a significant negative correlation between the participant's score on the TGUG and each phase ($p=0.107$; $r=-0.488$). As indicated by COPM and motivation scores, measured by a 0-to-5 Likert scale, the participant was motivated to complete the Wii Fit™ activities, but was more motivated to complete his typical walking activities. Due to the physical and psychological implications of falling, occupational and physical therapists should use motivating and interesting interventions to prevent falls. Further research is needed to determine the effectiveness of the Nintendo® Wii Fit™ to improve balance and reduce falls for older adults.

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APPENDIX A: INSTITUTIONAL REVIEW BOARD APPROVAL LETTER

EAST CAROLINA UNIVERSITY

University and Medical Center Institutional Review Board
East Carolina University • Brody School of Medicine
600 Moye Boulevard • Old Health Sciences Library, Room 1L-09 • Greenville, NC 27834
Office **252-744-2914** • Fax **252-744-2284** • **www.ecu.edu/irb**
Chair and Director of Biomedical IRB: L. Wiley Nifong, MD
Chair and Director of Behavioral and Social Science IRB: Susan L. McCammon, PhD

TO: Brittany Gardner, OTS, Occupational Therapy, ECU

FROM: UMCIRB

DATE: August 18, 2009

RE: Expedited Category Research Study

TITLE: "Effectiveness of the Nintendo Wii Fit TM Games on the Balance of a Community-Dwelling Older Adult in Eastern North Carolina"

UMCIRB #09-0613

This research study has undergone review and approval using expedited review on 8.12.09. This research study is eligible for review under an expedited category because it is a collection of data through noninvasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving x-rays or microwaves. Where medical devices are employed, they must be cleared/approved for marketing. (Studies intended to evaluate the safety and effectiveness of the medical device are not generally eligible for expedited review, including studies of cleared medical devices for new indications.) Examples: (a) physical sensors that are applied either to the surface of the body or at a distance and do not involve input of significant amounts of energy into the subject or an invasion of the subject's privacy; (b) weighing or testing sensory acuity; (c) magnetic resonance imaging; (d) electrocardiography, electroencephalography, thermography, detection of naturally occurring radioactivity, electroretinography, ultrasound, diagnostic infrared imaging, doppler blood flow, and echocardiography; (e) moderate exercise, muscular strength testing, body composition assessment, and flexibility testing where appropriate given the age, weight, and health of the individual and it is a collection of data from voice, video, digital, or image recordings made for research purposes 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 **8.12.09** to **8.11.10**. The approval includes the following items:

- Internal Processing Form (dated 6.9.09)
- Four Square Step Test
- Timed Get Up and Go Test
- Fall Risk for Older People in the Community Screening Tool
- Safety Assessment of Function and the Environment for Rehabilitation (SAFER)
- Survey of Activities and Fear of Falling in the Elderly (SAFFE)
- Mini-Mental State Exam (MMSE)
- Photo Release
- Conflict of Interest Form (dated 8.18.09)
- Consent Form

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 #09-0613
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APPENDIX B: CONSENT FORM

Consent Form

Title of Research Study: *Effectiveness of the Nintendo® Wii Fit™ Games on the Balance of a Community-Dwelling Older Adult in Eastern North Carolina.*

Principal Investigator: Brittany Gardner, OTS
Institution: ECU, CAHS, Department of Occupational Therapy
Telephone #: 252-744 6194

Introduction
You have been asked to participate in a research study being conducted by Brittany Gardner. This research study is designed to determine if using the Nintendo® Wii Fit™ games will help to improve balance. The assessments that will be performed as a part of this research study will evaluate your balance and risk for falls. There will also be a tool to assess the safety of your home in regards to fall prevention and recommendations will be made to ensure your home is safe for this study.

During the study, you will be asked to play the balance games on the Nintendo® Wii Fit™ for 15 minutes, 3 times a week, for 2 consecutive months. These games will require you to stand on the balance platform of the Nintendo® Wii Fit™ and shift your weight to the left, right, front and back. You will have a choice between any of the following games on the Nintendo® Wii Fit™: "soccer heading, "ski slalom", "ski jump", "table tilt", "tightrope walk", "balance bubble", "penguin slide", and "snowboard slalom". If you become tired during any point of the session, please stop playing the Nintendo® Wii Fit ™ and rest for as long as you need. The rest time will not count towards the 15 minutes. You can choose which games you would like to play each session and the games can be played in any order you want; however, the advanced games, which include: "tightrope walk", "balance bubble", "penguin slide", and "snowboard slalom" need to be "unlocked" before they can be played.

You will be asked to sign a separate photograph and videotaping release form that will indicate if you either accept or decline to have your picture taken and to be video recorded while participating in this study. Your acceptance or refusal to have your picture taken or to be video recorded will not influence your ability to participate in this study. Your photographs and videos will only be used for presentations of the study.

Plans and Procedures
Part 1: You will be asked to do the following assessments at no cost: Four Square Step Test (FSST), Survey of Activities and Fear of Falling in the Elderly (SAFFE), and Timed Get Up and Go (TGUG). The researcher will also conduct the Safety Assessment of Function and the Environment for Rehabilitation (SAFER) in your home and make any recommendations to improve the safety of your house, which will help to prevent you from falling. Also, the balance test on the Nintendo® Wii Fit™ will be used to determine if there are any changes in balance. The researcher will schedule a convenient time to come and conduct these tests within your home, given your permission.

There will be two standardized physical tests: the Timed Get-Up-and-Go Test, and the Four Square Step Test. The Timed Get-Up-and-Go Test measures how long it takes to get up from a chair, walk 10 feet, turn, return to the chair and sit down. This test will provide information about your risk for falling, and should take approximately 10 minutes. The Four Square Step Test will involve having you step within four squares on the floor. You will have to either step to the front, back, left or right as quickly as you can. This test will provide information about how quickly you can change direction and should take approximately 10 minutes. For your safety, a qualified therapist will be by your side at all times to protect you if you were to lose your balance.

After you have taken the Timed Get-Up-And-Go test and the Four Square Step Test, you will have a ten minute break before taking the "balance test" on the Nintendo® Wii Fit™. During the break, the researcher will help you create a "Mii" character, which will serve as your virtual representation on the Nintendo® Wii Fit™. After creating your "Mii", you will take the "balance test" on the Nintendo® Wii Fit ™. This test will measure your ability to balance on the platform of the Nintendo® Wii Fit™. You will be asked to do certain balance activities during this test, which will involve shifting your weight from left to right or maintaining your balance for a certain amount of time. This test will take approximately 20 minutes.

Part 2: During this session, the researcher will introduce you to the Nintendo® Wii Fit™ system. The researcher will show you how to play each game and allow time for you to practice the games.

Part 3: During this part of the research, you will play the Nintendo® Wii Fit™ games. There will be a total of 30 sessions, each of which will last 15 minutes. The study will occur over 2 consecutive months and you will be asked to play the Nintendo® Wii Fit™ balance games three times a week. You can play the games at any time, any day of the week; however, either the researcher or your wife must be present for your safety. If you become tired at any time, please stop playing the games and rest for as long as you would like. If you are not able to play the games during a session, you can make up the session the next day or the next week. You have no obligation to play the games each week if you are not feeling well; however, the total sessions should add up to 30.

Potential Risks and Discomforts
There may be a risk of falling during the TGUG or the FSST, but the TGUG and FSST will be performed by someone trained to conduct them and you will wear a safety belt. You may become tired while you are performing the tests. You will be allowed to rest as long as you like in between the tests or you may stop at anytime. These tests do not require a lot of physical activity or continued movement. Also, on the Nintendo® Wii Fit™, there is a body test, which shows your weight and Body Mass Index. During this portion of the body test, I will leave the room for privacy purposes. Only you will see your weight and body index and this information will not be recorded on the data collection chart because this is not relevant to the research study.

Potential Benefits
I hope the information you learn from the Nintendo® Wii Fit™ study will help you understand how your center of balance can be used to maintain balance and prevent falls. Also, this research study could help occupational and physical therapists use the Nintendo®

Wii Fit™ as a possible intervention technique with individuals who are having problems with balance.

Subject Privacy and Confidentiality of Records
Only the research team members will know your results unless you provide additional permission for your doctor to receive them also. This consent document and the results of each test will be kept in a locked file cabinet in Dr. Jane Painter's office. Only the researcher and her thesis advisor will know your true name and a pseudo name will be used to maintain your identity.

