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An Evaluation of Yoga for the Reduction of Fall Risk Factors in Older Adults

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AN EVALUATION OF YOGA FOR THE REDUCTION OF FALL RISK FACTORS IN OLDER ADULTS

By

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ABSTRACT

Research indicates that exercise may reduce the risk of falling in the elderly. Balance training has been a part of the different forms of exercise (e.g., aerobic exercise, strength training, tai chi, qigong) studied, but not in the use of yoga exercise. Scientific findings indicate that multifaceted interventions following the biopsychosocial model are likely to be more successful at reducing multiple fall risks. The purpose of this study was to evaluate the effects of an 8-week yoga intervention, balance training, and awareness class on measures of postural control, attention and visual search strategy, confidence, fear, and awareness to environmental hazards. Eighteen older community dwelling women, age *M*=76.06, *SD*=6.35, randomly selected for 3 treatment groups participated in a 2-weekly, 1 hour yoga (n=8), balance training (n=5) or an awareness class (n=5) for 8 weeks. Baseline assessments included measures of balance derived from the Neurocom Balance Master Machine (NC) and the Performance-Oriented Mobility Assessments (POMA), attention (Trail Making Test; TMT, and the Walking Trail Making Test ;WTMT), confidence (Activity-specific Balance Confidence test ; ABC), fear (Fear Efficacy Scale; FES), environmental awareness (Environmental Awareness Test; EAT) and steadiness (Steadiness Measure; SM). Neurocom and EAT measures were completed again post-intervention, while POMA, WTMT, ABC, FES, and SM measures were completed on a weekly basis as well as post-intervention and follow up. The TMT was completed at Post intervention and follow up. Statistical analysis did not show significant effects for yoga over balance training or control. Descriptive analysis in the form of effect size showed the yoga group's mean differences, pre-post, had improvement in the POMA (postural control, *ES*=1.61), SM (postural control, *ES*=0.66), and WTMT, (attention, *ES*=1.08). Additionally, yoga improved equally as well as balance training in the ABC (confidence, *ES*=0.32). Balance training resulted in stronger (pre-post) effects in the NCEX (postural control, *ES*=1.30), NCC (postural control, *ES*=1.05), TMT (attention, *ES*=0.72) and the FES (reduced fear, *ES*=0.52). The control-awareness treatment (i.e., control) resulted in the strongest changes over both the exercise treatments in EAT (awareness, *ES*=0.44). The control improved equally as well in the FES (*ES*=0.46) as the balance group (*ES*=0.52). The descriptive results suggest that yoga and balance training may have potential as an intervention for improving physiological and psychological fall risk factors among older adults.

INTRODUCTION

Falling is the leading cause of death in the older adult population (American Geriatric Society [AGS], 2005; Centers for Disease Control [CDC], 2006). Falls are also the leading cause of nonfatal injury (American Academy of Orthopaedic Surgeons [AAOS], 2000; CDC, 2006) and the most common cause of hospital admissions for trauma (CDC, 2006). According to the Centers for Disease Control in 2001 every hour an older adult dies as the result of a fall. In 2002, more than 13,000 persons 65 and older died from fall-related injuries (CDC, 2004). The number of falls and severity of injury increases with age (AAOS, 2000). Speechley and Tinetti, (1991) defined an elderly person as frail when he/she has problems with gait, balance, poor vision, poor strength, and lack of physical activity. The CDC (2001) reported that a frail elderly person is twice as likely to fall as healthier people of the same age and the frail elderly sustain more severe injuries from a fall.

Falls have personal and economic impacts. Personal impacts can be substantial and include pain, loss of confidence, decreases mobility (AAOS, 2000; CDC, 2006), loss of independence (AAOS, 2000; AGS, 2005; CDC, 2006), isolation, decreased quality of life (CDC, 2006), restricted activity (Tinetti, Speechley, & Ginter, 1988), and development of a fear of falling (AGS, 2005; Jorstad, Hauer, Becker, & Lamb, 2005; Kressig, et al., 2001; Kurlan, 2005; Sattin, Easley, Wolf et al., 2005). Half of the older adults suffering a hip fracture sustained in a fall never again regain their previous level of functioning, and many are unable to live independently after their injury (CDC, 2001). Economic impacts are also nontrivial. In 2003, more than 1.8 million seniors, aged 65 and older, were treated in emergency departments for fall-related injuries, and 421,000 were hospitalized (CDC, 2005). In 2000, there was a direct medical cost of $179 million for fatal injuries related to falls and $19.3 billion for non-fatal falls (CDC, 2006). The CDC (2006) estimates of future economic impact are immense. Specifically, the cost of fall injuries is expected to reach $43.8 billion by 2020. In 1985 nursing home care for the elderly was $31.1 billion and is estimated to be 4 times that amount by 2040. Given the increase in life expectancy, the number of people age 65 years and over is estimated to be 77.2 million by 2040.

Risk factors for falling are both physical and environmental in nature. Physically, the older person may begin to have poor vision (Ivers, Cumming, Mitchell, & Attebo, 1998), less muscular strength, flexibility, limited range of motion in ankle, knee, and hip joints, (AGS, 2005), and because of medical conditions, loss of feeling in the legs or feet (Ducic, Short, & Dellon, 2004; Hay, Bard, Fleury & Teasdale, 1995). These factors can make it difficult to recover balance when faced with an obstacle or change in the walking surface (Nashner, 1980). Inactivity plays a major role in the de-conditioning of muscles (Graafmans et al. 1996). Immobility may occur when a fear of falling is developed (Tinetti et al., 1994; Wolf et al., 2001) further increasing inactivity (Graafmans et al., 1996). Other physical factors can include medical conditions such as high blood pressure, arthritis, osteoporosis, inner ear disturbance, cardiovascular disease, Parkinson's disease, and diabetes (CDC, 2006). Medications used to treat these conditions can cause dizziness that greatly increases a senior's risk of falling (Cumming, 1998). Environmentally, stairs, ramps, rugs, bath mats, stacks of magazines, cluttered pathways, electrical cords, ice, or low lighting pose challenges to people who have limited ability to recover from a stumble or a slip, and especially for those who suffer from poor vision (Ivers et al., 1998). Some environmental and physical factors can be modified to decrease the risk of falling. Risks are multifactorial and falls are not typically the product of one risk factor (Tinetti et al., 1994; Wolf et al., 2001).

The risk factors of a person may present independently but more often are seen in combinations (Tinetti, Williams, & Mayewski, 1986). As such, combinations of risk factors should be addressed by multifactorial interventions (American Geriatric Society, British Geriatrics Society, and American Academy of Orthopedic Surgeons Panel on Fall Prevention [AGS PFP], 2001; Tinetti, 2003). Multifactorial targeted prevention programs for community elderly showed significantly lower health care costs for the intervention group over the control group (Rizzo, Baker, McAvay, & Tinetti, 1996). Additionally, the findings of Kressig et al. (2001) also accentuated the need for multifactorial, customized intervention strategies to prevent falls and fear of falling in the older adult population. Kressig and colleagues found that 50% of the cohort had activity related fear of falling regardless of demographic, functional or behavioral characteristics. Weatherall (2004) questioned whether multiple intervention strategies were more cost effective than exercise alone. It was found in the study that although exercise was a critical component of a prevention program, evidence for efficacy of multiple intervention strategies was greater.

Weatherall (2003) and the AGS PFP (2001) suggested that interventions should include, gait and balance training, appropriate use of assistive devices, review of medications, exercise programs, treatment for postural hypotension, modification of environmental hazards, treatment for cardiovascular disorders, and staff training in care facilities. Keysor and Jette (2001) concluded that interventions should follow the biopsychosocial model; that is, interventions need to address the biological systems impairment, and the older person's beliefs, fears, efficacy, social role, and environment. The Biopsychosocial Model of health related behaviors states that these three factors interact with each other to promote health related behavior changes (Figure 1). Biopsychosocial interventions should provide an integrated approach to improving fall risk factors.

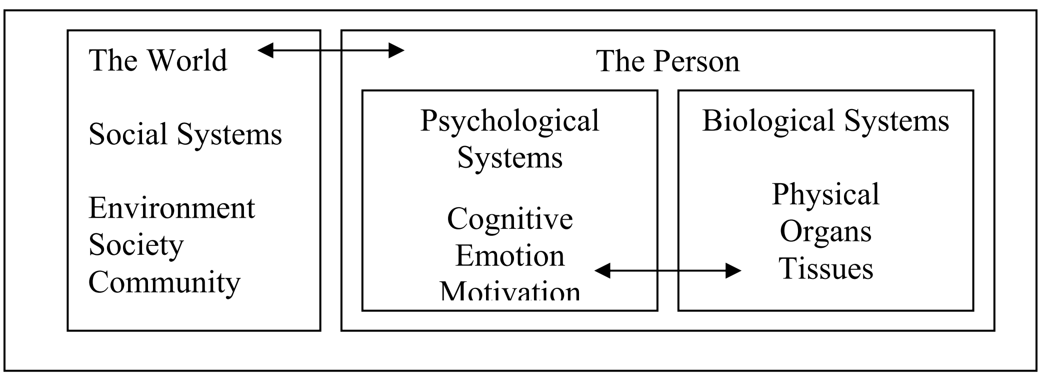


Figure 1: Biopsychosocial Model for health related behaviors (Adapted from Sarafino, 2006).

Multifactorial intervention programs that include two or more types of interventions may be complicated or time consuming. Designing a single intervention strategy that includes one activity but addresses multiple risk factors and employs the Biopsychosocial model would be ideal. Yoga has recently enjoyed much popularity in western culture and shows potential as an intervention in the prevention of falls by improving fall-related risk factors. Yoga may be considered a biopsychosocial intervention. Biologically or physically, yoga as an exercise may have beneficial effects on the body as any exercise regimen in that it utilizes muscle groups for producing and stabilizing body movement. Psychologically, there is a relaxation component to yoga that may produce positive effects on mood. Additionally, within the psychological context, yoga requires focused effort on the part of the participant and may help with attention. Yoga positions are challenging in that they require the participant to integrate muscular movement, balance ability, and breathing techniques. Socially, yoga can be practiced in a group setting which may encourage social interaction and participation. Yoga requires participants to be aware of environmental cues so as to complete the yoga poses accurately.

Evaluation of yoga as a biopsychosocial intervention is needed to determine if it can improve the fall risk factors of postural control or balance impairment, fear of falling, low self-efficacy, and cognitive impairment. Can yoga, in and of itself, provide an integrated approach to decreasing fall risk factors by modifying the biological/physical (postural control/balance), psychological (attention and learning), and social (awareness to environment) systems of an older adult? These questions are used as the basis for the study that is introduced next.

CHAPTER 1

AN EVALUATION OF YOGA FOR THE REDUCTION OF FALL RISK FACTORS IN OLDER ADULTS

The prevalence, economic impacts, and grave consequences of falls in the older adult population warrant investigation of fall prevention interventions. A fall may be the final event that makes an independent community-dwelling person into a dependent nursing home patient. Falls are hard to track. Falls often go unreported by the elderly and are relatively infrequent when compared to other behavior (Sattin, 1992). However, one fall can render an advanced age person immobile and disabled. It may be possible to decrease the number and impact of falls by improving known fall risk factors in individuals.

A variety of risk factors have been identified. They can be characterized as fitting into several general categories (i.e., lifestyle, chronic diseases, physiological impairment, musculoskeletal impairment, emotional disturbance, medications, and cognitive impairment). Assessments have been developed to identify the risk factors present in an individual and the level of the risk they present (Tinetti, 1986). Interventions have been established and have successful in decreasing the fall risk factors (Kressig et al., 2001). Interventions may be multifactorial so as to address multiple risk factors at once. Physical activity is the leading recommended intervention to improve several risk factors, primarily physical ability (Graafsman et al., 1996).

Fall risk factors may present independently or in multiples. Three risk factors that may occur in combination are cognitive impairment, fear of falling/decreased confidence, and postural control/balance impairment. Improving cognitive function may increase an elderly person's attention to environmental cues of hazards (Hausdorff & Yogev, 2006). Awareness of self in relation to the environment may decrease potential falls. Increasing confidence and self-efficacy in older adults' abilities by making them aware of their limits, may translate into decreased fear of falling (Sattin et al., 2005). A decrease in fear of falling may increase mobility and older adults' engagement in healthy activities, such as exercise and social functions. Figure 2 represents the potential effect of some type of intervention in improving risk factors in order to decrease falls in the elderly. Many risk factors have been identified. These risk factors may be modifiable with yoga. Cognitive impairment in the form of decreased attention may be improved with yoga because of the required mental focus in performing yoga. Fear may decrease due to an increase in confidence as a result of the older adult experiencing success in performing the yoga poses. The physiological effects of yoga may be similar to effects noted in other forms of exercise. Exercise increases strength and flexibility (American College of Sports Medicine, 2003) and may thereby increase postural control as well.

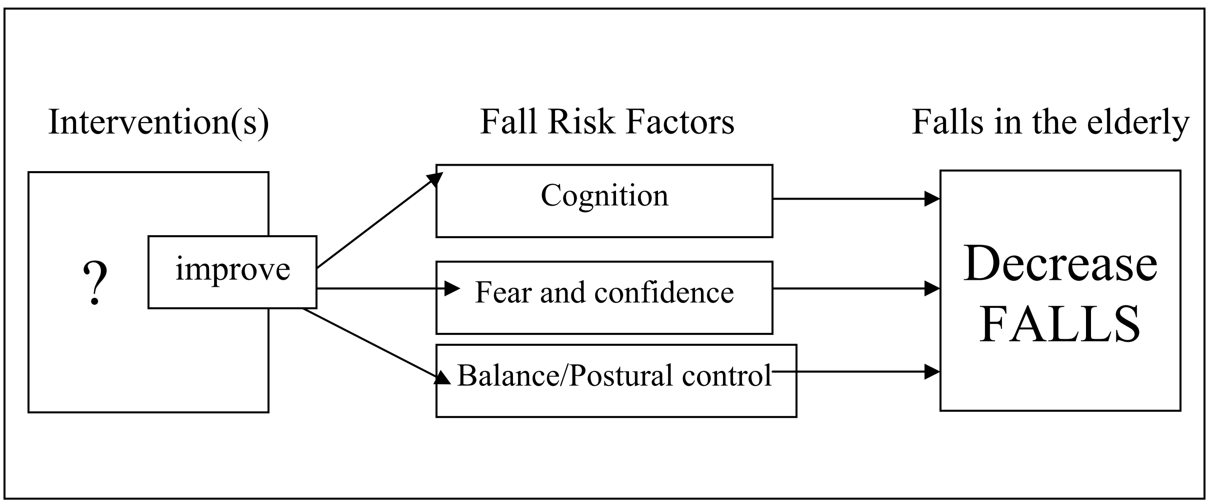


Figure 2: Concept Map. What intervention(s) can reduce fall risk factors and decrease falling in the elderly?

In this review, elaboration is provided on (a) three primary risk factors, (b) physical activity interventions that have been used to improve risk factors, and (c) yoga as an intervention. Yoga, in and of itself, may be considered a multifactorial intervention.

Risk Factors for Falling

Cognitive Impairment

The fourth edition of the Diagnostic and Statistical Manual of Mental Disorders, (DSM-IV) classifies decline in cognitive functioning consequent to the aging process as normal given a person's age (American Psychiatric Association, 2000). The American Geriatric Society reports that decline in cognitive ability occurs naturally as part of the aging process in that 5-8% of all people over 65 have some form of dementia (AGS, 2005). Some diseases such as Parkinson's and Alzheimer's are known for the deleterious effects on cognitive function caused by dementia and the significantly higher risk of falling (CDC, 2006).

Cognitive impairment may be caused by decreased mental ability due to dementia (AGS, 2005), senility (AAOS, 2000), and the associated memory loss or confusion (Mayo Clinic, 2004). Examples of decreased mental ability include deficits in attention, reaction time, orientation, memory, and language skills (American Psychiatric Association, 2000). Hausdorff and Yogev (2006) called attention to a growing number of studies that link cognitive function to gait disturbance and falls. Risk of falling related to cognitive impairment in advanced age has been measured by reaction time (RT) and attention. Impaired attention ability in the elderly has been defined as a limited capacity for processing information from the environment (Schmidt & Lee, 2005). RT is the length of time from the presentation of a stimulus to the onset of movement behavior. RT does require attention ability as the older person must recognize the stimulus in order to react to it. Movement time (MT) is the time from the onset of movement to the completion of the movement. The total amount of time of RT and MT is the response time. The response time which could avert a fall would be increased by increased RT (Schmidt & Lee, 2005).

Attention. Decreased attention may be the most important factor associated with cognitive impairment as a risk factor for falling in the elderly. Decreased attention may be due to an overload of stimulus in the environment, or avoiding attending to environmental cues. Impairment of attention has been assessed using dual task paradigm and visual search strategy studies (Ludt & Goodrich, 2002). The dual task paradigm requires an older person to perform two tasks at the same time (e.g. walking and repeating digits). Visual search skills require attention to locate hazardous items in the environment. Visual search skills are required for an older person to step accurately in the environment. Stepping accurately, combines cognitive, visual, and motor abilities, and was shown to decrease in older adults under reduced lighting and cognitive demand (Alexander, Ashton-Miller, Giordani et al., 2005).

Attentional resources in dual tasks were shown to increase cognitive load and adversely affect attention in the elderly. Several studies have reported that decreased attention, in turn, adversely affected postural control or balance (Brown, Sleik, Polych, & Gage, 2002; Rankin, Woollacott, Shumway-Cook, & Brown, 2000; Redfern, Muller, Jennings, & Furman, 2002; Sheridan, Solomont, Kowall, & Haudorff 2003; Shumway-Cook, Woollacott, Kerns, & Baldwin, 1997; Verghese et al., 2002). The "Walking While Talking" (WWT) test is a dual task, timed assessment that has been shown to reliably identify older individuals at higher risk for falling (Verghese et al., 2002). Verghese and colleagues's study examined the effect of a cognitive task on gait and cumulative falls in a 12 month period after testing of dual task, standard balance, and cognitive assessments. Lower scores on the balance assessment were associated with lower scores on the cognitive assessment and both were associated with higher completion times on the WWT. Low scores on these assessments identified elderly that had higher risk for falling.

Sheridan et al. (2003) also used a dual task design of walking and repeating random digits with Alzheimer's disease (AD) patients. Sheridan et al. found significant deficits in attention required to perform the two tasks. The AD patients exhibited some variability during their gait in usual walking conditions, but showed significant variability under dual task condition. Thus, when older persons with AD have a deficit in attention coupled with impaired gait, their locomotor function relies on cognitive functioning; especially the executive function. Contributing factors to elderly falls is a decline in elderly individuals' abilities to process sensory information and transform it into appropriate movements.

Like the study using dual task paradigm with AD, several studies indicated that postural control needed for walking in the older adults was harder to maintain when less attentional processing capacity was available (Brown et al., 2002; Rankin et al., 2000). This was especially the case when an individual had a history of falls (Shumway-Cook et al., 1997). Increasing levels of threat to postural control under the dual task paradigms showed a strong prioritization to postural control over the secondary task in older adults in Brown's study. That is, the older adults engaged in behaviors to avoid a fall rather than continue with the secondary task. Brown et al. expressed concern that when postural control is prioritized over a secondary task, there may be implications for the secondary task. For example, if an older adult is holding a child and has a stumble the older adult is likely to engage in behaviors to keep from falling rather than maintain holding the child. In contrast, the Shumway-Cook et al. and Rankin et al. studies showed that the postural control, or balance task, of the older adult group was more likely to be affected than the cognitive task. Both the Rankin and the Shumway-Cook studies suggested balance retraining programs include multiple tasks training to challenge balance and develop better postural stability.

