

THE EFFECTS OF A 15 WEEK EXERCISE INTERVENTION ON FITNESS AND POSTURAL  
CONTROL IN OLDER ADULTS

by

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## ABSTRACT

### THE EFFECTS OF A 15 WEEK EXERCISE INTERVENTION ON FITNESS AND POSTURAL CONTROL IN OLDER ADULTS

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Falls are the leading cause of nonfatal injuries in older adults, and often lead to adverse changes in confidence and lifestyle that trigger further declines in postural control. Decreased fitness is associated with poor performance on postural control assessments, especially those that increase task difficulty. The purpose of this study was to analyze the impact of a traditional Group Fitness class and a Wii Fitness exercise program on individual's ability to maintain postural control, with an environmental distracter.

87 community dwelling seniors were randomized into 1 of 3 groups (Control, Wii Fitness, Group Fitness). Interventions were delivered 3 times per week, for 15 weeks. A significant improvement in SOT equilibrium score was seen over time. There was a significant training group by time interaction for 6 min walk,  $p = 0.14$ , effect size = .776. There was a significant pre-test ( $7.2 \pm 1.4$ ) post-test ( $6.7 \pm 1.4$ ) comparison for 8 ft Up and Go,  $p = 0.017$ . There was a significant interaction between training groups and time ( $p = 0.010$ ) for chair stands. Post hoc tests revealed that equilibrium scores during cognitive distraction ( $38.1 \pm 20.9$ ) were significantly less than both the visual distraction ( $51.9 \pm 20.2$ ) and auditory

distraction ( $49.3 \pm 21.1$ ). There were no differences during the increased environmental load testing ( $p = 0.686$ ). Results indicated that both intervention programs were successful at improving postural control and fitness.

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CHAPTER 1  
INTRODUCTION  
1.1 Background

Falls are the most common cause of nonfatal injuries and hospital admissions for trauma in older adults (CDC, 2010). This major problem resulted in 2.2 million emergency room visits with more than 581,000 of these patients being hospitalized in 2009 (CDC, 2010). Additionally, falls are the leading cause of accidental death in adults over the age of 65, and a third of this population will fall once or more each year (CDC, 2010). In 2005 total lifetime medical costs equaled 5.9 Billion and by 2020, the annual direct and indirect cost of fall injuries is expected to reach \$54.9 billion before inflation (CDC, 2010). Medicare costs per fall averaged between \$9,113 and \$13,507 (CDC, 2010). Figure 1.1 displays the total lifetime medical costs of unintentional fall-related injuries in older adults (CDC, 2010).

**Total Lifetime Medical Costs of Unintentional Fall-Related Injuries in People 65 Years and Older Treated in Emergency Departments & Hospitalized, By Sex and Age, United States, 2005**

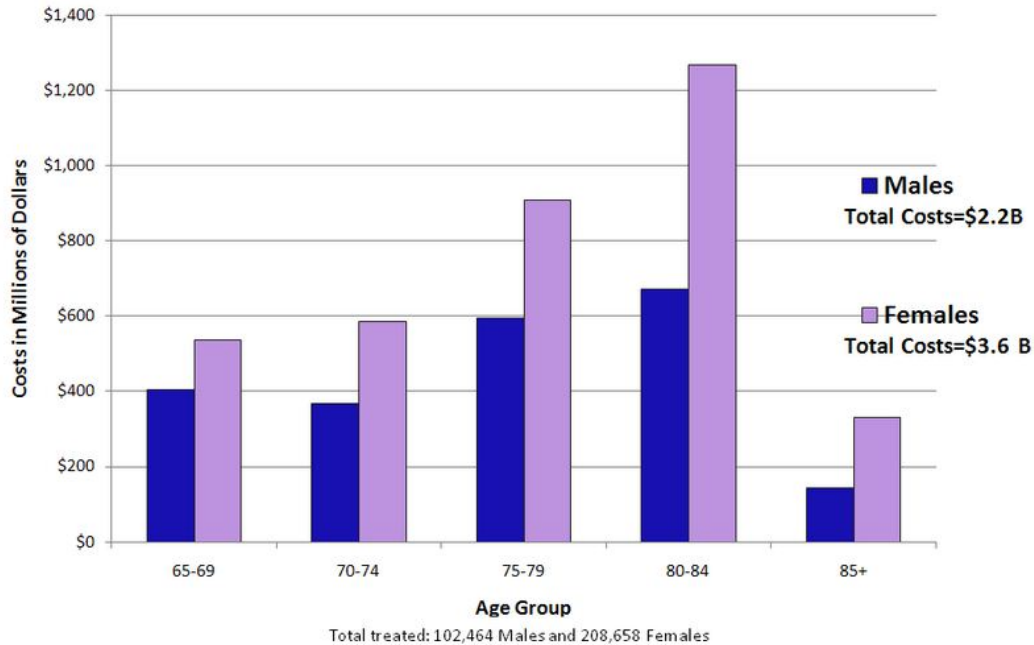


Figure 1.1 Total Lifetime Medical Costs of Unintentional Fall Related Injuries

Nonfatal falls often lead to injury, decreased activity, decreased confidence, altered lifestyle, and decreased quality of life (R. R. Miller et al., 2009). Although falls are not always fatal they often lead to injury, loss of function, and/or fear based changes in activity. These lifestyle changes of attitude and activity occur as a result of a common tendency to self limit activity level, which leads to a cyclical decline in postural control and an increased precedence of falls (Scheffer, Schuurmans, Van Dijk, Van Der Hooft, & De Rooij, 2008). This self limiting tendency is due to a fear of falling that commonly develops in these individuals. Fear of falling ranks as the top fear of community dwelling older adults (Howland, 1993; Kempen, Van Haastregt, McKee, Delbaere, & Zijlstra, 2009).

The ability to maintain postural control involves a number of sensory and physiological systems that can be affected by pathology or sub-clinical constraints (F. B. Horak, 2006). Sensory information is crucial for maintaining postural control. Somatosensory and vestibular

sensory information decline with the aging process, compromising movement ability. The ability to perform activities of daily living, and functional tasks are affected by age related declines in balance, cognition, health , fitness level, vision, and gait (Bassey et al., 1992; S. R. Lord, Clark, & Webster, 1991; Teasdale & Simoneau, 2001; Tinetti, Doucette, Claus, & Marottoli, 1995; Wood et al., 2009) This is a large public health concern due to the rapidly expanding population of adults over the age of 65, increasing the number susceptible than in years past.

#### *1.1.1 Purpose*

The purpose of this study was to evaluate the effectiveness of a 15 week exercise intervention program on increasing postural control and fitness level on a large community of adults over the age of 65.

#### 1.2 Definition of Terms

- 1) Postural Control: This is the act of maintaining, achieving, or restoring a state of balance before, during, or after any activity. Tests of postural control are a quantifiable measure of balance ability.
- 2) Postural Equilibrium: This involves the coordination of movement strategies to stabilize the center of mass in response to disturbances in stability (F. B. Horak, 2006).
- 3) Postural Orientation: This is the active alignment of the trunk and head with respect to gravity, visual surroundings, and internal references (F. B. Horak, 2006).
- 4) Balance Efficacy: This is an individual's perceived capacity to maintain one's balance in response to challenges to one's postural ability (Bandura, 1982; Hatch, Gill-Body, & Portney, 2003). Balance efficacy is a preferred measure of balance confidence than fear of falling due to the broader spectrum balance efficacy provides.
- 5) Fear of Falling: This is the amount of apprehension one has about their probability of experiencing a fall in the near future, real or imagined. This fear is sometimes referred to as "Post-fall syndrome" (Murphy & Isaacs, 1982).

6) Somatosensory: This is a vast system composed of receptors and processing centers that produce sensory modalities such as touch, temperature, proprioception, etc. This is one of the systems that play an important role in maintaining postural control alongside the vision and vestibular systems.

### 1.3 Scope and Delimitations

This study was done as an extension of The University of Texas at Arlington's Center for Healthy Living and Longevity and its ongoing study investigating falls and fall risk in older adults for the purposes of improving health and longevity in the community. Postural Control and Fitness Data were collected between the periods of January 2010 and May 2011 from 87 subjects over the age of 65.

### 1.4 Assumptions

This study assumed the following 1) All subjects increased their exercise workload significantly more than control group subjects. 2) All subjects exerted comparable amounts of effort during the exercise intervention. 3) All groups were equally distributed, and well representative of the general population.

### 1.5 Limitations

This study had some limitations that need to be considered. All subjects were from the Dallas/Fort Worth community, and therefore may not be representative of the greater population.

CHAPTER 2  
REVIEW OF LITERATURE

2.1 Fall Risk and Balance

It is well documented that as individuals age, degeneration of key systems responsible for and contributing to balance takes place. Previous studies have recorded various risk factors for falls including a history of falls, balance and gait abnormalities, lower extremity weakness, decreased muscle strength, old age, cognitive impairment, medications, drop in blood pressure, anemia, female gender, arthritis, and psychological factors { } (Nelson & Amin, 1990; R. Orr, 2010; Sai, Gallagher, Smith, & Logsdon, 2010; Scheffer et al., 2008; Silsupadol, Siu, Shumway-Cook, & Woollacott, 2006; Wood et al., 2009). The ability to perform functional tasks and activities of daily living in addition to maintaining postural control, are known to be affected by age related declines in cognition, balance, fitness level, gait, and vision (Nelson & Amin, 1990; Silsupadol et al., 2006). Falls occur when an individual fails to maintain their balance, also known as postural control. Variables involved in maintaining postural control can be categorized as either extrinsic (environmental) or intrinsic (personal) factors (Ashley, Gryfe, & Amies, 1977; Nickens, 1985). Examples of extrinsic factors include poor lighting, slippery surfaces, inappropriately placed furniture, and unfit foot-ware (Ashley et al., 1977). Conversely, examples of intrinsic factors include poor balance, sensory deterioration, neurological deterior, or muscle deterioration (Nelson & Amin, 1990; Persson et al., 2006; Rauch, Velazquez-Villasenor, Dimitri, & Merchant, 2001; Serrador, Lipsitz, Gopalakrishnan, Black, & Wood, 2009; Silsupadol et al., 2006). Extrinsic factors can be avoided and controlled. Intrinsic factors however, are directly impacted by the effects of aging, and can affect one's own balance. Intrinsic factors can be further classified as physical or psychological factors (Cummings, Salkeld, Thomas, & Szonyi, 2000).