Costs of Participation and Compensation
There will be **no** costs to you for participating in this research study. The policy of East Carolina University and/or Pitt County Memorial Hospital does not provide for payment or medical care for research participants because of physical or other injury that result from this research study. Every effort will be made to make the facilities of the School of Medicine and Pitt County Memorial Hospital available for care in the event of an injury.

Voluntary Participation
Participating in this study is voluntary. If you decide not to be in this study after it has already started, you may stop at any time without losing benefits that you should normally receive. You may stop at any time you choose without penalty.

Persons to Contact with Questions
The investigators will be available to answer any questions concerning this research, now or in the future. You may contact Brittany Gardner at bdg0714@ecu.edu or (540) 357-2006. You may also contact Dr. Jane Painter at phone number 252-744 6194 (days) or email her at painterj@ecu.edu. If you have questions about your rights as a research subject, you may call the Chair of the University and Medical Center Institutional Review Board at phone number 252-744-2914 (days).

Title of Research Study: *Effectiveness of the Nintendo® Wii Fit™ Games on the Balance of a Community-Dwelling Older Adult in Eastern North Carolina*

Consent to Participate

I have read all of the above information, asked questions and have received satisfactory answers in areas I did not understand. (A copy of this signed and dated consent form will be given to the person signing this form prior to conducting any research procedures.)

____

Participant's Name **(Print)** **Signature** **Date**

Permission to be re-contacted for future research being conducted by Dr. Jane Painter regarding falls research.

_____I would like to be contacted to participate in future falls research.

_____I do not want to be contacted to participate in future falls research.

I have conducted the consent process and orally reviewed the contents of the consent document. I believe the participant understands the research.

____

Principal Investigator's **(Print)** **Signature** **Date**

APPENDIX C: CONSENT FOR PICTURES

Photo Release

Have you fallen or are worried about falling?

I ________________________ give permission to have my picture taken or be videotaped while I am participating in *Effectiveness of the Nintendo® Wii Fit™ Games on the Balance of a Community-Dwelling Older Adult in Eastern North Carolina* research study. I understand that any picture or video taken will only be used for the purposes of this research project. I understand I have the right to change my mind at any time in regards to having my picture taken or being videotaped.

Date: ______________________________-

Witness: ____

APPENDIX D: TIMED GET UP AND GO INSTRUCTIONS

Timed Get Up and Go Test
Measures mobility in people who are able to walk on their own (assistive device permitted)

Name________________________
Date_________________________
Time to Complete_______________seconds

Instructions:
The person may wear their usual footwear and can use any assistive device they normally use.
1. Have the person sit in the chair with their back to the chair and their arms resting on the arm rests.
2. Ask the person to stand up from a standard chair and walk a distance of 10 ft. (3m).
3. Have the person turn around, walk back to the chair and sit down again.
Timing begins when the person starts to rise from the chair and ends when he or she returns to the chair and sits down.
The person should be given 1 practice trial and then 3actual trial. The times from the three actual trials are averaged.

<u>Predictive Results</u>
<u>Seconds Rating</u>
<10 Freely mobile
<20 Mostly independent
20-29 Variable mobility
>30 Impaired mobility
Source: Podsiadlo, D., Richardson, S. The timed ‘Up and Go’ Test: a Test of Basic Functional Mobility for Frail Elderly Persons. *Journal of American Geriatric Society*. 1991; 39:142-148

APPENDIX E: FOUR SQUARE STEP TEST INSTRUCTIONS

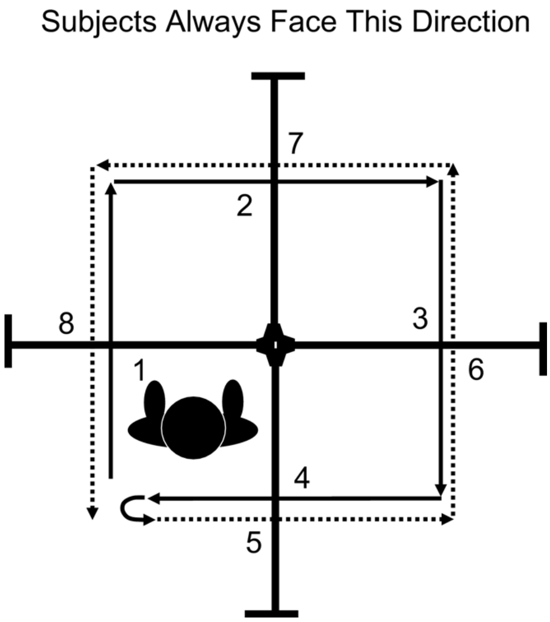
Authors: Dite W. Temple VA.

Equipment:

- Stop watch
- 4 canes (laid in a cross pattern)
- Gait belt
-

Sequence: (square 1 = the upper left) CW → 2-3-4-1 then immediately move CCW → 4-3-2-1

Instructions: “Try to complete the sequence as fast as possible without touching the sticks. Both feet must make contact with the floor in each square. If possible, face forward during the entire sequence”.



- Demonstrate.
- Allow a practice trial
- Two trials → the best time (in seconds) is taken as the score.
- Repeat a trial if the subject:
  - fails to complete the sequence successfully
  - loses balance
  - makes contact with the cane

Subjects who were unable to face forward during the entire sequence and needed to turn before stepping into the next square were still given a score.

Scoring: time in seconds. *Note: the stopwatch starts when the first foot contacts the floor in square 2.

APPENDIX F: SURVEY OF ACTIVITIES AND FEAR OF FALLING IN THE ELDERLY

SURVEY OF ACTIVITIES AND FEAR OF FALLING IN THE ELDERLY (SAFE)

Margie E. Lachman, Brandeis University

and Jonathan Howland, Boston University

Research supported by NIA Roybal Center AG11669

Dear SAFE User:

As you requested, I am sending a copy of the SAFFE. The scoring information is also included. I grant you permission to use the SAFFE in your research. Please cite the following reference in your work:

> Lachman, M. E., Howland, J., Tennstedt, S., Jette, A., Assman, S., & Peterson, E. (1998). Fear of Falling and Activity Restriction: The Survey of Activities and Fear of Falling in the Elderly. Journal of Gerontology: Psychological Sciences, 53B, P43-P50.

I ask that you please send me preprints and/or reprints of any articles that you prepare which report results with the SAFFE. I am most interested to hear about the research you are doing. Good luck with your research project. Feel free to contact me if you have further questions.

Sincerely yours,

Margie E. Lachman, Ph.D.
Professor

Scoring Information for Survey of Activities and Fear of Falling in the Elderly (SAFE)

A. Activity Level: Scored as the number of activities they do out of 11. No and nonresponse are given a 0 and a yes is given a 1. Count the number of 1's.

B. Fear of Falling: (see page 46 in Lachman et al., 1998) Recode scoring so that low scores mean low fear: 0 = not at all, 3 = very worried. Recode is 4=0, 3=1, 2=2, 1=3. The fear score is computed as the average worry scores across the 11 activities (or across as many of the activities that are done, i.e., if yes to A). Range is 0 to 3.

F. Activity Restriction: Number of activities that are reported as doing less than used to. That is the number of "less than you used to" responses (response 3) to the question, Compared to 5 years ago, would you say that you…. (range is from 0 to 11).

Scoring the reasons for not doing an activity is optional (see page 48 in the 1998 article):

C. Count the "not at all worried" responses to determine the number of activities that are not done due to reasons other than fear of falling.

D. Count the number of yes responses, to determine the number of activities that are not done because of other reasons in addition to fear of falling.

Activity Questionnaire

A. Do you currently:	1. Go to the store? 1. NO 2. YES ↓ ↓ GO TO C GO TO B	2. Prepare simple meals? 1. NO 2. YES ↓ ↓ GO TO C GO TO B
B. When you........, how worried are you that you might fall?	1. Very worried 2. Somewhat worried 3. A little worried, or 4. Not at all worried GO TO F	1. Very worried 2. Somewhat worried 3. A little worried, or 4. Not at all worried GO TO F
C. Do you not [ACTIVITY] because you are......... that you might fall?	1. Very worried GO 2. Somewhat worried → TO 3. A little worried D Or 4. Not at all worried → GO TO E	1. Very worried GO 2. Somewhat worried → TO 3. A little worried D Or 4. Not at all worried → GO TO E
D. Are there other reasons that you do not........	1. NO 2. YES → SPECIFY:__________ __________________________ __________________________ GO TO F	1. NO 2. YES → SPECIFY:__________ __________________________ __________________________ GO TO F
E. What are the reasons that you do not........	SPECIFY:_________________ ___ __________________________ ____ __________________________ ____ GO TO F	SPECIFY:____________________ ______________________________ ______________________________ GO TO F
F. Compared to 5 years ago, would you say that you........	1. More than you used to, 2. About the same, or 3. Less than you used to.	1. More than you used to, 2. About the same., or 3. Less than you used to.