Visual search skills are often needed for accurate stepping. Stepping accuracy combines attention, visual search skills and gait ability. Accurate stepping is required to avoid hazards in the environment. Alexander et al. (2005) evaluated cognitive skill, attention, and gait using a controlled walkway timed test. The Walking Trail Making Test (W-TMT) consisted of a 15-foot walkway with numbered and lettered circles. The participant traversed the walkway stepping on the circles sequentially, 1, A; 2, B; etc. The performance time was compared across age groups and was shown to increase with age and with increase cognitive load. The walking time increased disproportionately in the highest cognitive load condition for older adults.

Owsley, Ball, and Keeton (1995) identified deficits in attentional skills, slow visual processing and low central involvement when older adults with normal vision were unable to locate items of interest in the environment. Owsley et al. suggested that vision tests are important, but a more thorough assessment should include tests of visual search skills.

Ludt and Goodrich (2002) evaluated the Dynamic Visual Assessment (DVA) controlled walkway as a training tool. The purpose was to assess the visually impaired, older population's ability to detect and negotiate environmental hazards. The DVA was found to be effective in training low vision persons by scanning the environment more thoroughly and attend to pre-arranged items as soon as they were detected. With training, participants were able to detect items from further away. Increased ability to scan and attend to environmental cues may be an effective protocol to reduce the risk of falling in this population.

Reaction Time. Slowed RT is referred to as reduced reflexes by the National Institutes of Health Osteoporosis and Related Bone Diseases (NIHORBD, 2005), and the National Institute on Aging (NIA, 2004). RT requires attending to the initial stimulus. Slowed RTs in older people results in increased risk for falling (Lord & Fitzpatrick, 2001; Mayo Clinic, 2004; NIHORBD, 2005).

Maki, Edmonstone, and McIlroy (2000) and Rogers, Hedman, Johnson et al. (2001) assessed lateral stepping, or side stepping reactions, in older adults. They reported that compensatory stepping may provide an early indicator of risk of falling due to the need to compensate for lateral postural instability. Lateral stability is considered crucial because it is the falling to the side that is associated with most hip fractures. Here again, it may be that the RT for the stepping behavior that is impaired. Both studies compared older to younger groups. In both studies the stimulus perturbation was sudden and unexpected. The older adult groups were more likely to take multiple steps, use arm reactions, and crossover leg movement, which caused collision of limbs. There was little difference between the groups in the time to the stepping foot's first lift off (i.e. RT to the perturbation). But in terms of movement time, older adults took longer to place the stepping foot for the completion of the stepping behavior, and thus maintaining stability. Overall the total response time was increased. Subsequent lateral steps were quicker than the younger groups or the healthier older participants. The two studies suggest that research in lateral stability is useful to determine clinical measures for assessing fall risk, but also to incorporate balance recovery strategies into interventions.

Redfern (2002) looked at two age groups, young and old, compared them for RT in visual and auditory categories, and for RT to perturbations on a posture platform. Overall older adults in the sensory categories had slower RT then the younger group, specifically slower RT to auditory stimulus than to visual stimulus. However, in the perturbation category, older adults and younger adults showed nearly equal RTs. In fact, older adults were faster to react to small perturbations than the younger group. Redfern postulated that the older group perceived more risk from even small postural upsets.

Cognitive deficit in RT may also be identified by stepping behavior. Stepping forward, back, or side is a primary means for balance recovery after a trip (Nashner, 1980). Several studies investigated stepping behavior in older adults and found that stepping ability relies on RT and declines with age in older adults with or without balance impairment (Blaszczyk, Prince, Raiche, & Hebert, 2000; Hsaio & Robinovitch, 2001; Lord & Fitzpatrick, 2001; Maki et al., 2000; Medell & Alexander, 2000, Rogers et al., 2001).

Most findings agree that older adults' abilities to recover from a trip with a step (front, back, or side) depend largely on the position of their body at the perturbation. Hsiao and Robinovitch (2001) looked at balance recovery with a single backward step. They found that when the back foot lands, it is the distance of the foot from the other stance foot that determines recoverability. The closer the foot lands the greater the decrease in the ability to recover balance, resulting in a multiple step response. Multiple steps were usually shorter in stride length and were associated with un-recoverability. These studies failed to include various age groups and the participants were healthy elderly. The findings suggest that training recovery programs and fall prevention programs should include training large steps, which would require components of lower body strength, flexibility, and RT.

Choice stepping reaction time (CSRT) may be one of the best tests for evaluating of cognitive impairment indicated by motor control, attention, sensorimotor, neuropsychological, speed and balance assessments (Lord & Fitzpatrick, 2001). Poor performance in all of these assessments was strongly associated with poor performance in CSRT. For example, Lord & Fitzpatrick (2001) study using CSRT required older adults to evaluate step location and determine which leg to use as quickly as possible in 477 participants, including a younger group for comparison (n = 30). Although reaction time is the initial stage of response time, the authors concluded that the CSRT provided a new composite measure of the stages of response time, including selection and execution of the appropriate corrective balance responses. Poor performance was shown to be a measure of some cognitive impairment and a good predictor of fallers. Lord's study established a new composite assessment to measure fall risk, but also highlighted the need for interventions to improve cognitive impairment resulting in reduction of risk of falling in older adults.

Hausdorff and Yogev (2006) indicated that studies utilizing dual task designs have demonstrated that cognitive function is necessary for balance and gait and encourage future research to include cognitive function measures in any trials designed to reduce fall-related injuries. Further, these authors encouraged fall risk interventions include a cognitive component. Cognitive interventions in fall prevention programs are typically fall-related education (AGS PFP, 2001). However, Lord and Fitzpatrick (2001) have suggested that training in recovery of balance techniques (e.g., side stepping) can be a valuable intervention for prevention of fall or re-falling. Enhancing an elderly individual's ability to recover balance by stepping in any plane should be taught by exercise based therapies and include instruction of larger stepping movement to increase the base of support (Hsiao & Robinovitch, 2001). An exercise intervention for fall prevention should contain strength, flexibility, and RT activities (Hsiao & Robinovitch, 2001).

Interventions that incorporate practice in balance recovery behaviors, such as compensatory or rapid stepping, knee bending, ankle flexing, and hip bending, train for improved attention and RT (Hsiao & Robinovitch, 2001, Maki et al., 2000; Medell & Alexander, 2000; Rogers et al., 2001). Accordingly Jeandel and Vuillemin (2000) showed that balance training had a positive effect on RT in elderly participants.

Certain types of exercise have been associated with improved cognitive functioning. Most of these studies lacked experimental control, but are worth mentioning. Qigong, an exercise and meditation technique has been linked to mental health benefits in the form of increased attention (Leung & Singhal, 2004) and decreased effects of dementia (Li, Hong & Chan, 2001; Leung & Singhal, 2004). Tai chi was shown to have benefits of increased memory span (Wolf et al., 2001). An experimental study using transcendental meditation, mindful guided attention, and mental relaxation showed increased cognitive flexibility and word production in all experimental groups over the control (Alexander, Langer, Newman et al., 1989).

Rankin et al. (2000) suggested that balance re-training programs be multitask and cognitively demanding (i.e. paying attention to postural control while engaging in a secondary task). Yoga, tai chi (Sattin et al. 2005), and qigong (Leung & Singhal, 2004) exercises can be multi-tasking by requiring attention to postural control, the exercise position within the environment, and internal focus on breathing. Systematic observation of these interventions is needed to determine their cognitive benefits.

Fear of Falling and Loss of Confidence

In this paper, fear of falling and loss of confidence in physical ability are collapsed into one risk factor because of the strong relationship between them. An increase in fear is almost always associated with a decrease in confidence of ability. Fear of falling was found to be an independent risk factor and is significantly associated with falling in older adults (Li, Fisher, Harmer et al., 2003; Wolf et al., 1996). Fear of falling may occur as a result of a previous fall, or because the older person loses his/her stability. Fear is considered a normal emotion and is a healthy response to stimuli that may be harmful. Unfounded fear, or fear that limits activity in an older person, may be harmful because staying active is important to physical health (Bruce, Devine, & Prince, 2002). Reducing fear of falling and increasing self-efficacy and confidence are crucial in reducing the risk of falling.

Li et al. (2003) studied 256 older people with an average age of 77. Findings indicated that higher levels of fear were associated with higher levels of functional inability, lower quality of life, more activity restriction, and falls. They concluded that intervention aimed at preventing or reducing falls should include a fear of falling component. Kressig et al. (2001) found fear of falling to be a risk factor for falls in the elderly. Kressig et al. failed to find a significant association between activity-related fear of falling and age in a study which included 287 older adults, average age of 80 years, living in a similar environment and having similar fall histories. The Activities–specific Balance Confidence scale (ABC) and the Fear Efficacy Scale (FES) were used to measure activity-related fear and were reported to be significantly negatively correlated ($r = -.65$). Additionally, depression, use of a walking aid, slow gait speed, and being an African-American were directly related to being more fearful of falling. The authors suggested customized intervention strategies to prevent falls, called for the examination of how interventions affect fear of falling, and its association with functional and behavioral factors.

Fear of falling was found to be related to the formation of impaired gait (Kurlan, 2005). Kurlan identified the "fear of falling" gait as the hesitant, shuffling or sliding of feet, and an intense need to hold on to support. Kurlan studied one participant, but his observations are consistent with other studies in that impaired gait is a primary fall risk factor. In this particular study the participant was informed that there was no neurologic problem to explain her gait disorder. She was prescribed physical therapy and improved dramatically. The author surmised that this participant's fear was psychogenic (i.e., unfounded fear) that limited her mobility. The main conclusion of this report was that "fear" gait may be reversible with education and activity intervention.

Bruce et al. (2002) conducted a study which randomly sampled 1500 older adult women using self report measurement of fear of falling, and physical and cognitive function. The findings indicated that fear of falling was as common in healthy, high functioning older women as in sedentary women with reduced abilities. Reduced levels of participation in physical activity were also shown to be independently associated with fear of falling. As fear of falling is an important barrier to overcome, the Bruce et al. study indicated that programs aimed at improving activity in older women should also address how to reduce fear.

Interventions to reduce the fear of falling have been suggested to be critical to fall prevention as fear is a primary risk factor for falls in the elderly (Kressig et al., 2001; Kurlan, 2005; Sattin et al., 2005). Sattin et al.'s tai chi study was specifically designed to reduce fear of falling and included 311 participants, men and women. In the random controlled study, Sattin et al. successfully utilized the FES and the ABC to assess the effects of tai chi in the reduction of fear of falling. Tai chi exercise was found to significantly reduce fear of falling compared to a wellness education program. Additionally, the study showed that balance confidence increased significantly in experimental group participants whether they were sedentary or active at baseline. The authors caution that results may not generalize to more frail older adults but encourage tai chi as a safe form of activity for participants varying in physical capacities.

Although not the primary objective, reduced fear of falling has been observed as a secondary outcome in several studies. Two studies, in particular, that included exercise for strength and balance training found reductions in fear of falling (Robitaille et al., 2005; Wolf et al., 1996). Robitaille et al. also showed balance confidence to be higher in the trained group, although these confidence scores were not statistically significant. Wolf et al. (1996) found a significant decrease in fear of falling and increased efficacy in the trained group.

Postural Control and Balance Impairment

The Kellogg International Work Group (1987) defined the pattern of falls as follows:

> While the multiple reasons why people fall are not yet well understood, it is clear that impairments in balance and gait are not normal aspects of aging. The sequence of events in a fall sometimes follows the following pattern:
>
> I. a movement such as walking is planned and initiated;
> II. an unexpected or unperceived hazard is encountered and distorts the pattern of movement;
> III. the body is displaced beyond its base of support;
> IV. the corrective mechanisms is delayed or inaccurate;
> V. the point of no return has passed, and the patient falls.
>
> Balance, the ability to prevent falls upon displacement, relies upon proper functioning of a number of anatomical structures. It can be impaired by disease or age-related changes in any one of these structures, by drugs which reduce their efficient functioning, and by environmental factors (Kellogg International Workgroup, 1987, p. 6).

Impaired balance, a risk factor for falling, was established as a risk factor in early research by Sheldon (1963). Balance was measured by postural sway or body sway. Sway is defined as the amount of movement of the body around the base of support (i.e., the feet comfortably placed in a quiet stance). These early studies concluded that the distance of sway determined age-related decrease in balance. Older adults swayed more than younger adults and the decrease in balance associated with sway decreased the older adult's ability to avoid a fall. According to the Kellogg International Workgroup (1987) large amounts of sway in older adults becomes detrimental when,the body is displaced beyond the base of support and falling becomes inevitable. Later studies by Tinetti (1986) and Wallmann (2001) maintained that balance impairment differentiated fallers and non-fallers. Tinetti's study participants were care facility dwellers (n = 79). Tinetti utilized balance and gait evaluations to determine balance ability and compared it with self-report and facility report of falls. Falling was more prevalent in low balance ability participants. Participants in Wallmann's study were independent community-dwelling persons (n = 25). Wallmann utilized force plate tests of sensory organization and limits of stability. Balance scores were significantly lower in fallers. Both, Wallmann and Tinetti described self-report data of fallers as a limitation to their study. Tinetti also stated that environmental factors, not addressed in the 1986 study, could also be considered in future studies.

Impaired balance is often separated as an individual risk factor when in fact it is a state maintained by multiple systems such as the visual system, vestibular system, musculoskeletal system, proprioception, sensorimotor system, and the cognitive system (Koceja, Allway, & Earles, 1999; Schmidt & Lee, 2005; Woollacott, 2000). Impairment to any of these systems may be a risk factor. Postural control involves all the systems that play a role in keeping the body upright, and maintaining the center of gravity over the base of support (Schmidt & Lee, 2005; Woollacott, 2000). Postural control is essential to maintaining an individual's balance (Koceja et al., 1999). Balance instabilities are registered by the proprioceptive sensory system, which responds to motion, muscle stretch, and the head's linear and angular accelerations (Koceja et al., 1999; Schmidt & Lee, 2005). Balance can be affected by a variety of diseases such as diabetes, heart disease, problems with circulation, thyroid, or the nervous system (NIA, 2004). Loss of balance and mobility are not inevitable as people grow older, but loss of balance due to dizziness or unsteadiness is known to increase with age and with this, the risk of injury increases as well (NIA, 2004).

One or more risk factors associated for falls. These factors may affect postural control, which results in the person's inability to maintain equilibrium or balance (Koceja et al., 1999; Schmidt & Lee, 2005; Tinetti et al., 1986). For the purposes of this study, postural control and balance are referred to as a single unit. The individual systems, which integrate to form postural control are not addressed separately. Both balance and postural control are considered as one fall risk factor. It is assumed that studies discussing postural control impairment would also include impairment to balance and vice versa.

Postural control and balance are vital for locomotion and they prevent falls. Moreover, falls represent a breakdown in postural control and balance. Cognitive impairment is associated with reduction in postural control. Cognitive impairment was shown to have a negative effect on the older person's ability to maintain balance; however, balance may also be affected by decreased ability in the musculoskeletal system. With factors of the cognitive system and environmental factors not withstanding, balance may be maintained if the musculoskeletal system is healthy and prepared for perturbations (Brauer, Woollacott, & Shumway-Cook, 2001). Balance maintenance or recovery is largely affected by the rehearsing of the appropriate responses to different perturbations. If the older person can safely practice body positions that are up to the limits of the base of support, the muscles are better prepared to react more reflexively with unexpected hazards (Robitaille et al., 2005).

Balance has been found to be trainable, or re-trainable, through physical therapy (American Physical Therapists Association (APTA), 1999). Rankin et al., (2001) suggested that balance training programs must include multi-task training. Shumway-Cook et al. (1997) suggested that interventions should focus on attention to postural control while engaging in secondary tasks. Exercise as an intervention to improve balance was shown to be beneficial (Robitaille et al., 2005). Using a large sample of average 74 years of age participants, the results showed significant improvement in static balance and mobility in the exercise group. As falling was not a measure in the study, the authors were careful not to generalize that improved balance would translate to decreased falling in the study participants. The authors anticipated that improved balance could decrease risk of falling.

Summary of risk factors

Fear of falling and reduced confidence in ability, cognitive impairment, and balance impairment are three primary risk factors in older adults' risk for falling. Each of these risk factors is considered independent though correlated with each other. Fear of falling and decreased confidence in older adults has been associated with balance impairment because of older adults developing impaired gait or other recovery behaviors after a previous fall. Cognitive impairment in older adults has been associated with balance impairment because of attentional deficits and slowed reflexes to postural disturbances. Cognitive impairment and fear of falling in older adults have been found to have a relationship in that decreases in cognitive ability may increase irrational fear of falling or unfounded lack of confidence. Exercise applied to each risk factor was found to be successful intervention. Included in this paper are studies which employed exercise as an intervention for fall risk factors including some exercises of an eastern modality.

Exercise and Fall Risks

General Consideration

Physical activity in people is defined as moving one's body by using skeletal muscles that result in energy expenditure. Exercise is a subset of physical activity. Exercise is planned and organized with the goal of improving or maintaining physical health. Exercise is physical activity, but physical activity may include house-cleaning, gardening, or walking the dog. Exercise may take place in various contexts for play, recreational, competitive, well-being, health, and other reasons (Edwards, Edwards, & Basson, 2004). The U.S. Preventive Services Task Force recommends regular physical activity, especially balance exercises, for the prevention of falls (CDC, 2002). Remaining physically active as one ages is extremely important in order to protect oneself from risk of injury. A sedentary lifestyle leads to further loss of bone and muscle (Graafmans et al., 1996; NIHORBD, 2005).

Physical activity improves physical health, decreases the probability of disease, and decreases the likelihood of premature death (CDC, 2000). The benefits of exercise for all age populations has been shown to reduce health factors like blood pressure, heart rate, respiration, and body fat. Increases have been shown in strength, flexibility, and balance (Burbank, Reibe, Padula, & Nigg, 2002; Daley & Spinks, 2000). Studies noted an increased feeling of well being, decreased depression and anger (NIHORBD, 2005). Additionally, there may be an increased opportunity for social contact, improved cognitive functioning, and increased feeling of self-efficacy (Berger & Owen, 1988, 1992; Daley & Spinks, 2000; Edwards et al., 2004; Tsang, Cheng, & Lak, 2002; Tsang, Mok, Au Yeung, & Chan, 2003).

Older Adults and Exercise

For the older adults, appropriate forms of exercise are important because of the decline in functioning that occurs naturally during the course of the aging process (AGS, 2005). Important factors determining elderly persons' activities are related to the aging musculoskeletal system (AAOS, 2000), decreased vision (Ivers et al., 1998; Ivers, Norton, Cumming, et al. 2000), and decreased balance (Graafsman et al., 1996). Exercises that are slow and sub-maximal (i.e., minimal increase in heart rate) are safe for advanced age population; but, even more important, exercises that are enjoyable and relevant tend to be maintained (Berger & Owen, 1988, 1992; Li et al., 2001; Burbank et al., 2002; Tsang et al., 2003). Every physical activity can be adapted to accommodate limitations as a result of age and ability (NIHORBD, 2005). Treatments including exercise for elderly have been shown to reduce the overall risk of falls, but no particular exercise modality has been shown to have a significant effect of decreasing injuries from falling (Province et al., 1995). Several studies have shown that exercise decreased overall risk of falling, however if a fall did occur in older adults that exercise, the injuries sustained may be just as extensive as in the older adults that did not exercise.

Exercise is believed to be the best fall prevention strategy for mobility impairment due to balance and strength weakness (Graafmans et al., 1996). Exercise or physical activity in older adults is important for enhancing posture (AGS PFP, 2001; NIHORBD, 2005), agility (AGS, 2005), muscle strength (Keysor & Jette, 2001), balance, coordination (AAOS, 2000; Mayo Clinic, 2004), range of motion in joints, and flexible tendons and muscles (Keysor & Jette, 2001; NIA, 2004). Short-term exercise may not have a restorative effect on impairments to gait, balance, and health status (Buchner et al., 2004). Seated exercises were found to improve strength and flexibility but did not show sufficient evidence of improved balance (McMurdo, Millar, & Daly, 2000). Exercise is an easily implemented strategy in the prevention of falls, and may have an influence on senior independence by maintaining mobility (Graafsman et al., 1996).