Decreases

in function, which decrease one's ability to perform daily tasks, which predisposes the individual to falls, are affected by age related intrinsic deficiencies (Cummings et al., 2000; Horvat, Ray, Nocera, & Croce, 2006) The increased susceptibility to falls in older adults is a result of the pathological, physiological, and psychological changes associated with the aging process (Nelson & Amin, 1990; Silsupadol et al., 2006).

## 2.2 Postural Control

Postural control is a complex multi factorial mechanism involving the summation of numerous physiological factors acting together to maintain balance (F. B. Horak, 2006). Physical intrinsic factors affecting postural control include spatial and temporal integration of vestibular, visual, and somatosensory information from movement of the head and body, as well as response time to any stimulus challenging postural stability (F. B. Horak, 2006). Degeneration of vestibular, visual, and somatosensory function in conjunction with decreased sensorimotor processing, causes postural control to steadily decline after the age of 65 (Laughton, Slavin, & Katdare, 2002). All postural control systems decline with age and can be affected by sub-clinical constraints or pathology (Laughton et al., 2002). This in addition to the increased prevalence of neural disease, decreased neural processing, and decreased muscle strength, all work to inhibit postural control in older adults (Shupert, & Mirka, 1989; F. B. Horak, 2006). Other sensory changes that contribute to disequilibrium in older adults include decreased number of hair cells and decreased neural innervation of the vestibular region, which results in reduced vestibular reactivity and excitability (Bergstrom, 1973; Rauch et al., 2001; Rosenhall, 1973; Rosenhall & Rubin, 1975; Serrador et al., 2009).

## 2.3 Cognition

The goal of postural control maintenance systems seek to maintain postural orientation and postural equilibrium. Postural orientation is achieved by the active alignment of the trunk and head with respect to gravity, visual surroundings, and internal references (F. B. Horak,

2006b). Postural equilibrium involves the coordination of movement strategies to stabilize the center of mass in response to disturbances in stability (F. B. Horak, 2006). The specific strategy used in response to postural challenges is dependent on the stimulus causing the disturbance of stability (F. B. Horak, 2006). Additionally, the individual's expectations, goals, and prior experience also play a role (F. B. Horak, 2006).

A large continuous influx of postural information must be processed before a reaction may occur (F. B. Horak, 2006). The amount of cognitive processing required is dependent on the complexity of the postural task, and on the capabilities of the individual's postural control system (Bock & Beurskens, 2011; F. B. Horak, 2006). With increased task difficulty, comes increased cognitive processing (Bock & Beurskens, 2011; Teasdale & Simoneau, 2001). Thus, reaction time increases and performance decreases with increasing difficulty of postural task (Bock & Beurskens, 2011; Teasdale & Simoneau, 2001). The control of posture and other cognitive processing, share cognitive resources. Cognitive abilities steadily decline with age in older adults (Bock & Beurskens, 2011; Persson et al., 2006). This decreased cognitive capacity of older adults presents an even greater challenge to maintaining postural control (Bock & Beurskens, 2011; Teasdale & Simoneau, 2001). For example, talking on a cell phone and ascending/descending stairs, traversing the stairs may be compromised by the allocation of resources to the talking task, limiting processing to execute the walking movement (Bock & Beurskens, 2011; Teasdale & Simoneau, 2001). High cognitive processing to maintain postural control, coupled with the low cognitive capacity of older adults can turn seemingly ordinary tasks into a complex disorientating predicament.

#### 2.4 Vision

Poor vision reduces postural stability and doubles the risk of falls in older adults (S. R. Lord, 2006). Poor vision includes visual attributes such as visual acuity, visual field, contrast sensitivity, and depth perception. Specifically, some studies have shown that reduced contrast



sensitivity and depth perception are some of the most important visual risk factors for falls (S. R. Lord, 2006; S. R. Lord, 2006; Wood et al., 2009). In regards to sway and vision, it has been found that when individuals stand with their eyes closed, their postural sway increases by 20 – 70% (S. R. Lord et al., 1991; S. R. Lord, 2006); (S. R. Lord et al., 1991). Furthermore, tests involving misleading visual cues significantly increased sway (Lee & Lishman, 1975). One important visual field is visual acuity, which measures fine detail in vision and spatial resolution. There have been found to be correlations between visual acuity and fall risk (S. R. Lord & Dayhew, 2001). A decrease in this visual field may adversely affect postural control. Another visual field is contrast sensitivity, which is the visual property that allows one to distinguish between an object and the background. This is accomplished by taking into account the difference in color and brightness of objects in the same field of view. Amongst visual fields some researchers have found that contrast sensitivity may play one of the largest roles affecting postural control (Felson et al., 1989; S. R. Lord, Ward, Williams, & Anstey, 1994; S. R. Lord, 2006). Another important visual attribute to note is depth perception, which deals with the ability of an individual to judge distances and depths. Poor depth perception has also been found to be a predictor of increased sway in older adults (S. R. Lord & Menz, 2000). Depth perception may actually be a larger predictor of falls than contrast sensitivity or visual acuity according to Lord (2001). Ultimately, it appears that a significant decrease in any key visual field, can increase postural sway, the greater the decrease in vision, the greater the risk of a fall incident.

### 2.5 Overall Health

Reductions in mobility and decreased physical functioning can contribute to obesity, which is often the source of chronic diseases such as hypertension, diabetes, and cardiovascular diseases. Thus, the implication of this observation is that lack of physical activity results in declines in physical function. Older adults with decreased activity, function, strength, or ability tend to experience obesity and chronic health conditions at a greater prevalence than

their younger healthier counterparts. This includes lower femoral-neck bone mineral density, less maximal strength, and higher rates of stroke, osteoporosis, depression, hypertension, heart disease, and diabetes (Andresen et al., 2006; Feskanich, Willett, & Colditz, 2002; Gama et al., 2000; Martin, Hart, Spector, Doyle, & Harari, 2005; Newman et al., 2003; Penninx et al., 2009; Peterson et al., 2010; Serrador et al., 2009).

## 2.6 Fitness Level

The ability of muscles to generate and sustain strength and power is of significance for the ability to maintain reasonable quality of life in older adults as lower-limb power is of importance to perform functional tasks (Bassey et al., 1992; Janssen, Heymsfield, & Ross, 2002). Muscle strength and aerobic capacity are some of the most accessible variables contributing to balance (Newman et al., 2003). Previous research has demonstrated a link between decreased muscle strength and decreased postural control (Bassey et al., 1992; R. Orr, 2010) The aging process is also associated with deteriorating ability to maintain postural control, which is compounded by decreased muscle strength (F. B. Horak, 2006b)(Janssen et al., 2002; Newman et al., 2003). Specifically, low levels of lower-limb power negatively affect one's ability to climb stairs or recover from a fall, which in turn will make the use of any form of transportation, difficult. This could also make crossing a busy street quickly challenging, in addition to any event where one must react physically in an expedient fashion. Mechanical power is defined as the force applied to an object multiplied by the velocity of that object, or the amount of work done per unit time (Knuttggen & Kraemer, 1987). Strength decreases 7.5 to 8.5% per decade during adulthood while contraction velocity decreases 7% per decade (Skelton, Greig, Davies, & Young, 1994). These combine changes result in a loss of lower-limb power at a rate of 35% per decade (mean  $\pm$  standard deviation range = 213  $\pm$  51 W to 80  $\pm$  49 W over 24 years)(Skelton et al., 1994). There are clear and significant established correlations between lower-limb power, walking speed, stair-climbing speed, and stair-climbing power (Bassey et al.,

1992). If less work is being done in the same unit of time, mechanical power is reduced. Muscle power or the product of muscle force and contraction velocity, is negatively affected by numerous age related physiological changes. Orr outlines the many contributions of muscle weakness to postural instability in the elderly in a literature review of 74 articles. Concluding that there is a relationship between muscle strength and balance performance, and that muscle power and contraction velocity may play a larger role than muscle force alone in predicting postural instability. Laughton et al found that increased sway during quiet standing in older adults was due to increased muscular activity. This is a characteristic of age related declines in muscle activity which either precludes instability or is a compensatory mechanism. Poor chair stand performance is a physical characteristic commonly associated with fear of falling, suggesting that overall lower limb strength and deficits in dynamic postural control could be contributing factors(Deshpande et al., 2008).

### 2.7 Gait

For older adults, ambulation may present the most fundamental form of movement contributing to independence and function. Ambulation requires the incorporation and integration of a number of factors, including balance, strength, and gait for the purpose of walking without tripping, slipping or falling. The ability of an individual to access the environment, and successfully shift their body weight between single and double limb support phases is critical as the individual initiates gait and moves forward. The inability to maintain balance, lift the leg, and support the body, compromises the ability to move freely in the environment and complete most daily activities. These physiological changes can manifest themselves in reduced gait velocity, decreased stride length, and reduced single stance support time (Judge, Davis, & Ounpuu, 1996; Ko, Hausdorff, & Ferrucci, 2010). Decreased gait velocity is significantly related to increased fall risks and independent functioning (Imms & Edholm, 1981; Ko et al., 2010). Physiological parameters such as reduced peak hip extension, increased

anterior pelvic tilt, and reduced ankle plantar flexion, range of motion, and power are associated with aging, inactivity, and increased fall risk (Kerrigan, Todd, Della, Lipsitz, & Collins, 1998; Koa, Stenholma, & Ferruccia, 2010).