A. Do you currently:	3. Take a tub bath? 1. NO 2. YES ↓ ↓ GO TO C GO TO B	4. Get out of bed? 1. NO 2. YES ↓ ↓ GO TO C GO TO B
B. When you........, how worried are you that you might fall?	1. Very worried 2. Somewhat worried 3. A little worried, or 4. Not at all worried GO TO F	1. Very worried 2. Somewhat worried 3. A little worried, or 4. Not at all worried GO TO F
C. Do you not [ACTIVITY] because you are......... that you might fall?	1. Very worried GO 2. Somewhat worried → TO 3. A little worried D Or 4. Not at all worried → GO TO E	1. Very worried GO 2. Somewhat worried → TO 3. A little worried D Or 4. Not at all worried → GO TO E
D. Are there other reasons that you do not........	1. NO 2. YES → SPECIFY:__________ ___________________________ ___________________________ GO TO F	1. NO 2. YES → SPECIFY:__________ ___________________________ ___________________________ GO TO F
E. What are the reasons that you do not........	SPECIFY:__________________ ___ ___________________________ ____ ___________________________ ____ GO TO F	SPECIFY:____________________ ______________________________ ______________________________ GO TO F
F. Compared to 5 years ago, would you say that you........	1. More than you used to, 2. About the same, or 3. Less than you used to.	1. More than you used to, 2. About the same, or 3. Less than you used to.

A. Do you currently:	5. Take a walk for exercise? 1. NO 2. YES ↓ ↓ GO TO C GO TO B	6. Go out when it is slippery? 1. NO 2. YES ↓ ↓ GO TO C GO TO B
B. When you........, how worried are you that you might fall?	1. Very worried 2. Somewhat worried 3. A little worried, or 4. Not at all worried GO TO F	1. Very worried 2. Somewhat worried 3. A little worried, or 4. Not at all worried GO TO F
C. Do you not [ACTIVITY] because you are......... that you might fall?	1. Very worried GO 2. Somewhat worried → TO 3. A little worried D Or 4. Not at all worried → GO TO E	1. Very worried GO 2. Somewhat worried → TO 3. A little worried D Or 4. Not at all worried → GO TO E
D. Are there other reasons that you do not........	1. NO 2. YES → SPECIFY:___________ ___________________________ ___________________________ GO TO F	1. NO 2. YES → SPECIFY:___________ ___________________________ ___________________________ GO TO F
E. What are the reasons that you do not........	SPECIFY:___________________ ___ ___________________________ ____ ___________________________ ____ GO TO F	SPECIFY:_____________________ ________________________________ ________________________________ GO TO F
F. Compared to 5 years ago, would you say that you.....	1. More than you used to, 2. About the same, or 3. Less than you used to.	1. More than you used to, 2. About the same., or 3. Less than you used to.

A. Do you currently:	7. Visit a friend or relative? 1. NO 2. YES ↓ ↓ GO TO C GO TO B	8. Reach for something over your head? 1. NO 2. YES ↓ ↓ GO TO C GO TO B
B. When you........, how worried are you that you might fall?	1. Very worried 2. Somewhat worried 3. A little worried, or 4. Not at all worried GO TO F	1. Very worried 2. Somewhat worried 3. A little worried, or 4. Not at all worried GO TO F
C. Do you not [ACTIVITY] because you are......... that you might fall?	1. Very worried GO 2. Somewhat worried → TO 3. A little worried D Or 4. Not at all worried → GO TO E	1. Very worried GO 2. Somewhat worried → TO 3. A little worried D Or 4. Not at all worried → GO TO E
D. Are there other reasons that you do not....	1. NO 2. YES → SPECIFY:___________ ___________________________ ___________________________ GO TO F	1. NO 2. YES → SPECIFY:_________ ____________________________ ____________________________ GO TO F
E. What are the reasons that you do not........	SPECIFY:__________________ ___ ___________________________ ____ ___________________________ ____ GO TO F	SPECIFY:____________________ _______________________________ _______________________________ GO TO F
F. Compared to 5 years ago, would you say that you.....	1. More than you used to, 2. About the same, or 3. Less than you used to.	1. More than you used to, 2. About the same., or 3. Less than you used to.

A. Do you currently:	9. Go to a place with crowds? 1. NO 2. YES ↓ ↓ GO TO C GO TO B	10. Walk several blocks outside? 1. NO 2. YES ↓ ↓ GO TO C GO TO B
B. When you........, how worried are you that you might fall?	1. Very worried 2. Somewhat worried 3. A little worried, or 4. Not at all worried GO TO F	1. Very worried 2. Somewhat worried 3. A little worried, or 4. Not at all worried GO TO F
C. Do you not [ACTIVITY] because you are......... that you might fall?	1. Very worried GO 2. Somewhat worried → TO 3. A little worried D Or 4. Not at all worried → GO TO E	1. Very worried GO 2. Somewhat worried → TO 3. A little worried D Or 4. Not at all worried → GO TO E
D. Are there other reasons that you do not....	1. NO 2. YES → SPECIFY:___________ ___________________________ ___________________________ GO TO F	1. NO 2. YES → SPECIFY:_________ ___________________________ ___________________________ GO TO F
E. What are the reasons that you do not........	SPECIFY:_________________ ___ ___________________________ ____ ___________________________ ____ GO TO F	SPECIFY:____________________ ______________________________ ______________________________ GO TO F
F. Compared to 5 years ago, would you say that you.....	1. More than you used to, 2. About the same, or 3. Less than you used to.	1. More than you used to, 2. About the same., or 3. Less than you used to.

A. Do you currently:	11. Bend down to get something? 1. NO 2. YES ↓ ↓ GO TO C GO TO B
B. When you........, how worried are you that you might fall?	1. Very worried 2. Somewhat worried 3. A little worried, or 4. Not at all worried GO TO F
C. Do you not [ACTIVITY] because you are......... that you might fall?	1. Very worried GO 2. Somewhat worried → TO 3. A little worried D Or 4. Not at all worried → GO TO E
D. Are there other reasons that you do not....	1. NO 2. YES → SPECIFY:__________ _________________________ _________________________ GO TO F
E. What are the reasons that you do not........	SPECIFY:____________________ _____________________________ _____________________________ GO TO F
F. Compared to 5 years ago, would you say that you.....	1. More than you used to, 2. About the same, or 3. Less than you used to.

APPENDIX G: CANADIAN OCCUPATIONAL PERFORMANCE MEASURE

CANADIAN OCCUPATIONAL PERFORMANCE MEASURE

Authors:
Mary Law, Sue Baptiste, Anne Carswell,
Mary Ann McColl, Helene Polatajko, Nancy Pollock

The Canadian Occupational Performance Measure (COPM) is an individualized measure designed for use by occupational therapists to detect self-perceived change in occupational performance problems over time.

Client Name:		
Age:	Gender:	ID#:
Respondent (if not client):		
Date of Assessment:	Planned Date of Reassessment:	Date of Reassessment:

Therapist:
Facility/Agency:
Program:

Published by CAOT Publications ACE
Printed in Canada

STEP 1: IDENTIFICATION OF OCCUPATIONAL PERFORMANCE ISSUES	STEP 2: RATING IMPORTANCE
To identify occupational performance problems, concerns and issues, interview the client, asking about daily activities in self-care, productivity and leisure. Ask clients to identify daily activities which they want to do, need to do or are expected to do by encouraging them to think about a typical day. Then ask the client to identify which of these activities are difficult for them to do now to their satisfaction. Record these activity problems in Steps 1A, 1B, or 1C.	Using the scoring card provided, ask the client to rate, on a scale of 1 to 10, the importance of each activity. Place the ratings in the corresponding boxes in Steps 1A, 1B, or 1C.

