The Efficacy of a Six-Week T'ai Chi Intervention Compared to a "Sit and Be Fit" Class on Actual and Perceived Balance in the Community-Dwelling Elderly

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THE EFFICACY OF A SIX-WEEK T’AI CHI INTERVENTION COMPARED TO A “SIT AND BE FIT” CLASS ON ACTUAL AND PERCEIVED BALANCE IN THE COMMUNITY-DWELLING ELDERLY

By

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THESIS

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THE EFFICACY OF A SIX-WEEK T’AI CHI INTERVENTION COMPARED TO A “SIT & BE FIT” CLASS ON ACTUAL AND PERCEIVED BALANCE IN THE COMMUNITY-DWELLING ELDERLY

ABSTRACT

Recent evidence supports the use of T’ai chi to decrease fall risk and improve self-efficacy (Wolf et al., 1996). The purpose of this study was to compare T’ai chi to a “Sit and Be Fit” intervention in a sample of the community-dwelling elderly. Classes met twice weekly for six weeks. Authors investigated the effects of each intervention on perceived and actual balance using timed one-legged stance, Tinetti Balance Subscale and the Activities-specific Balance Confidence scale. Pre- and posttesting were performed within one week of intervention. The Kruskal-Wallis test was used to determine statistical differences between the two groups. The Wilcoxon signed-ranks test was utilized to test the hypothesis that the T’ai chi group would demonstrate an increase in actual and perceived balance performance. Although individual improvements in balance were noted for the T’ai chi group, results were not significant. T’ai chi shows promise in balance training for the community-dwelling elderly.
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CHAPTER 1
INTRODUCTION

The elderly constitute the fastest growing segment of the population in the United States. "As the number of people living into very advanced age multiplies rapidly, the problems of frailty and injuries will loom even larger and demand increased attention from clinicians, researchers, and policy makers" (Ory et al., 1993, p. 283). Falls are a common occurrence in the elderly population. About one third of people aged 65 and over fall each year (Burker et al., 1995; Campbell, Borrie, & Spears, 1989; Hornbrook et al., 1994; King & Tinetti, 1995; Reinsch, MacRae, Lachenbruch, & Tobis, 1992; Tinetti, Mendes de Leon, Doucette, & Baker, 1994; Tinetti, Speechley, & Ginter, 1988). Ten to fifteen percent of falls result in injury, which causes a decrease in functional independence. This decline in independence may never be fully restored. Often a fear of falling will force one to limit his/her activity, thereby further decreasing independence. Falls resulting in decreased activity level are compounded by a decreased confidence level (Maki, Holliday, & Topper, 1991; Tinetti, Richman, & Powell, 1990; Tinetti et al., 1988). Declines in activity due to decreased confidence result in deficits in strength and mobility that puts the individual at a greater risk for additional falls.
The etiology of falls has been thoroughly investigated (Campbell et al., 1989; Connell & Wolf, 1997; Cutson, 1994; Forster & Young, 1995; Gill, Williams, & Tinetti, 1995; Graafmans et al., 1996; Hornbrook et al., 1994; King & Tinetti, 1995). Research has shown that the cause of most falls is multifactorial. It appears that falls result from a combination of small deficits in strength, range of motion, cognition, balance, coordination and sensation. These deficits may go unnoticed and individually may be unimportant, making fall prevention very difficult. However, these combined physical deficits may inhibit the compensatory mechanisms necessary to prevent falls. Unless a major incident occurs, such as a fracture or head injury, many falls go unreported by the elderly (Powell & Myers, 1995; Tideiksaar, 1989, p. 88). Therefore, preventative measures to reduce falls play a key role in maintaining functional independence among the elderly.

Polypharmacy within this population can also be a contributing factor to the increased risk of falls. Common medications taken by the elderly, such as sedatives or diuretics, can have side effects or combined effects which further increase fall risk (Graafmans et al., 1996).

Reduced cognition and perception are contributing factors to the vicious cycle created by falls and fear of falling (Bandura, 1982; Kempen, Steverink, Ormel, & Deeg, 1996; Simmons & Hansen, 1996; Tinetti et al., 1988). The elderly individual with impaired cognition is at a higher risk for a fall because he/she may lack the mental capability to make an appropriate judgment about personal safety. Cognition has been
researched and tested in many studies. However, a direct relationship between impaired
cognition and an increased risk of falls has not been established. An elderly person's
perception of his/her own capabilities may be altered following a fall and/or injury.
One's self-efficacy, or belief in ability to cope with a given circumstance, has been
explored (Bandura, 1977; Bandura, 1982; Hill, Schwarz, Kalogeropoulos, & Gibson,
1996; Maki et al., 1991; Myers et al., 1996; Tinetti & Powell, 1993; Tinetti et al., 1990).
Further research needs to be done to correlate balance perception with actual balance
performance. An appropriate tool for assessment of self-efficacy related to falls among
the elderly has not been agreed upon, although several have been proposed and
investigated.

Another difficulty in the investigation of falls, and their causes, has been the
multitude of balance assessment tools utilized in the clinic and in research. Although
several have been researched, a general consensus has not been reached as to which tool
is the most sensitive and specific for the elderly population. Attempts have been made to
correlate these evaluative tools with fear of falling. Studies comparing actual balance
performance with fall-related efficacy have been limited (Maki et al., 1991; Myers et al.,

Fall prevention has commonly focused on a variety of exercise interventions. The
main theme of research has been to utilize some form of training to improve balance.
Topics of study include: posturography, computerized balance training, traditional
strength, flexibility and balance training, aquatherapy and T'ai chi (Baloh et al., 1994;
Judge, Whipple, & Wolfson, 1994; Lord & Castell, 1994; Province et al., 1995; Simmons & Hansen, 1996; Topp, Milesky, Wigglesworth, Holte, & Edwards, 1993; Wolf et al., 1996). The most effective method of training to improve balance within the elderly population is still unclear.

Exercise prescription for the elderly population is in its initial stages of development. Investigations into optimal length, frequency and duration of exercise interventions have been made (American College of Sports Medicine, 1991; Lord & Castell, 1994; Means, Rodell, O'Sullivan, & Cranford, 1996; Wolf et al., 1996). Unfortunately, a consensus has not been reached regarding ideal parameters for balance training of the elderly.

Growth in the elderly population, combined with dynamic changes in the United States healthcare system, creates an environment in which preventative methods are becoming necessary to contain costs. The costs of fall prevention compared with traditional post-injury methods of treatment have been investigated. Current research suggests that fall prevention programs are more cost effective than post-injury treatment (Englander, Hodson, & Terregrossa, 1996; Rizzo, Baker, McAvay, & Tinetti, 1996). Group exercise programs have been shown to be more cost-effective and successful for fall prevention in the elderly (Rizzo et al., 1996; Wolf et al., 1996).

Fall-related injuries are often a primary reason for seeking long-term care in otherwise healthy elderly (Burker et al., 1995). Participation in group intervention programs designed to improve balance and confidence in the community-dwelling elderly
could improve functional independence and reduce risk of falls. However, a challenge with geriatric research lies not only in recruitment of the elderly into prevention programs, but in maintaining attendance throughout the intervention (Means et al., 1996; Pacala, Judge, & Boult, 1996; Tinetti, Baker, et al., 1994). Balance improvement and enhanced self-efficacy through group exercise programs could reduce the economic responsibility for long-term care of the elderly.

The purpose of this study is to compare the effects of a T’ai chi exercise program and a “Sit and Be Fit” class on the perceived and clinically tested balance of an elderly population. It is the authors’ contention that participation in a T’ai chi program will show greater improvements in both the perceived and actual balance in an community-dwelling elderly population.
CHAPTER 2
LITERATURE REVIEW

Review of the literature reveals three essential components of balance related research relative to this study. These are: 1) etiology and risk factors attributed to falls and balance performance, 2) clinical assessment tools of actual and perceived balance, and 3) intervention programs for balance improvement. There is, however, no research comparing the effects of an exercise-based intervention program on perceived and actual balance performance in community dwelling elderly.

Balance and falling among the elderly are two very closely related topics. Previous studies cite that 24% to 39% of the community dwelling elderly over age 65 fall each year, and up to 50% of these have fallen two or more times. About 10% of falls result in a serious injury such as a hip or other fracture, head injury, or serious soft tissue injury (Campbell et al., 1989; Hornbrook et al., 1994; King & Tinetti, 1995; Reinsch et al., 1992; Tinetti, Baker, et al., 1994; Tinetti et al., 1988). Covington, Maxwell, and Clancy (1993) found that over 40% of elderly persons admitted to hospitals with fall related injuries are discharged to a nursing home, while an additional 10% require further home care assistance.

When determining the socioeconomic impact of falls, Englander et al. (1996) projected the average cost per fall for people over 65 to be $1398, or an annual cost of $20.24 billion. The total costs will continue to rise as the ‘baby boom’ generation
approaches retirement age around 2020. Projected cost per fall in the year 2020, in 1994 dollars, is $7399, with total costs for falls in the over 65 age group reaching $32.36 billion.

In an effort to reduce the rate of falls, it is necessary to identify risk factors and causes of falling. “Although some falls have a single, obvious cause, most appear to result from several factors” (Tinetti et al., 1988, p. 1701). These risk factors can be labeled as extrinsic or intrinsic. Extrinsic factors are external to the individual and create challenges to balance that must be overcome to avoid falling. Extrinsic factors include environmental hazards such as slippery floors, poor lighting and uneven ground surfaces, improper footwear, and misuse of assistive devices. Intrinsic factors are specific to the individual. These include normal age-associated physiologic changes, impairments in muscle strength, balance and endurance, and medication use (Campbell et al., 1989; Nevitt, Cummings, Kidd, & Black, 1989; O’Loughlin, Robitaille, Boivin, & Suissa, 1993; Tideiksaar, 1993; Tinetti et al., 1988). Other intrinsic factors such as chronic diseases, stroke, foot problems, gait impairments, orthostatic hypotension and dizziness have all been associated with an increased risk of falling (Campbell et al., 1989; Cutson, 1994; Nevitt et al., 1989; O’Loughlin et al., 1993; Tinetti et al., 1988). However, these will not be addressed since they are beyond the scope of this study.

Balance has been the focus of many studies because it is considered an intrinsic factor and is also directly influenced by extrinsic factors. Several studies show that balance abnormalities are associated with an increased risk of falling (Alexander, 1994;
Extrinsic Factors

Extrinsic factors are environmental hazards, ordinary activities, or movements that "create challenges to balance that must be overcome to avoid falling" (King & Tinetti, 1995, p. 1150). When a challenge to one's balance exceeds one's capabilities, a fall occurs. Common environmental hazards that challenge balance include: 1) slippery floors, 2) improper lighting (too little or high glare), 3) uneven ground surface (i.e. door threshold, cracks in sidewalk, throw-rugs, bumpy lawn), 4) improper height of furniture (i.e. bed, chair seat), 5) low toilet seat, 6) poor grab bar/railing support, and 7) improper footwear (Connell & Wolf, 1997; King & Tinetti, 1995; Lange, 1996; Tideiksaar, 1993; Weinberg & Strain, 1995).

Modification of an environment is a common intervention to reduce the risk of falls. However, Connell and Wolf (1997) address a very important point regarding this intervention. Semi-permanent structures (i.e. coffee table, couch and chair) which could cause a fall can be re-arranged or modified. Unfortunately, temporary obstructions such as phone cords, clutter, and pets cannot be permanently eliminated. Even though these obstructions can be removed temporarily, they are likely to recur in the near future. Anticipating these obstructions as being problematic is difficult due to their temporary
nature. The authors further state that temporary obstacles are of significant concern since “many people of all ages safely move around familiar environments on the basis of experience, rather than on the basis of attentiveness to existing conditions” (p.184).

An individual’s attitude toward safety awareness and change can be a significant barrier to fall prevention. An example of this is when individuals stumble while walking through a dark house. They claim to be accustomed to the house and its arrangement and normally do not have a problem walking in the dark. Such over confidence in ability can result in compromised safety.

Similarly, the execution of ordinary activities can be considered an extrinsic factor associated with falling. More specifically, when an individual is challenged with a temporary condition while performing a task, he/she is at a greater risk for falling. Likewise, the performance of multiple tasks simultaneously can predispose one to falls (Chen et al., 1996; Connell & Wolf, 1997; Tobis, Reinsch, Swanson, Byrd, & Scharf, 1985). A previous study by Chen, Ashton-Miller, Alexander, and Schultz (1994) found near significant results regarding the age effects on obstacle avoidance. From this, the authors suggest that healthy elderly adults have the essential abilities needed to avoid an obstacle while walking. However, this assumption is premature based on the significant findings of the second study (Chen et al., 1996). The near significant findings of the follow-up study may suggest that the elderly do not have the essential biomechanical abilities necessary to avoid an obstacle. A possible design flaw of the second study may
have resulted in the lack of statistical significance. Before drawing the conclusion that the elderly do have such abilities, a repeat of the initial study should be carried out.

Misuse or disuse of a prescribed assistive device can also contribute to falls (Lange, 1996). For example, falls can result from carrying a cane while walking instead of using it for support, lifting a rolling walker instead of pushing it, or simply not using an assistive device that has been prescribed. Other falls are the result of hazardous or imprudent behavior (Reinsch et al., 1992). Such activities include lifting or carrying heavy items, and climbing or balancing on unstable objects.