### 2.8 Psychological Factors

Other factors affecting postural control and fall risk include depression, low self esteem, anxiety, poor mental health, and fear of falling (Arfken, Lach, Birge, & Miller, 1994; Martin et al., 2005; Schmid et al., 2009; Shin et al., 2010; Vellas, Wayne, Romero, Baumgartner, & Garry, 1997). Fear of falling (FoF) has been recorded both as a result of falling, and as a risk factor leading up to a fall, so it can be both a cause and an effect of falling (Pang & Eng, 2008; Scheffer et al., 2008). On the causal side of things, this fear results in the restriction of activity, and is a strong predictor of physical function (Cummings et al., 2000; Fuzhong et al., 2002; Pang & Eng, 2008). Bertera & Bertera showed that FoF causes an avoidance of Activities of Daily Living, which is very common in community-dwelling older adults, however the factors mediating this relationship are unclear (Bertera & Bertera, 2008). Howland et al found this to be the single greatest fear in adults over the age of 65 (Howland, 1993). This fear was originally conceptualized and measured as a variable being completely present or absent in an individual, and was quite common in early research (Arfken et al., 1994; Martin et al., 2005; Schmid et al., 2009; Shin et al., 2010; Vellas et al., 1997). However, this method of measurement limits the degree in which FoF may affect function. Some researchers have illuminated the fact that many individuals express a concern about their balance during tasks, but would not necessarily categorize themselves as “fearful”, even when they have altered their behavior to avoid falling (Hatch et al., 2003). As a result, attempts to measure fear of falling have consequently focused on using the concept of “self efficacy” instead (Hatch et al., 2003). Self-Efficacy refers to an individual’s perceived capacity within a specific field or activity (Sai et al., 2010). Assessing the degree of falls related self-efficacy to specific activities in an individual is more desirable than

the global fear of falling. At least one study indicated that about one-third of elderly individuals develop a fear of falling as a result of a fall incident (Bertera & Bertera, 2008). FoF can be considered a protective response, preventing older adults from performing high risk activities, but can also lead to a unnecessary restriction of the very activities that will result in a long-term adverse effect on social, physical, or cognitive (Alcalde, 2010; Cummings et al., 2000). Cumming et al suggests that fear of falling causes falls (Cummings et al., 2000). Data from Cumming et al showed that patients with poor efficacy scores, from 2 local hospitals, were twice as likely to experience a fall event in the following 12 months compared to those with better fall efficacy scores (Cummings et al., 2000). Women reporting FoF reported higher prevalence of difficulty in Activities of Daily Living, and reductions of functional capacity, physical comorbidities, and a range of potentially adverse psychological characteristics (Cummings et al., 2000). In this same research study, FoF was independently associated with indicators of both mild and moderate reductions of functional capacity (Martin et al., 2005). Nonfallers who said they were afraid of falling had an increased risk of admission to an aged care institution (Martin et al., 2005). This adds to our understanding of the role of falls self efficacy in the FoF process as it appears to be a direct determinant of functional outcomes (Martin et al., 2005).

Several scales have been developed to measure the psychological effects of FoF, including, the Balance Efficacy Scale (BES), the Fall Efficacy Scale (FES), the Activities-specific Balance and Confidence Scale (ABC), and the survey of activities and fear of falling in the elderly (SAFE). However, these measures are a subjective feeling of well-being, and loss of independence.

## 2.9 Interventions

The purpose of numerous exercise programs geared at older adults is to decrease the risk of falls and increase function. In this context, a program should be designed based on successful evidence based activities aimed at increasing specific functions. Exercise interventions have had measured success in completely controlled environments such as hospitals (Kruse, Lemaster, & Madsen, 2010; Padula et al., 2011). Padula et al showed the benefits of lower extremity strengthening exercises to prevent fall rates in hospitalized adults. Kruse et al performed a similar study that added walking, and also saw increased strength and balance measures. Hale et al showed that less formal modes of exercise, such as going out into the community and being active, can have the same level of benefit as a water based exercise intervention (Hale, Waters, & Herbison, 2011). Even peer-led fall prevention programs are highly successful as Waters et al showed (2011). This study showed greater increases in function and balance in an at home exercise group when compared to a seated aerobics group (Waters, Hale, Robertson, Hale, & Herbison, 2011). Least formal of all exercise modalities comes with the numerous documented cases of at home exercise programs consistently improving fall risk parameters (K. L. Miller, Magel, & Hayes, 2010; Padula et al., 2011; Williams, Brand, Hill, Hunt, & Moran, 2010).

## CHAPTER 3

### METHODS

#### 3.1 Design

The research design was a 3 x 4 x 2 repeated measures ANOVA statistical research design to evaluate (i) the changes in postural control as they relate to increased environmental loading through differed attention, and (ii) the changes in fitness level. The first factor, a between factor, compared subjects between three groups (Wii-Fit, Group-Fit, Control). The second factor, a within factor, compared two different points in time (Pre and Post). Finally, the third factor, a within factor, compared the differed attention conditions (control, stroop, visual, auditory).

#### 3.2 Subjects

Eighty-Seven healthy subjects volunteered to participate in the study. All participants signed a University Institutional Review Board for Human Subjects Research approved informed consent and were required to obtain written permission from their physician to participate in exercise. They were randomly assigned to participate in either the Group Fitness or a Wii-Fitness exercise intervention 3 times per week.

Participants were excluded if they had a previous history of peripheral or vestibular abnormalities or had experienced 2 or more documented falls in the previous six months. Additionally participants were excluded if they were unable to ambulate without an aide.

#### 3.3 Experimental Protocol

Again, participants were randomized into a Group-Fit or Wii-Fit exercise intervention group. No exercise was prescribed to the control group. The Wii exercise group performed exercises three times per week, 45 minutes per day using a Wii-balance board and weighted vests. The intervention included 15-25 chair stands while wearing the weight vest, and bouts of

walking for 5 to 10 minutes at a time. The weight of the vest began at two pounds, and was increased two additional pounds every two weeks until it reached the maximum of ten pounds. Participants were only allowed to wear the vest while playing the Wii Bowling or Wii boxing games. The Wii Fit Plus balance board was also integrated into the program. Games played were focused on balance and body weight shifting. Participants did not wear the weighted vest while on the balance board. Every participant using the Wii balance board wore a gait belt in order for assistants to support them through the ensuing challenges to postural control. The Group-Fitness group also performed exercises three times per week, 45 minutes per day. The exercises were based on a traditional senior fitness program, and a rigorous group fitness program. All exercises were led by a certified fitness professional, with participants either seated or utilizing chairs for support. The Group-Fit exercise program was a progressively increasing intensity routine, with exercises aimed at increasing lower leg strength, upper body strength, and flexibility. Some lower leg strengthening exercises included chair stands and chair lunges, while some upper body exercises included triceps extensions and shoulder presses using a medium strength theraband. (Hygenic Cooperation, Akron, OH, USA) Each session included 3 bouts of walking for 5 – 10 minutes at a time, and ended with 10 - 15 minutes of stretching.

### 3.4 Data Collection, Processing, and Analyses

Data collected can be classified into (i) senior fitness data which includes 6 minute walk, 8 foot up and go, bicep curl test, chair stands, sit and reach, back scratch test, hand grip strength test, and a 2 minute step test and (ii) Postural Control data which includes Sensory Organization Test Composite Scores.

#### *3.4.1 Senior Fitness Data*

The Senior Fitness Test can be administered easily within the community setting. The entire battery of tests can be given to one or two people in about 30 minutes (Rikli & Jones, 2001). It includes measures of agility, cardiovascular capacity, lower limb strength, Upper body



strength, flexibility, and BMI. Skills from these dynamic tests are needed for a number of functions and activities of daily living. The 8ft up and go is a dynamic performance of agility representative of functional ability to do things like get up and down quickly for getting off a bus, crossing a busy street, or going to the bathroom (Rikli & Jones, 2001). The Chair Stands have a very high correlation to leg press capacity and have an ability to detect expected performance declines with age (Rikli & Jones, 2001). The arm curl test represents upper body strength, which might be reflected in one's ability to lifting things or do excessive yard work. The 6 minute step test is a valid measure of cardiovascular capacity, while the 2 minute step test is an alternative when space does not permit (Rikli & Jones, 2001). These functional measures test one's capacity to engage the environment which may be useful in order to walk the mall or exert one's self across distances. The purpose of the chair sit and reach is to assess flexibility, namely hamstring flexibility which affect's posture and mobility tasks (Rikli & Jones, 2001). The purpose of the back scratch test is to assess upper-body flexibility, namely shoulder flexibility which is important for performing functional tasks like combing one's hair, zipping up a dress, reaching for a seat belt, or putting on an over the head garment (Rikli & Jones, 2001).

Table 3.1 SFT Means and Standard Deviations for 60-, 70-, and 80- yr olds

Test item	60-69 yrs	70-79 yrs	80-89 yrs	<i>p</i> <sup>†</sup>
	( <i>n</i> = 32) (91% female)	( <i>n</i> = 96) (84% female)	( <i>n</i> = 62) (81% female)	
<b>Chair stand</b> (# in 30 sec)	14.0 (2.4)	12.9 (3.0)	11.9 (3.6)	.013*
<b>Arm curl</b> (# in 30 sec)	19.8 (4.1)	18.2 (3.9)	16.5 (4.1)	.007*
<b>6-min walk</b> (total yd)	677.8 (95.0)	621.0 (82.4)	550.1 (86.7)	.0001*
<b>2-min step</b> (# in 2 min)	100.4 (9.0)	92.6 (16.0)	83.5 (22.6)	.0001*
<b>Chair sit-and-reach</b> (in. from toe)	-0.4 (5.4)	-0.4 (6.2)	-3.3 (6.0)	.018**
<b>Back scratch</b> (in. from middle fingers)	1.0 (2.0)	-0.4 (3.0)	-1.8 (4.4)	.0009*
<b>8-ft up-and-go</b> (seconds)	5.2 (0.6)	6.1 (1.2)	7.1 (2.0)	.0001*

Table 3.2 24 Participant Senior Fitness Testing Station Set Up, Equipment needs, Number of Testers and Instructions

Station	Equipment	# of Testers	Brief Instructions
1. Chair stand test	Stopwatch	1	Demonstrate test; have all participants practice at once; test one at a time.
2. Arm curl test	Stopwatch 5-lb & 8-lb dumbbells (1 each)	1	Same instructions as station 1.
3. Height and weight; 2-minute step test	60-in. tape measure (mounted on wall) Two stopwatches, two tally counters, two 30-in. pieces of cord, masking tape	2 <sup>†</sup>	Demonstrate step test to all; have all practice at once; each tester measures two people's height and weight and administers their step test.
4. Chair sit-and-reach test	18-in. ruler (half a yardstick)	1	Same instructions as station 1.
5. Back scratch test	18-in. ruler (half a yardstick)	1	Same instructions as station 1.
6. 8-foot up-and-go test	Stopwatch, cone, measuring tape	1	Demonstrate test; participants line up and take turns with practice test, trial one, and trial two.
All stations (1–6)	Each station needs four chairs for testing, or for resting while waiting for turn, four score cards, and four pencils.		
6-minute walk test	This test is given after all others, with all assistants helping. Equipment needs are described under Official SFT Protocols.		See 6-minute test protocol. An experienced tester can test 12 people at a time, with another 12 used as scoring partners; however, if time permits, testing 6 at a time works better.