STEP 1A: Self-care		IMPORTANCE
Personal Care (e.g., dressing, bathing, feeding, hygiene)	______	☐
	______	☐
	______	☐
Functional Mobility (e.g., transfers, indoor, outdoor)	______	☐
	______	☐
	______	☐
Community Management (e.g., transportation, shopping, finances)	______	☐
	______	☐
	______	☐

STEP 1B: Productivity		
Paid/Unpaid Work (e.g., finding/keeping a job, volunteering)	______	☐
	______	☐
	______	☐
Household Management (e.g., cleaning, laundry, cooking)	______	☐
	______	☐
	______	☐
Play/School (e.g., play skills, homework)	______	☐
	______	☐
	______	☐

STEP 1C: Leisure		IMPORTANCE
Quiet Recreation (e.g., hobbies, crafts, reading)		
Active Recreation (e.g., sports, outings, travel)		
Socialization (e.g., visiting, phone calls, parties, correspondence)		

STEPS 3 & 4: SCORING - INITIAL ASSESSMENT and REASSESSMENT

Confirm with the client the 5 most important problems and record them below. Using the scoring cards, ask the client to rate each problem on performance and satisfaction, then calculate the total scores. Total scores are calculated by adding together the performance or satisfaction scores for all problems and dividing by the number of problems. At reassessment, the client scores each problem again for performance and satisfaction. Calculate the new scores and the change score.

Initial Assessment:			**Reassessment:**	
OCCUPATIONAL PERFORMANCE PROBLEMS:	PERFORMANCE 1	SATISFACTION 1	PERFORMANCE 1	SATISFACTION 1
1.				
2.				
3.				
4.				
5.				
SCORING:	PERFORMANCE SCORE 1	SATISFACTION SCORE 1	PERFORMANCE SCORE 2	SATISFACTION SCORE 2
Total score = Total performance or satisfaction scores / # of problems	/ =	/ =	/ =	/ =

CHANGE IN PERFORMANCE = Performance Score 2 [ ] – Performance Score 1 [ ] = [ ]

CHANGE IN SATISFACTION = Satisfaction Score 2 [ ] – Satisfaction Score 1 [ ] = [ ]

ADDITIONAL NOTES AND BACKGROUND INFORMATION

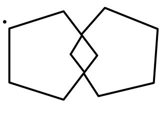
Initial Assessment:

Reassessment:

APPENDIX H: MINI MENTAL STATE EXAM

Client Name_________________ Assessor ___________________ Date________

Record client's answers in the spaces provided

		ORIENTATION:
5	( )	**QI What is the -** Year______ Season_______ Month_______ Day_______ Date_____
5	( )	**Q2** **Where are we** – Country ______ State______ Town/City__________________ Hospital/Street________________ Ward/House no. _______________
		REG ISTRATION:
3	( )	**Q3** Name these 3 objects **- apple, penny, table.** 1 second to say each. Then ask the person to repeat all three after you have said them. Score I point for each one correct on the first attempt. Repeat them (maximum *5* times) until he/she learns them. Count trials and record. Trials:
		ATTENTION AND CALCULATION:
5	( )	**Q4** Serial 7's: Count backwards from 100 by subtracting 7 **(93 86 79 72 65)** Score I point for each correct. (A correct response is one that is 7 less than the previous response even if the previous response is incorrect) Stop at *5* responses. **-OR-** Ask the person to spell the word "WORLD" forward and then backwards. Score 1 point for each letter in correct order. e.g. DLROW = *5,* DLORW = 3
		RECALL:
3	( )	**Q5** Ask for the names of the three objects given to remember in Q3. Score 1 point for each correct answer irrespective of the order they are recalled in. **apple penny table**
		LANGUAGE:
2	( )	**Q6** Show the person a "PENCIL" and a "WATCH". Have the person name them as you point. Score 1 point for each correct answer.
1	( )	**Q7** Have the person repeat the phrase **-** "NO IFS, ANDS, OR BUTS". Score 1 point for a correct repetition.
3	( )	**Q8** Have the person follow a 3 stage command. Take the paper in your right/left hand. Fold it in half once with both hands. Put it on the floor. Score 1 point for each part correctly executed.
1	( )	**Q9** Read and obey the message. **CLOSE YOUR EYES** Score 1 point if the person closes their eyes. They do not have to read aloud.
1	( )	**Q10** Ask the person to write a sentence of his/her own choice. The sentence should contain a subject and an object and make sense. Ignore spelling errors.
1	( )	**Q11** Ask the person to copy the design. Score I point if all sides and angles are preserved and the intersecting sides form a quadrangle. 
30	( )	**TOTAL SCORE**

References: 1. Derived from: Folstein MF. et al "Mini-Mental State" : a practical method for grading the cognitive state of patients for the clinician, *J Psychiatr Rex* 1975: 12:189. 2. Derived from: Cockrell JR et al Mini Mental State Examination (MMSE). Psychopharm Bull. 1988;24:689-692.
Compiled by Stephen Merrett. Mental Health Services For Older People, Country Liaison Service. March 2003

APPENDIX I: FALL RISK FOR OLDER PEOPLE IN THE COMMUNITY

Risk assessment developed by: National Ageing Research Institute
This assessment tool was developed initially for use with hospitalised older people (the Falls Risk for Hospitalised Older People – the FRHOP). The FRHOP has been shown to have high retest and inter-rater reliability, and to have moderate ability to predict falls in older people in hospital (Australasian Journal of Podiatric Medicine, 2004: 99-108). The tool has been expanded and modified to become the FROP-Com for use in the community setting, and consists of 13 risk factors being rated, most on a graded 0-3 scale. Information has been published on results of the FROP-Com between a group of older people with high falls risk (presenting to an emergency department after a fall) compared to age and gender matched non fallers (Disability and Rehabilitation, 2005: 499-506).
The guidelines suggest management options if a specific risk factor is identified.

The FROP-Com is currently being investigated for reliability and validity, and being used in several research studies and clinical settings. The tool may be modified based on the results of these studies. Therefore if you wish to use the FROP-Com please contact NARI at info@nari.unimelb.edu.au to request the most recent version.

(Downloadable)

---[[[[[[[[[[---

In 2005 the Department of Human Services funded the National Ageing Research Institute to review and recommend a set of falls prevention resources for general use. The materials used as the basis for this generic resource were developed by the National Ageing Research Institute. This and other falls prevention resources are available from the department's Aged Care website at: http://www.health.vic.gov.au/agedcare.

Falls Risk for Older People – Community setting (FROP-Com)

Personal details
Name:
Date of Assessment:

Address:____
DOB:____**Telephone:**________________

Marital Status:
Single / Married / Widowed / Divorced (separated) / Unknown (circle)

Usual living arrangements: ____

Recent health / community services use:

1. Community Aged Care Packages/Services Y/N
2. Community Rehabilitation Y/N
3. Doctors Appointment Y/N
4. Doctor Home Visit Y/N
5. Home Help Y/N
6. Home Modifications Y/N
7. Home Rehabilitation Y/N
8. Linkages Package Y/N
9. Meals on Wheels Y/N
10. OT Home visit Y/N
11. Outpatient Appointment Y/N
12. Other Y/N
13. Post Acute Care Y/N
14. Personal Care Y/N
15. Respite Care Y/N
16. District Nursing Services Y/N
17. Physiotherapist Appointment Y/N
18. Dietician Y/N
19. Podiatrist Y/N
20. Personal Alarm Y/N
21. Day Centre Y/N
22. Falls and Balance clinic Y/N

• Is English the individuals preferred language? If not, what is? ……………………………..	o Yes o No
• Does the individual have functional English?	o Yes o No

History of falls *(0-3points)*		SCORE
• Number of falls in the past 12 months? ……………………………..	o Nil in 12 months (0) o 1 in the last 12 months (1) o 2 or more in 12 months (2) o 1 or more requiring hospitalisation (3)	[ ]
• Was an injury sustained in any of the fall/s in the past 12 months? *(rate most severe injury due to a fall in the past 12 months)*	o No (0) o Minor injury, did not require medical attention (1) o Minor injury, did require medical attention (2) o Severe injury (fracture, etc) (3)	[ ]

• Describe the circumstances of the most recent fall in the past 12 months. **Time of fall**: AM / PM *(please circle)* **Location of fall**: inside home / outside home / community **Direction of fall**: left / right / forward / backward / down / can't remember / other **Cause of fall**: trip / slip / loss of balance / knees gave way / fainted / feeling dizzy or giddy / alcohol or meds / fell out of bed / unknown **Injuries:**	
Sub total for this page	[ ]