Movements that may lead to a loss of balance are common in activities of daily living. Simple transfers from sitting to standing, bending over to pick up an object, and stepping into a bathtub may cause a person’s center of mass to be displaced beyond his/her base of support. When the physical demands to perform these activities exceed the person’s capabilities to maintain his/her balance, a fall may occur (King & Tinetti, 1995). Overall, it is important to remember that the interaction between a person and the environment is highly complex and specific to the elderly individual. Thus, environmental factors contribute to falls in different ways with different groups of elderly (Lipsitz, Jonsson, Kelley & Koestner, 1991).
Intrinsic Factors

Normal age-associated physiologic changes produce deficits that can affect the ability of an elderly person to maintain his/her balance. Such changes are seen in the neuromuscular, musculoskeletal, somatosensory, visual, and vestibular systems. Neuromuscular changes include structural and chemical alterations that limit contractility and ultimately reduce physical strength. Aging also produces alterations in the number, size and type of muscle fibers and leads to weakness (Aniansson & Zetterberg, 1984; Fiatarone et al., 1990; Fiatarone et al., 1993; Guccione, 1993, p. 86; Hagberg et al., 1989).

Adults can lose up to 40% of their muscle mass between the ages of 30 and 80 with the lower extremities being the greatest affected. This decrease in muscle mass includes a preferential loss of Type II fibers (Dumitru, Gershkoff, & Walsh, 1994, pp. 231-232; Guccione, p. 86; Shumway-Cook & Woolacott, 1995, p. 172). Type II fibers are generally associated with muscles of mobility. Muscles of mobility are involved in producing the large ranges of motion throughout the body (Norkin & Levangie, 1992, p. 100-01). As these muscles decrease in fiber number and size, there are deficits in the ability to maintain a normal step length, gait speed, and protective stepping reactions, all of which are associated with balance.

In a study by Gehlsen and Whaley (1990), significant differences in balance were noted when comparing a group of non-fallers to those who had a history of falls. The
non-fallers had greater concentric strength of the hip, knee and ankle musculature than fallers. Although the normal aging process is inevitable, strength loss due to inactivity can be slowed. Decreased strength may be addressed through an appropriate intervention program (Weinberg & Strain, 1995). Even those 85 years and older can experience proportionate strength gains when given adequate stimulation (Fiatarone et al., 1990).

The neuromuscular junction also undergoes physiologic changes during aging which result in decreased muscle selectivity and motor recruitment (Felsenthal, Garrison & Steinberg, 1994; Guccione, 1993, p. 86). Investigations in motor nerve conduction velocities reveal progressive slowing which coincides with increased motor latency (Dumitru et al., 1994, p. 236). The gradual demyelination and remyelination process that occurs with normal aging can explain this. The increased latency time combined with decreased selectivity and motor recruitment places the elderly person at a greater risk for falling when his/her balance is challenged. All of these neuromuscular changes can lead to faulty balance responses.

In addition to the neuromuscular changes, the aging process also affects the periarticular connective tissues. As humans age, there is an increase in the amount of collagen in body tissues. The function of collagen is to provide stability to tissues. However, increased collagen levels can eventually lead to muscle and joint stiffness, which is compounded by inactivity (Guccione, 1993, p. 59; Kisner & Colby, 1985, p.119). Resultant increases in mechanical stability can inhibit an individual’s ability to react appropriately to perturbations, thus compromising balance. A study by Gehlsen and
Whaley (1990) showed that the elderly faller has a significant decrease in joint flexibility at the hip and ankle compared to non-fallers.

Aging tissue also experiences a loss of elastin. Elastin provides elasticity that allows a tissue to return to its original form after an imposed stress. As a result, this reduction produces a decrease in tissue recoil. Consequently, prolonged stress to tissues may cause improper joint positioning leading to the development of contractures or permanent postural changes. The flexed or stooped posture of many older adults can be associated with faulty postural alignment. This can produce a backward shift in the elderly person's center of mass. These permanent changes can further impair the balance responses of that individual (Guccione, 1993, p. 52; Shumway-Cook & Woollacott, 1995, p. 173).

The complex interaction between the somatosensory, visual, and vestibular systems, with a resultant motor response, is commonly referred to as postural control or balance. Several age-associated changes occur in these systems which result in impaired balance. Alterations in sensory receptor structure and lipofuscin buildup are associated with loss of vibratory sense and proprioception (Dumitru et al., 1994, p. 227; Skinner, Barrack, & Cook, 1984). Visual deficits include decreased focusing ability, light adaptation, color discrimination, and field deficits (Tideiksaar, 1997, p. 53-58; Wainapel, 1994, p. 327). A community-based study by Tobis et al. (1985) found significant visual-perceptual impairments and an increased dependence on environmental cues among fallers. The greater dependence on visual cues occurs when proprioceptive and vestibular
systems become impaired. Thus, as a result of age-associated impairments, the elderly may misinterpret visual cues and are at an increased risk for falls. Vestibular changes associated with normal aging include a 40% reduction in the cristae of the semicircular canals, with similar changes in the maculae. These changes, as well as vestibular dysfunctions such as Meniere’s disease, vertigo, or benign postural vertigo, can alter an individual’s sense of position or cause imbalance upon change of position (Fishman, 1994, p. 197). Norre, Forrez and Beckers (1987) found that the vestibular righting response also declines with age. Thus, if a person’s balance is challenged, he/she will have a decreased chance of regaining balance.

Many older adults are commonly prescribed medications that have been associated with falls and instability. Diuretics, hypnotics, sedatives, tricyclic antidepressants, tranquilizers, analgesics, nitrates, non-steroidal anti-inflammatory drugs, peripheral vasodilators and anti-hypertensives are all considered to create a higher risk for falls in the elderly (Graafmans et al., 1996). “Polypharmacy, a significant problem in the elderly, can lead to drug-drug interactions and additive side effects. . . such as sedation, hypotension and decreased reaction time” (Cutson, 1994, p. 152). Lange (1996) cites a 1990 report by the Health Care Finance Administration, which states that the average community-dwelling elderly individual consumes 12-15 prescription and over-the-counter medications daily.

Several studies have evaluated medication use as a fall risk factor. Tinetti, Baker et al. (1994) evaluated the use of any benzodiazepine or other sedative-hypnotic agents.
In this study, subjects who were currently taking greater than four medications were referred to their primary physician for a review of their prescriptions. The results of this study showed that cognitive intervention in conjunction with exercise decreased the occurrence of falls. Even though the role of medications is viewed as one of the most important and most modifiable intrinsic risk factors that can impact the elderly individual's balance (Cutson, 1994; King & Tinetti, 1995; Kippenbrock & Soja, 1993; Lange, 1996), pharmacological modification is beyond the scope of the authors' intentions. However, it is necessary to document all medications and dosages that are being consumed by elderly persons that fall.

The risk of falling increases with the number of risk factors present (Campbell et al., 1989; Nevitt et al., 1989; Tinetti et al., 1988). Tinetti et al. noted that, in a one year period, 8% of persons with no risk factors fell, whereas 78% of persons with greater than three risk factors fell. Nevitt et al. demonstrated similar results. However, both studies also showed that a significant number of elderly persons with none or few of the risk factors also fell. Tinetti et al. noted that modifying even a few of the risk factors that are present might reduce the number of disabilities experienced. Since exercise-induced changes in fitness are carried with a person wherever they go, the protective effects of such an intervention may be stronger than those from modifications to the environment (Hornbrook et al., 1994).
Characteristics of the Faller

When discussing falls among the elderly, it is helpful to determine the functional level of these individuals. While many people associate falls with the frail elderly (Cutson, 1994; Tinetti et al., 1988), a significant number of falls occur among healthy elderly. Several studies have made an attempt to classify fallers into groups to try to determine who is at risk for falls and what the expected consequences of the fall(s) may be (Northridge, Nevitt, Kelsey, & Link, 1995; Reinsch et al., 1992; Speechley & Tinetti, 1991). In both studies, researchers classified subjects as “frail” or “vigorous”. Northridge et al. noted that frail elderly are more than twice as susceptible to fall(s) than vigorous elderly. Speechley and Tinetti found that falls among the frail elderly tend to occur in the home during routine activities that do not pose a challenge to balance. However, when vigorous subjects fall, they tend to be performing activities that pose significant challenges to balance while active around the home or in the community (Reinsch et al., 1992; Speechley & Tinetti, 1991). Speechley and Tinetti showed that while the frail are more likely to fall, the vigorous elderly are more likely to suffer a serious injury. This is of importance when assigning a population to participate in a fall prevention/intervention program. The vigorous elderly must not be ruled out as research participants simply because they appear to be healthy.
Consequences of Falling

Falls tend to be very harmful with consequences such as bruises and abrasions, fractures, and mortality. In fact, falls are identified as the sixth leading cause of death among people over the age 65 (Baker & Harvey, 1985; Tinetti, Baker, et al., 1994). There are other sequelae to falls that are often overlooked but can be just as detrimental. King and Tinetti (1995) identify the inability to get up after falling, fear of falling (ptophobia), and decreased activity as such important sequelae. In a study by Tinetti, Liu, and Claus (1993), a trend is noted toward more frequent hospitalization and death among those elderly that are unable to get up after a fall. Fear of falling is common among all elderly, whether they have fallen or not. Between 40% and 73% of elderly who have fallen, and 20% to 46% of those who have not, express a fear of falling (King & Tinetti, 1995). “Fear (of falling) may result in a pattern of decreased mobility and alterations in daily activity that may decrease the quality of life” (Kippenbrock & Soja, 1993, p. 209). The fear of falling and resultant decreased activity will be covered in more detail later in this review of the literature.

Balance Assessment in the Elderly

Due to varying research results found on the many balance assessment tools available to the physical therapist, balance is one of the most difficult areas to assess.
functionally and thoroughly. These assessment tools can be divided into two main categories: 1) those correlated with falls and fear of falling and 2) those with no known correlation with falls. The assessment tools correlated with falls that will be discussed are: 1) Tinetti Balance Subscale, 2) reduced base of support stance time, 3) Berg Balance Scale, 4) Functional Reach, 5) postural sway and 6) Timed “Up & Go”.

Tinetti Modified Balance Subscale

The Tinetti Modified Balance Subscale is part of a larger assessment tool called the Tinetti Performance Oriented Mobility Assessment, or the POMA. Developed in 1986 by Tinetti, the purpose behind its creation was the content development of a functional mobility assessment tool appropriate for use with the elderly. Tinetti intended to use the POMA for identification of the following: 1) components of ADL mobility a person is likely to have difficulty with, 2) reasons for difficulty with mobility, 3) other problems a person may be susceptible to, 4) potential medical or rehabilitation treatments and 5) potential environmental changes.

The original subscale evaluates eight activities of daily living (Tinetti, 1986). Harada et al. (1995) eliminated two of the original tasks and replaced them with two more difficult tasks. The test is time efficient, taking only ten minutes to administer, and is performed clinically by physical therapists.
Studies have shown the Tinetti Balance Subscale to have both inter-rater reliability and test-retest reliability ranging from 0.95-0.98 (Harada et al., 1995; Thapa et al., 1996). Harada et al. reported a specificity level of 78% and a sensitivity level of 68% in the elderly population. Thapa et al. report the Tinetti Balance Subscale as “the best predictor of future rates of recurrent falls” due to it’s linear relationship.

Other studies, which focused on correlation of balance ability with fear of falling, used the Tinetti Balance Subscale. One such study (Baloh et al., 1994) compared Tinetti Subscale scores in young and old men and correlated these scores with previous fall incidence(s) and fear of falling in the future. The results showed a moderately increased number of “Abnormal” Tinetti Subscale task scores in those subjects who reported a fear of falling. This supported Tinetti’s original assertion that the risk of falls increased with the number of abnormalities revealed by the POMA (1986).

Maki, Holliday and Topper (1991) found lower scores on the Tinetti subscale in fallers both with and without a fear of falling. Explanation of these results lie in hidden risk factors, such as dizziness, vestibular disorder, and postural hypotension, that may not be revealed during the course of test administration. However, these sensations may be regularly experienced by the participant during ADL’s and may make subjects fearful of movement and falling. Not all fallers have hidden risk factors and may not exhibit fear of falling or movement during ADL’s. Several tasks evaluated in the POMA are not assessed in the subscale. These tasks include positional changes that may exacerbate a pre-existing condition. Therefore, the balance subscale is less likely to evoke fearful
symptoms during the course of testing. Maki et al. (1991) did report the lowest scores on the Tinetti POMA in fallers with fear of falling.

Reduced Base of Support Stance Tests

Balance is frequently evaluated by reducing the base of support of the individual. Semi-tandem standing, tandem standing and one-legged standing are timed to see how long these positions can be maintained (Berg, 1989; Maki, Holliday & Topper, 1991; Rossiter-Fornoff, Wolf, Wolfson & Buchner, 1995; Tinetti, McAvay & Claus, 1996; Topp, Mikesky, Wigglesworth, Holt & Edwards, 1993).