Exercise and Fall Risk Factors

In this section fall risk factors are reviewed that have been shown to have improvement with exercise protocols. Additional risk factors to the three main risk factors are introduced.

Musculoskeletal impairment, a primary fall risk factor, is identified by evaluation and modified with exercise intervention (Tinetti et al., 1994). A randomized controlled study of a community exercise program that included 20 weeks (2 times per week) of balance and strength training for women with osteoporosis showed that relative to the control, the women in the exercise group had substantial improvements, but not significant in the fall-related risk factors of dynamic balance and strength (Carter et al., 2002).

In contrast to Carter et al. (2002), Campbell et al. (1997) also conducted a randomized controlled study employing a home based exercise program for a period of one year. This program also included strength and balance training to prevent falls. Campbell et al. reported a 58% reduction in falls among older women who began an exercise program. The main measures were falls and changes to muscle strength and balance. In addition to a decrease in the number of falls in the exercise group there was also a significant increase in balance ability.

A behavioral study showed that exercising improved balance and gait in elderly women living in a care facility with an intervention of videotaped modelling of themselves and of peers (Neef, Bill-Harvey, Shade, et al. 1995). Videos of themselves and peers increased the likelihood of the participants' engagement in the exercise activity. Actual falls were tracked by care facility staff. Results indicated falls did not have a significant decrease even though fall risk factors (balance and gait) had been improved.

In another study, short-term strength and endurance training was shown to have no effect on gait, balance, or physical health status in older adults, but did have a protective effect on risk of falling, decreased clinic visits, and decreased hospital costs (Buchner et al., 1997). However, a similar study reported moderate support for short-term balance training in functionally independent elderly (Seidler & Martin, 1997). Both studies were randomized and controlled and participants were community dwelling.

Cognitive improvement due to exercise or physical activity has been found in several studies. Weuve et al. (2004) conducted a longitudinal study with women ages 70 – 81 which found that long term regular activity was associated with better cognitive function and less decline. Physical activities that participants reported in this study included walking, jogging, strength training, and yoga. A six-year longitudinal study with cardio fitness found results in agreement with the Weuve study. A higher level of cardio fitness was shown to be associated with preservation of cognitive function (Barnes, Yaffe, Satariano, & Tager, 2003). Bixby et al.

(2007) also reported that moderate, accumulated physical activity benefited cognitive function in participants up to 92 years.

Participating in exercise has been reported to increase self-efficacy. Studies have concluded that there are increases in self-esteem and well being with exercise (Daley & Spinks, 2000; Berger & Owen, 1992). If accurate, this assumption may have implications for older adults engaging in exercise. Some balance between confidence in ability to engage in certain activities and actual ability must be maintained for individuals' sake of safety. Some fear may actually be healthful. Elderly who participated in a more extensive exercise program (frequency and duration) showed lower fear of falling than the elderly of low-intensity exercise participation. The same study reported that fear was still present in the experimental groups' age range 65 – 85 years whether the level of exercise participation was high or low (Wong & Cheung, 2001). Campbell et al. (1997) found a decrease in fear of falling scores for the exercise group in their study over the control group of non exercisers. This effect was observed even at the one year follow up.

Physical activity and exercise is recommended for the prevention of falls. Forms of exercise can be modified for the older adult population. Exercise has been shown to have a positive effect for the reduction of fall risk factors such as, musculoskeletal impairment, cognitive impairment, and fear of falling (Tinetti et al., 1994; Neef et al., 1995; Berger & Owen, 1992; Wong & Cheung, 2001).

Eastern Modality Exercise

Tai chi and qigong are physical activities which consist of mobilizing the skeletal muscles and expending energy. Additionally, both exercises are organized in a general format to include a warm up period, the main body of exercise, and cool down period. The exercises gradually increase in difficulty as the class progresses through the main body with a gradual decrease through the cool down. Qigong can be practiced either in a sitting or a standing position and was modifiable for people who have poor standing ability or are wheelchair bound (Tsang et al., 2003). The benefits of tai chi have been documented (AAOS, 2002) and were shown to be effective in increasing dynamic balance (CDC, 2006; NIHORBD, 2005; Wolf et al., 1996; Wolfson et al., 1996) and strength (Wolf et al., 1996; Wolfson et al., 1996). Tai Chi emphasizes slow continuous movement with a gradual narrowing of the base of support during dynamic weight shifting (Wolf et al., 2001).

Qigong was found to be beneficial to the elderly in the prevention of falls (Li et al., 2001; Leung & Singhal, 2004), improved mobility (Tsang et al., 2003), reduction of pain (Tsang et al., 2003), and is less physically demanding than Tai Chi (Tsang et al., 2003). Further, qigong was found to be beneficial to the elderly for numerous risk factors such as arthritis, hypertension, asthma, and stroke recovery (Leung & Singhal, 2004; Li et al., 2001). Engaging in qigong on a regular basis can positively influence breathing, heart function, digestion, circulation, nervous system, metabolism, and keep general body processes steady (Tsang et al., 2003). Other studies have found relaxation benefits of yogic relaxation techniques for participants with chronic osteoarthritis (Garfinkel, Schumacher, Husain, et al. 1994). Chronic diseases such as hypertension have also been positively affected by interventions of the eastern influenced exercise modalities of mindfulness meditation, progressive muscle relaxation, and breathing techniques (Schneider et al., 1995).

Exercise has been established as an effective intervention for older adults to improve many fall risk factors, particularly musculoskeletal impairment implicated in balance impairment. But the draw to eastern exercise modalities is in the adaptability of the exercises to the aging population. The amount of focus required for poses may improve cognitive impairment by training dual task. The slow, controlled, gentle characteristics of the exercises allows participants to contact the reinforcing nature of successful performance and thereby, may increase confidence and self-efficacy while decreasing fear of falling. Yoga is such an eastern generated exercise. Yoga is under-evaluated as a fall prevention intervention. The following review explores the possibility of yoga as an intervention option for older adults with fall risk factors.

Yoga

Yoga: General View

Yoga is a unique option for older adults to engage in exercise activity (American College of Sports Medicine [ACSM] 2003; Alleger, 2002). Yoga is an ancient exercise, 4,000 – 8,000 years old, initially practiced by monks to relax the physical body to ready it for prayer. The word “yoga” comes from the Sanskrit word “yuja,” which means perfect alignment between the physical, mental, and spiritual self (Berger & Owen, 1988, 1992; Sahajpal & Ralte, 2000; Bell, 1999; Shaw, 2001). There are several different types of yoga: Hatha, Kundalini, Iyengar, Vini, and modern versions such as Yoga-Fit (Shaw, 2001; ACSM, 2003). Hatha yoga is probably the most well known and is described as the exercise version of yoga (Berger & Owen, 1988, 1992).

Yoga is defined as an exercise further using the definition provided by the American College of Sports Medicine (ACSM, 2003). The ACSM set forth the following standards for comprehensive fitness: (1) frequency of training should be three to five days per week, (2) intensity of training for endurance exercise should be 60% to 90% of maximum HR, (3) duration of training should be 20 to 60 minutes, (4) the mode of activity should use large muscle groups over time and be rhythmic and aerobic in nature, and (5) resistance/strength training should be moderate. Yoga fits all of these criteria with exception of (2). Yoga is certainly a sub-maximal activity and even the most challenging of yoga positions do not increase HR to 60% of maximum. However, yoga positions, which require an isometric hold for several minutes, do increase HR, and require increased endurance over time. Using ACSM guidelines for overall fitness, yoga may also be considered an exercise that can reap the benefits gained by other types of exercise. Namely, the benefits attributed to exercise are increased muscular strength and endurance, muscle flexibility, functional ability in the form of increased ability to engage in activities of daily living (ADLs). Yoga may then also be responsible for increased in mood states, increased in feelings of efficacy and personal control, and improved cognitive functioning, perhaps in the form of increased attention (Bethany-Bonura, 2007). The ACSM has modified the standards to adjust for senior fitness by suggesting extended warm up and cool down times and monitoring intensity by Borg's Rating of Perceived Exertion (RPE) rather than heart rate (Borg, 1982 in ACE 1996).

The practice of yoga includes breathing techniques, meditation, progressive muscle relaxation or physical poses (Berger & Owen, 1988, 1992; Kaliappan & Kaliappan, 1992; Garfinkel et al., 1994; Sahajpal & Ralte, 2000; Arambula, Peper, Kawakami, & Gibney, 2001; Vempati & Telles, 2002; Waelde, Thompson, Gallagher-Thompson, 2004). Yoga is physical activity whereby participants move through positions that are held statically and increase flexibility and strength. Yoga requires controlled breathing and an internal focus to increase awareness of one's mental and physical states. Yoga is sub-maximal, but can be challenging in that there is a dual task element requiring focus on posture, to include lifting the breast bone, keeping the head erect, eyes forward, shoulders back with a light pinching of shoulder blades, and tightened abdominal muscles and buttocks (NIHORBD, 2005). There are hundreds of yoga exercise poses called “asana” (Bell, 1999; Shaw, 2001), and all poses are modifiable to work with the senior population taking into account the beginner status, decreased flexibility, and decreased muscle strength (ACSM, 2003).

Yoga requires the participant to engage in focused effort to complete the poses and control his or her body. The participant must focus on all of the previously mentioned aspects of postural control while controlling breathing and positioning her limbs appropriately for the given pose. This differs from other forms of exercise in that other exercise can be employed with no need for extensive cognitive involvement. For example, exercise on a stationary bicycle requires no additional thought past setting the equipment for use as the circular movement of the legs is nearly automatic. The focus aspect of yoga is important in the participant’s awareness of the environment and awareness of self-control ability.

As there is a meditative component to yoga and some research combines yoga and meditation into one practice, a definition of meditation is warranted. Meditation is defined as a state of restful alertness (Alexander et al., 1989). The meditative state is achieved by allowing ones thoughts and attention to turn inward. Sometimes to aid the practitioner to focus and drown out distractions from the environment a mantra or meaningless sound is emitted. The commonly heard sound is “ohm.” Additionally, progressive muscle relaxation also may be a component of yoga practice. Jacobson 1938 as cited in Broota & Sanghvi, 1994) developed the technique that starts at one end of the body, usually the feet, and systematically relaxes one muscle group after another moving up the body toward the head. The practitioner tenses the muscle group while inhaling a deep long breath and then relaxes the muscle group as he/she exhales in a controlled fashion very slowly. Progressive muscle relaxation may be done as part of a yoga class format, usually at the end, or it may be completed independently.

Yoga and Fall Risk Factors

Yoga benefits have been the subject of many studies. Broadly, yoga has been found to improve many aspects of physical health and psychological health. Within physical health, studies have claimed improvement in cardio health (Schneider et al., 1995), musculoskeletal health (Raub, 2002), respiratory health, reproductive health, cancer, and Human Immunodeficiency Virus/Acquired Immune deficiency syndrome (HIV/AIDS). Within psychological health, studies have reported improvement in stress (Berger & Owen, 1988, 1992), depression (Janakiramaiah et al., 2000), post traumatic stress, pain management (Garfinkel et al., 1994), and sleep (Sahajpal & Ralte, 2000). Certainly such a wide array of claims must have some merit. However, with the limitations in yoga research, one must be cautious in interpreting results. Weaknesses have been found in the methods structuring yoga research.

Generally, questions have been raised about the lack of review boards, small sample sizes, variability in the yoga intervention, participant bias, and lack of controls (Walsh & Shaprio, 2006). Yoga has many forms and can be modified in an infinite number of ways. In this way if yoga intervention protocols are not delineated specifically, it is difficult to replicate previous findings. Participant bias is thought to be a limitation because people who participate in yoga studies tend to be interested in the topic already and want to see its success. Experimental groups are not always contrasted with a non-experimental control group, the gold standard when showing empirical evidence of experimental success. In terms of sample size, larger samples allow for broader generalization and more statistical power. Depending on the participants in exercise interventions, smaller size groups may contribute to safer delivery of the intervention.

Other fall risk factors. Studies have been conducted using yoga and mindfulness meditation as an intervention to modify a variety of fall-related risk factors in older adults such as chronic osteoarthritis (Garfinkel et al., 1994), hypertension (Schneider et al., 1995), and depression (Janakiramaiah et al., 2000; Sahajpal & Ralte, 2000). To date, no studies have been found that examine yoga exercise specifically as an intervention to decrease fall risk factors. Yoga studies of balance/postural control, musculoskeletal health, confidence in ability/self-efficacy and cognitive impairment have been conducted but not in the elderly population, and for decreased risk of falling. Following is a brief review of yoga studies that are related to these fall risk areas.

Cognitive impairment. Yoga research has been conducted in an effort to improve cognitive functioning but with mixed results. In children, yoga has been reported as a tool that improved concentration, attention, academic performance, and intelligence (Barnes & Nagarkar, 1989; Uma, Nagendra, Nagarathna, et al. 1989; Yellin, 1983; Zipkin, 1985). Yellin (1983) found increased cognitive performance and increased reading ability in developmentally delayed and mentally retarded children. Success was reportedly due to the increase of blood flow from body movement and fresh oxygen from breathing techniques. Critically speaking, blood flow and oxygen intake can be improved with any physical activity. Zipkin's (1985) review reported handicapped children benefited from yoga sessions over children in an exercise group by improved concentration, increased relaxation, and communication. Barnes and Nagarkar (1989), working with typically developing children also found an increase in concentration ability and relaxed mental state. The children practiced yoga several hours each week for four months. The Barnes's study, however, lacked a control group. In a large, one year controlled study with random assignment of mentally retarded child participants, yoga participation showed cognitive improvement in concentration and attention span (Uma et al., 1989).

Vishal, Singh and Madhu (1987) in a single group design found that short term memory improved in adults males practicing yoga over a six-month period of time. Sharma, Yadava, and Hooda, (2005) found support for short-term intervention in a 10 day yoga workshop, which showed enhanced ability to concentrate in participants in post treatment scores. Maintenance of enhanced concentration is likely to need maintenance of the intervention participation. Yet, another larger controlled study reported that three months of individual yoga and meditation practice did not produce any memory or cognitive improvement in the experimental group over the control (Yuille & Sereda, 1980). The Yuille & Sereda maintained that effects were non-existent because of reduced participation. Newberg et al. (2001) attempted to explain the reasons cognitive functioning may improve with yoga and/or meditation practice. The study utilized neuroimaging technology, single photon emission computed tomography (SPECT). Findings indicated yoga participants had increased frontal lobe activity and decreased parietal lobe activity. This type of brain activity is associated with increased attention and spatial awareness.

Of most interest, in terms of fall risk, is the effect of increased attention with yogic practice (Newberg et al., 2001). Cognitive impairment in the elderly as a risk factor for falling is largely based in the deficits on attention Shumway-Cook et al., 1997). Any attentional benefits gained from yoga may be helpful for fall prevention.

Fear and loss of confidence. In an effort to find evidence that yoga participation can increase self-efficacy and self-esteem, Cusumano and Robinson, (1993) conducted a study with female Japanese students. Two treatments, yoga and progressive relaxation control, were compared with pre and post treatment scores. While self-esteem increased for both groups, self efficacy did not. The limitation expressed by the researchers was short length of the study. The authors concluded that while the treatment made the participants feel better about themselves (i.e., higher self-esteem), the short treatment failed to affect self efficacy in the ability to perform yoga well. The authors suggested the students may not have felt they had mastered the procedures in just three sessions (Cusumano & Robinson, 1992).

A correlational study by Daubenmier (2005) estimated the relationships between the practice of yoga, self-objectification, and eating disorders. While eating disorders is less of a concern in the current literature review, long-term yoga practitioners, an average of six years, had self-objectification scores that indicated high competence based attributes (e.g. physical coordination, strength, and physical fitness).

Experiencing success in a yoga class may increase confidence and self-efficacy in the natural environment. More studies must aim at examining yoga effects in the elderly; specifically its effect on fear and self-efficacy.

Postural control and balance. Only a few studies have examined yoga as a treatment for musculoskeletal disorders in the elderly. Garfinkel et al. (1994) studied the effects of yoga on osteoarthritis and carpal tunnel syndrome in eight week programs. Both studies found significant improvement in pain management. The osteoarthritis study also showed improvement in range of motion and the carpal tunnel study showed improvement in strength.

Boehde and Porcari, (cited in Anders, 2005) is probably the best example of a study assessing the musculoskeletal effects of a yoga program. The American Council on Exercise (ACE) random and controlled study examined an eight-week program with participants, 33 years of age. The assessments for strength, flexibility, and balance were conducted pre and post treatment for both the experimental and control groups. Findings indicated that yoga had significantly improved the one-leg standing balance scores. Besides the obvious improvements yielded by practicing the variety of one-leg moves that are common in Hatha yoga, researchers maintain increases in proprioception and strengthening of the muscle in ankles and legs are part of the reason for better balance scores. However, these results are limited to this population at this time.

Luskin et al. (2000) suggested that future research of [eastern exercises] should test the long-term implications of practice by the elderly on disease prevention and should measure strength, balance, and flexibility as well as self-efficacy. Luskin goes on to state that there is ‘limited risk [in] these gentle forms of physical exercise pose for elderly person.’ (p.55).

Yoga versus Balance Training

Making a one to one comparison between the positions in a yoga class format (Shaw, 2001) and the exercises in a balance class format (Bovre, 2001) is not possible because of the different types of exercises. Standing positions in both yoga and balance training have a strength and flexibility training function, resulting in a large balance training effect because the activity of standing requires more of the postural control systems to activate. An example of a similar activity across both formats is the "tree pose" in a yoga class (Figure 3) and the one-leg stance in a balance training class (Figure 4). Essentially both exercises require the participant to stand on one leg while stabilizing the lower and upper body to maintain balance. In the one-leg stance the leg is bent at the knee so that the foot is raised behind. In the tree pose the knee is bent and raised to side so that the foot is resting on the opposite leg. In both positions the leg supporting the weight is engaging all the muscles of the leg and the muscles in the pelvis. The arms are relaxed at the sides for the one-leg stance and the palms are together in the center of the chest for the tree pose. With the knee to the side in the tree pose and arms pulled toward the center, there may be more challenge to lateral balance. Since the body is positioned similarly in the two positions, the difference in yoga is the focus on breathing while in the position. Verbal prompts guide the participant to breath in a slow, rhythmic pattern.

Figure 3: Tree pose

Figure 4: One-leg stance

Other standing positions in yoga consist of both strength and flexibility, sometimes separately but mostly simultaneously. For example, the warrior pose (Figure 5) is a lunge position whereby the buttocks and front and back thigh muscles of the bent leg are contracted and engaged. Additionally, the abdomen, lower back, upper back, shoulders and neck are engaged to maintain upright good posture. All of the muscles contracted and held in position are experiencing a strength training effect. The flexibility component of this pose is the extension of the inner thigh on the opposite leg. Other standing positions may be explained in a similar fashion. As mentioned before, in all yoga poses, once an appropriate position is established, participants are verbally prompted to breath appropriately.

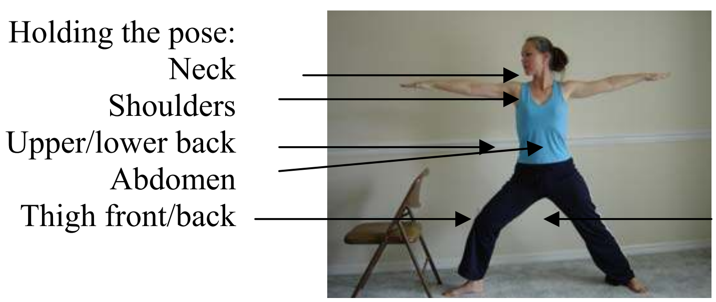


Figure 5: Warrior pose

Seated positions, whether in a chair or on the floor, are similar in the two class formats, yoga and balance training. Being seated requires less balance. Seated positions, in the balance training format, are for strength and flexibility training. Seated positions in yoga have a stronger flexibility component. Poses in yoga in the lying position are for flexibility and relaxation.