***Medications** (0-3 points)*		
• List all medications currently taken.	+ + + + + + + + + + + + + + + +	
• Number of prescription medications.	o No medication (0) o 1 –2 medications (1) o 3 medications (2) o 4 or more medications (3)	[ ]
• Does the individual take any of the following type of medication? o sedative o antidepressant o neuroleptics o central acting analgesic o digoxin o diuretics o type 1a antiarrythmic o vestibular suppressant	o None apply (0) o 1–2 apply (1) o 3 apply (2) o 4 or more apply (3)	[ ]
***Medical conditions** (0-3 points)*		
• Does the individual have a chronic medical condition/s affecting their balance & mobility? o Arthritis o Respiratory condition o Parkinson's Disease o Diabetes o Dementia oPeripheral neuropathy o Cardiac condition oStroke o Other neurological conditions o Lower Limb Amputation. oOsteoporosis o Vestibular Disorder o Other dizziness o Back pain olower limb joint replacement	o None apply (0) o 1-2 apply (1) o 3-4 apply (2) o 5 or more apply (3) Osteoporosis: o Unknown o does not have	[ ]

Sensory loss		
• Does the client have an uncorrected sensory deficit/s that limits their functional ability?	Vision: o no (0) o yes (1) Somato Sensory: o no (0) o yes (1)	[ ]
Feet & footwear		
• Does the client have foot problems, e.g. corns, bunions, swelling etc.	o no (0) o yes (1) (specify):	[ ]
• Does the client have inappropriate, poorly fitting or worn footwear?	o no (0) o yes (1) (specify):	[ ]
***Cognitive status**: (score 0-3 points).*		
• AMTS score o Age o Time to the nearest hour o Address to recall – 42 West St o Current year o Current location (where are we?) o Recognition of two persons (Dr, nurse) o Date of birth o Years of first World War o Name of current prime minister o Count backwards from 20 by ones	Number of correct responses: o 9-10 (0 point) o 7-8 (1 point) o 5-6 (2 points) o 4 or less (3 points) Score: ……………/ 10	[ ]
Continence:		
• Is the individual continent?	o Yes (0) o No (1)	[ ]
• Does the individual regularly have to go to the toilet in the night (3 or more times)?	o No (0) o Yes (1) (if uses a bottle, rate as 0)	[ ]
	Sub total for this page	[ ]
Nutritional status *(score 0-3 points)*		
• Has the individual's food intake declined in the past three months due to a loss of appetite, digestive problems, chewing or swallowing difficulties?	o No (0) o Small change, but intake remains good (1) o Moderate loss of appetite (2) o Severe loss of appetite / poor oral intake (3)	[ ]
• Weight loss during the last 3-12 months.	o Nil (0) o Minimal (<1 kg) or unsure (1) o Moderate (1-3kg) (2) o Marked (>3kg) (3)	[ ]
• Number of alcoholic drinks consumed in the past week	o Nil (0) o 1-3 (1) o 4-10 (2) o 11+ (3)	[ ]
Environment *(score 0-3 points)*		

• Was there anything in the area around where the most recent fall occurred that contributed to the fall (eg, obstacles, uneven path)? If yes, clarify the perceived extent to which the environment contributed. *(NOTE: If no falls, leave blank)*	o No environmental hazards (0) o Minimal involvement of environmental hazards (1) o Moderate involvement of environmental hazards (2) o Major involvement of environmental hazards (3)	[ ]
• Did the home environment appear safe? *(NOTE: only rate if undertaking a home visit assessment, leave blank otherwise)*	o Yes (0) o Minimal environmental hazards (1) o Moderate environmental hazards requiring modification (2) o Extremely unsafe environment (3)	[ ]
Functional Behaviour **(score 0 –3 points)**		
• ***Observed behaviours in Activities of Daily Living and Mobility indicate***	***o Consistently aware of current abilities /seeks appropriate assistance as required (0)*** o Generally aware of current abilities /occasional risk-taking behaviour (1) o Under-estimates abilities / inappropriately fearful of activity (2) o Over-estimates abilities/frequent risk-taking behaviour (3)	[ ]
Function **(score 0-3 points)**		
• ***Prior to this fall, how much assistance was the individual requiring for personal care activities of daily living (eg dressing, grooming, toileting)?*** *(NOTE: If no fall in last 12 months, rate current function)*	o none (completely independent) (0) o supervision (1) o some assistance required(2) o completely dependent (3)	[ ]
• ***Has this changed since the most recent fall?*** **(leave blank if no falls in 12 months)**	o No (0) ***o Yes (1) (specify):***	[ ]
• ***Prior to this fall, how much assistance was the individual requiring for instrumental activities of daily living (eg shopping, housework, laundry)?*** *(NOTE: If no fall in last 12 months, rate current function)*	o none (completely independent) (0) o supervision (1) o some assistance required(2) o completely dependent (3)	[ ]
• Has this changed since the most recent fall? *(leave blank if no falls in 12 months)*	o No (0) o Yes (1) (specify):	[ ]
	Sub total for this page	[ ]

Balance *(score 0-3 points)*		
• Does the individual, upon observation of walking and turning, appear unsteady or at risk of losing their balance? *(NOTE: Rate with usual walking aid. Tick one only, if level fluctuates, tick the most unsteady rating)*	o No unsteadiness observed (0) o Yes, minimally unsteady on walking or turning (1) o Yes, moderately unsteady on walking or turning (needs supervision) (2) o Yes, consistently and severely unsteady on walking or turning (needs constant hands on assistance (3)	[ ]
Gait / Physical Activity *(score 0-3 points)*		
• Can the individual walk safely around their own home?	o Independent, no gait aid needed (0) o Independent with a gait aid (1) o Safe with supervision / physical assistance o (2) o Unsafe (3)	[ ]
• Can the individual walk safely in the community?	o Independent, no gait aid needed (0) o Independent with a gait aid (1) o Safe with supervision / physical assistance (2) o Unsafe (3)	[ ]
• If a walking aid is used, list the aid and when it is used.	Aid……………………….. o indoors o outdoors	
• How physically active is the individual?	o Very active (exercises 3 times per week) (0) o Moderately active (exercises less than twice per week) (1) o Not very active (rarely leaves the house) (2) o Inactive (rarely leaves one room of the house) (3)	[ ]
• ***Has this changed since the most recent fall?***	o No (0) ***o Yes (1) (specify):***	[ ]
	Sub total for this page	[ ]
	Sub total for page 1	[ ]
	Sub total for page 2	[ ]
	Sub total for page 3	[ ]
	Total Risk Score	[ ]

Grading of falls risk:

o Low falls risk (0)	0 – 15	Implement actions for identified individual risk factors, & recommend health promotion behaviour to minimise future ongoing risk (eg – increased physical activity, good nutrition)
o Mild to moderate falls risk (1)	16 – 24	Implement actions for identified individual risk factors
o High falls risk (2)	> 24	Implement actions for identified individual risk factors, and implement additional actions for high falls risk

(maximum =63)

APPENDIX J: SAFETY ASSESSMENT OF FUNCTION AND THE ENVIRONMENT FOR REHABILITATION

COMPREHENSIVE REHABILITATION
COTA
AND MENTAL HEALTH SERVICES

700 Lawrence Avenue West, Suite 362,
Toronto, ON M6A 3B4, Phone: 416-785-9230
Fax: 785-9358, Email: info@cotarehab.on.ca

SAFER TOOL

☑ *Safety Assessment of Function & the Environment for Rehabilitation*

CLIENT'S NAME:

MMSE score:

TYPE OF HOUSING: __House __Apartment __Other

ADDRESSED - A
NOT APPLICABLE - NA
PROBLEM - P

		A	NA	P	COMMENTS
	LIVING SITUATION				**Score**
1.	Access/entrance/security				
2.	Lives alone/with others				
3.	Support – family/friends				
4.	Stairs/ramps - condition				
5.	- railings				
6.	Elevator				
7.	Environment cluttered				
8.	Scatter rugs/flooring				
9.	Wires/cords				
	MOBILITY				**Score**
10.	Positioning				
11.	Transfers				
12.	Walking/devices				
13.	Wheelchair/scooter				
14.	Venturing outside				
15.	Public/disabled transport				
16.	Car/driving				