A review of balance assessment tools (Berg, 1989) states that the ability to stand on one leg decreases with age. This is confirmed in a later group of studies known as the FICSIT trials. The acronym FICSIT stands for Frailty and Injuries: Cooperative Studies of Intervention Techniques. The FICSIT trials consisted of eight research sites across the country that examined the effects of numerous interventions on balance performance in various elderly populations. All the sites used the FICSIT-3 scale for balance assessment which consisted of a series of decreasing bases of support. The evaluation started with parallel standing (feet together), moved to semi-tandem standing, and ended with tandem standing. Each phase was timed for a maximum of 10 seconds. Three of the sites, which recruited well elderly, collected data on one-legged stance time as well. This became known as the FICSIT-4 scale (Rossiter-Fornoff et al., 1995).
Results of the study were difficult to compile due to the variation among populations. Consequently, estimated reliability of the balance scales was 0.66. Positive evidence of content validity was also reported in the study due to the high correlation of balance performance scores with age, gait speed and stride length. Overall, larger correlations were found with the FICSIT-4 scale, possibly due to a ceiling effect seen upon statistical analysis of the FICSIT-3 with well-elderly populations. Of the three stances tested in the FICSIT-3, only tandem stance was able to identify balance deficits among community dwelling elderly (Rossiter-Fornoff et al., 1995).

One-legged stance may be an important indicator of balance ability, as indicated by the results of the FICSIT trials. Other studies have examined only one-legged stance, both with eyes open and eyes closed (Maki et al., 1991; Topp et al., 1993). In the study by Topp et al. an exercise intervention program did improve static one-legged standing time with eyes open, but not with eyes closed (1993). The study by Maki et al. reveals a significantly decreased one-legged stance time among those participants who reported fear of falling regardless of history of falls (1991). These studies also concluded that one-legged stance time is influenced by fear of falling, especially with eyes closed.

Berg Balance Scale

The Berg Balance Scale (BBS) was developed due to the need for a timely, comprehensive, and safe assessment of balance (Berg, 1989). The tool evaluates 14
functional activities and requires about 15 minutes to administer. The Berg Balance Scale is highly correlated with the Tinetti Balance Subscale at 0.91. Inter-rater and intra-rater reliability was found to be 0.98 and 0.99 respectively (Harada et al., 1995). Thorbahn and Newton (1996) found the Berg to have 96% specificity among the elderly. However, these authors also found a low sensitivity of 53% and decreased ability to predict who would fall.

Harada et al. (1995, p. 467) explain, “The strength of the Berg Balance Scale lies in its detailed grading scale, which appears to be better at detecting balance impairment than the POMA balance subscale.” While the Berg may be a better test of actual balance ability, it may not be able to predict who is at risk for falls. Unfortunately, a large gap in BBS research lies in correlation with fear of falling. Unlike the Tinetti, virtually no research has been done comparing the results of the BBS to individuals with and without fear of falling.

**Functional Reach**

The Functional Reach (FR) test is a measure of maximal safe forward reaching in standing without taking a step (Weiner et al., 1992). This assessment tool was developed to “measure the margin of stability” (Duncan, Weiner, Chandler & Studenski, 1990, p. M192). The Functional Reach was designed by Duncan et al. (1990) to assess both dynamic postural control and a functional movement performed ubiquitously. The FR is
highly adaptable to any environment and only requires a yardstick and a level as props.

Due to its simplicity, the FR can be performed in the clinic or in the home (Duncan et al., 1990).

In the initial development of this tool, test-retest reliability was very high at 0.92 as was the intraclass correlation coefficient at 0.98 (Duncan et al., 1990). Further examination of the FR also found significant test-retest reliability and interobserver reliability. Functional reach is correlated significantly with physical frailty at 0.52-0.63. A functional reach score of less than 7 inches was found to be indicative of severe impairments (Weiner et al., 1992).

Continued investigation of the FR has focused on the effects of rehabilitation on functional reach scores. Correlation with rehabilitation and with other assessment tools (i.e. Mobility Skills Protocol, ten foot walking speed and Functional Independence Measure scores) has been relatively unsuccessful (Weiner, Bongiomi, Studenski, Duncan & Kochersberger, 1993). These authors found only marginal changes in functional reach scores with rehabilitation ($r = 0.38$), although this change was statistically significant. Sensitivity to change was found to be a strength of the FR and it remains relatively uncertain as to whether rehabilitation actually affects functional reach scores. Further research needs to be conducted on the FR to assess the efficacy of rehabilitation on scores and to determine possible correlation with falls.
The correlation of postural control mechanisms and balance has been extensively explored. As cited by Baloh et al. (1994), research supports the commonly held theory that amplitude and speed of postural sway is indicative of underlying balance capability. Baloh et al. report:

"Body sway is a normal phenomenon that occurs in everyone. Several studies have shown that sway increases in older people and that the frequency of falls increases; quantitative measurement of sway could be an important clinical tool for identifying older people at risk for falling." (p. 405)

Due to its heterogeneity, postural sway has become a basis of comparison for many clinical assessment tools. The Berg Balance Scale, the Tinetti Balance Subscale and the Functional Reach have all been correlated with postural sway (Baloh et al., 1994 & 1995; Berg et al., 1992; Duncan et al., 1990; Maki et al., 1991; Thapa et al., 1994 & 1996).

Results of these studies show low correlation ($r = 0.28$) between postural sway and the Tinetti Balance Subscale (Thapa et al., 1994). Berg et al. (1992) reported only moderate correlation (mean $r = -0.55$) between the Berg Balance Scale and postural sway. One possible explanation for this lack of correlation is the subjects use of different balance strategies during postural sway tests than during functional activities.

The largest drawback of postural sway evaluation is that it must be performed in a clinic equipped with computerized force plates. This set-up is not only complicated but time consuming. The subject must find a comfortable stance atop the force plates and
their feet must be traced to ensure that they resume the same position with each sequential test. The benefits of such a set-up are great. Not only is quantitative objective sway and balance data generated, but pseudorandomized balance challenges can be administered to test antero-posterior (A-P) and medio-lateral (M-L) sway mechanisms. These challenges can even be administered to the very unstable with the support of a halter or grab rails. This can be used not only for balance testing, but training as well.

Tests of static standing, A-P and M-L sway are administered both with eyes open and eyes closed (Baloh et al., 1994; Maki et al., 1991; Thapa et al., 1994 & 1996). This lengthens the time it takes to perform a postural sway assessment. However, these repeated tests of balance with eyes closed have been highly correlated with falls and fear of falling. Thapa et al. (1994) reported that in the frail elderly population, postural sway was one of the best predictors of recurrent falls. Several other authors have reported a high correlation with fear of falling and increased postural sway with eyes closed (Baloh et al., 1994; Baloh et al., 1995; Maki et al., 1991).

The largest reported increase in sway is seen in static, not dynamic, testing (Berg et al., 1992; Baloh et al., 1994; Maki et al., 1991). An interesting theory has been discussed by several authors as to the reason behind this seeming anomaly. The "stiffening" theory explains how elderly with fear of falling will stiffen during dynamic tests. By doing so, they improve their test score by decreasing the amount of sway. During a static test subjects are more relaxed, even with eyes closed, and instability will become apparent in the increased sway (Baloh et al., 1994).
Another highly functional balance and mobility assessment tool is the timed “Up & Go” test. The test evaluates arising from a chair, walking 3 meters, turning around, walking back to the chair and sitting down (Mathias et al., 1986). Excellent intra- and inter-rater reliability, 0.99 for each, has been established (Mathias et al., 1986, Podsialdo et al., 1991). The original study by Mathias et al., awarded scores on a scale of one to five based on the quality of the performance. The authors also found the “Up & Go” to be correlated with postural sway, gait speed, step length, stride width, stepping frequency, double support time and stride time. Using the original rating scale, the initial finding was that a score of 3 or higher indicated risk for falls. In 1991, Podsialdo and Richardson decided to eliminate the rating scale and began timing performances of the test. Timing was found to be reliable and to correlate with other measures of balance and mobility such as the Berg Balance Scale, timed gait speed, and functional capacity.

The timed “Up & Go” is quick and easy to administer, requiring no equipment except a wristwatch. The test is functional and can be performed by any person, regardless of disability or frailty, because assistive devices can be used and the test is individually paced.

Obviously, much time and research has been devoted to balance assessment tools and their reliability, validity, and correlation with falls and fear of falling. Research has also included tests that have not been correlated with falls and fear of falling. Some of
these balance tests include obstacle courses, timed chair stands, and timed ten-foot walk. None of these are applicable to this study.

**Self-efficacy in the Elderly**

The second component crucial to this study is the evaluation of self-efficacy related to balance. The concept that one’s belief in their own capabilities, or self-efficacy, can influence performance is relatively new to researchers. This concept has been recognized clinically for some time. The therapist provides encouragement and positive feedback to patients known to be fearful. Throughout the development of physical therapy practice, therapists have learned that helping patients overcome fears and doubts improves their function. This section of the literature review will focus on Bandura’s concept of self-efficacy, fear of falling in the elderly and self-efficacy assessment tools related to falls and fear of falling. These tools are the Falls Efficacy Scale, the Modified Falls Efficacy Scale and the Activities-specific Balance Confidence Scale.

**Bandura’s Concept of Self-efficacy**

Perceived self-efficacy is defined as “[a human being’s] judgment of how well one can execute courses of action required to deal with prospective situations” (Bandura,
These efficacy expectations reflect a person’s perceived, rather than, actual ability. One of the key concepts in Bandura’s learning theory is perception of self-capabilities that influence behavior, not actual capabilities.

In the book, *Social Learning Theory*, Bandura states, “The strength of people’s convictions in their own effectiveness determines whether they will even try to cope with difficult situations” (1977, p. 79). Bandura goes on to explain that people will avoid an action or situation if they fear it, but if they believe themselves capable, they will perform the action even if they perceive it as threatening. Therefore, it is belief in ability to cope with the situation, not the action or situation itself that limits performance of activities. “The stronger the efficacy or mastery expectations, the more active the efforts . . . Those who give up prematurely will retain their self-debilitating expectations and fears for a long time” (p.80).

Bandura states, “performance accomplishments provide the most dependable source of efficacy expectations because they are based on personal experiences” (1977, p.81). The person with a history of falls should have a greater fear of falling and less perceived ability to cope with threatening situations. However, this has not been consistently found in research, possibly due to the fact that once a person falls, they have knowledge of what it is like to fall, and know first-hand that they have the ability to cope with a fall. On the other hand, a person who has never fallen must cope with both a fear of falling and a fear of the unknown.
Attempts to change a person’s behavior with verbal persuasion are relatively unsuccessful according to Bandura. As previously stated, this method is commonly used both in the clinic and in research. The therapist tries to convince the person that they are physically capable of performing an activity. Even if successful, effects of verbal persuasion are short-lived and quickly erased by actual experiences (Bandura, 1977). This can lead to either positive or negative results. If the person has a successful performance of a feared activity, they are much more likely to remember this, and use it as a basis for further activity, thus increasing their independence. However, if the person has a negative experience, they will not only remember the failed performance, but the false encouragement of the therapist.

Attempts have been made to correlate efficacy with physical and mental characteristics that may or may not hinder the individual from living in the community. Slow walking pace, difficulty getting up after a fall, depression and anxiety has been correlated with low self-efficacy (Tinetti & Powell, 1993). They also reported that “efficacy remained a strong determinant of ADL-IADL, physical activity, and social functioning “(p. 37).

Fear of Falling

Applying Bandura’s concepts of self-efficacy to the elderly with fear of falling reveals a vicious cycle. The elderly, with or without a history of falls, may restrict
activity due to fear of falling (Arfken, Lach, Birge, & Miller, 1994; Maki, Holliday, &
Topper, 1991; Tinetti, Richman, & Powell, 1990; Myers, Powell, Maki, Holliday,
Brawley, & Sherk, 1996; Tinetti & Powell, 1993). Decrease in activity leads to functional
decline and increased dependence upon others. Loss of independence further restricts
activity, and the functional decline may lead to a physical disability which furthers the
fear of falling and may, in fact, predispose the person to falls (Myers et al., 1996;
Simmons & Hansen, 1996; Tinetti & Powell, 1993).

As Bandura states, "it is mainly perceived inefficacy in coping with potentially
aversive events that makes them fearsome" (1982, p. 136). The elderly may believe that
they are only capable of performing a physical activity such as walking or stair-climbing
under certain circumstances, such as in their own home. They feel that they are unable to
cope with any challenges that may be presented while performing this activity in a
different environment. Outside what is familiar, they limit their activities and may be
fearful of new challenges. By not challenging the body systems, they lose their capacity
to deal with challenges so any new circumstance can seem very threatening.

Fear of falling, or ptophobia, is defined as "a lasting concern about falling that
leads to an individual avoiding activities that he/she remains capable of performing"
(Tinetti & Powell, 1993, p. 36). Ptophobia was first established, and treated, as a clinical
syndrome in 1982 by Bhala et al. Using three case studies for illustration, treatment
involved physical therapy and behavioral psychology. Since this time, much has been
learned about fear of falling.
Clinical and postural balance tests show correlation with fear of falling. The most frequently studied has been the correlation of the Tinetti POMA with falls and fear of falling. Abnormal Tinetti POMA scores (< 28) have been correlated with high risk of falls and fear of falling in the elderly (Baloh et al., 1994; Baloh et al., 1995; Tinetti, 1986). Tests of spontaneous postural sway have also shown significant correlation with fear of falling, especially with eyes closed (Baloh et al., 1994; Baloh et al., 1995). There does not appear to be a correlation between fear of falling and physiological changes associated with aging. Maki et al. (1991) reported no correlation between fear of falling and decreased proprioception or vibration sensation, decreased range of motion at hip, knee and ankle, history of vertigo or dizziness, neurological, orthopedic, metabolic or psychiatric disorders, or the use of sedatives.