In both class formats, classes progress from easier to gradually more difficult positions or exercises. In yoga, the positions are chosen based on the muscle groups a particular pose works. For example, the superman pose, which primarily strengthens the lower back may be followed by the knee squeeze in order to work the opposing muscle group or stretch the group just worked.

Yoga Intervention and Supporting Theories

Cognitive Behavioral Theory. In Cognitive Behavioral Theory it is stated that the way a person thinks influences his behavior. It is also described as the mind-body interaction. Cognitive Behavioral theory may provide the framework explaining how yoga as an intervention may change fall risk behavior by learning new motor behavior, by attending to environmental cues that moderate new motor behaviors, and by changing the belief in one's ability to operate more efficiently on one's own environment. Yoga was found to be a successful mind-body therapy for the treatment of musculoskeletal disorders (Luskin et al., 2000) and increasing attentional ability (Newberg et al., 2001; Uma et al., 1989; Yellin, 1983). The effect of yoga on fear of falling was not yet studied; however, tai chi, another eastern exercise modality to yoga, was found to decrease fear and increase efficacy (Sattin et al., 2005; Wolf et al., 1996). Yoga studies showed its effect on increased efficacy (Cusumano & Robinson, 1992).

Observational Learning Theory. Learning is any relatively permanent change in behavior that can be attributed to experience (Coon, 2005). Higher learning involves thinking, knowing, understanding, and anticipation, and may include information, expectations, and perceptions. Bandura (1997) believed learning by observing a model allows the participant to see by example before beginning practice (in Coon, 2005). "By observing a model a person may be able to (1) learn new responses, (2) learn to carry out or avoid previously learned responses, (3) learn a general rule that can be applied to various situations" (Coon, 2005, p. 246). For observational learning to occur the learner must pay attention to the model, remember the behavior, and reproduce the behavior. If the learner is successful, he will receive verbal reinforcement for the response initially from the model, but later reinforcement may be in the form of self-efficacy (Bandura, 1997). Practice is necessary for a behavior to be learned and then become more automated (Schmidt & Lee, 2005). Postures learned in yoga and practiced may be generalized to the natural environment and thus, yoga may serve as a rehearsal to movement behaviors needed for balance recovery.

Self-efficacy Theory. According to Bandura (1995), "Self-efficacy is the belief in one's capability to organize and execute the courses of action required to manage prospective situations". Self-efficacy is gained by mastery experience, vicarious experience, verbal persuasion, and physiological states (Bandura, 1995). Yoga for older adults may allow the participants to enhance physical ability and subsequently improve self-efficacy. Improved physical abilities gained by practicing yoga and the older adult's belief in their ability may translate to performing new recovery behaviors to avert a fall. Self-efficacy increase may then be associated with fall prevention in the elderly.

Purpose of the Study

The purpose of this dissertation study was to evaluate the effects of traditional Hatha yoga (modified for older adults) on three fall risk factors, cognitive impairment, fear and decreased confidence, balance impairment, and lastly, awareness to the environment. If yoga can improve cognitive functioning, increase balance, reduce fear of falling, and increase confidence in ability, and increase environmental awareness, then it may be considered a BioPsychoSocial (BPS) intervention. BPS was suggested by Keysor and Jett (2000) as the most integrated comprehensive option for interventions in fall prevention. As the name would imply a BPS model for intervention includes a biological or physical component, a psychological (cognitive or behavioral) component, and social or environmental component. Yoga may fit this definition as an appropriate BPS intervention. As an exercise, yoga may produce physiological changes in the body, such as increased muscular strength and flexibility, as well as, changes to the postural control systems that increase balance. Psychologically, participants of yoga exercise may learn new postural control behaviors through modelling and repetition. Practice over time may increase muscle memory and have a rehearsal effect for random events that may cause falling. Additionally, yoga exercise may increase attention ability thereby increasing awareness to the environment and awareness of oneself in the environment. In the social-cognitive context, participating in yoga may increase physical ability, and thereby increase the participant's feeling of self-efficacy. Yoga classes may be in a group format and in that way may provide social support among older adults. Older adults in a group format may also be able to judge their abilities or learn by observing classmates.

Hypotheses

The hypotheses proposed for this study of yoga as an intervention for reducing fall risk factors were:

(1) Participants of the yoga intervention will show stronger improvement in physical fall risk factor than the balance training and the fall-risk awareness class interventions as indicated by:

a. Increased postural control

b. Increased steadiness

(2) Participants in the yoga intervention will show stronger improvement in psychological risk factors than the balance training and the fall-risk awareness class interventions as indicated by:

a. Increased attention

b. Increased visual search strategy

c. Increased confidence in balance ability

d. Decreased fear of falling

(3) Participants of the yoga intervention and the fall-risk awareness group will show greater improvement in their ability to recognize hazards in the environment than the balance group.

CHAPTER 2:

METHOD

Participants

Using the IRB Guidelines for projects involving physical exercise, the inclusion criteria included: participant's willingness to participate after full understanding of the elements and risks involved, completion of a health history form, and a signed informed consent form (Appendices A & B). Participants with the following conditions were excluded: advanced osteoporosis, hip replacement, glaucoma, Parkinson's disease, common occurrences of dizziness, or any surgery within the past year. Advanced osteoporosis was defined as the inability of the participant to place any weight on the lower body without the risk of bones breaking. Other medical conditions such as inner ear disturbance or high blood pressure were not considered to be conditions for exclusion.

Twenty six participants were recruited from among the current users of any of the activities sponsored by the hospital supported Health Happiness You (H2U) senior wellness program in Panama City, Florida. Eight participants discontinued in the course of the study leaving a total of 18 participants. The senior participants were female, between the ages of 65 – 86. All participants, through self-report, had a fall or near fall in the previous year. A brief description of the project was published in the H2U June and July 2007 newsletter to recruit participants. The beginning 26 participants were randomly assigned to one three groups: yoga exercise, balance training exercise, and control group.

Table 1
Participants of the study (N=18) Female, ages 65-86

Factor	Category	*f*
Age	65-69	3
	70-79	9
	80-86	6
Marital Status	Married	10
	Widowed	7
	Never married	1
Falls	Falls	9
(past 12 months)	Near fall	18

Setting

The setting was a hospital-supported rehabilitation center in Panama City, Florida. The center had a large multi–purpose physical therapy room. The room had chairs, various types of physical therapy equipment, a Neurocom Balance Master machine, and a raised surface (physical therapy mat). The temperature of the setting was in compliance with Guidelines for projects involving physical exercise adapted by the Institutional Review Board (IRB) of Florida State University, January 1989. Also in compliance with the guidelines, the primary researcher was certified in CPR and First Aid through the American Red Cross. For all assessments and interventions the lighting in the room was normal florescent lighting with the exception of the Environmental Awareness Test which included condition whereby the participants identifying poor lighting.

Florida State University Human Subjects Committee and Bay County Review Board approval was received prior to the beginning of the study (Appendices C & D). Participants were informed of their right to participate freely and stop participation at any time. For issues of privacy and confidentiality, the information obtained from the participant on the health history and the specific locations of the study were only available to the primary researcher and the doctoral defense committee. Information obtained during the course of the study remains (and will remain) confidential, to the extent allowed by law. Health history forms were filled out at the time of recruitment as information on the form establishes inclusion. Participants were then randomly assigned to one of the three groups.

Instrumentation

Performance Oriented Mobility Assessment (Tinetti, 1994, Appendix E). The static balance assessments were adapted from the Performance-Oriented Mobility Assessment (POMA; Tinetti, 1994). The 11 assessments adapted from the POMA included: standing balance, feet together (eyes open); standing balance, feet together (eyes closed); one leg standing balance, toe stand, heel stand, sitting down in a chair, arising from a chair, immediate standing balance after arising, 360 degree turn, reaching up, and bending over. Each POMA test score ranges from 0 – 2 points and the 11 tests used were combined for a maximum score of 22. For scoring of the POMA a correct position and complete steadiness was scored as 2 points, slightly incorrect and some unsteadiness was scored as 1 point, and unable to perform assessment was scored 0 points. POMA tests were completed with shoes.

Psychometric data for the POMA indicates reliability for all the individual maneuvers, $r = 0.50$. Face validity was determined by a consensus of physical therapists. Concurrent validity was determined by correlations between separate physical therapists' composite scores of assessments of balance, transfers, and gait ($r = .63$).

Pro Balance Master test (NeuroCom International, Inc. 1997, Appendix E). The Pro Balance Master System uses forceplate technology to measure center of gravity and sway. A forceplate is an instrument with subsurface sensors which can signal the magnitude and location of forces exerted on the surface (Neurocom, 1997). Center of gravity (COG) is a point in an object in which all its mass may be considered to be concentrated with respect to the pull of gravity. In normal erect standing posture, the center of gravity is located at the level of the hips and slightly forward of the ankle joints (Neurocom, 1997). Sway is the ongoing body movements that maintain a person's upright posture (Neurocom, 1997). The primary test from the Balance Master machine that was used for this study is the Limit of Stability (LOS). LOS is the maximum distance a person can lean in a given direction, measured in angular distance from vertical, without losing balance, thus if the COG passes 100% of the LOS boundary, a step or a reach must occur to re-establish a new base of support. The speed and direction of the COG movement vary. As such the LOS test has measures of reaction time, movement velocity, excursion distance, and directional control. Reaction time (RT) is the time in seconds between the signal to move and the initiation of movement. Movement velocity is the average speed of COG movement expressed in degrees per second, between 5% and 95% of the distance to the primary endpoint. Excursion is the distance traveled from the starting point of sway to the endpoint. Directional control is a comparison of the amount of movement in the intentional direction toward the target to the amount of extraneous movement away from the target.

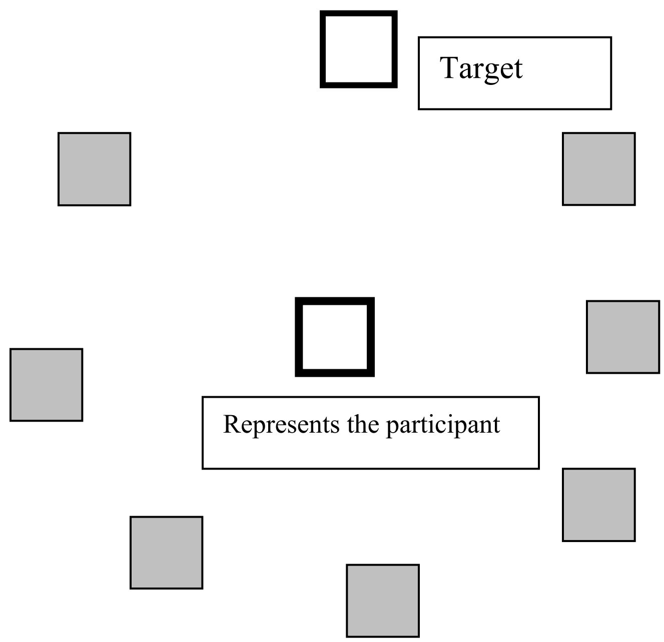


Figure 6: Computer screen image

The risks involved while using the Neurocom machine were associated with the process of stepping up onto the machine platform before testing and stepping down from the platform after testing. The Neurocom machine is equipped with a harness that was placed on the participant throughout the Neurocom testing procedures. The machine operator was always in a position to provide immediate support to the participant before, during, and after testing. Test-retest reliability of Limits of Stability testing has been established for the measures of directional control (*r* = .73), endpoint excursion (*r* = .92), and movement velocity (*r* = .85) (Hornyik & Harter, 2001).

Fear Efficacy Scale (FES, Tinetti, 1990; Appendix E). This scale was constructed as a measure of self-efficacy although the wording of the questions is not consistent with other self efficacy scales. The questions pertained to the falling of older adults during generally non-hazardous activities of daily living. Participants were asked how concerned they are about falling while performing 10 tasks of progressive difficulty in the home environment. These tasks are cleaning the house, getting dressed or undressed, preparing simple meals, taking a shower or bath, going to shop, getting in or out of a chair, going up or down stairs, walking around outside, reaching up or bending down, and answering the telephone. A four-point scale was used ranging from 1 (*not concerned at all*) to 4 (*very concerned*). An example question is, “How concerned are you about falling when you are getting dressed or undressed?”

The FES was evaluated for internal consistency and test-retest reliability (Jorstad, 2005), Cronbach alpha = .90 and r_{tt} = .71, respectively indicate sufficient reliability. Additionally, the FES has a concurrent validity with the Activities-Specific Balance Confidence Scale (ABC) scale of *r* = .84 and a convergent validity of *r* = -.76 with the Survey of Activities and fear of falling in the Elderly, fear of falling scale (SAFFE; Jorstad, 2005).

Activities-specific Balance Confidence Scale (ABC, Powell, 1995; Appendix E). The ABC assessed participants’ confidence levels in maintaining balance when they engage in 16 activities with increasing complexity. The difference of the ABC from the FES is that nine of the activities take place in a public setting. The scale ranges from 0% (*no confidence*) to 100% (*fully confident*) with no descriptors in between the two endpoints. Higher scores are associated with higher confidence levels. The ABC’s Cronbach alpha = .96, and r_{tt} = .71, respectively (Jorstad, 2005). The ABC has a concurrent validity with the FES scale, *r* = .84 and a convergent validity of *r* = .49 with the Physical efficacy scale (Jorstad, 2005).

Trail Making Test Trails 3 and 5 (Reynolds, 2002, Appendix E). The TMT was designed for the purposes of testing visual search, sequencing ability, and attention. The TMT Part A consisted of 25 randomly arranged sequential numbered circles (1-2-3-4…., etc) and the TMT

Part B consisted of 25 randomly arranged sequential numbers and letters in an alternating sequence (1-A-2-B-3-C…., etc). Test-retest reliability for the TMT was found to be $r_{tt} = .90$.

Walking Trail Making Test Part B (Alexander et al., 2005, Appendix E). The W-TMT Part B consisted of a 15-foot pathway with numbered and lettered 8-inch circles arranged sequentially. The distance between circles for both step length and width is +/- 10-inches of an averaged adult step length/width. A steadiness measure was assessed as the participant as they traverse the pathway. Steadiness Measure is operationally defined in a following section. The W-TMT was evaluated for test-retest reliability and ranged between (r = .90-.99).

Environmental Awareness Test (EAT; Principal investigator of the current study, Appendix E). The EAT was derived from the Dynamic Visual Assessment (DVA) (Ludt & Goodrich, 2002). The DVA was a contrived environment with three types of hazards, drop downs, e.g. curbs, obstacles, trash can, and overhangs, and tree branches. The participant was required to traverse the route, stop and, verbally identify the hazard. The DVA is believed to be an ecologically valid test by the authors of the study. In the current EAT, a room was contrived with 18 fall risk hazards. The measurement consisted of the correct number of hazards identified out the total number of hazards present.

Steadiness measure (Appendix E). Steadiness for each participant was measured during the POMA, the W-TMT, the Environmental Awareness Assessment, and during the interventions of Yoga and Balance Training. The purpose of this measure was to evaluate the participant's ability to perform the specific activities. During the assessments and interventions the observers looked for steadiness (2pts.), unsteadiness (1 pt.), and near falls or falls (0 pts.). Steadiness (Tinetti, 1986) was defined as performing the activity without any incident of unsteadiness, reaching out for a person or an object to regain stability. The definition of unsteadiness (Tinetti, 1986) was any instance a participant must reach out and place a hand on an object or a person, or must step forward, side, or back to maintain stability and standing. The definition of near fall (Sattin, 1992) was considered as any instance a participant's downward movement stops at a plane lower than the plane they started originally. A fall was defined as anytime a participant through downward movement ends resting on the floor (Sattin, 1992). Tinetti (1986) determined face validity of the steadiness operational definitions with a consensus of physical therapists. Concurrent validity of the definitions was correlated with separate physical therapists' assessment of balance, transfers and gait with an acceptable Pearson's coefficient of .63.

Falls self-report. The measure of actual falls consisted of a self-report by the participant and was monitored over the period of the study. Each week the participant was interviewed about any falls from the preceding week, their location, the activity when the fall occurred, and severity of fall (Campbell, 1997, Wolf et al., 2001, Appendix E). Calendars for each month were given to all participants to record falls during the baseline, intervention, and post-intervention (Campbell, 1997, Wolf et al., 2001, Appendix E).

Interventions

Yoga. A total of 13 yoga exercises (Appendix F) comprised the intervention. Yoga, defined in a previous section, is an eastern exercise modality that includes body positions, breathing techniques, and focus on postural control. The participants were led by instruction through the exercises. They were encouraged not to complete the exercises on their own. To avoid the difficulty of lowering and rising to and from the floor, a raised physical therapy mat was offered for the seated and lying poses and was utilized by one participant. All of the exercises were at a beginner level and modified for use with the senior population. Exercises were modified even further depending on the individual. All exercises were completed with the use of a chair for additional support if needed with the intention of reducing reliance on the support. Participants were asked to wear comfortable clothes that allowed for free movement to perform the exercises. The yoga exercises were taught in order, included instruction on appropriate breathing technique, and prompts to be aware of limb placement and postural control.

The yoga intervention was performed with the participants in a group of eight, two times per week lasting approximately 1 hour. The intervention phase was eight weeks in length. The yoga instructor was certified by the American Council on Exercise and had 12 years of experience teaching yoga. Each group of exercises was demonstrated and the participants were guided through them until they reached a level of comfort and ability, not mastery. Feedback for safety and effectiveness of the exercise was provided as needed.

The risks associated with modified yoga exercise were minimal. The possible risks include falling, broken bones or muscle injuries. These risks were minimized by the presence of trained staff in a safe setting. The yoga instruction was provided in small group setting. The participants were guided through each exercise given demonstration, instruction, and immediate feedback. The participants were strongly encouraged to work within their individual abilities. The participants were under constant observation by the instructor and observers at all times.

Both the instructor and the observer were responsible for providing immediate support to prevent falling in any instance of unsteadiness. An example of the class format is provided in Appendix F.

Balance training exercise. The balance training class consisted of five components: warm up, balance drills, lower body strength, upper body strength, and stretch and range of motion. All standing work was performed near a chair or a bar to provide support if needed. Upper body strength work was performed while seated. All exercises were at a beginner level and considered to be appropriate for the advanced age group. Participants were encouraged to work at their own level. They were asked to wear comfortable clothes to allow freedom of movement. The balance intervention was performed with the participants in a group of five, two times per week lasting approximately 1 hour. The intervention phase lasted eight weeks. The instructor was certified by the American Council on Exercise and had 13 years of experience teaching group exercise and had training in the older adult age group. The risks associated with balance training exercise were minimal. The possible risks include falling, broken bones or muscle injuries. An example of the class format is provided in Appendix F.

Fall risk awareness group. The awareness group served as a control group in that participants were not subjected to yoga and balance training. The group met two days per week for a period of eight weeks. The class lasted approximately 50 minutes to one hour. Seven topic areas were covered, one each week: fall risk factors, individual changes during aging, balance, home safety, posture, exercise, and walking/healthy feet. The class was a lecture and discussion format guided with handouts and worksheets. A sample of the syllabus is provided in Appendix F.

Design and Procedure

Study timeline. The study was conducted along a 25-week timeline with staggered starts for each intervention group, yoga, balance training, and risk awareness, respectively. Appendix G provides an illustration of the study timeline. Each group was in a four week baseline period prior to the start of intervention, eight weeks of intervention/classroom lecture, and a four-week follow-up for a total of 16 weeks contact time. The purposes of the staggered start for each intervention were multi-fold. First, the staggered start provided a multiple baseline across interventions to strengthen experimental control between groups as the participants had access to each other and may have discuss their individual classes. Next, in respect for the rehabilitation center's scheduling, staggering start times reduced conflict with center's regular patients.