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		A	NA	P	COMMENTS
	KITCHEN				**Score**
17	Toaster/toaster oven				
18	Microwave				
19	Stove - gas/electric				
20	- readable controls				
21	- removable dials/fuses				
22	- grease & clutter				
23	Evidence of burns or fires				
24	Kettle – manual/electric/shut off				
25	Storage – accessible/safe				
26	Knives/scissors - safe storage/use				
27	Food supply-fridge/cupboards				
28	Garbage – storage/disposal				
29	Evidence of alcohol				
	FIRE HAZARDS				**Score**
30	Smoking/candles/signs of burns				
31	Smoke&carbon monoxide detectors				
32	Wiring/plugs				
33	Electric blanket/pad/heater				
34	Furnace/thermostat/fireplace				
35	Fire exit				
	EATING				**Score**
36	Liquids/food - to mouth/swallowing				
37	Nutrition				
	HOUSEHOLD				**Score**
38	Preparation – hot drinks				
39	- meals				
40	Carrying drinks/meals				
41	Meals On Wheels				
42	Shopping				
43	Handling money/safekeeping				
44	Financial management/abuse				
45	Bed making				
46	Cleaning – light/heavy				
47	Laundry				
48	Iron - manual/auto shut-off				

		A	NA	P	COMMENTS
	DRESSING				**Score**
49	Dress				
50	Undress				
51	Appropriate selection				
	GROOMING				**Score**
52	Hair care				
53	Nail care				
54	Shaving				
55	Teeth - oral hygiene				
	BATHROOM				**Score**
56	Sponge bath/shower/bath				
57	- seating/transfer aid				
58	- shower extension				
59	- grab bar				
60	- non-skid aid				
61	Continence - bladder				
62	- bowel				
63	Toiletting				
64	- raised toilet seat				
65	- versaframe/grab bar				
66	Door lock				
67	Safe water temperature				
68	Taps				
	MEDICATION				**Score**
69	In use as prescribed/dosette				
70	Safe storage of family drugs				
71	Ordering/delivery				
	COMMUNICATION				**Score**
72	Use of telephone				
73	- location(s)				
74	- emergency # posted/readable				
75	- ability to dial 911/emergency #				
76	Speech				
77	Vision				
78	Hearing				
79	Reading				

		A	NA	P	COMMENTS
80	Writing				
81	Alert system				
82	TV/radio				
	WANDERING				**Score**
83	Night/day				
84	Wandering person's registry				
85	Neighbours aware				
86	Medic alert/identification				
87	Windows/doors				
88	Enclosed yard				
89	Local traffic				
	MEMORY AIDS				**Score**
90	Clocks/can tell time				
91	Calendar/date book/notes				
	GENERAL				**Score**
92	Intercom/call button				
93	Lighting/night light				
94	Bulbs/fuses/snow/grass				
95	Storage of dangerous substances				
96	Leisure				
97	Abuse				

Category	SAFER Score	95th percentile	99th percentile
Living situation		3	5
Mobility		3	4
Kitchen		3	7
Fire Hazards		1	2
Eating		1	2
Household		4	7
Dressing		2	3
Grooming		2	4
Bathroom		4	6
Medication		1	3
Communication		4	6
Wandering		3	5
Memory aids		1	2
General		2	3
SAFER Total Score		**19**	**32**

Therapist's name (Please print) Therapist's signature & designation Date (dd/mm/yy)

APPENDIX K: PHASE 1 CHART

Directions:
You can play the games in any order you would like and there is no requirement as to how many games you play in each session. The only balance game that will not be played for this study is the "Lotus Focus" game because this does not require standing balance. Each session should last approximately 15 minutes, 3 times a week if possible. There will be a total of 30 sessions, with the study lasting for 2 months. Please record the score of each balance game. Record each score if you play the game multiple times in one session

Key to abbreviations for Wii Fit™ games
S.H.: Soccer heading game
S.J.: Ski jump
S.S.: Ski Slalom
T.T.: Table tilt
T.W.: Tightrope walk
B.B.: Balance bubble
P.S.: Penguin slide
Sn. S: Snowboard slalom
*=Advanced games that must be unlocked

#	Date	Time (start-end)	S.H.	S.J.	S.S.	T.T.	T.W. *	B.B. *	P.S.*	Sn.S.*	Balance Test
T	10-02	2:45- 3:30	28	0 91	53.25 06.25	40	16 yds 31 yds				L: 53.1 R: 46.9
1	10-05	8:30- 9:00	44 43 87 68	41 60 49 72	50:13 58:56 45:40 46:56	89	16 yds 1:43.21				L: 46.0 R: 54.0
2	10-07	8:00- 8:30	22 33 84 87	109 91 74	51.73 1:06.41 44.01	40 98	37 yds 19 yds 1:37.8				
3	10-09	8:25- 9:15	201 106 182	177 0 72 43	44.78 50.20 1:02 53.00 48.90	83 115	1:15.20 1:18.20	118 280 536 525			L: 48.3 R: 51.7
4	10-12	12:00- 12:45	41 46 92	47 0 96 116	55.56 39.78 59.25 44.76 57.23	60 50 50	1:30.53	978 686 888 946	53 50		L: 45.4 R: 54.6
5	10-13	12:35- 1:35	120 179	58 56 47 66	58.33 51.43 36.01	107	1:15.63	985 291 1023 684	52 74 72	1:51.20 1:31.05 2:04.90 1:32.81	
6	10-14	8:30- 9:30	137 100 107	48 60 76 129	51.25 42.36 1:10.28 45.88	40 50 70	1:12.10 1:22.18	908 1123 1029 1042	48 57 61 47	1:30.08 1:27.28 1:50.76 1:13.06	L: 45.3 R: 54.7

7	10-15	9:20- 10:15 2:05- 3:05	65 144 114	58 0 0 159 169	1:30.93 1:30.96 1:10.70	60 106 50 70 60	1:30.05 20 yds	995 1018 1237 999	75 49 50 65	42.60 1:16.36 1:22.26 1:16.45	L: 50.4 R: 49.6
8	10-16	1:00- 2:10	20 57	37 131 0	1:33.20 1:26.56 1:18.16 1:14.13	60 70	1:35.46	1132 1196 892	41 67	1:55.00 1:41.66	L: 55.3 R: 44.7
9	10-19	1:15- 2:15	67 41 83	95 62 177	1:28.88 1:23.15 1:19.03	50 70 50	7 yds 20 yds 21 yds	54.70 s 1011 847	57 51 67	2:13.43 2:23.93 2:12.58	L: 48.2 R: 51.8
10	10-20	1:25- 2:25	41 45 109	53 118 0	2:04.21 1:11.08 1:34.28	88 106	1:25.41	50.78 s	47 74 37	1:49.95 2:17.86 2:02.61	L: 51.8 R: 48.2
11	10-21	9:15- 10:30	91 45 63	72 0 0	1:07.46 1:25.45 1:45.81	50 50 60	1:12.53	58.63 s 362 891	69 82	1:50.83 2:03.10 1:58.48	L: 52.1 R: 47.9
12	10-22	12:50- 1:50	57 45 68	159 80 64	1:39.16 1:16.50 1:11.78	70 50 70	1:33.75 1:40.11 1:21.30	757 644 964	86 72 60	1:35.01 2:24.71 1:43.15	L: 52.8 R: 47.2
13	10-23	1:15- 2:45	52 30 89	263 0 79	1:11.88 1:15.25 1:24.36	50 122 70	7 yds 1:11.46 1:20.20	646 250 545	91 77 48	2:35.61 1:46.36 1:35.86	L: 49.0 R: 51.0
14	10-26	1:15- 2:20	86 41 127	231 41 127	1:11.48 1:25.56 1:12.70	70 105 70	25 yds 19 yds 7 yds	1095 697 1000	73 69 67	1:51.78 2:13.16 1:42.36	L: 58.9 R: 41.1
15	10-27	2:15- 3:20	43 90 115	131 58 0	1:29.80 1:14.36 1:13.68	82 138 70	1:32.23 1:34.63 19 yds	908 1008 896	87 82 72	1:33.56 2:11.56 1:30.48	L: 49.9 R: 50.1
16	10-29	1:25- 2:20	116 205 122	114 40 45	2:34.71 1:27.43 1:07.00	91 85	7 yds 1:21:25 24 yds 50.11	1046 1259 656 606	100 60 85	1:21.28 1:28.16 1:56.53	L: 53.6 R: 46.4
17	10-30	2:00- 3:00	104 182 148	0 33 25	1:14.93 105.66 1:15.10	70 98 133	22 yds 1:07.31 22 yds	932 603 1072	79 68 84	1:47.30 1:47.33 1:19.38	L: 46.6 R: 53.4
18	11-02	2:20- 3:20	129 150 99	126 0 0	1:15.03 1:18.48 1:07.46	128 60 60	1:07.70 19 yds 1:19.45	889 49.16 s 1008	67 71 92	1:45.18 1:30.11 1:42.21	L: 53.2 R: 46.8
19	11-03	2:20- 3:20	130 89 131	71 0 96	1:15.93 1:02.05 1:02.93	70 102 70	1:10.15 53.78 22 yds	641 708 348	97 87 79	1:43.61 1:45.86 1:48.46	L: 53.6 R: 46.4