Other studies have reported correlations of fear of falling and decreased life satisfaction, decreased quality of life, and frailty (Arfken, Lach, Birge & Miller, 1994). Of those who report falls, 25-27% have a fear of falling and 25-26% report a restriction in activity (Tinetti & Powell, 1993; Tinetti, Richman & Powell, 1990). In 1994, Arfken et al. reported that 9% of those with fear of falling had fractures the next year. These statistics show the large problem created by the phenomenon of fear of falling.

Little is known about how phobophobia develops. Not all people with falls have fear of falling, and not all those with fear of falling have fallen. Using Bandura's theories, the principles of performance accomplishment and vicarious experience can be applied to explain this seemingly odd occurrence (Bandura, 1982). As previously discussed, the
concept of performance accomplishment states that the greatest influence on self-efficacy will come from personal experience. In those who have fallen there is direct knowledge of the experience. Therefore, the person has certain expectations regarding future falls. They may not fear falls because they already know what to expect. However, those who have not fallen may have a certain vicarious expectation about a fall that they have never experienced. Stories from friends or family regarding disastrous fall outcomes may invoke ptophobia. Anticipation of an injurious fall and fear of the unknown may create a greater fear than in those without a history of falls.

Perceived self-efficacy is also known to be influenced by feelings of futility and depression (Bandura, 1982; Kempen et al., 1996). Feelings of personal inefficacy and an inability to have control over events surrounding one's life all contribute to depression in the geriatric population. Bandura states, "people can give up trying because they...expect their efforts to produce no results due to the unresponsiveness, negative bias or punitiveness of the environment" (1982, p. 140). Perceived lack of control is a source of depression and futility in the elderly. Research has since been conducted on the effect of depression in the elderly and its influence on self-efficacy perception. Kempen et al. (1996) reports the depressed elderly tend to underestimate their level of function. They had a greater discrepancy between perceived and actual performance measures. The depressed elderly underestimated their capabilities, but performed at a higher level.

Fear of falling has been identified by many sources as a clinical problem requiring treatment (Arfken et al., 1994; Bhala et al., 1982; Myers et al., 1996; Simmons &
Hansen, 1996; Tinetti & Powell, 1993). Fear of falling is not a normal age associated change and has potential for modification and treatment both by physical therapists and behavioral psychologists. Tinetti and Powell stated that falling and fear of falling, “. . . are specific entities, with specific risk factors which may be amenable to intervention. Fear of falling, therefore, represents a common, and potentially modifiable, cause of physical dependence and functional decline among elderly persons” (p. 38).

Self-efficacy Assessment in the Elderly

Falls Efficacy Scale

In a continued effort to assess the amount of fall-related efficacy correlated with a fall, the Falls Efficacy Scale (FES) was developed. A board of physicians, physical therapists, occupational therapists and rehabilitation nurses created the FES. The scale consists of ten activities of daily living considered essential for an individual to live independently in the community. The activities originally consisted of the following: 1) getting dressed, 2) getting on/off the toilet, 3) preparing simple meals, 4) taking bath/shower, 5) getting in and out of chair, 6) getting in and out of bed, 7) answering door and telephone, 8) walking around house, 9) reaching into cabinets/closets and 10) personal grooming. After a pre-test, however, little difficulty was found in personal grooming and toileting by the community dwelling elderly. These were then replaced by
light housekeeping and simple shopping tasks (Tinetti, Richman & Powell, 1990). The scale was scored by self-report from participants. Individual task scores ranged from 1-10. Total scores ranged from 10-100 with lower scores indicating higher self-efficacy.

The Falls Efficacy Scale has a test-retest reliability of 0.71, making it a reliable tool to assess self-efficacy in the elderly as related to fear of falling (Tinetti, Richman, & Powell, 1990). These authors assume validity of the FES because of the consensus drawn by a board of professionals regarding the ADL’s to be evaluated. However, the authors gave no quantitative data for this validity. Powell and Myers (1995) examined the internal consistency of the FES and found it to be 0.90. A later study revealed the potential of the FES for predicting changes in function in the elderly. However, more research is needed to investigate this possibility (Tinetti & Powell, 1993).

Tinetti et al. (1994) compared the effects of fear of falling and self-efficacy to function. The efficacy score was highest among those with no fear of falling (mean = 91.2). In those with fear, but no activity restriction, the mean score was 81.7. The mean was 69.3 for those with fear and activity restriction. Fall-related efficacy scores were most highly correlated with ADL-IADL (instrumental activities of daily living) scores at 0.55. This association remained even when scores from the highest cohort of self-efficacy were removed from the data. As the results of this study showed, “While fear of falling and fall-related efficacy responses were associated statistically with each other, fall-related efficacy proved a better determinant of function” (Tinetti, Mendes de Leon, Doucette & Baker, 1994, p. M145).
In 1996, Hill et al. developed the modified FES (MFES). The authors concentrated on improving the reliability and validity of the FES, rather than develop a new tool. The new scale consists of the original ten ADL tasks, plus four additional tasks. These activities include: 1) using public transportation, 2) crossing roads, 3) light gardening or hanging out wash and 4) using front or rear steps of the home.

The tasks were scored using a visual analog scale ranging from zero to ten. Only the halfway point was labeled on the scale as “fairly confident”. The MFES was shown to have internal consistency and test-retest reliability of 0.95 (Hill, Schwarz, Kalogeropoulos & Gibson, 1996).

Significant differences were found in scores between a healthy elderly group and a group of participants who were patients at the Fall and Balance Clinic (Hill et al., 1996). The results support keeping the two easier items found on the FES, as these are ADL’s commonly experienced by all ages and levels of function in the elderly. High inter-class correlation and good validity was also found among items assessed in the MFES.

The authors assert that tasks which are rated as most fear inducing, for both healthy and impaired elderly, tend to be very difficult indoor activities (i.e. reaching into high or low cupboards) or outdoor activities. The study did not examine whether or not this fear was correlated with activity restriction. However, Bandura’s theory of self-
efficacy would lead to the conclusion that the lack of coping mechanisms for these challenges would lead to a restriction of performance.

Activities-specific Balance Confidence Scale

The Activities-specific Balance Confidence Scale (ABC) was developed by Powell and Myers in 1995. These authors felt that the FES left much open for interpretation in scoring. Many of the activities described in the FES can have different meanings to different people. For example, reaching activities can be very easy or very difficult if one is sitting versus if one is standing on a chair. The authors also stated that the FES might not be very sensitive for high functioning elderly due to the seeming simplicity of the tasks evaluated.

The ABC was developed in much the same way as the FES. A group of physical and occupational therapists, and a group of seniors, were asked to list the ten most important activities of independent living. A common trend noted was that the therapists tended to choose activities that involved transfers, bending, reaching and ambulating. The seniors, however, only consistently targeted one transfer related activity, a car transfer. Items such as light housekeeping, walking and meal preparation were identified by more than 50% of those polled. The seniors, over 50% of whom had fallen in the past year, were also asked, “Are you afraid of falling during any normal daily activities, and
which ones?" The most common responses were general ambulation, walking on ice, standing on a chair and climbing stairs.

Powell and Myers then chose 16 activities that included tasks within the home and environmental barriers found outside the home. These activities consisted of: 1) walking around the house, 2) walking up and down stairs, 3) picking up a slipper off the floor, 4) reaching at eye level, 5) reaching on tiptoes, 6) standing on chair to reach, 7) sweeping the floor, 8) walking outside to nearby car, 9) getting in/out of car, 10) walking across parking lot, 11) walking up and down a ramp, 12) walking in crowded mall, 13) walking in crowd while being bumped, 14) riding an escalator holding rail, 15) riding an escalator not holding rail and 16) walking on icy sidewalk. These activities are much more specific than those listed in the FES.

Reliability was determined to be 0.92 for total ABC scores. Internal consistency was very high at 0.96. The scale appears to be responsive to all confidence levels among those tested. Unlike the FES, the ABC did not show a ceiling effect secondary to low sensitivity. Those participants who had fallen in the past year did have somewhat lower scores on the ABC compared with those who had not fallen. However, injury did not seem to effect the scores. Overall comparison of the ABC and the FES reveals that the FES shows a wide range of scores for those demonstrating low mobility (44%-84%). For those in the high mobility category, scores tended to be restricted (90%-98%). In comparison, wide ranges of scores were seen in both the low (5%-84%) and the high (36%-95%) mobility groups with the ABC scale.
As seen in the literature, the Activities-specific Balance Confidence Scale is more reliable and valid than the Falls Efficacy Scale. The two primary concerns of the FES were the seeming ceiling effect noted with high functioning elderly and the lack of specificity of the tasks analyzed. The results of the Powell and Myers study seem to suggest that the ABC does not have either concern limiting its use. The Activities-specific Balance Confidence scale seems appropriate for use with any chosen geriatric population, be they highly active or frail and fearful.

**Intervention Programs for the Community Dwelling Elderly**

There are several different types of balance enhancement tools that have been researched for use in the elderly population to reduce the risk of falls. The techniques that have been applied generally focus on education and physical exercise (strengthening, stretching and endurance). Appropriate exercise prescription for the elderly population has also been widely researched. Exercises designed specifically for balance enhancement include: 1) computerized balance training, 2) aerobic dance, 3) Feldenkrais, 4) surface orientation training and 5) T’ai chi ch’uan.
Several interventions have included education and behavior modification to reduce the risk of falls in the elderly. In a study done by Means et al. (1996), cognitive intervention sessions were used in conjunction with exercise. These sessions included: 1) evaluation of home safety hazards, 2) general safety awareness, 3) the contribution of various health factors to falls, 4) proper body mechanics and 5) the importance of regular exercise. Even though the mean number of falls decreased, there was no statistically significant reduction at follow-up. Two of the sites from the FICSIT trials used some type of education or behavior modification. Similarly, there were no significant reductions in the number of falls for either group (Province et al., 1995). Another study used fall prevention educational videos for its control group and balance results were compared with those of the exercise group. As expected, the control group did not have any increases in strength or balance. However, a follow-up was not performed to determine any long-term effects on fall risk (Judge et al., 1994).

Tinetti et al. (1994) utilized a more individualized approach. For each subject, a nurse and physical therapist evaluated various targeted risk factors and appropriate interventions were applied. One of those factors was the threat of environmental hazards. After the subject’s home was assessed, environmental hazards were removed. A physical therapist prescribed exercises based on the limitations of that individual. Although
balance was not directly assessed, the results of this study did produce a reduction in the proportion of subjects who fell and in the incidence of falls.

General Exercise Programs for the Elderly

General exercise programs for balance improvement within the literature reveal components of strength, flexibility and endurance (Judge et al., 1994; Lord & Castell, 1994; Lord et al., 1995; Means et al., 1996; Province et al., 1995; Tinetti et al., 1994; Simmons & Hansen, 1996). Muscle weakness has been shown to be a normal response to aging, which can impede normal balance responses (Fiatarone et al., 1993; Guccione p. 240). Not surprisingly, several interventions have focused on strengthening exercises.

A commonly used method of increasing strength has been progressive resistance training. Used at high-intensities, it has been shown to produce significant gains in muscle strength, even in those 85 years and older (Fiatarone et al., 1990). Nonetheless, strengthening exercises alone have not proven effective in improving the balance of elderly persons, even when used in conjunction with balance training (Judge, Whipple & Wolfson, 1994; Topp et al., 1993; Wolfson et al., 1996).

Strengthening exercises that have been examined are as varied as the types of resistance that have been applied. Mechanical resistance machines for the knee extensors and ankle dorsiflexors have been shown to increase isokinetic strength, but failed to significantly improve balance in the elderly. In this three-month study, sandbags and the
individual's own body weight were also used as resistance. The exercises performed with
the sandbags were for hip abductors and extensors, knee flexors and ankle plantar flexors.
An increase in overall leg strength was produced, but balance measures of timed chair
rise and gait velocity were insignificant (Judge et al., 1994).

Another study used surgical tubing for strengthening the upper and lower body.
Although gait velocity, single limb stance and tandem walk times were positively
affected in this study, the results were not significant (Topp et al., 1993). In the FICSIT
trials, eight different research sites within the United States participated in an attempt at
sufficiently improving balance to decrease fall risk within the elderly. Five of these
locations used resistance exercises, along with various other interventions such as balance
training or education. Of the sites that used resistance training, all failed to result in
significant balance improvement (Province et al., 1995).

A connection between the elderly individual’s perceived balance and/or fear of
falling and improvements in strength have not been clearly investigated. The FICSIT
trial did examine fear of falling before and after intervention. Results associating
improved strength and fear of falling were inconclusive (Wolf et al., 1996). Perceived
balance has not been directly compared to strength improvements.

Loss of flexibility in the elderly can inhibit a normal balance response. As a
result, stretching has been a component of some exercise interventions (Guccione, 1993,
though flexibility is an important balance component, none of the interventions focused
on improving flexibility in isolation. Means et al. (1996) applied stretches to subject's hamstring, gluteus maximus, hip flexors, gastroc-soleus complex and the erector spinae, in conjunction with several other interventions, over a period of six weeks. The subjects did achieve clinically important increases in flexibility. However, the results of the study did not show significant improvements in balance as determined by a timed obstacle course. Flexibility was a component in several other studies that also failed to show balance improvement (Lord & Castell, 1994; Lord et al., 1995; Province et al., 1995). The relationship of increased flexibility and self-efficacy has not been investigated.