Orientation sessions were held for each of the three intervention groups at staggered times along the study time line. At the orientation sessions participants signed the consent forms and were given the baseline assessments for the POMA, W-TMT, TMT, FES, ABC, and the Falls Self Report. The participants were also given a schedule for the intervention/lecture classes. The Neurocom balance master test was scheduled during the three groups' baseline periods and participants were tested based on availability of the rehabilitation facility. The Environmental Awareness Test (EAT) required special preparation and was set up at a multi-purpose classroom location. The EAT assessment was scheduled within each groups' baseline time periods.

In summary, within the 16 weeks of contact time, each group had the Neurocom test, TMT, and EAT assessed at baseline and post intervention. The W-TMT, FES, and ABC were tested every other week, at post intervention, and at the one-month follow-up. The POMA and Falls Self-Report were tested weekly from baseline through the intervention and at the one-month follow-up. Steadiness Measures of the interventions were assessed weekly during the intervention. Interventions were video taped for interobserver reliability scoring of steadiness measures.

Performance Oriented Mobility Assessment. In conducting the assessment, the examiner stood facing the participant and slightly to the side. Unsteadiness was expected and the examiner was ready to provide immediate support. Reliability observers for all testing procedures stood behind and to the right of the participant at a distance of no greater than 4 feet. The observers were positioned to not cause any distraction to the participant but be close enough to render assistance if needed. The examiner stood in a position outlined in the POMA protocols. The examiner demonstrated each test that required demonstration prior to testing the participant. For all tests, a chair was placed in a location in front of the participant to provide immediate support if needed.

The tools needed for these assessments were three stopwatches (1 for examiner, 1 for the observer, and 1 for the reliability observer), a clipboard, observation forms, pencils, and a chair to provide immediate support for the participant. The examiner had the primary responsibility of performing the assessment procedures and in this case was a certified trainer with experience in assessment procedures.

The POMA balance assessments were used prior to intervention as baseline indicators for the participant's balance ability. The measures were taken each week during the intervention before the exercises began for that day and then at one month post-intervention. Appendix E shows the POMA assessments.

For all tests, once the participant refused to perform the test for any reason other than a recently acquired medical condition, the test was scored as a zero. For new health conditions that prohibited testing, the procedure was delayed until the participant was fit again. If the condition persisted, the participant was dropped from the study.

NeuroCom Pro Balance Master test. The participant stepped onto the platform which contains the forceplate. The participant was placed securely in the harness assembly for safety. The participant's feet were adjusted to be placed properly on the forceplate. A computer monitor screen in front of the participant contained a figure representing the position of the participant in the center of a circle and eight targets located around the circle (Figure 6). The participant was asked to voluntarily sway in the direction of each target. A cursor coincided with the participant's movement as she swayed toward a given target. Each excursion toward a target was a trial. The trials were averaged into scores for forward, backward, right and left movement.

Fear Efficacy Scale, Activities-specific Balance Confidence Scale, and Trail Making Test Trails 3 and 5. These three assessments were pencil and paper style. Participants were seated at a table and read the protocols for each administration. The TMT was also timed and for both parts the participant connected the circles in order as rapidly as possible. A stopwatch was used to measure the time from start to completion.

Walking Trail Making Test Part B. The participant was asked to travel the length of the pathway as quickly and safely as possible while stepping on the circles in sequential order. In accordance with previously administered W-TMT, the participant was instructed to imagine the pathway as an icy surface with the numbered/lettered circles as safe places to step without slipping. A stopwatch was used to measure the length of time it took to travel the length of the pathway. The examiner was available any time the participant needed assistance or additional support.

Environmental Awareness Test. The participants were asked to walk through the environment and verbally identify the hazards. The measurement consisted of the correct number of hazards identified out the total number of hazards present. Observers were present for interobserver reliability and to assess steadiness (defined in the previous section) as the participant traveled through the environment.

Observation procedures. Observers were present for all sessions during baseline, intervention, and follow-up. The primary roles of observers was to score the POMA, EAT, and W-TMT and to assess steadiness measure for the yoga, balance training, W-TMT, and EAT. The observers were trained on the protocols and scoring for each test. The researcher demonstrated and explained the intervention procedures as well as provided pictures of the yoga and balance training exercises. Participants were observed continuously throughout the assessments and intervention procedures. For all procedures the observers sat in a position behind or to the side of the participants. Due to the nature of the participants' abilities and age, the observers were prepared to render assistance in the case of falls or near falls.

Data Analysis

Data was taken on three written assessments and five physical assessments. The written assessments were the Fear Efficacy Scale (FES), the Activity Specific Balance Confidence Scale (ABC), and the Trail Making Test (TMT). The physical assessments were the Neurocom balance master machine, the Performance Oriented Mobility Assessment (POMA), the Walking Trail Making Test W-TMT), the environmental awareness test (EAT), and a steadiness measure assessed during the intervention. Data were analyzed using the SPSS statistical package. To test the three hypotheses repeated measures multivariate analysis of variance (RM MANOVA) were conducted. To test hypothesis one, POMA scores were subjected to RM MANOVA with group (i.e. yoga, balance, and awareness) as a between subjects factor, and 13 trials as a within subjects factor. "Neurocom Balance master" scores were subjected to the same analysis, but with only two trials, pre and post intervention.

To test hypothesis two, Repeated-measures MANOVA were conducted on participants' TMT scores using pre, post and follow-up as three within subject measures and group as a between subject factor. Similarly W-TMT, FES, and ABC, were subjected to RM MANOVA with group as a between subject factor and seven trials (one pre-intervention, four during intervention, one post-intervention, and one follow-up) as within subject factor.

To test hypothesis three, EAT was subjected to RM MANOVA with only baseline and post measures as a within subjects factor and group as a between subjects factor. Means and standard deviations were calculated for each variable by group and trial and normality assumptions (i.e. skewness and kurtosis) were also examined to assure lack of violation or appropriate adjustment.

Descriptive statistical analysis was also conducted. Time, treatment, and treatment by time interaction effect sizes were calculated to investigate further effectiveness of the treatments. Time effect was calculated for each treatment by subtracting the pre intervention means from the post intervention means then dividing by the total mean standard deviation of the total pre intervention means, [(pre mean $_{yoga}$ – post mean $_{yoga}$)/$SD_{total\ pooled}$]. The treatment effect size was calculated for comparison of treatments by subtracting the total treatment mean of a group from the total treatment mean of another group then dividing by the standard deviation of the total pre intervention means, [(total treatment mean $_{yoga}$ – total treatment $_{balance}$)/$SD_{total\ pooled.}$]. Treatment by time interaction effect sizes was calculated by subtracting the pre means of the two groups to be compared from the post means of the groups and dividing by the standard deviation of the total pre intervention means [(yoga $_{post}$ – balance $_{post}$) – (yoga $_{pre}$ – balance $_{pre}$)/ $SD_{total\ pooled}$].

CHAPTER 3

RESULTS

Sampling issues, normality assumptions, and pre-intervention group comparisons

Of the 26 participants that began the study, 18 participants remained after 8 participants dropped from all groups through the course of the study. Two participants dropped from the yoga group due to injuries, one of which was sustained in a fall. Five participants dropped from the balance group, one from an injury sustained in fall, two for declining health, one because of a death in the family, and one participant because the balance training program was not challenging enough. One participant dropped from the control group because of declining health. The data collected and analyzed was from the remaining 8 participants in the yoga group, 5 participants in the balance-training group, and 5 participants in the control group. There were 16 class meetings per group lasting 45min – 1 hour. Overall attendance was 85%, 84%, and 90% for Yoga, balance training, and control groups, respectively.

Few violations of normality (i.e., *skewness* and *kurtosis* > |2.0|) were observed for the dependent variables to test hypothesis one, NCRT, NCV, NCEX, POMA, and SM. Additionally, there were few violations of normality for the remaining dependent variables for hypotheses two and three, TMT, WTMT, ABC, FES, and EAT.

Initial analysis of the pre-intervention assessments (i.e. baseline) using One-way ANOVA showed a significant difference in age between the yoga group and the control group, $F(2,15) = 3.158$, $p = .027$. The means and SDs of age were: Yoga, $M = 73.5$, $SD = 6.23$, Balance Training, $M = 74.80$, $SD = 3.11$, and Control, $M = 81.40$, $SD = 6.54$, respectively (see Table 2). LSD multiple pair-wise mean comparison showed that the Control group participants were on average older than Yoga and Balance Training groups' participants. ANOVA resulted in treatment significant effect for NCEX score (Neurocom excursion), $F(2,15) = 3.287$, $p = .025$. The corresponding means and SDs in NCEX were: Yoga, $M = 67.69$, $SD = 10.90$, Balance Training, $M= 65.50$, $SD = 10.97$, and Control, $M = 53.60$, $SD = 6.46$. (see Table 2). LSD multiple pair-wise mean comparison showed that the yoga group on average scored higher in NCEX than the balance training or control groups. Similarly, ANOVA on the pre intervention assessment of NCC score (Neurocom composite) resulted in significant treatment effect, $F(2,15) = 2.777$, $p = .032$. Means and SDs were: Yoga, $M = 71.88$, $SD = 8.90$, Balance Training, $M=$

68.00, *SD* = 8.03, Control, *M* = 61.40, *SD* = 3.44 (see Table 2). LSD multiple pair-wise mean comparison showed that the Yoga group participants scored on average higher in the NCC than Control group participants. ANOVA pertaining to the ABC pre intervention score (confidence in balance ability) resulted in significant treatment effect, $F(2,15) = 5.039$, $p = .010$. Means and SDs were: Yoga, *M* = 81.08, *SD* = 13.66, Balance Training, *M*= 81.13, *SD* = 13.89, Control, *M* = 57.62, *SD* = 14.86. (see Table 13). LSD procedure indicated that the Yoga group participants scored on average higher in the ABC than Control group participants. In all other pre intervention assessments the treatment mean values were not significantly different. (see Tables 3, 4, 10, 11, 12, & 14)

Hypotheses Testing

The first hypothesis assumed that participants of the yoga group would show stronger improvement in the physical fall risk factor than the balance training and the control groups' participants as indicated by an increase in postural control. Moreover, the yoga group participants were expected to show a stronger improvement in the physical fall risk factor than the balance training as indicated by an increase in steadiness. The hypothesis was tested using a Repeated Measures Analysis of Variance (RM MANOVA). The DVs used to test postural control differences were the variables measured by the Neurocom Balance Master Machine and the POMA. The Neurocom machine provided 3 subtests for Limits of Sway (LOS), reaction time (NCRT), velocity (NCV), max excursion points (NCEX), and a composite score (NCC). The second part of hypothesis one was tested using the SM scored during the yoga and balance training interventions. Means and *SD*s pertaining to the first hypothesis are presented in Tables 2, 3, and 4.

Neurocom. RM ANOVAs pertaining to Neurocom variables are presented in Table 5. Significant (p > .05) time effect was evident for NCV, Wilks' $\lambda = .760$, $F(1,15) = 4.725$, $\delta^2 = .240$, $p = .046$, and NCEX, Wilks' $\lambda = .432$, $F(1,15) = 19.748$, $\delta^2 = .568$, $p = .001$. The total mean differences in *ES* units for NCV and NCEX were *ES* = 0.49 and *ES* = 0.68, respectively. (see Table 6). Time by treatment effects were non-significant ($p > .05$) for all NC subtests (see Table 4). Treatment effects for the NCEX and NCC reached significance level, NCEX, $F(2,15) = .5.835$, $\delta^2 = .438$, $p = .013$, and NCC, $F(2,15) = 7.933$, $\delta^2 = .514$, $p = .004$. The treatment effect mean differences for NCEX (yoga - balance, *ES* = 0.20, yoga – control, *ES* = 1.35, and Balance - control *ES* = 1.56) and for NCC (yoga - balance, *ES* = 0.04, yoga – control, *ES* = 1.41, and

Balance - control *ES* = 1.38) Figure 7 represents the four NC tests and the three groups by time, though the treatment by time interaction was non-significant.

Table 2
Descriptive statistics for NC, pre- post by treatment

Variable	Treatment Groups							
	Yoga		*Balance Training*		*Control*		*Total*	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Pre and post								
NCRT1[b]	1.08	0.26	1.17	0.34	1.21	0.34	1.14	0.29
NCRT2	0.94	0.25	0.98	0.17	1.13	0.29	1.01	0.24
NCV1[a]	2.76	0.99	2.56	0.80	2.70	0.89	2.69	0.86
NCV2	3.34	0.95	3.20	0.72	2.68	0.70	3.12	0.83
NCEX1[a]	67.69	10.90	65.50	10.97	53.60	6.46	63.17	11.18
NCEX2	73.44	10.53	80.10	9.50	57.30	7.45	70.78	12.77
NCC1[a]	71.88	8.90	68.00	8.80	61.40	3.44	67.89	8.57
NCC2	73.75	5.90	77.00	4.36	60.00	9.17	70.83	9.39

a Increase in mean indicates improvement
b Decrease in mean indicates improvement
NCRT = Neurocom Reaction Time, NCV = Neurocom Velocity, NCEX = Neurocom Excursion, NCC = Neurocom Composite

POMA. RM ANOVAs pertaining to the POMA variable are presented in Table 5. Time, treatment, and time by treatment effects were non-significant ($p > .05$) for the POMA (see Table 5). Figure 7 represents POMA by treatment and time though non-significant ($p > .05$).

Table 3

Descriptive statistics for Performance Oriented Mobility Assessment by treatment

Variable	Treatment Groups							
	Yoga		*Balance Training*		*Control*		*Total*	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
POMA1 [a]	16.88	2.85	18.00	1.87	17.40	1.67	17.33	2.25
POMA2	18.38	1.60	18.20	2.59	17.40	1.82	18.06	1.89
POMA3	18.25	2.05	20.00	0.71	17.20	1.79	18.44	1.95
POMA4	18.13	3.09	20.00	1.58	17.80	2.95	18.56	2.73
POMA5	18.00	2.07	19.20	0.45	17.60	1.52	18.22	1.66
POMA6	19.63	1.30	20.40	1.34	18.40	1.82	19.50	1.58
POMA7	19.75	1.83	19.80	1.30	17.60	1.82	19.17	1.89
POMA8	20.25	2.19	20.40	0.55	17.80	1.64	19.61	2.00
POMA9	19.75	1.49	21.20	1.30	18.20	2.17	19.722	1.93
POMA10	20.50	0.92	20.80	1.10	19.00	2.12	20.17	1.50
POMA11	20.38	1.19	21.00	0.71	18.40	1.95	20.00	1.64

a Increase in mean indicates improvement

SM. RM ANOVA results pertaining to SM are presented in Table 5. Time, treatment, and time by treatment effects were non-significant ($p > .05$) for the SM (see Table 5). Figure 7 presents the yoga and balance treatment mean values by time.

Table 4

During intervention descriptive statistics for Steadiness Measure for Yoga and Balance Training

Variable	Treatment Groups					
	Yoga		Balance Training		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*
SM1[a *]	27.44	5.56	27.80	2.39	27.58	4.47
SM2	27.13	3.78	27.90	1.08	27.42	2.98
SM3	29.00	1.44	28.80	0.76	28.92	1.19
SM4	29.44	1.08	28.60	2.28	29.12	1.61
SM5	29.81	1.60	28.90	1.71	29.46	1.64
SM6	29.81	1.87	29.80	1.15	29.81	1.58
SM7	30.19	1.19	29.70	0.84	30.00	1.06
SM8	30.38	0.69	29.00	0.35	29.85	0.90

a Increase in mean indicates improvement in steadiness

*Steadiness Measure (SM) was assessed only on the Yoga and Balance Training (Treatment) groups

Table 5

RM ANOVA Results for Neurocom Balance Master, POMA, and Steadiness Measure

Variable	Effect	Wilk's λ	*F*	*df*	*p*	δ^2
NCRT						
	Time	.829	3.09	1,15	.099	.171
	Treatment	.903	.804	2,15	.466	.097
	Time by Treatment	.982	.135	2,15	.875	.018
NCV						
	Time	.760	4.725	1,15	.046*	.240
	Treatment	.959	.324	2,15	.728	.041
	Time by Treatment	.860	1.217	2,15	.324	.140
NCEX						
	Time	.432	19.748	1,15	.001*	.568
	Treatment	.562	5.835	2,15	.013*	.438
	Time by Treatment	.702	3.185	2,15	.070	.298
NCC						
	Time	.872	2.192	1,15	.159	.128
	Treatment	.486	7.933	2,15	.004*	.514
	Time by Treatment	.803	1.839	2,15	.193	.197

Significant $p > .05$

NCRT = Neurocom Reaction Time, NCV = Neurocom Velocity, NCEX = Neurocom Excursion, NCC = Neurocom Composite

POMA = Performance Oriented Mobility Assessment, SM = Steadiness Measure

Table 5- Continued

RM ANOVA Results for Neurocom Balance Master, POMA, and Steadiness Measure

Variable	Effect	Wilk's λ	*F*	*df*	*p*	δ^2
POMA						
	Time	.153	3.327	10,6	.077	.847
	Treatment	.712	3.029	2,15	.079	.288
	Time by Treatment	.095	1.349	20,12	.302	.692
SM						
	Time	.190	3.050	7,5	.119	.810
	Treatment	.990	.113	1,11	.743	.010
	Time by Treatment	.355	1.300	7,5	.400	.645

Significant $p > .05$

NCRT = Neurocom Reaction Time, NCV = Neurocom Velocity, NCEX = Neurocom Excursion, NCC = Neurocom Composite

POMA = Performance Oriented Mobility Assessment, SM = Steadiness Measure

Treatment by time interaction effects were non-significant ($p > .05$) for all DVs. The time by treatment means for the NC, POMA, and SM variables are shown in Figure 7. Though non-significant, the general trend of these variables as a function of treatment and time is of interest; specifically because of sample size limitations. On average, the participants in the 3 treatment groups remained stable across time in NCRT (top left graph-bottom lines). NCV for the yoga and balance groups have upward trends compared to the control (top left of Figure 7). The yoga and balance groups on average increased more in NCEX and NCC variables than the control group (top right; four lines). POMA (bottom left) increased in all 3-treatment groups, but the increase was noticed more in the yoga and balance groups over time. SM increased similarly in the yoga and balance groups over time.