\* With 24 total participants, 4 are assigned to each station to begin testing, then are rotated clockwise through the 6-station circuit.

† Only one tester is needed at this station if the 6-minute walk test is given instead of the 2-minute step test.

### 3.4.2 Postural Control Data

The Sensory Organization Test (SOT) on the NeuroCom® Equitest System provides information regarding the use sensory input or combination of inputs to maintain postural

stability. This system utilizes a force platform and measures vertical reaction forces that are generated from the participants' center of pressure movement from a fixed base of support and transducers embedded in the force platform (NeuroCom International, 2000). The SOT is used to assess balance abilities and limitations in a wide variety of populations by determining how individuals are able to respond and adapt to a variety of sensory manipulations. Inaccurate information is delivered to the eyes, feet and joints through sway referencing of the visual surround and support surface (NeuroCom International, 2000). This alteration disrupts the available sensory information and allows the tester to evaluate the individual's use of their sensory modalities that provide afferent information to maintain postural control (NeuroCom International, 2000). The SOT determines how an individual reacts to constant or changing information from the sway referenced senses.

During the SOT, participants were tested under these six conditions, three trials per condition, for a total of 18 trials. Each trial lasted 20 seconds. The support surface (force plate) and walls (visual surround) moved in response to the participants center of gravity (estimated) sway. The overall composite equilibrium score provides a representative score of the individuals' ability to maintain postural stability during all conditions. Effective use of the individuals' sensory inputs is determined from the overall pattern of scores on each of the six conditions. The composite equilibrium score is the weighted average of all scores including condition 1 average scores, condition 2 average scores and three equilibrium scores from each of the trials in conditions 3 thru 6.

The strategy analysis score quantifies the amount of movement of either the ankles or the hips by plotting the information from the force plate and equilibrium scores together (Persson et al., 2006). The closer the score is to 0 the more movement/adjustments the individual has made with their hips to maintain stability, likewise the closer to 100 represents ankle adjustments in order to maintain postural stability. Scores between 0 and 100 represent a combination of the two strategies (R. Orr, 2010). The most typical strategy dictates that as

stability is maintained individuals will utilize primarily an ankle strategy and shift to hip strategy when balance becomes more difficult (R. Orr, 2010). The minor adjustments utilized during ankle strategy are more desirable, because they result in less vertical force, while a shift towards hip strategy occurs as a result of greater instability.

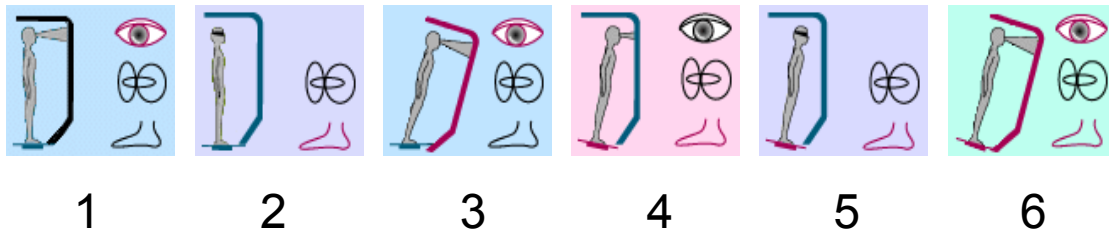


Figure 3.1 Conditions of the Sensory Organization Test

In the above figure, the “eye” denotes the visual system, the “circles” denote the vestibular system, and the “foot” denotes the somatosensory system. The Sensory Organization Test protocol objectively identifies abnormalities in the participant’s use of the three sensory systems that contribute to postural control: somatosensory, visual and vestibular. During the assessment, inaccurate information is delivered to the participant’s eyes, feet and joints through “sway referencing” of the visual surround and/or the support surface. Each participant was fitted with a padded harness that is attached to the device’s framework in order to protect him/her from a fall. Each condition was performed three times.

Condition 6 was chosen for additional testing of environmental and cognitive loads, due to the increased integration needed to combine vision, somatosensory and vestibular systems. We chose condition 6 because we felt that it would be the most sensitive assessment of postural control. Additional tests included visual, auditory and cognitive distracters. The visual distracter chosen for this study was a first person roller coaster simulation (The Discovery Channel, ). These were chosen because they do not provide a fixed horizon for the participant to fixate on during testing. For the auditory distracters we used audio of crowded streets as a distracter to more readily simulate public places (*Metro handles crowds for inauguration.*).

Cognitive load testing included a Stroop test. The Stroop Task is a psychological test of cognitive and attentional capacity. This test is affective due to our ability to read words more quickly and automatically than we can name colors. If a word is printed or displayed in a color different from the color it actually names; for example, if the word "blue" is written in red we will say the word "blue" more readily than we can name the color in which it is displayed, which in this case is "red" (Young, ). Although the actual words are printed in a color of ink different from the color name they represent. You are asked to respond with the color you see, and inhibit or disregard the word you read (Young, ). During cognitive load testing the number of incorrect responses were recorded.

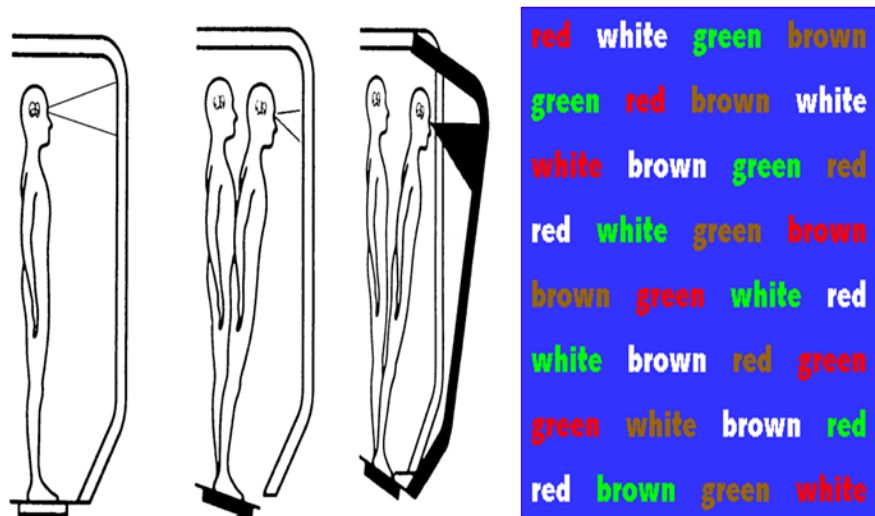


Figure 3.2 Divided Attention Cognitive Loading



Figure 3.3 Divided Attention Visual Loading

### 3.5 Statistical Analysis

SPSS version 18.0 statistical software was used to conduct all data analysis. Analysis included descriptive summaries and a one-way analysis of variance (ANOVA). A composite score was compiled across all conditions and group comparisons were analyzed with a one-way analysis of variance to determine if there are differences between groups. Outcome measures included a SOT composite equilibrium score, derived from the strategy analysis for each condition.

## CHAPTER 4

### RESULTS

#### 4.1 SOT Equilibrium Results

There was no divided attention condition by training group by time interaction ( $p = 0.579$ ) for SOT equilibrium. There were no divided attention by group ( $p = 0.599$ ), divided attention condition by time ( $p = 0.160$ ), or time by group ( $p = 0.578$ ) interactions for SOT equilibrium. There was a significant improvement in the SOT equilibrium score over time ( $p = 0.007$ ), the pre-test SOT equilibrium was  $38.8 \pm 25.0$  and the post-test score was  $51.1 \pm 17.2$ . There was a significant difference in SOT equilibrium scores between the divided attention conditions ( $p = 0.000$ ). Post hoc tests revealed that equilibrium while performing the Stroop ( $38.1 \pm 20.9$ ) was significantly less than both the visual distracter ( $51.9 \pm 20.2$ ) and auditory distracter ( $49.3 \pm 21.1$ ). There were no differences between the various exercise intervention groups across all increased environmental load balance testing situations ( $p = 0.686$ ).



Table 4.1 Mean  $\pm$  SD SOT Equilibrium Scores by Training Group, Divided Attention Condition and Time

Divided Attention Condition	Wii Fit		Geri Fit		Control		DA Condition Means
	Pre	Post	Pre	Post	Pre	Post	
Control	24.8 $\pm$ 25.1	51.2 $\pm$ 23.6	32.6 $\pm$ 23.3	46.7 $\pm$ 13.1	36.5 $\pm$ 32.5	50.2 $\pm$ 19.7	40.3 $\pm$ 20.9*
Stroop	25.9 $\pm$ 20.0	38.1 $\pm$ 23.8	31.3 $\pm$ 23.2	44.2 $\pm$ 19.3	47.7 $\pm$ 19.9	41.9 $\pm$ 12.5	38.1 $\pm$ 20.9†
Visual	41.7 $\pm$ 28.6	61.0 $\pm$ 12.1	36.9 $\pm$ 26.0	55.8 $\pm$ 15.6	55.5 $\pm$ 25.7	60.8 $\pm$ 9.2	51.9 $\pm$ 20.2
Auditory	41.4 $\pm$ 28.5	49.7 $\pm$ 27.8	39.2 $\pm$ 24.5	53.6 $\pm$ 19.3	52.0 $\pm$ 25.5	60.1 $\pm$ 9.5	49.3 $\pm$ 21.1
Time Main Effect		Pre	Post				
		38.8 $\pm$ 25.0		51.1 $\pm$ 17.2§			

\*Main effect for divided attention condition Control (no distraction) was different from Visual and Auditory, †Main effect for divided attention condition, Stroop was different from Visual and Auditory, §Time main effect, pre-test different from post-test,  $p \leq 0.05$ .