Aging also produces postural changes, which can impede normal balance responses (Brown et al. 1995). A study by Simmons and Hansen (1996) compared the effects of postural exercises performed on land and in water. The authors suggested that the elderly would feel safer in the aquatic environment and thus would be more comfortable performing the exercises. Both land and water groups experienced significant improvements in balance. Greater increases were seen in the water group which could suggest "... that water exercise enhanced [the] elderly subjects postural control..." (p. M236). Speculations were made that the water medium decreased the subject's fear of falling, but no objective measurements of perception were taken. In contrast, two other studies utilized postural exercises on land. However, balance was not significantly improved when measured by functional reach (Lord et al., 1995; Means et al., 1996).
Regular aerobic exercise has been shown to improve vital capacity, minute ventilation and maximum oxygen consumption (Barry & Eathorne, 1994; Guccione, 1993, p. 204). Walking is a common form of exercise in the elderly population. Lord and Castell (1994) used a walking program over a 10-week period as the main intervention to improve balance. Other activities used in conjunction with walking included strength, flexibility and relaxation. Even though the subjects did show improvements in strength and balance, results were not significant. However, Simmons and Hansen (1996) used walking in water, with other aquatic exercises, and produced an increase in the balance responses of its subjects. Neither of these studies correlated perceived balance and actual balance improvements with increased endurance. Further investigations into the role of endurance in self-efficacy need to be made.

Exercise Prescription and the Elderly

The American College of Sports Medicine (ACSM) has formulated recommendations on frequency, duration and intensity for exercise programs (1991). In order to produce a training response, an exercise program should be followed at least three times per week. The frequency of training programs in the elderly has varied. Some studies used three times per week (Judge et al., 1994; Means 1996; Mills 1994) while others exercised only once or twice a week (Lord & Castell, 1994; Lord et al., 1995).
Intensity and duration of interventions are inversely related to each other. Specifically, lower intensity exercise needs to be longer in duration in order to produce a significant training response. The ACSM (1991) recommends that the duration of aerobic exercise should be 20 to 60 minutes. The duration of the treatment interventions used in research has varied from 15 minutes (Wolf et al., 1996) to 60 minutes (Lord & Castell, 1994; Lord et al., 1995; Means et al., 1996) with 45 minutes used most frequently (Judge et al., 1996; Simmons & Hansen, 1996; Wolfson et al., 1996).

Balance Specific Exercise Programs for the Elderly

Several therapeutic interventions have been designed to specifically challenge balance. Many of these balance specific activities are commonly used in physical therapy. The effects on balance have not been fully documented. Furthermore, the mechanisms by which most of these techniques improve balance are speculative. Computerized balance training, aerobic dance, Feldenkrais, surface orientation and T’ai chi all show promise in elderly balance training for the future.

The most recent technological advancement in assessing and training balance is the computerized balance system. To assess an individual’s balance, the subject stands on computerized force plates, which contain transducers that sense movement. Any position change is then sent to a computer and a subject’s balance is objectively assessed. Even though it usually serves as an assessment tool, the system can also be utilized for balance
training. Balance is challenged when the subjects are asked to replicate a cursor position on a monitor by moving their center of mass without foot displacement. Increasing body sway then progressively challenges the individual's limits of postural stability. One benefit of this system is that halters or safety rails can be used for the very unstable.

The computerized balance systems have been utilized as an intervention only on rare occasions, which may be due to the cost of such a system. In the FICSIT trials, computerized balance training was one intervention utilized to improve dynamic balance in an attempt to decrease fall risk. However, the subjects in this group did not achieve any significant balance improvement. The study collected data on each subject's fear of falling, yet comparisons with any achieved gains were not made (Wolf et al., 1996). Another study, which used this type of training combined with resistance exercise, also failed to produce a positive change in balance (Judge et al., 1994). Even though computerized balance training is a highly advanced system, it has yet to be documented as successful in actually improving balance in the elderly. It is also unknown what the training effects are on the self-efficacy of elderly subjects.

Another area of balance training for the elderly that has been examined is aerobic dance. In a study by Hopkins et al. (1990), community-dwelling women aged 57-77 volunteered to participate in a low-impact aerobic dance class. The 50-minute sessions were held three times a week for 12 weeks. Balance was assessed using timed single limb stance. The post-test results revealed significant differences between the exercise group and the control group. Strength, cardiorespiratory endurance, flexibility, agility
and body fat were all positively affected by this intervention. Significant balance improvements were also noted for the exercise group. Aerobic dance, therefore, has the potential to increase the elderly individual’s balance. Further research is needed to determine how these balance changes achieved through dance correspond to the self-efficacy of the elderly person.

Various other methods of balance training are utilized in physical therapy practice. However, little or no research has been done on their individualized effects on actual and perceived balance. One of these methods is known as Feldenkrais, which practices "awareness through movement" (Feldenkrais, p. 19). It utilizes the ideas of Mosche Feldenkrais, an Israeli physician, who proposed that the body’s "adaptive potential" or balance responses can be relearned by repeating various intentional movements (p. 19). These smaller motions give the individual more movement options to choose from. In other words, the individual learns or relearns movements that improve balance responses by allowing more options for the body to react to disturbances.

Although many of its concepts are used in physical therapy practice, limited research has been performed on the effectiveness of Feldenkrais on self-efficacy and balance performance. Gutman et al. (1977) compared Feldenkrais with conventional exercises for an elderly population. There were no significant differences between the exercise group and the Feldenkrais group. However, the balance assessment tool used had no proven validity or reliability. No steps were taken to measure the subject’s perceived balance during this study. Further research is needed in both of these areas.
One difficulty with using Feldenkrais as an intervention method is that practitioners must be formally trained in its principles in order to practice the methods correctly. (Brown, Finney, & Sarantakis, 1996).

Surface orientation training varies the types of surfaces upon which the individual must remain upright. Surfaces such as foam rollers, mats and therapeutic balls challenge the individual by means of ambiguous somatosensory cues. Balancing on these surfaces requires quick responses and appropriately timed co-contractions in order to maintain postural control. The individual effects of these methods on actual and perceived balance have not been studied. Even though they are commonly used in the clinic to improve balance, further research needs to be done to determine if their effects are reliable and valid (Judge et al., 1994; Wolfson et al., 1996).

A more promising balance specific training is T’ai chi ch’uan, or T’ai chi. A “slow motion, dance-like, Chinese martial art”, T’ai chi is believed to improve balance (Wanning, 1993, p. 349). The philosophy of this ancient exercise is holistic. Its focus is on body, mind and spirit. Master Alfred Huang contends that not all exercise provides beneficial movement. Consequently, movement potential is rarely developed to its fullest. T’ai chi provides education in motion that emphasizes effectiveness, efficiency and endurance. Movements are performed with minimal effort, but achieve maximum results. The activities are performed slowly, gently and gracefully with awareness of body alignment, functional movement and coordination of movement with breathing (Huang, 1993).
T'ai chi is also posture based. Practitioners of this martial art must "attune the
body" by learning to balance and stand in proper alignment. Huang believes that in order
to balance properly, one must "... learn to stand in different positions while attaining and
maintaining equilibrium in various postures" (Huang, 1993, p. 19). If one can
successfully perform these motions, then it is believed that one's confidence in all
movement will improve.

Forsythe (1996) similarly states: "T'ai chi gives people confidence that they can
move in ways they might have been afraid to try without this training. By so doing, T'ai
chi builds the confidence that leads to more independent and thus more fulfilling lives"
(p. 35). In other words, as an elderly person becomes more adept in performing T'ai chi,
he or she feels confident in the ability to move. As confidence increases, fear of falling
diminishes. Activity is promoted and the effects of immobility decrease as fear of falling
lessens.

Upon examination of the basic movements of T'ai chi, one can identify benefits
for the elderly population. A therapeutic benefit is progressive movement from small to
large ranges of motion. The progression is excellent for the elderly whose movement can
be slow and limited in range of motion. Improved posture is another benefit of T'ai chi.
Movements of head, neck and trunk extension are incorporated which can begin to
minimize the progression into the flexed posture commonly encountered in the elderly
population. Finally, T'ai chi enhances balance responses in the elderly. Diagonal,
asymmetrical motions of the arms and legs combined with unilateral weight shifting further challenges the balance responses of the elderly individual (Forsythe 1996).

There are several different styles of T’ai chi. They are all derivatives of the oldest form which was developed over hundreds of years ago in ancient China (Robinson 1996). The newer styles all use thirteen original positions. The older forms of T’ai chi had some difficult motions that would be considered inappropriate for the elderly. The more recent styles do not, however, utilize motions such as jumping, leaping or bouncing and are more conducive for the older adult.

T’ai chi is a relatively novel concept to the Western population even though it has been used in Eastern cultures for centuries. It is also new to the area of rehabilitation. Little research has been done on its effectiveness for improving actual or perceived balance in any population. In the Atlanta FICSIT trial, T’ai chi was used as an intervention. It was compared with computerized balance training and education. The T’ai chi movements chosen in this study were intended to impact the elderly individual’s decreased base of support, decreased body and trunk rotation and reciprocal arm movements.

The T’ai chi group met twice a week for 15 weeks. At the end of the study, those subjects that were in the T’ai chi group experienced an improvement in their perceived balance and a decrease in their rate of falls (Wolf et al., 1996). Since the study indirectly assessed balance through rate of falls, a more direct assessment of T’ai chi’s effects on balance is warranted. After the FICSIT trail, a related study examined the same group
and used T'ai chi as a maintenance program. Although there was some decline noted in the balance improvements gained from the FICSIT trial, these results continued to show improvements as compared to baseline. Even at low frequency, T'ai chi shows promise for preservation of balance (Wolfson, 1996).

The long-term benefits of practicing T'ai chi have also been examined. A study by Tse and Bailey (1992) compared the balance of long term practitioners of T'ai chi (1 to 20 years) with subjects who had never attempted the exercise. Those subjects experienced in T'ai chi scored higher on the balance tests of timed single limb stance and tandem walking. The authors concluded that those who performed T'ai chi on a regular basis had better postural control and thus better balance. However, it is difficult to generalize the results of this study to the elderly population at large as sample size was small (n = 18).

A recent study attempted to support the efficacy of T'ai chi as a balance training tool (Wolf, Barnhart, Ellison, Coogler & the Atlanta FICSIT group, 1997). The authors chose to examine postural sway via a force platform during quiet stance as a measure of postural stability. The results failed to show significant improvements in balance as measured by postural sway. However, T'ai chi is a dynamic activity requiring participants to maintain brief periods of one-legged stance while moving the other extremities. Therefore, resultant improvements in balance from T'ai chi may not be reflected by a static measure of balance while supported by both lower extremities.
Further investigations need to focus on the effects of T’ai chi on actual and perceived balance performance.
CHAPTER 3

METHODOLOGY

Design

The design of this study was a Nonequivalent Pretest-Posttest Control Group in which two groups were compared before and after an intervention. Subjects for the T'ai chi group were recruited through local retirement/senior living centers in the greater Grand Rapids area by mailings and local advertising. The intervention group participated in a T'ai chi exercise program two times a week for six weeks. The second group of subjects was recruited through an ongoing “Sit and be Fit” class at a local health club. This population was chosen as a sample of convenience secondary to difficulty with subject recruitment. The members of this group maintained their participation in the “Sit and be Fit” exercise program for two to three times per week for six weeks.

The T'ai chi group participated in a six week T'ai chi exercise program consisting of: 1) a five to ten minute general warm-up, 2) 20-30 minutes of beginning to intermediate level T'ai chi movements and 3) a five to ten minute cool down. The exercise program was led by a certified aerobics instructor trained in T'ai chi movements. Members of the “Sit and be Fit” group maintained participation in their exercise program
two to three times per week for this duration. The “Sit And Be Fit” exercise program consisted of: 1) five to ten minute seated warm-up, 2) 30 minutes of upper and lower extremity range of motion, strengthening using resistance of elastic bands or free weights while seated, combined with occasional standing activities, 3) ten minutes of “fun-filled” activities and 4) five to ten minutes seated cool down. A certified aerobics instructor led this class.

Sample

The sample was chosen from community-dwelling, ambulatory elderly over 60 years of age. For the purposes of this study, ambulatory was defined as the ability to ambulate in the community with or without use of an assistive device. Exclusion criteria included: 1) orthopedic or neurological injury/surgery within the last year as reported on the subjective health questionnaire (Appendix C), 2) a score of less than 24/30 on the Folstein Mini Mental State Examination (MMSE) (Appendix E), 3) gross limitations in upper or lower extremity range of motion as determined through a functional screen and 4) a Functional Reach less than seven inches.
Instrumentation

The one-legged stance time and the Tinetti Balance Subscale were used to objectify the balance ability of each participant. The Activities-specific Balance Confidence scale was also utilized to assess perceived balance ability.

The timed one-legged stance test was chosen because it has a high correlation with fear of falling and proven validity as a test of actual balance ability (Topp et al., 1993; Maki et al., 1991). In this test, subjects are asked to stand on their favored leg with the opposite foot at mid-calf level. Subjects are timed for up to 30 seconds. The test was performed with eyes open. A sequence of three repeated measures was utilized to generate an average one-legged stance time.

There are two primary reasons why the authors chose to use the Tinetti Balance Subscale as a measure of balance ability. The Tinetti Balance Subscale has been correlated with fear of falling and is a good predictor of falls (Baloh et al., 1994; Maki, Holliday & Topper, 1991). Secondly, the Tinetti POMA, which could determine a more accurate measure of actual balance ability, is time consuming and may provoke fearful symptomatology in subjects.