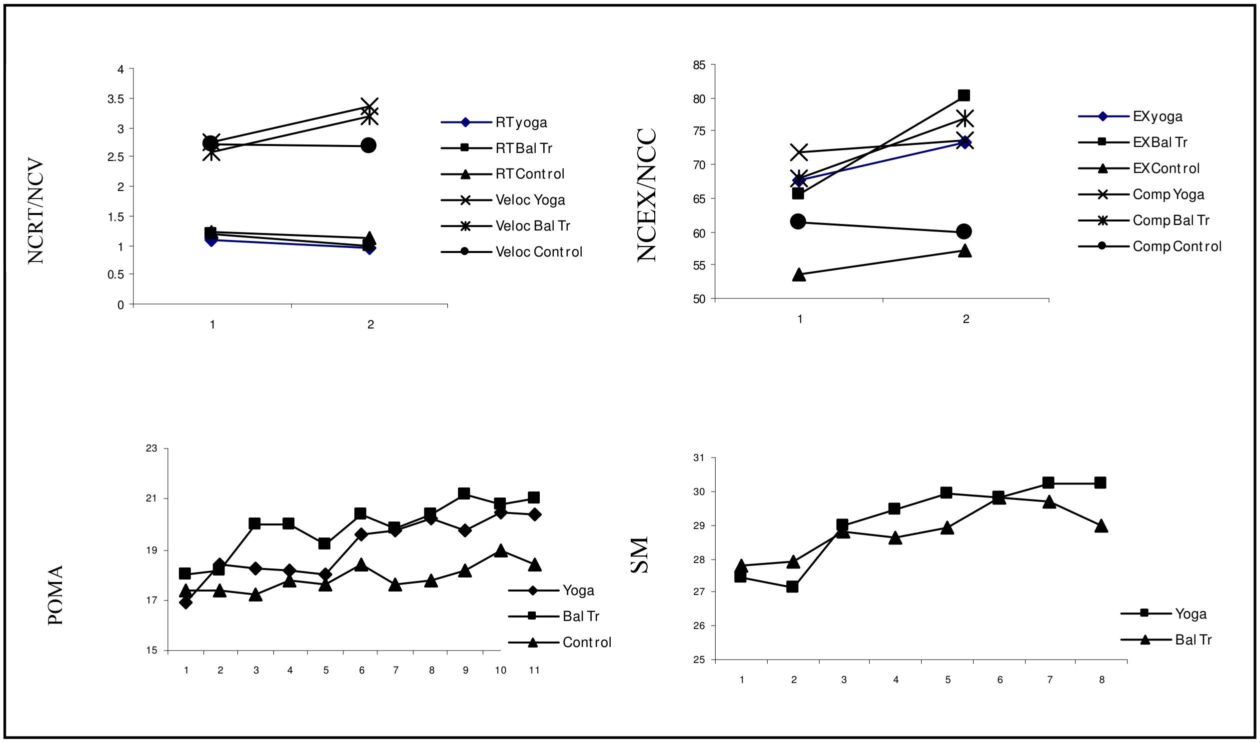


Figure 7. Means for three treatment groups by time for NC subtests, Performance Oriented Mobility Assessment, and Steadiness Measure. NC subtests, pre and post intervention (data points 1 and 2, respectively), POMA pre intervention (1), intervention (2-9), post intervention (10), and Follow up (11), and SM pre intervention (1), intervention (2-6), post intervention (7), and Follow up (8).

Descriptive Statistics Pertaining to the First Hypothesis

ES values were calculated for the dependent variables pertaining to the first hypothesis. NCRT, NCV, NCEX, and NCC subtests were performed only at pre and post intervention. POMA ES values were calculated across pre-intervention, intervention, post intervention, and follow up (see Tables 6 & 7). The *ES* values were calculated so that a positive value indicates improvement and a negative value indicates a decline in postural control. The NC pre-post interventions *ES*s for each of the 3 treatment groups are presented in Table 6. Generally, both yoga and treatment groups improved over the control group, and the balance group improved more than the yoga group. However, these differences were non-significant.

*ES*s consistently showed Balance Training group participants improved more in all the NC subtests over the yoga group (see Table 6). Differences were smaller for the NCRT for all three groups, 0.45, 0.66, and 0.31 for Yoga, Balance and Control groups, respectively. The NCV subtest showed Yoga and Balance Training resulted in similar *ESs* (0.67 and 0.74, respectively), and both were greater then the control *ES* (-0.02). Balance Training resulted in the greatest change from pre to post intervention in the NCEX subtest (*ES* = 1.30) and NCC (*ES* = 1.05) than both the yoga treatment (NCEX *ES* = 0.52, and NCC *ES* = 0.22), and the control group (NCEX *ES* = 0.32, and NCC *ES* = -0.16).

SM *ES*s are shown in Table 6. SM was assessed during intervention in participants of the yoga and balance treatment only. The *ES*s indicate that Yoga participants on average showed greater SM improvement (*ES* = 0.66) the Balance Training participants (*ES* = 0.27).

ESs for the POMA assessments showed Yoga participants improved more from the pre to post intervention (*ES* = 1.61), and from pre intervention to follow up (*ES* = 1.56) than the Balance Training (pre to post intervention, *ES* = 1.24 and pre intervention to follow, *ES* = 1.33), and the control group (pre to post intervention, *ES* = 0.71, and the pre intervention to follow up *ES* = 0.71). During Intervention *ES* was calculated by averaging the POMA2 – 9 scores (see Table 7). Balance Training participants improved performance in the Intervention time period (*ES* = 1.33) more than the Yoga group participants (*ES* = 0.61). From post intervention to follow up (a four week period without treatment) The 3 groups showed little improvement or decline from the post to the follow up period. *ES*s for Yoga, Balance, and Control treatment groups were -0.05, *ES* = 0.09, and -0.27, respectively. (see Table 7)

Table 6

ESs for Neurocom subtest by treatment and time

Variables	*Pre to Post intervention ***ES*
NCRT	
Yoga	0.48
Balance	0.66
Control	0.31
Overall	0.45
NCV	
Yoga	0.67
Balance	0.74
Control	-0.02
Overall	0.49
NCEX	
Yoga	0.52
Balance	1.30
Control	0.32
Overall	0.68
NCC	
Yoga	0.22
Balance	1.05
Control	-0.16
Overall	.34
	During intervention
SM***	
Yoga	0.66
Balance	0.27
Overall	0.51

* NC was assessed only at Pre and Post intervention.

** *ES*s were calculated so that a positive number indicates improvement.

*** Steadiness Measure *ES*s only during intervention with yoga and balance

NCRT = Neurocom Reaction Time, NCV = Neurocom Velocity, NCEX = Neurocom Excursion, NCC = Neurocom Composite

Table 7

ESs for Performance Oriented Mobility Assessment by treatment and time

Variables	Pre to Post intervention *ES***	During Intervention* *ES***	Pre intervention to Follow up *ES***	Post intervention to Follow up *ES***
POMA				
Yoga	1.61	0.61	1.56	-0.05
Balance	1.24	1.33	1.33	0.09
Control	0.71	0.35	0.71	-0.27
Overall	1.26	0.74	1.19	-0.08

**ES*s for POMA during intervention were calculated with the average of POMA2 – 9 (see Table 3)

***ES*s were calculated so that a positive number indicates improvement.

Mean differences for the NC subtests, POMA, and SM, were calculated for time by treatment interaction, and were compared for changes over time (Table 8 & 9). In all NC tests across all time periods yoga showed less improvement than the Balance Training group. However, in the POMA, yoga showed a greater effect over the Balance Training group. Yoga and the Balance Training groups both consistently showed improvement over the Control.

The SM was a measure specifically for steadiness within the exercise treatments only. The control group did not have an exercise intervention. The SM was assessed only during the intervention of yoga and balance. Time by treatment interaction resulted in *ES* = 0.39, indicating that yoga had a greater effect over balance training.

Table 8

ES for treatment by time interaction for NC and SM

Variable	Pre to Post intervention
NCRT	
Yoga vs. Balance	-0.21*
Balance vs. Control	0.35
Yoga vs. Control	0.14
NCV	
Yoga vs. Balance	-0.07
Balance vs. Control	0.76
Yoga vs. Control	0.70
NCEX	
Yoga vs. Balance	-0.79
Balance vs. Control	0.98
Yoga vs. Control	0.19
NCC	
Yoga vs. Balance	-0.83
Balance vs. Control	1.21
Yoga vs. Control	0.38
SM**	During intervention
Yoga vs. Balance	.39

* A positive number indicates greater improvement of the first group over the second group and a negative number indicates the second group showed greater improvement.
** SM was assessed only during the intervention period of Yoga and Balance Training
NCRT = Neurocom Reaction Time, NCV = Neurocom Velocity, NCEX = Neurocom Excursion, NCC = Neurocom Composite

Table 9

ES for treatment by time interaction for Performance Oriented Mobility Assessment

Variable	Pre to Post intervention	Pre intervention to Follow up	Post intervention to Follow up
POMA			
Yoga vs. Balance	0.36*	0.22	-0.14
Balance vs. Control	0.53	0.89	0.36
Yoga vs. Control	0.90	1.11	0.21

* A positive number indicates greater improvement of the first group over the second group and a negative number indicates the second group showed greater improvement.

Summary of Analysis testing the first Hypothesis

The first hypothesis stated that participants of the Yoga group would show stronger improvement in the physical fall risk factors than the balance training and the control groups as indicated by an increase in postural control. Statistical analysis did not to support this assertion. Participants exposed to Yoga treatment did not differ from participants of the Balance Training or Control groups in the postural control after treatment. Furthermore, Balance Training participants did not show any statistically significant improvement over the control group participants. All participants improved over time in NCV and NCEX.

Descriptive analysis in the form of *ES* indicated that Balance Training was more effective than yoga for the NC subtests, but that Yoga was more effective than Balance Training for the POMA. Both Yoga and Balance Training consistently showed greater improvement than the Control group.

Hypothesis one further stated that the yoga group would show a stronger improvement in the physical fall risk factor than the balance training group as indicated by an increase in steadiness. The Yoga group did not show the improvement was significantly higher than the Balance Training for the SM. However, *ES* indicated that Yoga had a stronger *ES* over time in steadiness over Balance Training. Both groups exhibited improvement over time. Although, hypothesis one was not supported statistically, and thus the null hypothesis is retained, the time effect means are important for further considerations.

Analysis of Variables for Hypothesis Two

Hypothesis two stated participants in the yoga group would show stronger improvement in psychological risk factors than the Balance Training and Control groups as indicated by an increase in attention, visual search strategy, confidence in balance ability, and a decrease of fear of falling. The hypothesis was tested using RM ANOVAs with time as the within subject factor and treatment as the between subjects factor. A test for mean equality of the groups at the pre-intervention assessment for all dependent variables revealed that the yoga participants were significantly ($p < 05$) higher than the participants in the control for the ABC variable ($M = 81.08$, $SD = 13.66$ vs. $M = 57.62$, $SD = 14.86$, respectively). In all other variables for hypothesis two, mean differences were non-significant ($p > 05$). Visual search strategies were assessed by the Trail Making Test (TMT), the Walking Trail Making Test (WTMT), and the Environmental Awareness Test (EAT). Confidence in balance ability was assessed using the ABC, and fear of falling was assessed by the FES. Means and SDs pertaining to the second hypothesis are presented in Tables 10, 11, 12, 13, and 14.

TMT. RM ANOVAs effects pertaining to TMT are presented in Table 15. Significant ($p < .05$) time effect was evident for TMT, Wilks' $\lambda = .303$, $F(2,14) = 16.113$, $\delta^2 = .697$, $p = .001$. *ES* for TMT across the 3 groups was 2.52. Treatment and time by treatment effects were non-significant ($p < .05$) for the TMT (see Table 15). Figure 8 represents the three group's means by time.

Table 10
Descriptive statistics for Trail Making Test by treatment

Variable	Treatment Groups							
	Yoga		Balance Training		Control		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
TMT1[b]	164.00	61.81	199.00	87.84	179.80	38.48	178.11	62.93
TMT2	147.88	39.05	153.80	36.07	166.00	23.87	154.56	33.59
TMT3	125.75	28.45	144.80	40.73	145.60	29.11	136.56	31.97

b Decrease in number indicates improvement

WTMT. RM ANOVAs pertaining to WTMT are presented in Table 15. Time, treatment, and time by treatment effects were non-significant ($p > .05$) for the WTMT. Figure 8 represents WTMT by treatment and time though non-significant (p > .05).

Table 11

Descriptive statistics for Walking Trail Making Test by treatment

Variable	Treatment Groups							
	Yoga		Balance Training		Control		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
WTMT1[b]	151.50	47.71	133.20	33.84	160.80	23.39	149.00	38.11
WTMT2	103.75	28.81	117.00	35.85	164.20	56.84	124.22	45.69
WTMT3	98.25	17.74	142.20	51.21	144.20	38.81	123.22	40.37
WTMT4	105.63	30.44	125.00	43.11	138.60	24.41	120.17	34.14
WTMT5	119.88	48.79	116.20	27.67	137.00	42.49	123.61	40.75
WTMT6	110.50	44.38	108.60	31.60	129.20	30.22	115.17	36.63
WTMT7	95.38	30.94	102.80	39.32	134.40	34.98	108.28	36.52

b Decrease in mean indicates improvement

EAT. RM ANOVAs pertaining to the EAT variable are presented in Table 15. Time, treatment, and time by treatment effects were non-significant ($p > .05$) for the EAT Figure 8 represents EAT by treatment and time though non-significant (p > .05).

Table 12

Descriptive statistics for Environmental Awareness Test, pre- post by treatment

Variable	Treatment Groups							
	Yoga		Balance Training		Control		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Pre and post								
EAT1[a]	11.13	2.48	11.40	1.14	11.40	1.34	11.28	1.81
EAT2	11.50	1.85	11.20	1.64	12.20	0.45	11.61	1.50

a Increase in mean indicates improvement in steadiness

ABC. RM ANOVA pertaining to the ABC is presented in Table 15. Significant time effect was evident for ABC, Wilks' $\lambda = .251$, $F(6,10) = 4.967$, $\delta^2 = .749$, $p = .013$. (see Table 15).

The total mean difference was *ES* = 4.51. Significant treatment effect, $F(2,15) = 5.110$, $\delta^2 = .405$, $p = .020$ was obtained. The standardized treatment effect mean differences across time were: yoga - balance, *ES* = 0.09, yoga – control, *ES* = 1.23, and Balance - control *ES* = 1.31. Time by treatment effect was non-significant. (see Table 15) Figure 8 represents the three treatment groups by time.

Table 13

Descriptive statistics for Activity-specific Balance Confidence scale by treatment

Variable	Treatment Groups							
	Yoga		Balance Training		Control		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
ABC1[a]	81.08	13.66	81.13	13.89	57.62	14.86	74.58	17.10
ABC2	83.20	14.47	80.63	11.22	67.55	16.87	78.14	15.15
ABC3	79.46	19.74	84.00	8.78	59.93	17.87	75.30	18.80
ABC4	82.50	14.22	82.75	6.93	70.00	15.61	79.10	13.62
ABC5	83.67	19.75	89.13	6.77	64.94	14.89	79.99	17.92
ABC6	86.57	15.59	87.26	10.02	52.63	21.06	77.33	21.83
ABC7	87.43	14.98	89.25	7.70	64.38	20.18	81.53	17.96

a Increase in number indicates improvement

FES. RM ANOVA pertaining to the FES is presented in Table 15. Significant ($p < .05$) time effect was evident for FES, Wilks' $\lambda = .315$, $F(6,10) = 3.618$, $\delta^2 = .685$, $p = .036$, resulting in *ES* = 2.24 across the 3 groups. Treatment and time by treatment effect were non significant ($p > .05$). (see Table 15) Figure 8 represents the three groups by time.

Table 14
Descriptive statistics for Fear Efficacy Scale by treatment

Variable	Treatment Groups							
	Yoga		Balance Training		Control		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
FES1[b]	1.45	0.60	1.66	0.94	1.97	0.43	1.66	0.69
FES2	1.43	0.67	1.53	0.49	1.86	0.49	1.58	0.57
FES3	1.35	0.61	1.64	0.58	1.75	0.57	1.54	0.58
FES4	1.29	0.48	1.34	0.30	1.64	0.61	1.40	0.48
FES5	1.29	0.51	1.29	0.28	1.64	0.53	1.39	0.46
FES6	1.25	0.45	1.31	0.21	1.66	0.70	1.38	0.50
FES7	1.26	0.47	1.18	0.10	1.60	0.50	1.33	0.42

b Decrease in number indicates improvement

Table 15
RM ANOVA Results for TMT, WTMT, ABC, FES, and EAT

Variable	Effect	Wilk's λ	*F*	*df*	*p*	δ^2
TMT						
	Time	.303	16.113	2,14	.001*	.697
	Treatment	.938	.493	2,15	.621	.062
	Time by Treatment	.895	.397	4,28	.809	.540
WTMT						
	Time	.384	2.669	6,10	.082	.616
	Treatment	.787	2.029	2,15	.166	.213
	Time by Treatment	.364	1.098	12,20	.412	.397

Significant $p > .05$
TMT = Trail Making Test, WTMT = Walking Trail Making Test, ABC = Activity-specific Balance Confidence test, FES = Fear Efficacy Scale, EAT = Environmental Awareness Test.

Table 15- Continued

RM ANOVA Results for TMT, WTMT, ABC, FES, and EAT

Variable	Effect	Wilk's λ	*F*	*df*	*p*	δ^2
ABC						
	Time	.251	4.967	6,10	.013*	.749
	Treatment	.595	5.110	2,15	.020*	.405
	Time by Treatment	.317	1.294	12,20	.295	.437
FES						
	Time	.315	3.618	6,10	.036*	.685
	Treatment	.870	1.122	2,15	.351	.130
	Time by Treatment	.481	.737	12,20	.702	.307
EAT						
	Time	.971	.442	1,15	.516	.029
	Treatment	.972	.218	2,15	.806	.028
	Time by Treatment	.961	.308	2,15	.739	.039

Significant $p > .05$

TMT = Trail Making Test, WTMT = Walking Trail Making Test, ABC = Activity-specific Balance Confidence test, FES = Fear Efficacy Scale, EAT = Environmental Awareness Test.

Descriptive statistics pertaining to the second hypothesis

ES values were calculated for the dependent variables pertaining to the second hypothesis. (see Tables 16, 17, & 18) Generally, all groups improved over time in TMT, WTMT and the FES, but yoga group participants improving more in the WTMT. The Balance Training group improved more in the FES.

Time (pre-post) effect sizes for TMT showed better improvement of the yoga treatment (*ES* = 0.26) over the control group (*ES* = 0.22), but lower improvement of yoga over the Balance Training treatment (*ES* = 0.72). Balance Training (*ES* = 0.86) continued to show improvement over yoga (*ES* = 0.61) and the control (*ES* = 0.54) at the pre=intervention to follow up assessment. (see Table 16)

Table 16
Effect sizes for Trail Making Test by treatment and time

Variable	Pre to Post intervention *Effect Size**	Pre intervention to Follow up *Effect Size**	Post intervention to Follow up *Effect Size**
TMT			
Yoga	0.26	0.61	0.35
Balance	0.72	0.86	0.74
Control	0.22	0.54	0.32
Overall	0.37	0.66	0.29

* Percent and Effect size were calculated so that a positive number indicates an improvement.
** TMT was not assessed during intervention.

The yoga participants showed the highest positive change in WRMT for pre/post, *ES* = 1.08, and pre intervention to follow up, *ES* = 1.47, compared to balance training, ES = 0.65 and 0.80, respectively, and control participants, ES = 0.83 and 0.69, respectively. Balance training participants showed the strongest effect for FES; changes at all time periods exceeding the other treatment groups (pre to post intervention, *ES* = 0.52, during intervention, *ES* = 0.36, pre intervention to follow up, *ES* = 0.72, and post intervention to follow up, *ES* = 0.19. The Control group *ESs* were, 0.46, 0.33, = 0.55, *and* 0.09, respectively, and the yoga ESs were: 0.30, *ES* = 0.21, 0.28, and -0.01, respectively. For ABC, balance training resulted in the highest positive change over the yoga and control group in all time periods pre to post intervention, *ES* = 0.36, during intervention, *ES* = 0.50, pre intervention to follow up, *ES* = 0.48, and post intervention to follow up, *ES* = 0.12. Yoga showed greater effect in the pre to post intervention, *ES* = 0.32, over the control *ES* = 0-0.29. There was a large effect for the control group in the last time period, post intervention to follow up *ES* = 0.69. (see Table 17)

Table 17
Effect sizes for WTMT, ABC, and FES by treatment and time

Variables	Pre to Post intervention *Effect Size**	During Intervention *Effect Size**	Pre intervention to Follow up *Effect Size**	Post intervention to Follow up *Effect Size**
WTMT				
Yoga	1.08	-0.42	1.47	0.40
Balance	0.65	0.02	0.80	0.15
Control	0.83	0.71	0.69	-0.14
Overall	0.89	0.02	1.07	0.18
ABC				
Yoga	0.32	0.03	0.37	0.50
Balance	0.36	0.50	0.48	0.12
Control	-0.29	-0.15	0.40	0.69
Overall	0.16	0.11	0.41	0.25
FES				
Yoga	0.30	0.21	0.28	-0.01
Balance	0.52	0.36	0.72	0.19
Control	0.46	0.33	0.55	0.09
Overall	0.42	0.28	0.49	0.07

Percent and Effect size were calculated so that a positive number indicates an improvement.
WTMT = Walking Trail Making Test, ABC = Activity-specific Balance Confidence test, FES = Fear Efficacy Scale

The EAT was measured only at pre and post assessment. The control group (*ES* = 0.44) exceeded Yoga (*ES* = 0.20) and Balance Training (*ES* = -0.11) (see Table 18)

Table 18
Effect sizes for Environmental Awareness Test by treatment and time

Variables	Pre to Post intervention Effect Size*
EAT**	
Yoga	0.20
Balance	-0.11
Control	0.44
Overall	0.18

* Percent and Effect size were calculated so that a positive number indicates an improvement.
** EAT assessed only pre and post intervention

Effect sizes showed Balance Training as having the greatest effect sizes over the yoga and control groups in TMT, ABC, and FES (all time periods). Yoga treatment resulted in larger ES over the Balance and Control groups in the WTMT and over the control group in the TMT and ABC. The Control treatment resulted in larger effects over yoga in the FES and over the Balance Training group only in the EAT.