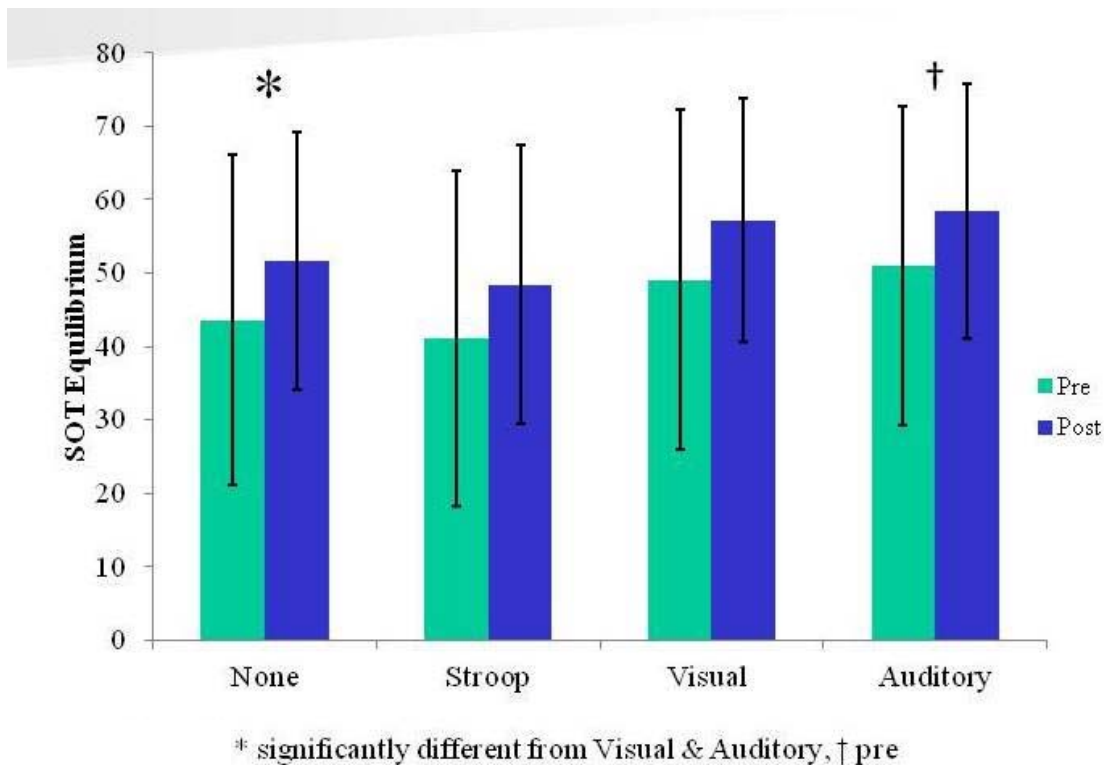


Figure 4.1 SOT Equilibrium Scores by Divided Attention Condition and Time

#### 4.2 SOT Strategy Results

There was no divided attention condition by training group by time interaction ( $p = 0.699$ ) for SOT strategy. There were no time by training group ( $p = 0.862$ ), divided attention condition by training group ( $p = 0.959$ ), or divided attention condition by time ( $p = 0.072$ ) interactions for SOT strategy. There were no differences between training groups ( $p = 0.491$ ). There was a significant difference between the pre-test SOT strategy ( $54.2 \pm 20.8$ ) and post-test SOT strategy ( $62.8 \pm 11.4$ ) scores,  $p = 0.012$ , effect size = .745. There was a significant difference in the SOT strategy employed between the environmental loading conditions ( $p = 0.009$ ). The SOT strategy was  $63.5 \pm 13.2$  in the no distraction condition,  $53.6 \pm 18.6$  in the Stroop condition,  $58.0 \pm 17.7$  in the visual DA condition, and  $58.9 \pm 18.2$  auditory DA condition.

Post hoc tests revealed that no distraction (control) was significantly different from the Stroop condition.

Table 4.2 Mean  $\pm$  SD SOT Strategy Scores by Training Group, Divided Attention Condition, and Time

Divided Attention Condition	Wii Fit		Geri Fit		Control		Condition Means
	Pre	Post	Pre	Post	Pre	Post	
Control	62.1 $\pm$ 5.5	64.1 $\pm$ 11.2	62.6 $\pm$ 14.0	57.9 $\pm$ 14.0	65.3 $\pm$ 17.0	68.9 $\pm$ 19.1	62.9 $\pm$ 12.1*
Stroop	49.0 $\pm$ 26.8	53.9 $\pm$ 14.7	44.4 $\pm$ 20.4	56.4 $\pm$ 14.3	55.1 $\pm$ 24.8	62.9 $\pm$ 11.9	47.7 $\pm$ 22.4
Visual	47.1 $\pm$ 25.6	63.3 $\pm$ 8.7	55.1 $\pm$ 24.8	62.7 $\pm$ 8.9	62.7 $\pm$ 14.5	65.3 $\pm$ 17.8	49.8 $\pm$ 24.4
Auditory	48.1 $\pm$ 27.0	66.4 $\pm$ 9.9	45.1 $\pm$ 30.1	60.8 $\pm$ 9.0	61.7 $\pm$ 23.3	71.3 $\pm$ 11.8	48.9 $\pm$ 27.7
Time Main Effect		Pre	Post				
		54.2 $\pm$ 20.8		62.8 $\pm$ 11.4†			

\*Main effect for divided attention condition Control (no distraction) was different Stroop, †Time main effect, pre-test different from post-test,  $p \leq 0.05$ .

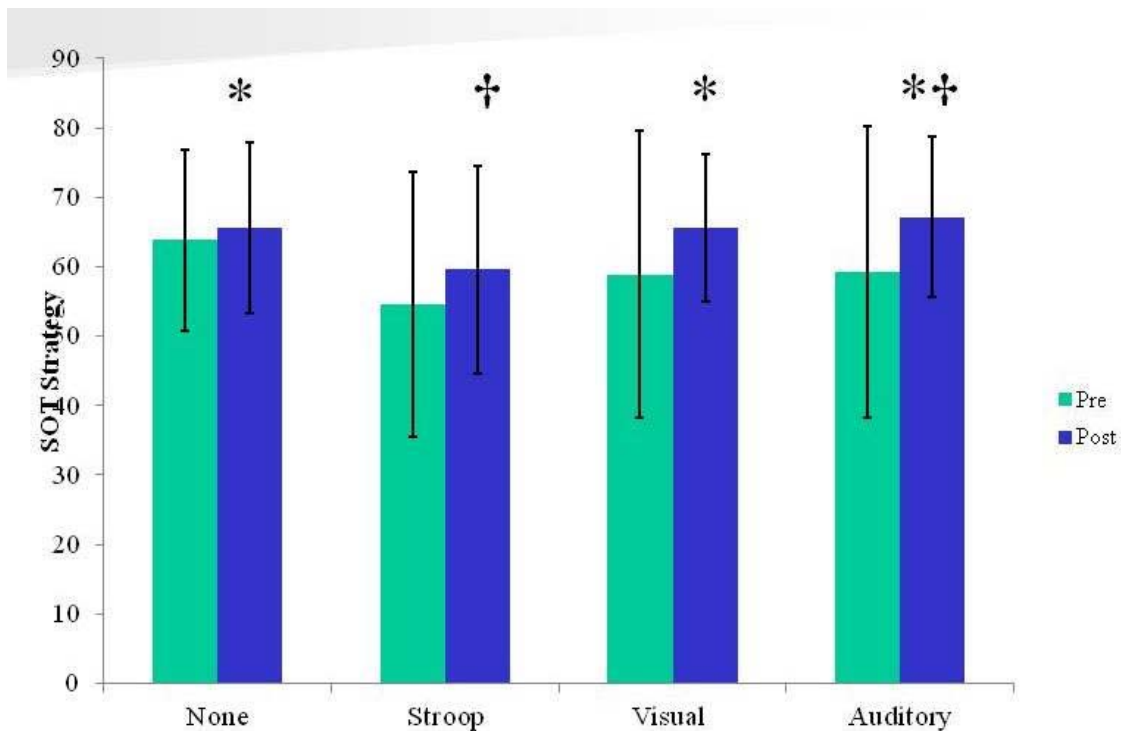


Figure 2. \* significantly different from Stroop, † pre significantly different from

Figure 4.2 SOT Strategy Scores by Divided Attention Condition and Time

#### 4.3 Fitness Measures

There was a significant training group by time interaction for 6 min walk,  $p = 0.14$ , effect size = .776. The post-hoc test revealed that the control group pre-test ( $578.2 \pm 121.8$ ) was significantly different from the control group post test ( $448.0 \pm 268.0$ ). There were no pre-post differences ( $p = 0.455$ ) or training group differences ( $p = 0.705$ ) for the 6 min walk. There was a significant pre-test ( $7.2 \pm 1.4$ ) post-test ( $6.7 \pm 1.4$ ) comparison for 8 ft Up and Go,  $p = 0.017$ . There was no interaction between training group and time ( $p = 0.246$ ) or differences between training groups ( $p = 0.227$ ) for 8 ft Up and Go.

There was a significant interaction between training groups and time ( $p = 0.010$ ) for chair stands. The Wii Fitness training group performed significantly more chair stands on the post-test ( $14.4 \pm 5.2$ ) when compared to the pre-test ( $10.0 \pm 4.2$ ), and the Group Fitness training

group also performed significantly more chair stands on the post-test ( $14.1 \pm 5.4$ ) when compared to the pre-test ( $10.4 \pm 4.4$ ). There was a significant time effect for chair stands ( $p = 0.004$ ) and there were no differences between the training groups ( $p = 0.320$ ).