The Tinetti Balance Subscale evaluates eight activities and grades them on a scale from 0-2. These activities include: 1) sitting down on a chair, 2) getting up from a chair, 3) sitting balance, 4) immediate standing, 5) standing with feet together for 10 seconds, 6) sternal nudge, 7) standing eyes closed for 10 seconds and 8) a 360 degree turn (Harada et
al., 1995). Scores are given based upon ability to perform each task as normal (2), adaptive (1), or abnormal (0). The total score ranges from 0 to 16. The test takes approximately 5 minutes to administer.

Finally, the Activities-specific Balance Confidence scale (ABC) was utilized because of established validity and reliability (Powell and Myers, 1995). Due to the apparent lack of ceiling effect demonstrated by high functioning elderly, the ABC was highly applicable to this study. The test is self-administered and can be taken in approximately 10 minutes (Appendix H). Subjects are questioned on a wide spectrum of daily activities that include tasks performed within the home and environmental barriers found outside the home. These activities consist of: 1) walking around the house, 2) up and down stairs, 3) picking a slipper up off the floor, 4) reaching at eye level, 5) reaching on tip toes, 6) standing on a chair and reach, 7) sweeping the floor, 8) walking outside to nearby car, 9) getting in an out of car, 10) walking across parking lot, 11) walking up and down a ramp, 12) walking in a crowded mall, 13) walking in a crowd while being bumped, 14) riding an escalator holding a rail, 15) riding an escalator not holding a rail and 16) walking on an icy sidewalk. Subjects were asked to rate their confidence in performing each task on a visual analog scale from zero to 100%.
Procedure

Pretest

After volunteering to participate in the study, individuals were asked to sign an informed consent form (Appendix A) in which they acknowledged that absence from three or more classes would result in termination from the study. Participants were then required to fill out a subjective health questionnaire. Subjects were informed that all information provided would be kept coded and confidential.

In order to screen for cognitive impairments, the Folstein Mini Mental State Examination was administered by a student physical therapist. No subjects scored below 24/30 which would have resulted in exclusion from the study. This criteria was established for safety reasons and possible biasing of ABC scores. All subjects in the T'ai chi group obtained a written physician approval before participating in the study. Physicians were given the option to allow subjects to participate with or without monitoring of vital signs (Appendix D). The "Sit and be Fit" participants reported physician knowledge of their participation in an exercise program.

Next, all individuals were assessed through a physical screen administered by a student physical therapist. The screen (Appendix F) included a gross assessment of active range of motion of the upper and lower extremities. Subjects were asked to perform shoulder flexion, abduction, extension, external and internal rotation, as well as,
elbow flexion and extension. At this time, a gait belt was placed on subjects to guard against falls. Lower extremity range of motion was then assessed through a series of three standing partial squats. Goniometric measurements were taken at the lateral aspect of the left knee to insure knee flexion of greater than or equal to 135 degrees. Subjects were provided the opportunity to use a chair for balance if needed. No subjects demonstrated gross limitations in upper or lower extremity range of motion which would limit their ability to perform the T'ai chi movements.

Next, the participants were asked to perform three trials of the Functional Reach as described by Duncan et al. (1990). The Functional Reach was also administered by a student physical therapist and recorded (Appendix F). Failure to achieve an average functional reach of seven inches resulted in exclusion of the subject. Two subjects were excluded from the study based upon this criterion.

Subjects then performed three trials of the one-legged stance test administered by student physical therapist and recorded (Appendix F). The Tinetti Balance Subscale (Appendix G), followed by the ABC scale (Appendix H), was administered by a student physical therapist and recorded. Timed one-legged stance, the Tinetti Balance Subscale and ABC scale were performed in this order. Pre-intervention balance status was then recorded on the Pre-Test Data Collection Sheet (Appendix I).
Exercise Intervention

**T’ai Chi Group**

T’ai chi was selected as the exercise intervention program based on information gained through the Atlanta FICSIT trial research (Wolf et al., 1996). Ten basic T’ai chi movements were chosen that would safely challenge the balance of the participants. T’ai chi movements that involved one-legged standing for greater than 5 seconds were not utilized. Exercises focused on alignment, flexibility and stability while incorporating trunk rotation and upper extremity motions in a slow controlled manner. The lower extremities provided a stable base of support with varied stances. Some of these lower extremity postures are similar to mini-squats and lunges. The T’ai chi names for these movements are: 1) open the door, 2) part the wild horse’s mane, 3) crane spreads wings, 4) brush knee and push, 5) play the pipa, 6) repulse the monkey, 7) grasp the bird’s tail, 8) willows in the breeze/double weight shift, 9) wave hands like clouds/double weight shift, 10) single whip and 11) close the door. (Exercise progression outlined in Appendix J).

Each session began with a seated warm up focusing on major muscle groups, body awareness and postural alignment. Upper extremity T’ai chi movements were performed in sitting. T’ai chi movements were then performed in standing. Progression of T’ai chi began with learning one or two movements a class. These initial movements were built upon as subjects attained greater skill until the final progression was achieved.
Subjects performed these exercises as tolerated and were allowed to use a chair for rest or support at any time during the class. Sessions ended with a cool down performed in sitting or standing. This cool down was similar to the warm up and included relaxation techniques.

In an effort to continually challenge their balance, participants were encouraged to perform greater degrees of movement through their available range of motion as individual abilities improved. However, subjects were not individually coached for perfection of exercise technique. Authors were present at each exercise class. A video taped record of the first, middle and last classes were obtained.

“Sit and Be Fit” Group

Participants in the “Sit and Be Fit” class were required to continue their attendance two to three times weekly during the six week intervention. Attendees were required to sign in at the beginning of each meeting. The authors had no control over what exercises were performed during this class and were not involved during any session. As this class has been ongoing for a year or more, it was assumed that participants had voluntarily engaged in this exercise for some time prior to this study. A video taped record was obtained during the first week of intervention for documentation of exercise type, duration and progression. It was understood that the exercises did not vary from this format.
Within one week of the six-week intervention, posttest measurements of timed one-legged stance, Tinetti Balance Subscale and ABC scale were obtained for both the T'ai chi and “Sit and Be Fit” groups. Tests were administered in the same order as pretest protocol. Scores were recorded on the Posttest Data Collection Sheet (Appendix J). Subjects in the T'ai chi group were asked the following subjective questions: 1) “Have you noticed any physical changes in yourself since participating in the exercise class?” 2) “How do you think we did with the class?” 3) “Do you have any suggestions for improving the class?” These questions were posed with the intent of gaining subjective information on an individual basis that may not have been revealed through objective tests. The authors also wanted to supplement ideas for future research based on participant experiences during the intervention.
CHAPTER 4
DATA ANALYSIS

Characteristics of Subjects

Subject’s ages ranged from 62 to 87 with a mean age of 75 overall. There were 19 females and two males that volunteered for the study. The “Sit & Be Fit” group was comprised of six women, whereas the T’ai chi group had two males and 13 females (see Table 1). Of these, two females were dropped from the "Sit & Be fit" group. One subject was excluded for failing to attend class and the other for prolonged hospitalization. One male and two females were dropped from the T’ai chi group for missing greater than three classes for various reasons. Two females were also dropped from this group for prolonged illness.

Prior to the intervention, subjects were primarily recruited from local retirement communities. In addition, subjects were recruited at a local Senior Group and contacted via a mailing. In total, approximately 100 senior citizens were contacted.

At the onset of the study, participants signed an informed consent form stating that they would be excluded from the study should they miss three or more classes. However, shortly after beginning the T’ai Chi intervention it was determined that this criteria should be changed to allow subjects to miss three classes. The authors
based this decision on the small sample size and the tendency for participants to miss
class due to illness, inclement weather or doctor’s appointments.

Table 1. Demographics of subjects

<table>
<thead>
<tr>
<th>Group Characteristics</th>
<th>T'ai Chi</th>
<th>Sit &amp; Be Fit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>2 men, 13 women</td>
<td>6 women</td>
</tr>
<tr>
<td>Mean age (range)</td>
<td>70.3 (63-87)</td>
<td>72.7 (62-82)</td>
</tr>
<tr>
<td>Subjects dropped</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Prior Exercise level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not active</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Low level</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>High level</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Assistive devices</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rolling walker</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Cane</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>None</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Relevant Health Info.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arthritis</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Prior Stroke (&gt; 1 yr. Ago)</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Macular degeneration</td>
<td>2 (1 legally blind)</td>
<td>0</td>
</tr>
<tr>
<td>Chronic Bronchitis</td>
<td>1 (continuous O₂ 2-4L/min)</td>
<td>0</td>
</tr>
<tr>
<td>Vertigo</td>
<td>1 (recent Hx of falls)</td>
<td>1</td>
</tr>
</tbody>
</table>
Statistical Analysis

Pretest (Table 2) and posttest (Table 3) data were collected in an attempt to show that T'ai chi would result in significant improvements in actual and perceived balance performance. Data were obtained from one-legged stance time, the Tinetti Balance Subscale and the Activities-specific Balance Confidence scale.

Due to the small sample size (n=14), data were analyzed using non-parametric statistical tests. The Kruskal-Wallis test (Chi Square) was used to determine statistical differences between the T'ai chi (n = 10) and “Sit and Be Fit” (n = 4) groups at pretest and posttest for each of the above measures. The Wilcoxon signed-ranks test was utilized to test the hypothesis that the T'ai chi group would demonstrate an increase in actual and perceived balance performance.

Table 2. Mean scores at Pretest

<table>
<thead>
<tr>
<th></th>
<th>T'ai chi Group (n = 10)</th>
<th>“Sit &amp; Be Fit” Group (n = 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>One-legged Stance</strong></td>
<td>9.43 sec ± 19.32</td>
<td>11.17 sec ± 6.21 *</td>
</tr>
<tr>
<td>(time in seconds)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tinetti Balance</strong></td>
<td>14.1 ± 1.52</td>
<td>15.75 ± 0.50 *</td>
</tr>
<tr>
<td>Subscale (0 - 16 points)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ABC Scale</strong></td>
<td>76.73 ± 17.55</td>
<td>83.05 ± 10.32</td>
</tr>
<tr>
<td>(%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* denotes significance at p ≤ 0.05
At pretest, the Kruskal-Wallis test revealed a significant difference between TC and SF on one-legged stance time with a Chi Square ($x^2$) of 3.69 ($p = 0.05$). Similarly, a significant difference was revealed among Tinetti Balance Subscale scores with $x^2 = 5.19$ ($p = 0.02$). No significant difference was revealed among ABC scores with a value of $x^2 = 0.00$ ($p = 1.00$).

Table 3. Mean scores at Posttest

<table>
<thead>
<tr>
<th></th>
<th>Tai Chi Group (n=14)</th>
<th>“Sit &amp; Be Fit” Group (n=4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>One-legged Stance</strong></td>
<td>10.37 ± 17.30</td>
<td>15.75 ± 17.31</td>
</tr>
<tr>
<td>(time in seconds)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tinetti Balance</strong></td>
<td>13.70 ± 1.83</td>
<td>15.75 ± 0.50</td>
</tr>
<tr>
<td>Subscale (16 points)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ABC Scale</strong></td>
<td>79.30 ± 15.85</td>
<td>88.37 ± 6.16</td>
</tr>
<tr>
<td>(%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Posttest analysis, using the Chi Square test, revealed no significant differences between TC and SF for all three measures. All posttest data were adjusted for the pre-measurement differences between TC and SF.

Overall, analysis of the alternative hypothesis using the Wilcoxon signed-ranks test ($T$) revealed no significant differences between pretest and posttest scores for either TC or SF groups. One-legged stance for TC was $T = 11.50$ ($p = 0.27$) and SF $T = -1.00$ ($p = 0.88$). Tinetti Balance Subscale for TC was $T = -6.50$ ($p = 0.56$) and SF $T = 0.00$.
ABC for TC was $T = 7.50$ ($p = 0.49$) and SF $T = 4.00$ (0.25). In summary, data provided insufficient evidence to support the research hypotheses that posttest measurement differences existed between the TC and SF groups.

However, examination of individual ABC scores revealed that six subjects in the T’ai chi group showed improvements in overall ABC scores. In comparison, the “Sit & Be Fit” group showed no change in overall ABC scores during the six-week intervention. In addition, many participants of the T’ai chi group showed improvements in confidence in some of the tasks noted on the ABC scale (Table 4).

Table 4. ABC score task improvements among T’ai chi group

<table>
<thead>
<tr>
<th>Task improved</th>
<th>Subjects improved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walk up and down stairs</td>
<td>3</td>
</tr>
<tr>
<td>Stand on chair to reach</td>
<td>6</td>
</tr>
<tr>
<td>Reach on tiptoes</td>
<td>6</td>
</tr>
<tr>
<td>Walk outside to nearby car</td>
<td>3</td>
</tr>
<tr>
<td>Walk up and down a ramp</td>
<td>3</td>
</tr>
<tr>
<td>Walk in a crowded mall</td>
<td>3</td>
</tr>
<tr>
<td>Ride an escalator not holding rail</td>
<td>6</td>
</tr>
<tr>
<td>Walk on an icy sidewalk</td>
<td>9</td>
</tr>
</tbody>
</table>
CHAPTER 5

DISCUSSION

Summary of Results

Although statistical measures failed to show an improvement in actual or perceived balance after the T’ai chi intervention, a general improvement trend was noted throughout participants’ scores. Many subjects had marked improvements in either one-legged stance time or overall scores on the ABC. Seven subjects showed an improvement in one-legged stance time. Many subjects at pretest were completely unable, or unwilling, to perform the one-legged stance test. After the T’ai chi intervention, several of these subjects were not only more willing to try the one-legged stance test, but had improved times. Participants of the “Sit & Be Fit” group also showed improvements in one-legged stance time. The authors feel that this is a reflection of practice of one-legged stance in the class, as well as, a higher activity level of participants prior to the study.