A comparison of the mean differences for time by treatment interaction was calculated for all groups (Table 19, 20, and 21). The Yoga treatment resulted in greater effect over the balance training treatment in the WTMT and in the EAT. Yoga effects were smaller when compared to the balance training group in the TMT, ABC and the FES. The Control group showed the greatest effect over both the yoga group and the Balance Training group in the EAT.

Table 19

ES for treatment by time interaction for Trail Making Test

Variable	Pre to Post intervention	Pre intervention to Follow up	Post intervention to Follow up
TMT**			
Yoga vs. Balance	-0.46*	-0.25	0.21
Balance vs. Control	0.50	0.29	-0.18
Yoga vs. Control	0.04	0.06	0.03

*A positive number indicates greater improvement of the first group over the second group and a negative number indicates the second showed greater improvement.
**TMT not assessed during the intervention.

Table 20

ES for treatment by time interaction for WTMT, ABC, and FES

Variable	Pre to Post intervention	During Intervention	Pre intervention to Follow up	Post intervention to Follow up
WTMT				
Yoga vs. Balance	0.43*	-0.44	0.67	0.24
Balance vs. Control	-0.18	-0.69	0.11	0.29
Yoga vs. Control	0.25	-1.14	1.27	0.53
ABC				
Yoga vs. Balance	-0.04	-0.47	-0.10	-0.07
Balance vs. Control	0.65	0.65	0.08	-0.57
Yoga vs. Control	0.61	0.18	-0.02	-0.64
FES				
Yoga vs. Balance	-0.21	-0.15	-0.43	-0.22
Balance vs. Control	0.06	0.03	0.16	0.10
Yoga vs. Control	-0.16	-0.12	-0.27	-0.03

A positive number indicates greater improvement of the first group over the second group and a negative number indicates the second showed greater improvement.
WTMT = Walking Trail Making Test, ABC = Activity-specific Balance Confidence test, FES = Fear Efficacy Scale

Table 21

ES for treatment by time interaction for Environmental Awareness Test

Variable	Pre to Post intervention
EAT**	
Yoga vs. Balance	0.32*
Balance vs. Control	-0.55
Yoga vs. Control	-0.23

* A positive number indicates greater improvement of the first group over the second group and a negative number indicates the second showed greater improvement.
** EAT assessed only pre and post intervention

The means of the TMT, WTMT, ABC, FES, and EAT were graphed with respect to treatment and time (Figure 8). Generally, all scores show expected directional changes (i.e. TMT, WTMT, and FES scores decrease and ABC and EAT scores increase). The groups at pre intervention (baseline) were shown to be significantly different for the ABC. The groups were not significantly different for any of the other measure. The ABC graph (upper left) shows a difference in the treatment groups from the control. Both exercise treatment groups had a similar ABC increase. The control group showed less effect, and had noticeable variability in the data points across time. The mean differences among the 3 groups at baseline are evident on the graph. The ABC resulted in statistically significant ($p < .05$) effect for time.

The graph for the FES (upper right) shows all groups decreased over time. The balance training and control groups had higher scores than the Yoga group. Time effect for FES was statistically significant ($p < .05$). The WTMT graph (middle left) also shows all groups decreasing over time. Yoga participants decreased more than the balance training and control participants, but showed variability through the intervention period. The TMT graph (middle right) shows all groups decreasing over time with the balance-training group having the sharpest decline at post intervention. Time effect for TMT was significant (p < .05). Lastly, the EAT graph (bottom center) showed the control group scores increased more than the 2 treatment groups over time. The yoga and balance training participants achieved lower than the control participants EAT, though time, treatment, and time by treatment effects were non-significant ($p > .05$).

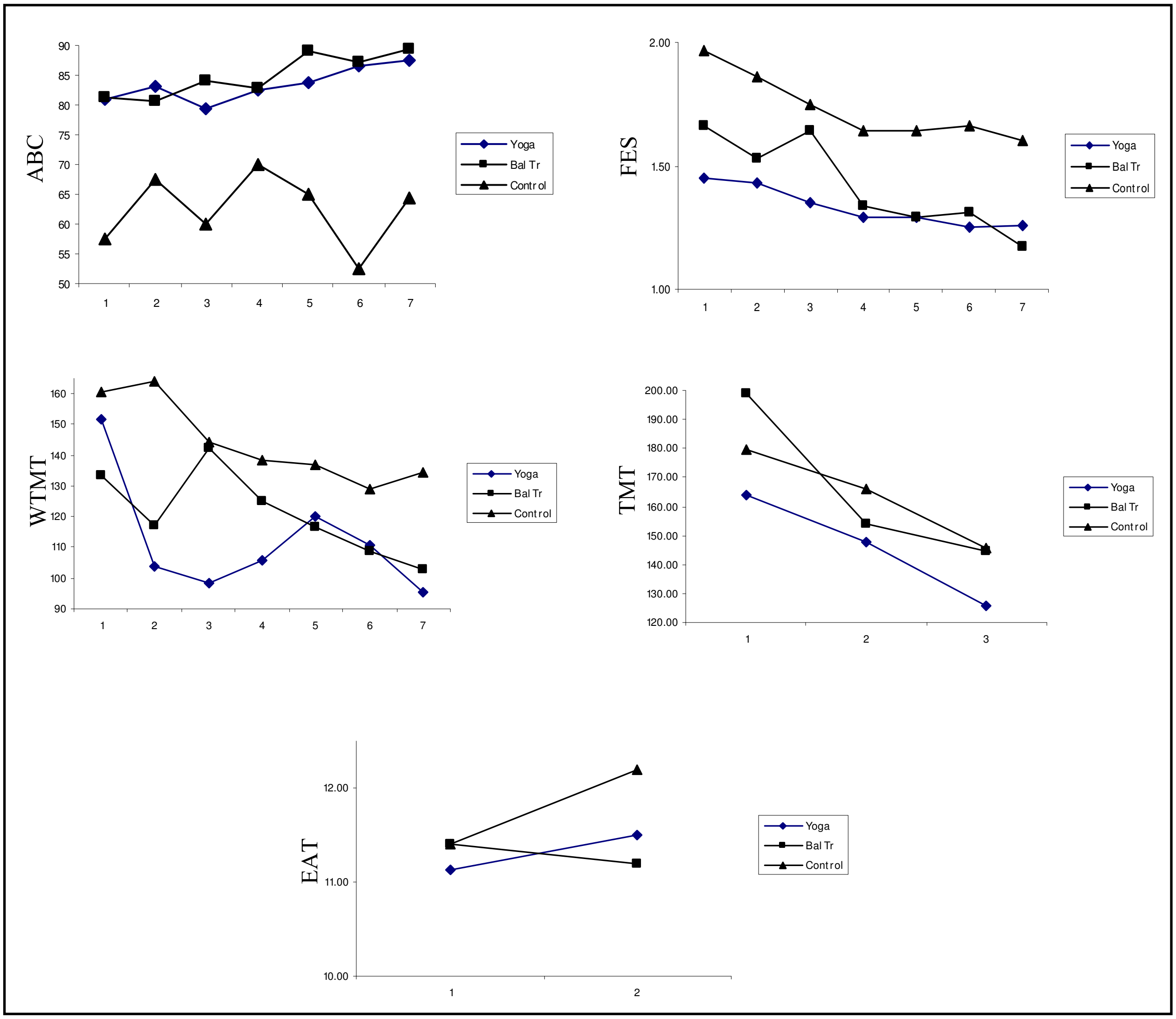


Figure 8. Means for three groups by time for ABC, FES, and WTMT: pre intervention (data point 1), intervention (2-5), post intervention (6), and follow up (7), TMT: pre intervention, post intervention, and follow up (data points 1, 2, and 3 respectively), and EAT: pre intervention and post intervention (data points 1 and 2, respectively). TMT = Trail Making Test, WTMT = Walking Trail Making Test, ABC = Activity-specific Balance Confidence test, FES = Fear Efficacy Scale, EAT = Environmental Awareness Test.

Summary of the Findings of Hypothesis Two

The second hypothesis stated that participants in the yoga group would show stronger improvement in psychological risk factors than the Balance Training and Control groups as indicated by an increase in attention, visual search strategy, confidence in balance ability, and a decrease of fear of falling. Statistical analysis failed to support this assertion. Particpants exposed to yoga treatment did not differ from participants of balance training or control after treatment. Balance training did not show statistical significance over control. All particpants improved over time for TMT, ABC, and FES. Descriptive analysis demonstrated yoga to be more effective for the WTMT and the EAT. Yoga resulted in increases for the ABC over the control but not over balance training. For FES, Yoga had the least effect compared to the Balance Training and the Control. Descriptively, the treatment groups show support for this hypothesis, but statistically, the null hypothesis of mean equality is retained for hypothesis two. Yoga was not found to be statistically significant in the improvement of these psychological risk factors.

Analysis of Hypothesis Three

Hypothesis three stated participants of the Yoga and Control groups would show greater improvement in their ability to travel in the environment than the Balance Training group. This hypothesis was tested using the EAT. The EAT is a measure of attention and visual search strategies. The previous section also reported the results of the EAT analysis. RM ANOVA was non significant for the EAT for either time, treatment, or time by treatment ($p > .05$).

Descriptively, the Yoga and Control groups did show greater $ES = 0.20$ and 0.44, respectively over Balance Training (-0.11). The comparison of change showed the Control group to have improved over the Yoga group. Descriptively hypothesis three is supported but statistically, the null hypothesis was retained.

Falls and Unsteadiness

Falls and instances of unsteadiness were tracked by self-report. The participants were given a monthly calendar to make notes regarding location, activity, and injury sustained during a period of unsteadiness or a fall. Participants returned 49 of 72 calendars handed out per person. There was a return rate of 68%. The reasons for failing to return the calendar reports were that they were lost or forgotten. To provide follow up to the self-report calendars, the researcher spoke briefly to each participant at each session, and ask them specifically if they had had any instances of unsteadiness or falling, which was recorded or not recorded on a report form. Falls were reported because of tripping on an object, and shuffling and not lifting feet. Unsteadiness was reported because of tripping on an object, a slippery floor, being sick, carrying items, and undressing. All falls occurred at home and nine instances of unsteadiness occurred at home with only one instance in the community. Injuries sustained were reported as bruises only. The participants that were dropped because of sustaining injuries in a fall were not included in the final count. The injuries sustained in the two falls were a broken ankle and a broken wrist. The total number of falls through out the course of the study was 3 and the instances of unsteadiness were 10. Cross tabulation tables display the numbers of falls and instances of unsteadiness by group. (Tables 22 and 23)

The frequency of Falls and Unsteadiness were higher in yoga treatment. The Chi square test of independence failed to show any significance for Falls or Unsteadiness between the treatment groups. Pearson Chi-square for Falls, X^2.(df = 4)= 4.50, p = .343 (Table 22) and Pearson Chi-square for Unsteadiness, X^2 = (df = 8) = 11.19, p = .191 (Table 23).

Table 22
Cross-Tabulation of Falls throughout the Study

			Falls			Total
			.00	1.0	2.0	
Treatment	1.00	Count % within Treatment	5 62.5%	2 25%	1 12.5%	8 100%
	2.00	Count % within Treatment	5 100%	0 0%	0 0%	5 100%
	3.00	Count % within Treatment	5 100%	0 0%	0 0%	5 100%
Total		Count % within Treatment % within Falls	15 83.3% 100%	2 11.1% 100%	1 5.6% 100%	18 100% 100%

Table 23
Cross-Tabulation of Unsteadiness Throughout the Study

			Unsteadiness				
			.00	1.00	2.00	3.00	Total
Treatment	1.00	Count % within Treatment	3 37.5%	1 12.5%	3 37.5%	1 12.5%	8 100%
	2.00	Count % within Treatment	2 40.0%	3 60.0%	0 0%	0 0%	5 100%
	3.00	Count % within Treatment	3 60.0%	0 0%	1 20.0%	1 20.0%	5 100%
Total		Count % within Treatment % within Unsteadiness	8 44.5% 100%	4 22.2% 100%	4 22.2% 100%	2 11.1% 100%	18 100% 100%

Behavior Analysis

The study consisted of a variety of dependent variables measured by both physical assessment and self-report survey. Three measurements of observed behavior in the study were the POMA, the WTMT's steadiness measure, and the exercise treatment SM during the interventions of Yoga and Balance Training. The POMA was observed and assessed 11 times, and the WTMT's steadiness measure was observed and assessed 7 times over 16 weeks for all three groups. The SM was observed and assessed 16 times during the eight-week Yoga and Balance Training interventions. Because of potential subjectivity of the POMA, WTMT steadiness measure, and exercise treatment SM, observers were trained on definitions and scoring and interobserver agreement was assessed.

Multiple Baseline Graph, POMA. The multiple baseline graphs represent the group averaged POMA scores over the weeks of the study across the three groups, Yoga, Balance

Training and Control (Figure 9). The graph shows data points trending upward for all three-study groups. The trend lines for the two treatment groups show slightly steeper incline. The trend line of the control group is flatter. There is only one data point for baseline, and it does not represent a true baseline. However data points in the intervention period do rise above baseline in the treatments groups, but not in the control group. The bandwidth of the Yoga group's data points during intervention is above the baseline point. The bandwidth of the post intervention and the follow up data points are also above the baseline, and even with that of the intervention. The follow up data point, four weeks after the end of intervention, is slightly lower than the post intervention data point. Yoga participants improved in the POMA assessment over the period of the study. The Balance Training group's intervention bandwidth of data points touches the baseline data point but does not overlap. The bandwidth of the post intervention and follow up data point are above the baseline data point and even with the intervention bandwidth. Unlike yoga, the Balance Training follow up data point does not decrease from the post intervention. Like Yoga, the Balance Training group showed consistent improvement over the period of the study. In contrast to the treatment groups, the control group's bandwidths for baseline, intervention, post intervention, and follow up are all the same, although a slight trend upward is detected. In analysis of the graphs, the Yoga and the Balance Training groups had essentially the same progress with the yoga group slightly above. This interpretation is supported by the descriptive statistics analysis from a previous section.

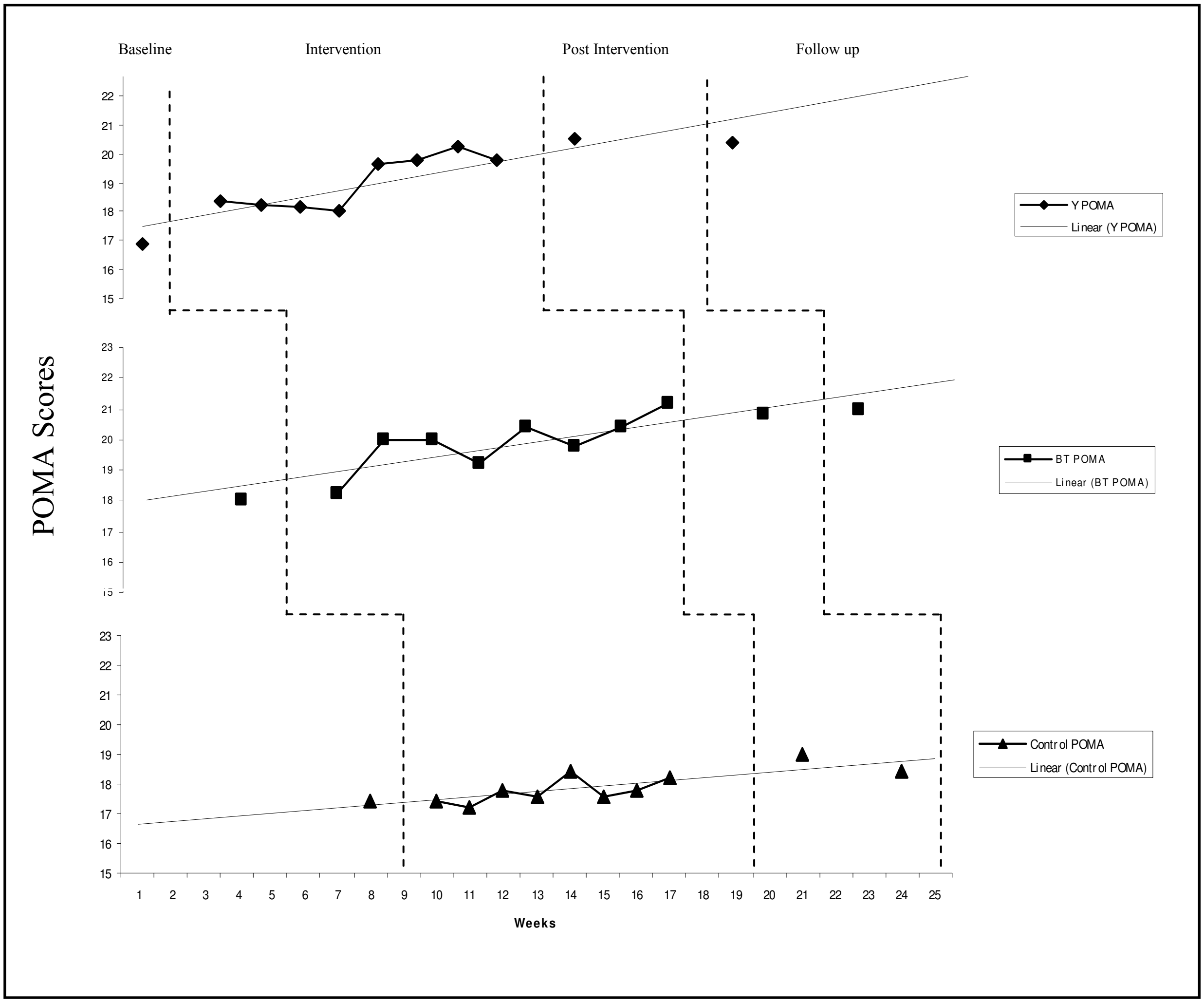


Figure 9. Multiple baseline graph for Performance Oriented Mobility Assessment.

SM Graph. The SM graph represents the two treatments groups over the eight-week period of intervention (Figure 10). The treatment groups had steadiness assessed at two intervention sessions per week on 16 yoga positions or balance exercises, each assessed 0 – 2 points. The graph represents the average of each participant per week averaged by group. It is not possible to compare the measure against a baseline, however the SM for both groups trends upward over time. The participants of each group improved in their ability to complete the exercises with less unsteadiness. The trend line of the yoga group indicates that Yoga had slightly more improvement. This interpretation is supported by the descriptive statistics analysis from a previous section.