There were no differences in grip strength for training group by time ( $p = 0.411$ ), time ( $p = 0.423$ ) or training groups ( $p = 0.774$ ). There was a significant difference between pre-test ( $16.6 \pm 3.9$ ) and post-test curls ( $18.6 \pm 3.8$ ),  $p = 0.022$ . There was no training group by time interaction ( $p = 0.748$ ) or between differences between groups ( $p = 0.188$ ) for curls. There was no training group by time interaction ( $p = 0.984$ ) differences between pre-test and post-test ( $p = 0.729$ ) or differences between training groups ( $p = 0.599$ ) for shoulder stretch. There was no training group by time interaction ( $p = 0.878$ ), differences between pre-test and post-test ( $p = 0.278$ ) or differences between training groups ( $p = 0.618$ ) for BMI.

Table 4.3 Mean  $\pm$  SD for Senior Fitness Measures by Training Group and Time

Variable	Wii Fit		Geri Fit		Control	
	Pre	Post	Pre	Post	Pre	Post
6 Min Walk (yds)	505.3 $\pm$ 111.5	555.9 $\pm$ 88.6	455.0 $\pm$ 171.8	483.3 $\pm$ 183.4	578.2 $\pm$ 121.8	448.0 $\pm$ 268.0*
8 ft Up and Go (sec)	8.0 $\pm$ 1.5	7.1 $\pm$ 1.2	7.4 $\pm$ 1.4	6.8 $\pm$ 1.0	6.3 $\pm$ 1.2	6.2 $\pm$ 2.0†
Chair Stands (#)	10.0 $\pm$ 2.3	14.4 $\pm$ 3.0‡	10.4 $\pm$ 4.1	14.1 $\pm$ 5.9‡	16.4 $\pm$ 6.1	15.0 $\pm$ 5.7
Grip Strength (kg)	23.4 $\pm$ 8.6	24.7 $\pm$ 7.7	25.9 $\pm$ 8.6	25.4 $\pm$ 9.8	27.3 $\pm$ 6.1	28.2 $\pm$ 9.0
Curls (#)	14.7 $\pm$ 3.1	16.9 $\pm$ 3.2	16.5 $\pm$ 4.4	19.2 $\pm$ 3.8	18.6 $\pm$ 2.2	19.8 $\pm$ 3.9§
Shoulder Stretch (in)	5.3 $\pm$ 5.0	5.2 $\pm$ 7.3	5.4 $\pm$ 3.3	5.1 $\pm$ 3.4	8.0 $\pm$ 6.9	7.6 $\pm$ 7.1
Sit-and-Reach (in)	-0.4 $\pm$ 2.5	-1.8 $\pm$ 2.8	0.5 $\pm$ 2.8	0.4 $\pm$ 2.2	-0.5 $\pm$ 1.6	-0.6 $\pm$ 2.4
BMI	28.0 $\pm$ 4.7	27.5 $\pm$ 5.2	26.6 $\pm$ 6.2	26.4 $\pm$ 5.7	29.4 $\pm$ 1.4	29.0 $\pm$ 1.9

\* Control group pre-test significantly different from Control group post-test for 6 Min Walk, † Pre-test 8 ft Up and Go significantly different from post-test, ‡ Wii Fit pre-test significantly different from post-test and Geri Fit pre-test significantly different from post-test on Chair Stands, §pre-test curls significantly different from post-test curls,  $p \leq 0.05$ .