Ceiling effect, the inability to show improvements due to a high initial measurement, limits the sensitivity of a measurement tool. As the majority of participants had high ABC scores at pre-test, the authors feel that there was a ceiling effect caused by the simplicity of some of these tasks. Participants with a score of less
than 90% at pretest generally showed improvement after the T'ai chi intervention on the following four tasks: 1) standing on a chair to reach, 2) reaching on tiptoes, 3) riding an escalator not holding rail and 4) walking on an icy sidewalk. Subjects also showed improvements in several other tasks (Table 4). As a rule, subjects in the “Sit & Be Fit” class showed no change in ABC scores as previously mentioned.

Discussion of Findings

The authors feel that there were many individual improvements among the T’ai chi group compared to the “Sit & be Fit” group. Although statistical analysis failed to show significant changes in one-legged stance time, Tinetti Balance Subscale score and Activities-specific Balance Scale score, many individual participants in the T’ai chi group did show improvements on some or all of these measures. In contrast, statistical analysis showed no change in the “Sit & Be Fit” group scores because individual scores remained relatively constant among these subjects. Therefore, it is the authors’ contention that the measures used to score individuals’ actual and perceived balance may not have been appropriate for this sample of high-functioning, community-dwelling elderly.

Due to the lack of ceiling effect, one-legged stance time was the most appropriate measure of balance performance used in this study. Although the two groups had significant differences in stance times at the onset of the study, both groups showed increased mean stance time over the course of the six-week intervention. There are two
explanations for the improvement seen in the “Sit & Be Fit” group. The first reason was that one individual increased stance time by over 30 seconds. With such a small sample size (n=4), a large increase in stance time was more apparent in the statistical results. The second explanation was that the “Sit & Be Fit” group practiced one-legged stance during the class, which was beyond the control of the authors. Previous research has shown that practice of one-legged stance will result in improved one-legged stance time (Fansler, Pott, & Shepard, 1985). However, the task is not functional, as it is not used in isolation in activities of daily living. One-legged stance has been shown to be a good measure of balance ability (Rossiter-Fornoff et al., 1995). However, it is not an appropriate training method for improving balance during functional activities.

The Tinetti Balance Subscale was an inappropriate measure for this sample because of the ceiling effect among high-functioning subjects. Both groups scored high (mean = 14.57) on the scale at pretest leaving little room for improvement (i.e. ceiling effect). Although this test measures dynamic, functional abilities, many of the tasks are very simple. Interestingly, some participants showed a decrease in Tinetti scores from pretest to posttest. One reason for this difference was lack of administrator experience with this tool. As testing progressed, the student physical therapist gained experience in administration and became more critical of subject performance. In so doing, differences in performance of the same task amongst different subjects became apparent. Therefore, what was initially rated as “normal” (2) for one subject may have been rated as “adaptive” (1) for a later subject. In addition, four participants of the T'ai chi group
reported declining health status during the course of the six-week intervention. Three of these four subjects demonstrated decreased posttest Tinetti scores.

Statistical results from the Activities-specific Balance Subscale were variable. Both groups showed a change in pretest compared to posttest scores. However, these changes were not significant. The overall mean (mean = 78.53) for both groups was high at pretest, leaving only small room for improvement in posttest scores. The ceiling effect produced by the high functioning subjects made it necessary for the authors to look further into each specific task of the ABC scale. At posttest, several individuals showed marked improvements in tasks on which they scored low at pretest (Table 4).

Lack of administration experience also effected results. At pretest, the student physical therapist provided the subjects with limited cues on how to rate themselves. As testing progressed, it became apparent that many subjects did not fully understand that they were to rate their confidence in performing each task, as opposed to their ability to perform the task. At that time, the student physical therapist provided clarification through verbal cues such as, "Rate yourself on how confident you feel performing each task, not whether you actually do each task." Therefore, pretest scores may not have been an accurate measure of baseline confidence.

The authors felt that the “Sit & Be Fit” group demonstrated a different motivation for participating in this research study as compared to the T’ai chi group. The “Sit & Be Fit” group members consistently voiced concern regarding their performance on the tests. In contrast, the majority of T’ai chi group members were interested in learning and
perfecting the T’ai chi exercises. They were not as interested in improving their test performance. As the ABC scale is subjective in nature, desire to show improvement over a given time period could significantly impact results.

In addition, there was a discrepancy in group sizes. During subject recruitment, only 21 people out of 100 volunteered to participate in the study. Due to a small number of volunteers, the authors were unable to randomize subjects into a control group without substantial loss of participants. Subjects volunteered for the study based on the understanding that they would be able to participate in a free exercise class. As a result, the “Sit & Be Fit” exercise class was recruited as a nonequivalent sample of convenience.

The overall small sample size (n = 14) also significantly impacted the results. A larger sample population may have reflected changes in subjects’ balance performance more accurately. A greater sample size would also have provided the authors with the opportunity to randomize subjects into equivalent control and experimental groups. The resultant true experimental design of the study would have allowed the authors to compare the T’ai chi intervention to an actual control group. By comparing subjects not previously participating in a structured exercise program (T’ai chi group) to subjects already voluntarily participating in an exercise program (“Sit & Be Fit” group), improvements as a result of T’ai chi were masked by concurrent gains seen in the “Sit & Be Fit” group.
The authors encountered several obstacles during subject recruitment. Many of the potential subjects were unwilling to participate in the study unless they could be in the exercise group. Therefore, the authors were unable to randomize subjects into equivalent control and experimental groups without a significant decrease in sample size. The non-equivalency of the two groups limited the ability to show statistical significance because of the intrinsic differences between each group. The members of the “Sit & Be Fit” group were already participating in a structured exercise program prior to the onset of this study. These subjects were more active than those recruited for the T’ai chi group as reflected in their overall higher scores.

There are several characteristics unique to the community-dwelling elderly that provided a challenge to the authors during subject recruitment. Prior research has determined transportation problems exist for the elderly population that can inhibit participation in research (Pacala et al., 1996). Evidence of this was apparent in the current study. Many potential subjects were unwilling to participate unless the exercise class was held at their living center or near their home. Also, the rate of absence during inclement weather was significantly increased for those subjects required to travel to the exercise site.

Another characteristic unique to geriatric research is the prevalence of chronic disease and hospitalization among the elderly population (Guccione, p. 12). The aging
Individual has a lower functional reserve and may be more prone to sickness than his or her younger counterpart (Guccione, p. 428). Three subjects were dropped due to prolonged illness and hospitalization during this study. In addition, four subjects missed class(es) due to temporary illness or a doctor’s appointment.

In addition, the study had several procedural limitations. First, the student’s inexperience with the testing tools was a significant limitation of the study as previously mentioned. Unfamiliarity with testing tools was reflected by the inconsistency of grading and participant cueing. Second, testing was not performed by an unbiased individual. Third, the authors were not blinded to subject participation in either intervention group. Although attempts were made to blind the authors from subjects’ pretest scores, the authors were aware of subjects’ performance during the intervention period possibly resulting in biased posttest scores.

A final procedural weakness was the repeated use of a subjective questionnaire. Participant’s perception of improvements at posttest may have affected the scores of the ABC. At pretest, the subjects were not aware of what was being tested. By posttest, participants had generated individual ideas of what was expected to improve through participation in the study. As a result, subjects may have rated themselves higher at posttest.

Another limitation of the study was that the exercise program was self-paced and non-individualized. Therefore, subjects were allowed to sit down at any time during the class or use a chair for support. The subjects did not receive any individual cueing from
the instructor or authors during the course of the class. Therefore, participants may have been doing the exercises incorrectly and not receiving their maximum benefits. Several participants also mentioned during post-intervention questioning that they had difficulty seeing and/or hearing the instructor during the class.

Possibly the most significant limitation was the short duration of the intervention period. The study took place over a period of six weeks. The majority of class time was utilized to teach the subjects the basic T'ai chi movements. As a result, subjects did not have the opportunity to develop a training response from the intervention. Other research shows that a 15 week intervention may be necessary to show changes resulting from a T'ai chi exercise program (Wolf et al., 1996).

**Other Findings & Interests**

In an attempt to gain additional information from the T'ai chi group that may not have been revealed from the actual and perceived balance measures, the authors asked the following three questions at posttest: 1) “What, if any, changes have you noticed about yourself since participating in the T'ai chi class?” 2) “How do you think we (the authors) did with the class?” 3) “How could we (the authors) have improved the class?” Participants gave their responses verbally to the questions. The majority of participants stated that they really enjoyed the class and had few suggestions for improvement. A few participants mentioned difficulty seeing or hearing the instructor during the class.
However, many participants stated that they had noticed changes within themselves as a result of participating in the study. These changes ranged from physical improvements to emotional uplifting (Table 5).

From these responses and the general trends seen in one-legged stance time and ABC scores, the authors concluded that participation in the T'ai chi class had many positive effects for this elderly sample. Videotaped recordings of the sample throughout the class reveal improved body awareness, postural control, balance and mobility during T'ai chi movements. However, the authors were unable to predict what specific changes would occur due to participation in the class. Therefore, the authors had difficulty choosing appropriate tests to significantly measure these changes.

Table 5. Quotes from participants regarding changes in themselves

<table>
<thead>
<tr>
<th>Physical Changes</th>
<th>Emotional Uplifting</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Numbness in my hands fades after class&quot;</td>
<td>&quot;I enjoy being with people&quot;</td>
</tr>
<tr>
<td>&quot;I walk straighter like I used to&quot;</td>
<td>&quot;I feel better&quot;</td>
</tr>
<tr>
<td>&quot;I have more mobility in arms and legs&quot;</td>
<td>&quot;I have more ambition to do things&quot;</td>
</tr>
<tr>
<td>&quot;My back is a lot better&quot;</td>
<td>&quot;I look forward to getting out&quot;</td>
</tr>
<tr>
<td>&quot;Low back pain at first, but not anymore&quot;</td>
<td>&quot;I have more confidence to do things&quot;</td>
</tr>
<tr>
<td>&quot;I walk further with back straighter&quot;</td>
<td>&quot;It has made me more self-reliant&quot;</td>
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<tr>
<td>&quot;Able to use my back better to bend&quot;</td>
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</tr>
<tr>
<td>&quot;Feel more agile&quot;</td>
<td></td>
</tr>
<tr>
<td>&quot;My back is more agile&quot;</td>
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</table>
In physical therapy practice, clinicians need an appropriate method for objectifying balance improvements among the community-dwelling elderly. As the average elderly individual may only challenge their balance during functional activities, a functional test of balance is needed. It can also be said that since T'ai chi is a dynamic balance training tool, balance improvements may be more clearly revealed through a functional test. The Tinetti Balance Subscale was used in this study to measure functional balance ability. However, the Tinetti Balance Subscale was not an appropriate measure of dynamic balance ability due to the ceiling effect noted in this group of high functioning elderly.

Fear of falling has been shown to significantly impair activity in the elderly (Arfken et al., 1994; Bhala et al., 1982; Myers et al., 1996; Simmons & Hansen, 1996; Tinetti & Powell, 1993). As stated by Tinetti & Powell (1993), this is a “potentially modifiable impairment” requiring effective intervention. The authors of this study used the ABC scale as a clinical measure of fear of falling. However, the ABC scale was not appropriate for use in this group of high functioning elderly because of the observed ceiling effect. The subjects involved in this study perform many of the tasks questioned on the ABC scale everyday. For this reason, the authors concluded that the individuals were already highly confident in their performance of these everyday activities.
Therefore, only the more difficult tasks investigated by the ABC scale (Table 4) reflected improvements in confidence due to participation in a T’ai chi exercise program.

Research has shown that exercise can reduce the negative effects of immobility commonly seen in the elderly (Fiatarone et al., 1993; Guccione p. 240; Hopkins et al., 1990; Lord & Castell, 1994; Simmons & Hansen, 1996; Wolf et al., 1996). Despite the lack of significance in this current study, there were general trends of improvement noted in both groups’ actual and perceived balance performance. Therefore, the authors concluded that participation in an exercise program produces individual improvements in actual and perceived balance among the high functioning community-dwelling elderly. These improvements in actual balance performance and confidence can help to maintain or increase functional independence in the community-dwelling elderly.

**Future Directions**

Future investigations into the benefits of T’ai chi should include a program at least 15 weeks in duration as recommended by Wolf et al. (1996). Although the current study was only six weeks in duration, general improvement trends were noted on an individual basis. Another recommendation is that a frequency of three times a week be utilized to increase transfer of learning from class to class. Increasing the frequency of the class would decrease review time and increase practice time. In order to reap the full benefits of T’ai chi, subjects may learn movements faster and with greater accuracy by
increasing the number of instructors. In addition, instructor encouragement may result in
increased subject confidence with movements. As a result, subjects may feel more
confident and decrease the amount of time spent using a chair for support or resting.

Another suggestion for further research is to obtain a larger sample population.
More subjects would enable randomization into a control and exercise group. A quasi-
experimental equivalent pretest-posttest control study would limit concurrent
improvements in balance performance. Therefore, balance improvements resulting from
a T’ai chi intervention could be clearly identified.