20	11-04	2:40- 3:40	138 117 106	118 45 128	1:10.46 1:04.83 1:02.50	60 127 138	1:00.02 25 yds 25 yds	970 1112 646	98 102 109	1:22.96 1:46.53 2:13.41	L: 51.8 R: 48.2
21	11-09	1:25- 2:25	82 78 91	97 94 60	1:39.53 1:10.65 1:03.30	70 70 145	1:05.46 22 yds 26 yds	696 605 595	80 90 104	1:46.16 1:25.95 1:16.86	L: 49.3 R: 50.7
22	11-10	2:20- 3:20	151 162 166	151 159 91	1:00.83 1:10.16 1:07.36	70 119 88	57.30 56.98 40.56	997 606 956	84 64 99	1:40.25 1:46.08 1:13.83	L: 45.9 R: 54.1
23	11-11	3:20- 4:20	89 164 89	120 82 126	58.68 1:02.53 55.78	50 131 114	56.01 47.11 45.25	605 891 1013	90 107 62	2:02.70 1:35.85 1:53.91	L: 49.4 R: 50.6
24	11-12	2:25- 3:20	132 158 116	135 80 147	59.46 1:04.23 1:29.46	110 118 104	1:03.10 40.53 50.43	52.10 s 358 930	83 101 78	1:34.18 1:34.95 1:33.31	L: 50.3 R: 49.7
25	11-13	2:10- 3:05	170 180 94	114 163 87	1:07.58 1:01.06 1:11.68	118 50 108	50.03 47.10 23 yds	1005 366 995	84 87 89	1:18.06 1:38.95 1:47.21	L: 44.4 R: 55.6
26	11-16	1:50- 2:45	117 72 198	129 111 134	1:04.10 1:05.60 55.53	127 85 70	20 yds 48.65 41.25	647 995 707	103 94 101	1:33.56 1:40.56 1:47.66	L: 54.8 R: 45.2
27	11-17	2:45- 3:45	140 144 177	126 93 227	1:41.61 1:01.95 1:01.25	70 119 99	46.86 22 yds 10 yds	1236 1198 51.55 s	94 75 63	2:08.26 1:41.35 2:10.90	L: 55.4 R: 44.6
28	11-18	2:30- 3:25	101 149 167	163 128 153	1:20.86 1:10.75 59.83	85 70 60	44.93 44.61 36.73	361 836 1000	76 89 93	1:12.21 1:37.41 2:07.46	L: 53.3 R: 46.7
29	11-19	1:45- 2:45	156 170 193	143 104 131	1:03.45 58.73 59.95	123 122 84	45.40 10 yds 47.88	696 1100 944	61 88 89	1:34.31 1:39.41 1:58.65	L: 54.2 R: 45.8
30	11-20	1:05- 2:10	186 178 182	123 126 232	1:15.80 59.15 1:07.91	118 135 60	39.66 28 yds 35.83	1090 986 994 604 650	64 83 85 82	1:27.88 1:22.53 1:49.70 1:40.23 2:11.53 1:19.21	L: 51.2 R: 48.8

Journal: Please record your thoughts/feelings for each session; this does not have to be in detail, just a few thoughts about the session or how you were feeling that day

Session 1: Felt like I had more energy for my 3 and ¾ mile walk after doing the games.

Session 2: A little tired today after a typical short Tue nite. Did 20 minutes and it seemed to short.

Session 3: Still a little stiff from yesterday's yard mowing and oil and filter change on wife's car.

Session 4: I'm enjoying setting new records, but finding it difficult to hold to a reasonable time.

Session 5: I'm still learning techniques and the snowboarding appears to be the most difficult at this time. I also tried some aerobic games, running and boxing.
Session 6: I began with a short run in place to warm up before starting balance games. I noticed a little light headedness after several ski jump attempts. Took a short rest then continued. I finished with some boxing and strength games.
Session 7: I broke the session into a morning and an afternoon workout. Also tried advanced difficulty on several games. I'm still setting best times or distances on several games. I did the balance test with eyes closed.
Session 8: I played advanced games where available. I'm still a little sore from yesterday's strength games. I'm still having fun.
Session 9: Coming down with head cold. Balance definitely not up to normal. I limited myself to balance games only.
Session 10: Cold a little better. Still set a couple of new bests.
Session 11: Did a full lap of the island run for warm-up, seems that the most difficult for me at this time are the ski jump and snowboarding. Ski jump is a timing issue as opposed to balance. The snowboard is combination of balance and timing.
Session 12: Felt very sluggish today. It may be the effects of the cold medicine.
Session 13: Did lap of island run for warm-up. I played games in reverse order to see if fatigue has much effect. I rested 15 minutes between Table Tilt and Ski Slalom. Had new records in Ski Jump, Table Tilt, Tightrope Walk, and Penguin Slide.
Session 14: Cold is much worse today. Chest muscles sore from coughing plus I didn't get much sleep last night due to coughing. It shows in the overall scores even though there were a couple of 2^{nd} bests.
Session 15: Much better day today. Cough medicine is working.
Session 16: I went thru the games in reverse order again and still set some new highs. There is still much room for improvement. I did the body test balance with eyes closed and I'm still not as steady as I believe I can be.
Session 17: Obviously the ski jump is still the most difficult for me. Trying to jump without jumping is a fine line. Maybe I'll get it before session 30.
Session 18: It's Monday, I didn't have the patience and concentration to do my best.
Session 19: Good day, still on some cold medicine.
Session 20: Very good day, no cold medicine so far today. Toughest is still snowboard and ski jump. Pesky bees get me in the balance bubble game.
Session 21: Felt a little sluggish after 4 days off. By the end of the session I was doing much better.
Session 22: Felt like it was the best day yet overall. I'm looking forward to tomorrow.
Session 23: Normal day, nothing special.
Session 24: Pretty good day, best yet on tightrope.
Session 25: Beginning to get frustrated with the bees in the Balance Bubble game.
Session 26: Pretty good day for a Monday. Felt really good. I'm now completing the ski jumps, but still trying for more distance.
Session 27: Felt good, but I find myself trying to hard as I see the end coming. I had my first complete run in Balance Bubble in over two weeks, and best Ski Jump in over three weeks.
Session 28: Good day, set new best in Tightrope Walk and Snowboard Slalom.
Session 29: Another good day, but no new bests. I can't believe only one more session to go.
Session 30: (last session!) Real good session. I felt sorry that it was the last.
Overall, how did you feel about the study? I enjoyed this study very much and know that my balance has improved. I hope the study data proves useful and may someday benefit others.

APPENDIX L: PHASE 2 CHART

Directions: This phase will last approximately 3 weeks, for a total of 15 sessions. For this phase, you will use the stepping activities on the Nintendo Wii Fit, instead of walking outside. You can play any of the Wii Fit games in addition to the various stepping activities; however, you will not walk outside for this 3 week phase. Each session should last approximately 60 minutes.