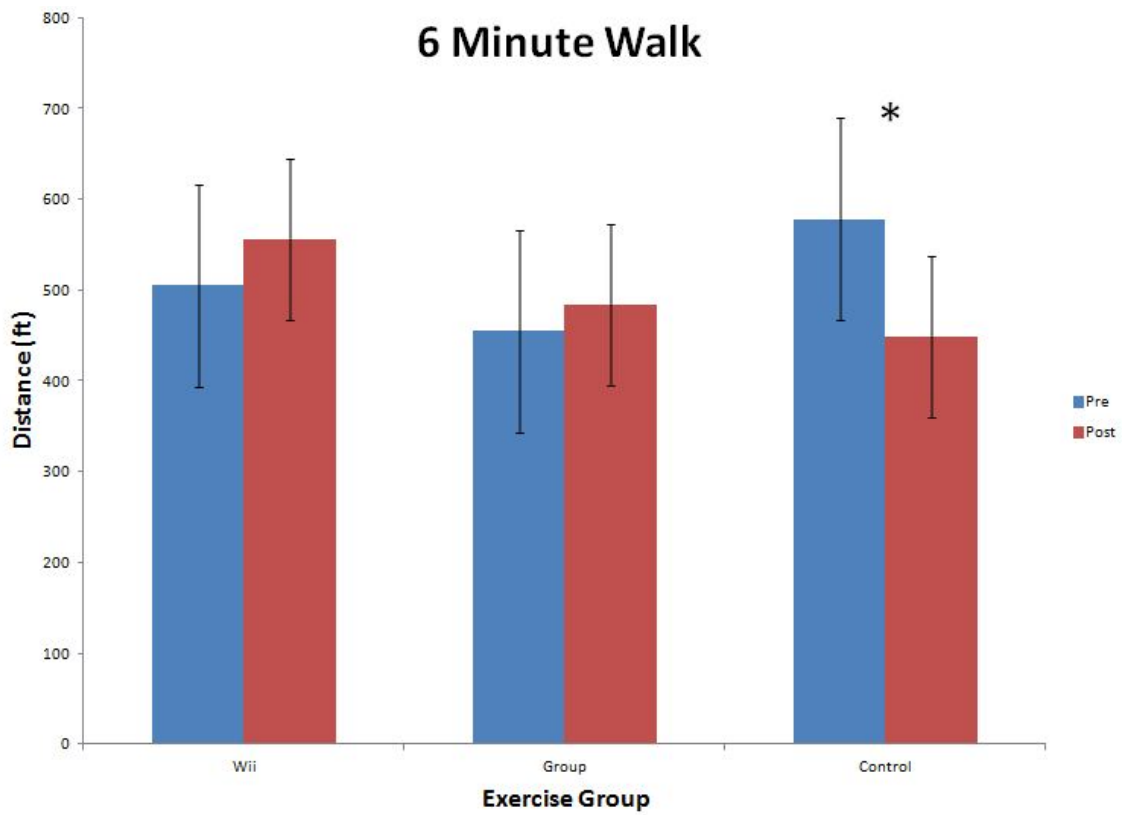


Figure 4.3 Six Minute Walk by Training Group and Time



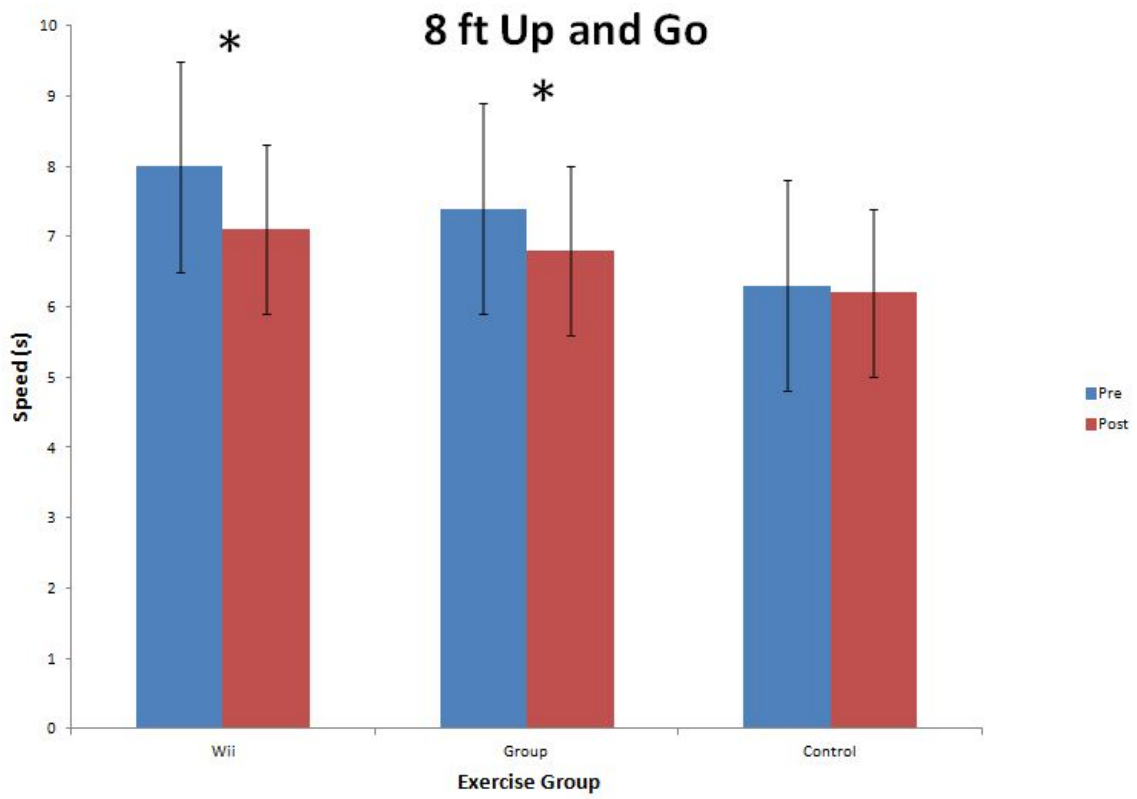


Figure 4.4 Eight foot Up and Go by Training Group and Time

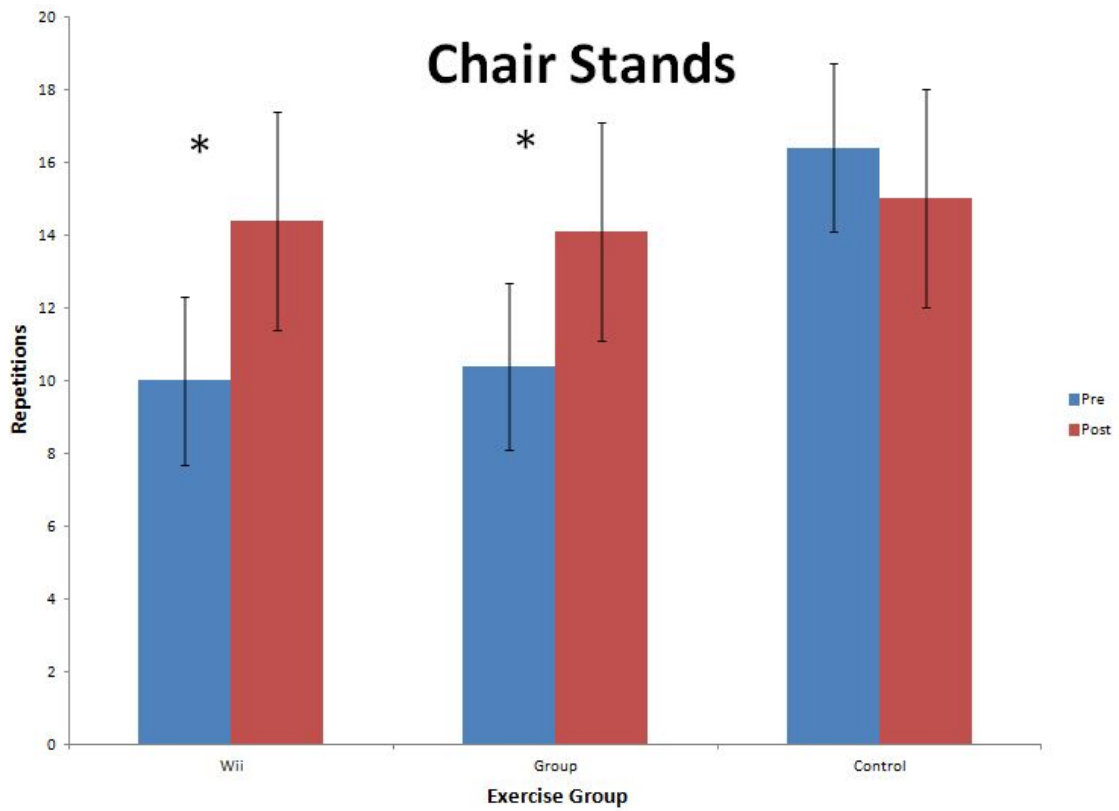


Figure 4.5 Chair Stands by Training Group and Time

## CHAPTER 5

### CONCLUSION

The purpose of this study was to investigate effective strategies for preventing falls through exercise interventions. These interventions were designed to enhance balance, strength, confidence, gait, and general fitness, in addition to decreasing disability and falls. The population is aging at an increasing pace, and falls, along with all conditions associated with aging will follow this trend. This is one of few studies examining the numerous benefits of unconventional functional exercise programs such as gaming systems, balance boards, and weight vests, for the purposes of increasing postural control and fitness level. Additionally, no other studies to our knowledge have tested the effects of increasing environmental load on postural control in as unique a manner as this study did, uniquely targeting the cognitive, auditory, and visual components of differed attention, all while using the NeuroCom® Equitest System to measure balance.

The evidence presented in this study supports the notion that differed attention has a negative effect on postural control. This study effectively improved postural control as SOT results show that there was a significant difference from pre to post testing, even though there was not necessarily one between groups. This tells us that both exercise groups improved postural control as a result of this exercise intervention. Additionally, groups showed decreased balance performance on the Stroop task when compared to the auditory or visual differed attention conditions.

This intervention also effectively improved fitness level in these older adults. Both groups significantly improved their ability to perform the 8 foot up and go test as well as chair stands. Neither group had any significant changes in 6 minute walk capacity. However, the control group did decrease their 6 minute walk distance. Neither group had significant

improvements in bicep curls, hand grip strength, flexibility, or BMI. This suggests that lower leg strength and cardio vascular capacity may be the most amendable factors for fitness level in older adults. Perhaps 15 weeks is not enough time to improve upper body strength, flexibility, and grip strength. It is also likely that greater, more direct, means of altering body composition are needed to truly affect BMI.

### 5.1 Implications

Improvements in balance, lower-limb strength, and gait may ultimately yield reductions in physical disability and falls, thereby conferring greater independence and enhanced quality of life to older adults. Based on these findings, it is evident that older adults have more difficulty maintaining postural control with a cognitive task, than in environments with visual or auditory distracters. Older Individuals have a diminished capacity to coordinate and process environmental distracters, while maintaining postural stability. They are also required to employ more hip strategy to maintain balance in the more challenging conditions. This decrease in postural stability during static conditions is concerning and could account for the increased incidence in falls within this population. Furthermore this data documents the ability to make improvements in differed attention postural control and fitness scores with the adoption of frequent exercise training. In this regard, training programs should be studied for their effectiveness in physiotherapeutically increasing postural control in older individuals during differed attention conditions, thereby reducing the susceptibility for falls within this population. Although the evidence from this study did not identify a specific mode of exercise, it did show increases for both Group Fitness and Wii Fitness exercise groups. These findings indicate that while declines in postural control and fitness are expected with ageing, the addition of regular exercise can improve postural control, even performance with environmental distracters. We did see that older adults performed worse with the cognitive distracters when compared to auditory and visual. This suggests that cognitive tasks are the most demanding on postural control when compared to other types of distracters. Cognitive performance also increased the more than

performance in the other tasks. This suggests that cognitive performance is more amendable than auditory and visual.

Data from this study indicates that engagement in physical activity programs do increase postural stability and senior fitness performance. This finding is important and should be used as justification for the development of exercise interventions to decrease fall risk in all community based programs that serve older adults. Future research should focus on dynamic conditions and situations that further complicate attention to postural control by increasing processing demands by exploring the impact in conjunction with cognitive tasks and determining if this further exposes older adults to falls. Determining the physical and cognitive contributions to postural stability is vital to both understanding postural control challenges and deriving components of future interventions aimed at reducing postural instability.

APPENDIX A  
INFORMED CONSENT



INFORMED CONSENT

**APPROVED**

PRINCIPAL INVESTIGATOR: Christopher Ray, Ph.D., ATC, CSCS

JUL 28 2012

TITLE OF PROJECT: Performance Trial for Non-Frail and Pre-Frail Elderly

**Institutional Review Board**

Before you say that you will be in this research study you need to read this form. It is important for you to understand all the information in this form. This form will tell you what the study is about and how it will be done. It will tell you about some problems that might happen for you during the study. When you read a paper like this to learn about a clinical trial it is called "informed consent". The people who are doing this research study are giving you very important information about the study. When you give your consent for something, it is the same as giving your permission. This consent form may contain words that you do not understand. Please talk to someone from the research staff if you have questions. Do not sign this consent form unless all your questions have been answered and you feel comfortable with the information you have read. You will be given a copy of the form to keep.

You are being asked to take part in this study because you may have some or none of the characteristics of frailty. Characteristics of frailty include loss of muscle strength, lower body weight, greater fall risk, less physical activity, and/or less independence.

PURPOSE:

We want to learn about treatments that may be effective in preventing older people from becoming frail.

DURATION:

You will be in the study for about 15 weeks or four months. The study will take place at the University of Texas at Arlington. There will be about (100) people in this study.

The researcher may decide to take you off the study if s/he feels that it is in your best interest, if you are not able to follow the rules of the study, if the study is stopped before it is finished or if new information becomes available that indicates it would be best for you to stop being in the study.

PROCEDURES:

All of the procedures that are being done in this study are approved for someone in your condition, nothing is considered experimental.

You will be screened to see if you qualify to be in the study. If you meet the screening criteria, you will be invited to take part in the study. Before you can participate in the study, you must get your medical doctor's written permission for you to participate.

If you qualify to be in the study and consent to take part you will be given an appointment to return. On that day you will be asked to complete a questionnaire, which will ask you questions about your general health. On the same day you will be asked to

PRINCIPAL INVESTIGATOR: Christopher Ray, Ph.D., ATC, CSCS  
 TITLE OF PROJECT: PerFoRmance Trial for Non-Frail and Pre-Frail Elderly

complete initial baseline testing of your strength, weight, balance, heart rate, blood pressure, and walking speed. Collected data may be used by collaborators of this research project, unless otherwise stated by the participant. You will also be scheduled to have a bone density scan before you start the study activity. These same tests including another bone density test will be repeated at the end of the study. If you are a caregiver for a frail family member, you may be asked, via a phone call and emails or letters, to complete additional phone interviews and questionnaires: the Resilience Scale for Adults, the Resilience Scale, and a Caregiver Questionnaire. The interviews will ask additional information about your caregiver role and services which may be helpful to you in resuming or maintaining your participation in this program. You may then be offered additional services aimed to assist you in remaining in the program, taking into account the health status of your family member. After completing the pre-testing procedures, you will be randomly assigned to one of four possible treatments: a control treatment, a Geri-fit treatment, or Progressive Functional Rehabilitation treatment. You will have equal 1 in 4 chance of getting assigned to group 1, group 2, group 3, or group 4.

**APPROVED**

JUL 28 2012

Institutional Review Board

You will be randomly assigned to one of three different groups:

Group 1: Control	Group 2: Geri-Fit	Group3: PFR	Group 4: Home based exercise
No changes to daily activity. You will take part in the initial and final study visits (questionnaires and bone density scans), but will not take part in the exercise programs which are part of this study.	Exercise (seated and standing activities) for 45 minutes 3 times per week for 15 weeks by an instructor in the department of Kinesiology Biomechanics and Movement Studies Lab and the adjoining gym. You will be physically monitored by a member of the research team while doing this exercise. You will take part in the initial and final study visits (questionnaires and bone density scans).	Exercise wearing a weighted vest for 45 minutes 3 times per week for 15 weeks by a certified instructor in the department of Kinesiology Biomechanics and Movement Studies Lab and the adjoining gym. Exercises include chair stands, walking, ascending & descending stairs, and Wii sports (bowling, golf, tennis, and baseball). If you are in this group, you will wear a gait belt and will be closely monitored by a representative from the research team to prevent falls. You will take part in the	Exercise at home for 45 minutes 3 times a week on your own according to a plan you will be given by the study coordinator. You will wear a physical activity monitor during the entire 15 week study period which will be downloaded every other week to record your physical activity. You will take part in the initial and final study visits (questionnaires and bone density scans).