A final recommendation for future research is to identify a more appropriate
measure of functional balance ability in the vigorous community-dwelling elderly. As
previously mentioned, individual improvements gained from the T’ai chi intervention
were masked by the noted ceiling effect on the Tinetti Balance Subscale. Possible tools
to investigate are the Berg Balance Scale, functional reach and/or the Tinetti POMA.

Conclusion

Wolf et al. (1996) suggested that T’ai chi has the potential for improving balance
performance and decreasing rate of falls among the elderly. The authors of this study
tried to demonstrate similar results among the community-dwelling elderly. We
attempted to quantify balance improvements and decrease fear of falling. These
improvements would benefit the growing elderly population by decreasing fall risk and increasing confidence.

The need for more cost-effective preventative measures by physical therapists is vital in the changing U.S. healthcare system (Englander, Hodson, & Terregossa, 1996). Preventative group exercise, like T’ai chi, is less expensive than traditional post-injury methods of intervention (Rizzo et al., 1996). Through such exercise programs, the elderly are provided with the necessary training to counteract the negative effects of aging and overcome environmental challenges.

Although the current study failed to show significant improvements in actual and perceived balance, the overall trend seen amongst the T’ai chi group suggests benefits from this intervention. As previously mentioned, one-legged stance was an accurate reflection of balance performance within a vigorous community-dwelling elderly population since no ceiling effect exists. We feel that improvement in the “Sit & Be Fit” group was the result of practicing one-legged stance during class. However, the T’ai chi group also improved one-legged stance time suggesting benefits from this intervention. The Tinetti Balance Subscale may not be an appropriate tool for this population due to the simplicity of the tasks evaluated. The ABC scale shows promise amongst individual community-dwelling elderly. Although the overall mean was high for this group, many individuals demonstrated increased confidence where improvement was possible.

Comments from the participants of the study indicated that they enjoyed this exercise program. At the completion of the study, arrangements were made to continue
the T'ai chi program. Many individuals are continuing to attend this class. Based on subjective questioning and general improvement trends seen in actual balance and confidence, we believe that T'ai chi is beneficial for preventing effects of immobility commonly seen in the elderly population. In addition, the subjects’ improvements in confidence may enable them to perform more difficult tasks. As a result, the elderly individual would feel confident to challenge his/her balance on a daily basis thus breaking the cycle induced by fear of falling.
BIBLIOGRAPHY


APPENDIX A

Informed Consent
INFORMED CONSENT FORM

I understand that this study will examine the effects of an exercise program on functional performance of activities of daily living in healthy elderly individuals. Knowledge gained from this study will help future physical therapists to construct appropriate exercise programs for this population.

I also understand that:
1. my participation in this study is purely voluntary, and that I may withdraw at any time.

2. participation in this study may involve a one hour exercise program, two times a week for six weeks and absence from two or more classes will result in my termination from the study.

3. I have been selected for this study because I meet the requirements for inclusion of community-dwelling, elderly and have no history of recent neurological or orthopedic injury.

4. it is not anticipated that this study will result in emotional or physical harm.

5. if published, the information I provided in the health questionnaire will be kept strictly confidential and the data will be coded to insure anonymity of all participants.

6. if I have any questions or concerns regarding this study or my rights as a participant, I may contact any of the researchers [Todd Sanders at (616) 748-0328, Janine Bonner at (616) 261-5647, or Jen Laudenslager at (616) 530-2851] or Dr. Paul Huizenga, Chair of Grand Valley State University Human Subjects Review committee at (616) 895-2472.

7. a video or picture of the participants may be used in presentation form to better illustrate the results of this study.

8. a summary of the results will be made available to me upon my request.

I acknowledge that:
1. I have been given an opportunity to ask questions regarding this study, and that these questions have been answered to my satisfaction.

2. I have read and understand the above information, and that I agree to participate in this study.

Witness

Participant Signature

Date

Date

I am interested in receiving a summary of the study results.
APPENDIX B

Subjective Health Questionnaire
SUBJECTIVE HEALTH QUESTIONNAIRE

All the information requested in this form will be kept confidential. Please be as accurate and complete as possible.

Purpose: The information requested on this form is necessary to assess the physical condition of each subject for inclusion into the study.

A. Personal Data:

Name: ______________________________________ Date: ____________________

Address: ______________________________________________________________________

Birthdate: _________________________________ Gender: M _____ F. ID # ______

Telephone _________________________________ 

B. Health and Medical Information:

1.) Have you been diagnosed with any of the following? Mark Y or N

Diabetes ____

Heart problems / surgery ____

Hypertension _____

Angina _____

Other _____

If you answered yes to any of the above please explain.

_______________________________________________________________________________

_______________________________________________________________________________

2.) Skeletal / muscular history:

Have you had any bone or joint surgery within the last year? _____

If yes, please explain: ________________________________________________
3.) Neurological history:

Please check if you have been medically diagnosed with any of the following neurological disorders within the last year:

- Stroke
- Multiple Sclerosis
- Brain or spinal tumors
- Parkinson's disease
- Myasthenia Gravis
- Muscular Dystrophy
- Alzheimer's Disease

If you checked any of the above, please explain:

________________________________________________________________________

________________________________________________________________________

4.) Are you taking any medication? Y____ N ____

If yes, please list all medications: ____________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

C. LIFESTYLE INVENTORY

1.) What physical and recreational activities do you participate in, and how often?

<table>
<thead>
<tr>
<th>ACTIVITY (golf, walking, etc.)</th>
<th>FREQUENCY (daily, weekly, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>
APPENDIX C

Mini-Mental State Exam
NOTE TO USERS

Copyrighted materials in this document have not been filmed at the request of the author. They are available for consultation in the author's university library.
APPENDIX D

Physician’s Consent Form
December 21, 1997

To Whom It May Concern:

As physical therapy students at Grand Valley State University, we are required to complete a Master's thesis. Henceforth, we are asking you for your approval for ________________ to participate in a modified Tai Chi exercise class consisting of low impact flexibility and mobility exercises. The participants of this study will be required to undergo a pre-screening evaluation of flexibility and mobility as well as an inquiry into their previous medical history. During the course of the study, we will be monitoring vital signs as deemed appropriate or upon your request. If you feel the above patient would be an appropriate candidate for this study, please sign below.

I ____________________________ hereby approve the above patient for participation in the aforementioned study.

Please indicate if you would be interested in the following:

___ Please monitor the above patient's vital signs during this study.

___ I am interested in obtaining a copy of the results of this study. Please send to this address: __________________________________________________________.

Sincerely,

Janine Bonner Jennifer Laudenslager Todd Sanders
APPENDIX E

Functional Screen
FUNCTIONAL RANGE/STRENGTH SCREEN

UPPER EXTREMITY RANGE
Shoulder:
  Flexion _____ Extension _____ Abduction _____
  Int. Rot. _____ Ext. Rot. _____

Elbow:
  Flexion _____ Extension _____

SQUAT
  Trial 1 _____ Trial 2 _____ Trial 3 _____
  Avg _____

FORWARD REACH
  Trial 1 _____ Trial 2 _____ Trial 3 _____
  Avg _____

ONE LEG STANCE TIME (Dominant Leg)
  (only if Average forward reach is > or = 7”)
  Trial 1 _____ Trial 2 _____ Trial 3 _____
  Avg _____
APPENDIX F

Tinetti Balance Subscale
<table>
<thead>
<tr>
<th>Maneuver</th>
<th>Normal(2)</th>
<th>Adaptive(1)</th>
<th>Abnormal(0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitting balance</td>
<td>Steady, stable</td>
<td>Holds onto chair to keep upright</td>
<td>Lean, slides down in chair</td>
</tr>
<tr>
<td>Arising from chair</td>
<td>Able to rise in a single movement without use of arms</td>
<td>Uses arms to pull or push up, and/or moves forward in chair first</td>
<td>Multiple attempts required or unable without assistance</td>
</tr>
<tr>
<td>Immediate standing</td>
<td>Steady without holding onto anything</td>
<td>Steady but uses A.D. or other object for support</td>
<td>Any sign of instability</td>
</tr>
<tr>
<td>Standing balance for 10 seconds</td>
<td>Steady, able to stand with feet together, no support</td>
<td>Steady, but cannot put feet together</td>
<td>Any sign of instability or support use</td>
</tr>
<tr>
<td>Balance with eyes closed, feet together</td>
<td>Steady, no support feet together</td>
<td>Steady with feet apart</td>
<td>Any sign of instability or holding</td>
</tr>
<tr>
<td>Turning balance (360 degrees)</td>
<td>No grabbing or staggering, no holding, steps are continuous</td>
<td>Steps are discontinuous</td>
<td>Any sign of instability or use of support</td>
</tr>
<tr>
<td>Nudge on Sternum (feet together, light even pressure over sternum 3 times)</td>
<td>Steady, able to withstand pressure</td>
<td>Needs to move feet, but able to maintain</td>
<td>Begins to fall, or examiner has to help keep balance</td>
</tr>
<tr>
<td>Sitting down in chair</td>
<td>Able to sit down in one movement</td>
<td>Needs to use arms to guide self into chair or not smooth motion</td>
<td>Falls into chair, misjudges distances</td>
</tr>
</tbody>
</table>
APPENDIX G

Activities-specific Balance Confidence Scale
ABC SCALE

Please mark on the line, at what percent do you feel yourself confident at performing the following activities: (0% = no confidence, 100% = complete confidence)

<table>
<thead>
<tr>
<th>Activity</th>
<th>0</th>
<th>50</th>
<th>100</th>
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</thead>
<tbody>
<tr>
<td>1. Walking around the house</td>
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<tr>
<td>2. Going up and down stairs</td>
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<tr>
<td>3. Pick up a slipper from the floor</td>
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<tr>
<td>4. Reach at eye level</td>
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<tr>
<td>5. Reach on tiptoes</td>
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<tr>
<td>6. Stand on chair to reach</td>
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<tr>
<td>7. Sweep the floor</td>
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<tr>
<td>8. Walk outside to nearby car</td>
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<tr>
<td>9. Get in/ out of car</td>
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<tr>
<td>10. Walk across parking lot</td>
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<tr>
<td>11. Up and down a ramp</td>
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<tr>
<td>12. Walk in a crowded mall</td>
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<td>13. Walk in a crowd/ get bumped</td>
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<tr>
<td>14. Escalator holding rail</td>
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<tr>
<td>15. Escalator not holding rail</td>
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<tr>
<td>16. Walk on icy sidewalk</td>
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</tbody>
</table>
APPENDIX H

Data Collection Sheets
## PRETEST DATA COLLECTION SHEET

<table>
<thead>
<tr>
<th>SUBJECT ID #</th>
<th>TINETTI SCORE</th>
<th>1 LEG STANCE TIME</th>
<th>ABC SCORE</th>
<th>ABC TASK SCORES</th>
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<tbody>
<tr>
<td>1</td>
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APPENDIX I

T'ai chi Exercise Progression
PART WILD HORSE'S MANE

1. Begin with weight on left foot; T'ai chi ball with left hand on top, right foot in T-step.
2. Right hand (palm up) comes up and out towards the front of the body; step with right foot; left hand (palm down) goes towards left hip.
3. Arms float back to step one and sequence is repeated (not shown).
CRANE SPREADS WINGS

1. Half empty step; turn left foot in; weight on both feet; left arm comes forward; press right hand on left wrist.
2. Twist body to left, then back to center.
3. Scoop left arm up; right hand to right hip; weight shift to left foot; right heel up.
BRUSH KNEE AND PUSH

STEP 1
1. Arms circle around to left with feet in T-step.

STEP 2
2. Left hand brushes by face to push forward.
3. Right hand circles and brushes by right knee.

STEP 3
1. Half empty step: turn back foot in so weight is on both feet; move arms in saw type motion; left arm slices backward.
2. Right arm slices forward while body twists left; left hand comes forward and settles under right elbow as toes of front foot come up.
REPULSE THE MONKEY

STEP 1

STEP 2

STEP 3

STEP 4
REPULSE THE MONKEY (CONT.)

1. Right T-step; hands from play to pipa: left arm circles back, right arm remains front with palm up.
2. Left arm bends and hand brushes by face while right foot steps back.
3. Left hand (palm down) meets right hand (palm up) in front of body.
4. Right arm circles back, left arm remains front with palm up; feet in T-step.
5. Right arm bends and hand brushes by face while left foot steps back.
6. Right hand (palm down) meets left hand (palm up) in front of body.
1. Right T-step to bow step.
2. Both arms circle back left while doing ¾ of Part the Wild Horse’s Mane.
3. Left hand comes back up to the right hand and clap; both arms circle back left; left hand touches right wrist and arms push forward.
4. Left hand rests on top of right hand; both elbows pull towards ribs while shifting weight into left foot; push both hands forward shifting weight forward to bow step.
WILLOWS IN THE BREEZE

1. Double weight shift: lift left foot and bring in,
   shift weight left, turn right foot in,
   shift weight right.
2. Hands sweep across front of body from left
to right as weight shifts side to side.
WAVE HANDS LIKE CLOUDS

1. Double weight shift.
2. Both hands to the side of the body with right higher than left as if holding a baby.
3. Keeping hands in this position, bring both across the body while shifting weight to the right foot.
4. Switch left hand higher and repeat while shifting weight to the left foot.
SINGLE WHIP

1. Right T-step to Bow step.
2. Both arms circle backwards to the left.
3. Left hand stays back; fingers pointing to floor.
4. Right hand pushes forward.