<u>Scale for rating motivation level</u>
(Adapted from Brown, et al., 2009)
0: not motivated at all, no interest in activity
1: slightly motivated, slight interest in activity and a little excited to complete
2: somewhat motivated, some interest in activity and somewhat excited to complete
3: fairly motivated, fairly interested in activity and fairly excited to complete
4: very motivated, very interested in activity and excited to complete
5: extremely motivated, extremely interested in

#	Date	Time	Wii Game	Score	Motivation level	Additional Wii games
1	12/30/09	9:05AM	Basic Step	221	3	4:00PM Golf 9 holes
				225	3	4:30 Baseball 3
				239	3	innings
		9:20	Basic Run (1 Lap)	130	4	4:45 Bowling 2
		9:28	Advanced Step	304	4	games
				369	4	
		9:40	Free Step (10 Min)	997 steps	4	
		10:00	Free Run (20 Min)	4.308 Mi	3	
		10:30	Advanced Step	436	4	
	Total	59 Min			Av mot: 3.5	
2	12/31/09	9:05AM	Basic Step	194	3	
				246	3	
		9:15	Advanced Step	354	4	
				420	4	
		9:30	Basic Run (1 Lap)	47	4	
		9:40	Free Step (20 Min)	1985 steps	4	
		10:15	Free Run (10 Min)	2.295 Mi	4	
		10:30	Advanced Step	403	4	
	Total	61 Min		455	4	
					Av. mot: 3.7	
3	01/01/10	9:45AM	Basic Step	242	3	
				198	3	
		9:55	Advanced Step	414	4	
				348	4	
		10:05	Basic Run (1 Lap)	140	4	
		10:15	Free Step (20 Min)	2002 steps	4	
		10:45	Basic Run (1 Lap)	163	4	
		10:55	Advanced Step	404	4	
		11:05	Basic Run (1 Lap)	132	4	
	Total	59 Min			Av. mot: 3.7	
4	01/04/10	9:45AM	Basic Step	245	4	2:30PM Rhythm
				277	4	Boxing

				218	3	Soccer Heading
		10:00	Basic Run (1 Lap)	153	4	Ski Slalom
				116	3	Ski Jump
				83	3	Table Tilt
		10:25	Advanced Step	460	4	
				470	4	Additional 13 Min
		10:45	Free Step (20 Min)	2042 steps	4	Day Total 75 Min
		11:10	Basic Step	221	4	
	Total	62 Min			Av. mot: 3.7	
5	01/05/10	9:30AM	Basic Step	241	4	
				278	4	
		9:40	Basic Run (1 Lap)	180	4	
		9:50	Advanced Step	454	4	
		10:00	Free Step (10 Min)	1006 steps	4	
		10:15	Free Run (10 Min)	2.167 Mi	3	
		10:35	Free Step (10 Min)	1032 steps	4	
		10:55	Basic Run (1 Lap)	109	4	
		11:00	Advanced Step	451	4	
	Total	59 Min			Av. mot: 3.8	
6	1/6/10	8:30AM	Basic Step	210	3	
				232	3	
				269	4	
		8:45	Basic Run (1 Lap)	92	3	
				84	3	
		9:10	Advanced Step	454	4	
				489	4	
		9:20	Free Step (20 Min)	2042 steps	4	
		9:50	Basic Run (1 Lap)	116	4	
	Total	59 Min			Av. mot: 3.5	
7	1/7/10	8:50AM	Basic Step	213	4	
				217	4	
		9:00	Basic Run (1 Lap)	122	4	
				120	4	
		9:20	Advanced Step	468	4	
				460	4	
		9:45	Free Step (20 Min)	2034 steps	4	
		10:10	Basic Run (1 Lap)	123	4	
	Total	60 Min			Av mot: 4	
8	1/8/10	9:00AM	Basic Step	256	4	
				221	4	
		9:10	Basic Run (1 Lap)	157	4	
				121	4	
		9:30	Advanced Step	503	4	
				523	4	
		9:50	Free Step (20 Min)	2080 steps	4	
		10:15	Basic Run (1 Lap)	113	4	
	Total	59 Min			Av. mot: 4	
9	1/11/10	9:10AM	Basic Step	259	3	
				251	3	

				290	4	
		9:25	Basic Run (1 Lap)	113	4	
				89	3	
		9:45	Advanced Step	428	4	
				493	4	
		10:00	Free Step (20 Min)	2206 steps	4	
		10:30	Basic Run (1 Lap)	82	3	
	Total	60 Min			Av. mot: 3.5	
10	1/12/10	2:25PM	Basic Step	262	4	
				223	3	
		2:35	Basic Run (1 Lap)	91	4	
		2:45	Free Run (10 Min)	2.059 Mi	3	
		3:00	Advanced Step	335	3	
				478	4	
		3:15	Free Step (20 Min)	2010 steps	3	
		3:40	Basic run (1 Lap)	92	3	
	Total	61 Min			Av mot: 3.4	
11	1/13/10	8:45AM	Basic Step	242	3	
				246	3	
				251	3	
		9:00	Free run (10 Min)	2.058 Mi	4	
				2.269 Mi	4	
		9:30	Advanced Step	480	4	
				478	4	
		9:45	Free Step (20 Min)	2010 steps	4	
	Total	59 Min			Av mot: 3.6	
12	1/14/10	9:05AM	Basic Step	270	4	
				240	4	
				245	4	
		9:20	Free Run (10 Min)	2.029 Mi	3	
		9:45	Basic Run (1 Lap)	58	3	
		10:00	Advanced Step	480	4	
				467	4	
				507	4	
		10:25	Free Step (10 Min)	1007 steps	4	
		10:40	Basic Run (1 Lap)	59	4	
	Total	59 Min			Av mot: 3.8	
13	1/15/10	8:45AM	Basic Step	245	3	
				262	3	
		8:55	Free Run (10 Min)	2.162 Mi	4	
		9:10	Free Step (20 Min)	2113 steps	4	
		9:40	Free Run (20 Min)	4.118 Mi	3	
		10:05	Advanced Step	465	3	
	Total	61 Min			Av mot: 3.3	
14	1/18/10	9:00AM	Basic Step	228	3	3:30 PM Golf (9 holes)
				237	3	
		9:10	Basic Run (1 Lap)	59	3	Wii fitness (Tennis, Putting, Home Run Hitting)
		9:30	Free Run (10 Min)	2.239 Mi	3	
		9:45	Advanced Step	539	3	

	    Total	 9:55 10:15 10:30 62 Min	 Free Step (10 Min) Free Run (10 Min) Advanced Step	474 1090 steps 2.023 Mi 476	3 3 3 3 Av. mot: 3	 Extra 45 Min Day Total 107 Min
15	1/19/10 Total	9:00AM 9:15 9:30 9:45 10:00 10:15 10:25 61 Min	Basic Step Basic Run (1 Lap) Advanced Step Free Step (10 Min) Free Run (10 Min) Basic Run (1 Lap) Basic Step	253 252 77 60 474 516 1097 steps 2.285 Mi 84 224	3 3 3 3 3 3 3 2 2 2 Av mot: 2.7 OVERALL AVERAGE: 3.5	

APPENDIX M: PHASE 3 CHART

Phase 3 chart: This is the final phase of the research study. This phase will last 3 weeks and consists of walking outside and not playing any Wii games.

<u>Scale for rating motivation level</u>
(Adapted from Brown, et al., 2009).
0: not motivated at all, no interest in activity
1: slightly motivated, slight interest in activity and a little excited to complete
2: somewhat motivated, some interest in activity and somewhat excited to complete
3: fairly motivated, fairly interested in activity and fairly excited to complete
4: very motivated, very interested in activity and excited to complete
5: extremely motivated, extremely interested in activity and extremely excited to complete

Session	Date	Time	Distance walked	Motivation level	Additional activities
1	1/25/10	10:06 AM 63 Min	3.1 Miles	4	
2	1/26/10	9:18 AM 59 Min	3.1 Miles	4	
3	1/27/10	9:08 AM 63 Min	3.5 Miles	5	
4	1/28/10	9:00 AM 85 Min	4.5 Miles	5	
5	1/29/10	9:10 AM 57 Min	3.1 Miles	5	
6	2/01/10	1:41 PM 74 Min	3.8 Miles	4	1 Hour Chipping and Shoveling ice.
7	2/03/10	9:07 AM 59 Min	3.1 Miles	4	
8	2/04/10	9:07 AM 68 Min	4.0 Miles	5	
9	2/05/10	9:51 AM 62 Min	3.2 Miles	5	
10	2/06/10	8:42 AM 57 Min	3.1 Miles	4	
11	2/08/10	9:03 AM 80 Min	4.5 Miles	5	
12	2/09/10	8:40 AM 56 Min	3.1 Miles	4	
13	2/10/10	8:56 AM 58 Min	3.25 Miles	5	
14	2/11/10	9:56 AM 53 Min	3.1 Miles	4	
15	2/12/10	9:09 AM 87 Min	5.0 Miles	5 OVERALL AVERAGE: 4.5	