JUL 18 2011



PRINCIPAL INVESTIGATOR: Christopher Ray, Ph.D., ATC, CSCS  
 TITLE OF PROJECT: PerFoRmance Trial for Non-Frail and Pre-Frail Elderly

		initial and final study visits (questionnaires and bone density scans).	
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JUL 18 2011

**APPROVED**

JUL 28 2012

POSSIBLE RISKS/DISCOMFORTS:

The potential risks of being in this study are that you could sustain an exercise related injury such as a fall or strain from the exercise that you may be doing.

The people doing this research project will do everything they can to make sure you do not get hurt during the project. If you do get hurt, you should tell the researcher or his/her staff and they will help you to get necessary medical care. You have not given up any of your legal rights by signing this form.

POSSIBLE BENEFITS/ALTERNATIVE PROCEDURES/TREATMENTS:

There are no direct benefits to you for being in the study. We hope that what we learn in this study will help others with your condition in the future. Another option is taking part in a rehabilitation or exercise program on your own without being in the study. Your other option is to not be in the study.

CONFIDENTIALITY:

Every attempt will be made to see that your study results are kept confidential. A copy of the records from this study will be stored in a locked office or other locked area in the department of Kinesiology for at least three (3) years after the end of this research. The results of this study may be published and/or presented at meetings without naming you as a subject. Although your rights and privacy will be maintained, the Secretary of the Department of Health and Human Services, the University of Texas at Arlington Institutional Review Board, and personnel particular to this research have access to the

PRINCIPAL INVESTIGATOR: Christopher Ray, Ph.D., ATC, CSCS  
TITLE OF PROJECT: PerFoRmance Trial for Non-Frail and Pre-Frail Elderly

study records. Your medical records will be kept completely confidential according to current legal requirements. They will not be revealed unless required by law, or as stated above.

COMPENSATION FOR MEDICAL TREATMENT:

The University of Texas at Arlington (UTA) will pay the cost of emergency first aid for any injury that occurs as a result of your participation in this study. UTA will not pay for any other medical treatment. Claims against UTA or any of its agents or employees may be submitted according to the Texas Tort Claims Act (TTCA). These claims may be settled to the extent allowable by state law as provided under the TTCA, (Tex. Civ. Prac. & Rem. Code, secs. 101.001, et seq.). For more information about claims, you may contact the Chairman of the Institutional Review Board of UTA at 817-272-3723.

FINANCIAL COSTS:

There are no costs to you for being in the study.

PRINCIPAL INVESTIGATOR: Christopher Ray, Ph.D., ATC, CSCS  
TITLE OF PROJECT: PerFoRmance Trial for Pre-Frail Elderly

CONTACT FOR QUESTIONS:

If you have any questions, problems or research-related medical problems at any time, you may call the Principal Investigator Christopher Ray at 817 272-0082. You may call the Chairman of the Institutional Review Board at 817-272-3723 for any questions you may have about your rights as a research subject.

VOLUNTARY PARTICIPATION:

You freely and voluntarily choose to be in this research project.

You can stop taking part in this study at any time. If you decide to stop taking part in this study, you should let the researcher or his/her staff know so that they can make sure you are safely taken out of the study.

By signing below, you confirm that you have read or had this document read to you. You will be given a signed copy of this informed consent document. You have been and will continue to be given the chance to ask questions and to discuss your participation with the investigators.

PRINCIPAL INVESTIGATOR: \_\_\_\_\_  
DATE

\_\_\_\_\_  
SIGNATURE OF VOLUNTEER DATE

JUL 18 2011

**APPROVED**

JUL 28 2012

Institutional Review Board



APPENDIX B  
SENSORY ORGANIZATION TEST PRINTOUT

Name:  
 ID: ATID00549  
 Date of Birth:  
 Height: 5'6"

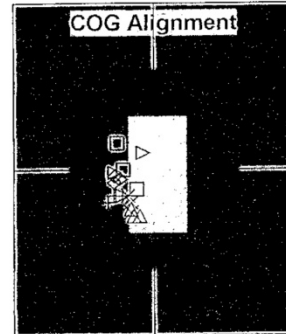
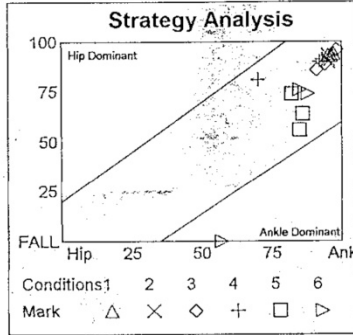
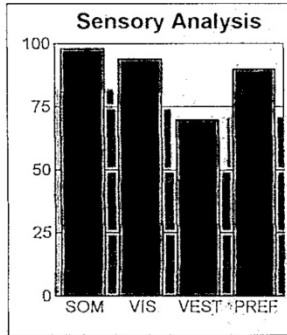
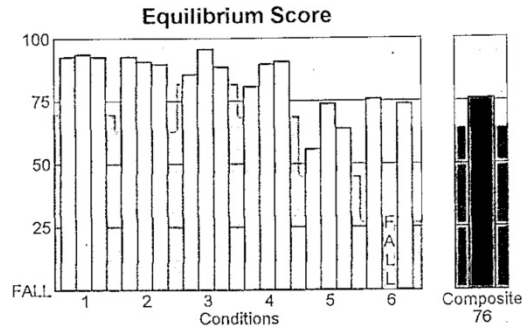
Diagnosis: Not Specified  
 Operator: Ray, C T  
 Referral Source: Not Specified

File: FD549.DRX  
 Date: 11/10/2011  
 Time: 14:00:12

Comments:

### Sensory Organization Test

(Sway Referenced Gain: 1.0)



**Data Range Note:** User Data Range: 70-79

Post Test Comment:  
 sot post

APPENDIX C  
SENIOR FITNESS TEST PRINTOUT

## Scorecard: Senior Fitness Test

Date 11/16/11  
 Name [REDACTED] M     F  Age 70 Ht 5'5" Wt 160

Test Item	Trial 1	Trial 2	Comments
1. Chair Stand Test (# in 30 sec)	<u>20</u>	N/A	
2. Arm Curl (# in 30 sec)	<u>19 with 5lbs</u>	N/A	
3. 6-Minute Walk (# of yd)	<u>2000</u>	N/A	<u>1111/1 +50</u>
4. 2-Minute Step Test* (# of steps)	<u>130 steps</u>	N/A	
5. Chair Sit-and-Reach (nearest 1/2 in.: + or -)	<u>+1.7 inch</u>	<u>1 inch</u>	Extended leg. R or L
6. Back Scratch (nearest 1/2 in.: + or -)	<u>+6 inch</u>	<u>+6.5 inch</u>	Hand over: R or L shoulder <u>134/74</u>
7. 8-Ft Up-and-Go (nearest 1/10 sec)	<u>5:88 sec</u>	<u>4:88 sec</u>	BP: <u>134/74</u> HR: <u>50</u> <u>135/78</u> HR: <u>54</u>

DYNAMO  
 WRIP  
 1) 30  
 2) 32  
 3) 32  
 135/78  
 HR: 54

\* Omit 2-minute step test if 6-minute walk test is given.

15 cups 3 hrs ago  
 No meds

## Scorecard: Senior Fitness Test

Date \_\_\_\_\_  
 Name \_\_\_\_\_ M \_\_\_\_\_ F \_\_\_\_\_ Age \_\_\_\_\_ Ht \_\_\_\_\_ Wt \_\_\_\_\_

Test Item	Trial 1	Trial 2	Comments
1. Chair Stand Test (# in 30 sec)	_____	N/A	
2. Arm Curl (# in 30 sec)	_____	N/A	
3. 6-Minute Walk (# of yd)	_____	N/A	
4. 2-Minute Step Test* (# of steps)	_____	N/A	
5. Chair Sit-and-Reach (nearest 1/2 in.: + or -)	_____	_____	Extended leg. R or L
6. Back Scratch (nearest 1/2 in.: + or -)	_____	_____	Hand over: R or L shoulder
7. 8-Ft Up-and-Go (nearest 1/10 sec)	_____	_____	

\* Omit 2-minute step test if 6-minute walk test is given.

APPENDIX D  
CALCANEAL DENSITOMETER PRINTOUT



Achilles InSight  
Ultrasound Results

UTA  
VA

ID 438  
DATE 11/10/2011  
TIME 10:42 AM  
Version 5.60

STIFFNESS INDEX 98 ±2

AGE 70  
SEX Female  
FOOT Right

REFERENCE USA

% YOUNG ADULT T SCORE -0.1

% AGE MATCHED Z SCORE 1.7

DOCTOR Christopher Ray

COMMENTS

Bone quality is within the normal range.

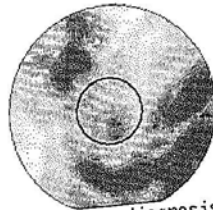
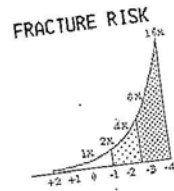
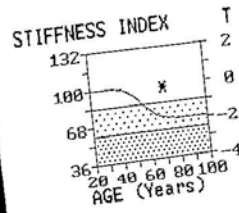


Image not for diagnosis



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## BIOGRAPHICAL INFORMATION

Forest Melton is the Clinical Coordinator for The Center for Healthy Living and Longevity. He received his B.S. in Physiology from The University of Arizona and his M.S. in Exercise Physiology and Health Care Administration from The University of Texas Arlington. As an aspiring physician, his research interests include postural control and aging.

Upon receiving his Masters, Forest plans on moving back to Arizona to be with his friends and family and study for the Medical College entrance exam. Forest also plans on furthering his research interests through The University of Arizona's Center for Aging.