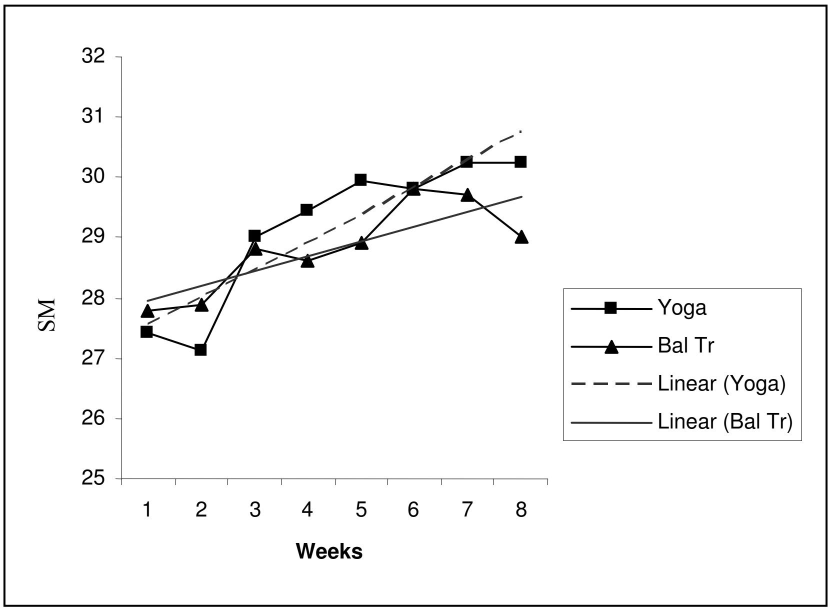


Figure 10. Graph of Steadiness Measure for Yoga and Balance Training. Groups across eight weeks of intervention

WTMT Steadiness Measure. WTMT was an assessment for attention and visual search strategy (Figure 11). As the participant completed the assessment, their walking movement was assessed for steadiness (0 – 2 points). There were seven assessments for the WTMT. The averaged group scores are graphed at pre intervention, intervention, post intervention, and follow up. The Yoga group increases above the other groups and maintains a higher score. The graph shows no large treatment effect for any group.

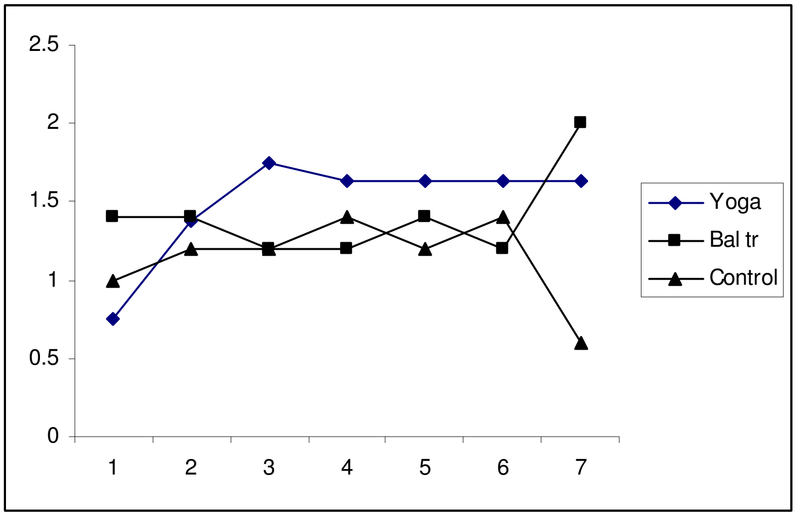


Figure 11. Graph of Walking Trail Making Test steadiness measures by group. Pre intervention (data point 1), intervention (2-5), post intervention (6), and follow up (7).

Interobserver Agreement

Interobserver agreement (IOA) was obtained at sessions with all the groups. IOA was consistently collected in all groups and thus, the data was collapsed into study averages. IOA was obtained for 60% of all POMA assessments, 30% of all TMT, 30% of all WTMT, 100% of all EAT assessments, and 75% of SM during intervention sessions. IOA was not conducted on the ABC, FES, or the NC subtests. The ABC and FES were self-report survey format assessments. In the NC subtests, computer program reliability is assumed. The IOA average was 93% for the POMA, 100% for the TMT, 100%, for the WTMT, 97% for the EAT, and 91% for SM. (see Table 24)

Table 24
Interobserver Agreement for the POMA, WTMT, TMT, EAT, and SM

Variables	Percent conducted	Range of IOA	IOA average
POMA	60%	64-100%	93%
TMT	30%	100-100%	100%
WTMT	30%	100-100%	100%
EAT	100%	83-100%	97%
SM	75%	63-100%	91%

POMA = Performance Oriented Mobility Assessment, TMT = Trail Making Test, WTMT = Walking Trail Making Test, EAT = Environmental Awareness Test, and SM = Steadiness Measure.

CHAPTER 4

DISCUSSION

Fall prevention in older adults may be addressed through the reduction of fall risk factors (AGS-PFP, 2001). Many fall risk factors have been identified and classified as internal, inside the older adult, or external, outside the individual or in the environment. The need for effective interventions that can decrease risk was firmly established, particularly interventions that are multifaceted and take into consideration multiple risk factors (Tinetti, 2003). The Biopsychosocial model applied to fall risk interventions is an integrated approach addressing several systems involved in fall prevention (Keysor & Jette, 2001). More specifically, biological or physical risks are impairment to postural control. Psychological risk factors are associated with a decline in cognitive function and attention, decline in self-efficacy, and an increase in fear of falling. Social or environmental risk factors are unexpected hazards in the environment. A call for research by Sattin (1992) expressed the need for interventions that address multiple factors associated with falling.

Different types of exercise have been established as a reliable intervention for increasing physical fitness in older adults and indirectly minimize fall risks (Daley & Spinks, 2000). Exercise strengthens and stretches the muscles, and improves other physiological systems such as the cardiovascular and respiratory systems. Balance Training, as a specific format of exercise, has been used to decrease fall risk associated with postural control (Carter et al., 2002). Exercise in general has also been shown to improve cognitive functioning such as memory, concentration, and awareness (Weuve et al., 2004). Additionally, Exercise has been shown to improve self-efficacy in older adults by increasing physical ability. Both exercise and balance training have been modified for safety and effectiveness for use with the older adult population. Yoga is also an exercise that has been successfully modified and used with the older adult population (Bonura, 2007; Garfinkel et al., 1994).

Yoga has a unique constellation of attributes that may be considered multifaceted. Yoga is known to address the physical component of health, and has an added psychological quality of increasing attention and focus required for task performance (Shaw, 2001). Yoga consists of postures, breathing techniques, and meditation. Yoga may be considered a biopsychosocial intervention because it meets the needs of an integrated fall risk intervention (Keysor and Jette, 2001). Generally, there is a dearth of methodologically sound studies using yoga as an intervention. The limitations concerning yoga research centered on the need for larger sample sizes, control groups, randomization of the participants, and short-term studies. The current study was designed to overcome several of these methodological shortcomings by using a sound research plan, although the design failed to maintain sufficient sample size due to objective circumstances.

The purpose of the present study was to examine the effect of hatha yoga on three risk factors associated with falling in older adults. The risk factors are impairment to cognitive function, fear and decreased confidence, and balance impairment. For yoga to be considered a biopsychosocial (BPS) intervention, it needs to be effective on biological-physical factors, psychological-cognitive factors, and environmental-social factors. It was hypothesized that yoga would have a greater effect over the balance training and control groups on the physical fall factor indicated by an increase in postural control and steadiness. It was also hypothesized that yoga would have greater effect over the balance training and control conditions on the psychological risk factor indicated by increased attention, visual search strategy, efficacy in balance ability, and decreased fear of falling. Finally, it was hypothesized that yoga and the control group which was exposed to a fall risk awareness class, would show greater improvement in awareness of hazards in the environment.

Main Results

The Effect of Yoga and Balance Training on the Physiological Risk Factor: Hypothesis One

Yoga vs. balance. Both yoga and balance training showed improvement in postural control. Results were mixed for yoga. Yoga resulted in greater improvement in Performance Oriented Mobility Assessment and Steadiness Measures than balance training but lower improvement in the Neurocom subtests. While statistically no significant results were found for the Performance Oriented Mobility Assessment, yoga's pre-post scores on the Performance Oriented Mobility Assessment, (*ES* = 1.61) showed stronger improvement than balance training (*ES* = 1.24) for the same period. The Neurocom subtests were Reaction Time, Velocity, Excursion, and a Composite measure. Yoga's mean differences for time (pre-post) on the Neurocom subtests ranged from *ES* = 0.22 - 0.67 compared to the range for balance training, *ES*

= 0.77 - 1.05. Statistical significance was found for the Excursion and Composite scores indicating increased sway ability.

Yoga's higher improvement in the Performance-Oriented Mobility Assessment may be attributed to the same type of movement performed in both yoga and the POMA. The Performance-Oriented Mobility Assessment is a combination of static and dynamic assessments, but is predominantly static. Yoga poses are static in nature (i.e., a pose is achieved, and then held for a length of time). For most of the test positions in the Performance-Oriented Mobility Assessment, static positions are achieved, and then held for some time. The Neurocom assessments, conversely, are dynamic (i.e., the movement is continuous). The balance training class in comparison to yoga was more dynamic in that the individual exercises required continuous movement. Although balance training had a larger effect, it is still important to note that yoga improved over baseline in the dynamic Neurocom tests.

The effect of yoga on postural control was likely in that exercise has been shown to have positive effects on the musculoskeletal system, which is an integral part of postural control. Exercise in older adults has shown similar results for increases in balance due to increased strength and flexibility (Daley & Spinks, 2000). Balance training exercise programs that incorporated static and dynamic movement, resulted in balance increases (Carter et al., 2002). There are fewer studies evaluating the effect of yoga on the musculoskeletal system. However, two studies using a yoga treatment did show positive results for increased muscle strength and flexibility (Garfinkel et al., 2002; Raub, 2002), and balance (Boehde & Porcari, 2005). The results of the current study also supported previous findings that exercise treatments, in general, for older adults are effective in improving musculoskeletal strength and flexibility, and thereby increasing postural control (Daley & Spinks, 2000). The current results, though non-significant, tacitly show that yoga had an effect on postural control that warrants further investigation.

For the Steadiness Measure, mean differences for time showed yoga had greater improvement over balance training (yoga, $ES = 0.66$ and balance, $ES = 0.27$). The steadiness measure was an indication of how much additional support was needed by the participants when performing the exercises during the treatment. Higher scores in Steadiness Measure showed that both balance and yoga participants were less reliant on the chair, or did not need to take a step in order to maintain balance. There was an increase of Steadiness over time with yoga participants requiring less support over the balance training. The treatment by time mean difference for yoga – balance was, *ES* = 0.39.

The steadiness measure results showed yoga participants performed the yoga exercise more steadily than balance participants performed the balance exercises. The use of steadiness measures for assessment during intervention is new, and thus prevents any comparisons with findings of other studies. The current results showed that steadiness measures provided a good tool to objectively evaluate observation data, and may provide valuable information for future research or application of exercise or yoga interventions.

Yoga may have shown stronger results in the steadiness measure because of the type of static, or still, activity. Yoga participants achieved a pose by shifting the center of gravity and establishing a new base of support, and then concentrating to hold that position. Balance training, on the other hand, with the dynamic movement may in fact be more difficult. The dynamic movement required continuous shifting of the center of gravity away from and toward the base of support. Thus a new static base of support was not established. The continuous movement may have contributed to more opportunity for unsteadiness to occur. This is supposition at this point because there were no previous studies found that specifically compared yoga and balance training using a measure of steadiness.

Yoga and balance vs. control. Both yoga and balance training improved over the control in all the variables postulated in the first hypothesis. Mean differences for time (pre – post) on the Neurocom subtests showed a change range for yoga, *ES* = 0.22 - 0.67, balance training, *ES* = 0.66 – 1.30 compared with the control change, *ES* = -0.16 - 0.32**.** For the Performance-Oriented Mobility Assessment, yoga and balance training's changes were *ES* = 1.61 and 1.24, respectively. The control group *ES* = 0.71. Time by treatment interaction showed that balance training had larger effects over the control in the Neurocom than did yoga. Conversely, time by treatment effect in the Performance-Oriented Mobility Assessment showed yoga as having larger effects over the control than did the balance training.

The results of the exercise treatment groups over the control were expected. The exercise treatments subjected the participants to physical activities, which would likely produce physiological changes in postural control. The control treatment participants were subjected to a standard lecture style class with no physical activity. The control's class included information on good posture and standing/walking with steadiness, but provided no practice. The very small positive changes in postural control as indicated by the Neurocom Excursion and the POMA for the control may have been improved by the control participants' awareness to their own body in the environment. Additionally, with repeated assessments, participants can become more comfortable with the assessment, and may learn how to perform it to some extent. Even with becoming more comfortable with assessments, true change in postural control would not be possible without physical practice like that of the exercise treatments.

The Effect of Yoga on the Psychological Risk Factors: Hypothesis Two

Visual search and attention measures. Generally, both yoga and balance training resulted in improvement over the control in psychological risk factors that were postulated in the second hypothesis. Though statistically non-significant, descriptive analysis revealed that balance training resulted in greater positive changes in all psychological variables over yoga except in the Walking Trail Making test. For the visual search strategies and attention assessments, Walking Trail Making Test and the Trail Making Test, yoga and balance treatments were mixed. In the Walking Trail Making test yoga and control improved over balance, and in the Trail Making Test, balance improved over yoga and control. The Walking Trail Making Test is a more complex task, because more attention is needed to complete it successfully (Alexander et al., 2005; Woolacott, 2000). Visual search skills are needed for accurate stepping (Lord & Fitzpatrick, 2001). Yoga participants performed better on the Walking Trail Making Test, which was a test that combines physical ability, visual search skills, and attention. Yoga participants may have carried out the assessment better because of the need for visual focus in some of the yoga poses (i.e. 'tree pose'). Balance participants' activity required less need for external focus. When compared with the Trail Making Test, the Walking Trail Making Test may be a preferable assessment for performance in the natural environment in terms of attention to environmental cues and postural control.

Yoga participants did not perform as well as the balance participants on the Trail Making Test. The Trail Making Test, pen and paper version of the Walking Trail Making did not require a physical ability but still needed visual search of the sequence. Balance training exercises did not require the participants to use extensive visual focus. The Trail Making Test was designed for general evaluation of cognitive function, and was not used as a measurement in an exercise intervention, and thus there are no comparisons of results. Both balance training and yoga participants' scores increased in the Trail Making Test, however, the reason for yoga's smaller increase is uncertain.

Fear and self-efficacy measures. Fear of falling decreased in both treatments' participants, but the effect was higher in the balance and control treatments. In fact, the control treatment participants showed a greater decrease in fear over time than did yoga participants. The control group's fall risk awareness class was effective in decreasing fear and increasing awareness to environmental hazards, but was not effective in increasing ability or confidence. This is in keeping with informational format classes. A physical change is needed in order to produce a change in ability. Bandura (1977) stated that an increase in ability might change the belief in ones' capability, and thus increase self-efficacy. Ability could be increased through experience, and knowledge could be increased by verbal persuasion. The balance training's participants fear decrease might have been due to the participants increase in ability much like their increase in confidence.

In the Activity-specific Balance Confidence, balance participants showed a higher degree of increased confidence followed closely by the yoga participants. Increases in confidence required an increase in physical ability along with an increase in the participants' belief in their physical capability. Thus, the control group, with only an awareness class and no physical activity, actually declined in their confidence in ability. The Activity-specific Balance Confidence is a measure of self-efficacy. An increase in self-efficacy was also seen in studies with participation in exercise programs (Robitaille et al., 2005; Sattin et al., 2005; Wolf et al., 1996).

Balance training may have had greater improvement in confidence over yoga if balance training was thought to be more difficult than yoga. Balance training's dynamic movement may challenge the postural control system more than yoga, and thus achieve a greater physical training effect. A greater physiological effect may lead to greater ability. If the participant feels he/she has achieved a higher ability, they may also feel they have a higher capability in the natural environment (Bandura, 1997).

The Effect of Yoga and Control on Environmental Awareness; Hypothesis Three

The Environmental Awareness Test assessment staged 18 hazards in an everyday environment both inside and outside the building. The control group participants, which attended a Fall Risk Awareness class were able to recognize more hazards overall after the class (*ES* =

0.44) then the other treatment groups. The yoga participants (*ES* = 0.20) showed greater recognition over time than the balance training participants (*ES* = -0.11). The most commonly missed items outside were stair height, lack of handrails, and ramp safety. The most commonly missed items indoor were dim lighting, use of an inappropriate ladder, and low sitting furniture. Largely, the participants of all groups were more able to recognize hazards indoors rather than outside. This may be due to the older adults with decreased mobility spending more time indoors.

The treatment groups' effects on the Environmental Awareness Test were similar for yoga and the control participants. The control's results were expected as the group participated in an intervention specifically designed to teach fall risks. The results show that participants did learn what fall risks may look like in an environment. The exercise treatments were not exposed to the informational class. A previous study of a similar instrument to the EAT found that participant's attention to the environment and visual search skills could be quantified accurately in using the Dynamic Visual assessment (Ludt & Goodrich, 2002). The Environmental Awareness Test included the general concept of the Dynamic Visual Assessment but was constructed specifically for use in the current fall risk study. Although constructed as an assessment tool, it may be utilized as a training intervention. In an applied format, participants could be trained as to what seemingly innocuous hazards look like in a natural environment.

Behavior Analysis

Behavior analysis does not take into account the covert behaviors associated with fear and self-efficacy, but does not discount the importance of self-report measures. Behavior analysis is used to measure the observable behaviors, essentially the physical measures of the Performance Oriented Mobility, Steadiness, and the Walking Trail Making steadiness. The visual analysis of Behavior Analysis coincided with the other descriptive statistics and indicated that exercise treatment participants improved over the control ones. The effects of the exercise treatments were expected in that a physical intervention of yoga and balance training positively changed physical or postural control measures. The control participants were not subjected to physical activity, and did not produce a physical change. The arguments previously mentioned concerning the reasons for yoga and balance training's success over control are sustained here. Simply, engaging in physical activity is likely to increase physical ability. The strength in behavior analysis is the repeated probes throughout the course of an intervention. The graphing of repeated probes allow for immediate analysis of the data to look for appropriate trends indicating that an intervention is working. The individuals of all treatment groups had their weekly assessment probes monitored. For the purposes of this study, the balance and yoga interventions would not have been modified the way they would have been in an applied format. An opportunity for future application was found in possibly collecting data on overt behaviors while participants are taking the Trail Making Test.

Methodological Considerations

Selection of groups and assessments. Previous yoga research (Khalsa, 2006; Shapiro, 2006; Sherman, 2006) and a meta-analysis evaluating yoga research (Bonura, Aloe, Tenenbaum, & Becker, 2007) have suggested methodological limitations in yoga research; claiming yoga's benefits cannot be considered conclusive at this point in time. In the present study, randomization and selection of participants for the groups, using a control group for comparison to the treatment groups, and increasing the treatments' duration addressed some concerns. The groups were standardized by including only women ages 65 and older. An effort to control extraneous variables was made by asking the participants of all groups to refrain from engaging in additional activity, or to begin new activities outside their current routines. Self- report assessments, Activity-specific Balance Confidence test and Fear Efficacy Scale, were selected with valid and reliable psychometric characteristics and theoretical suitability. The self-report assessments were paired with physiological assessments. Specifically, two assessments measuring the same dimension were chosen for both postural control, Neurocom and Performance Oriented Mobility Assessment, and for attention, Trail Making Test and Walking Trail Making Test. The pairing of these tests in the current study was aimed at strengthening the empirical results.

Treatment duration and adherence. The intervention period of eight weeks with two sessions per week was chosen to ensure an appropriate length of time for effects to show in the treatment groups. Previous research has shown that as little as 5 weeks has been effective for short-term balance training (Seidler & Martin, 1997). Other studies have shown exercise intervention periods to range from 4 months to one year (Carter et al., 2002; Tinetti, 2003). Issues of adherence begin to become apparent with programs longer than 6 months (Buchner et al., 1997; Campbell et al., 1997) Tinetti (2003) maintained that optimal frequency needed to minimize risks for falling is yet to be determined. It has been shown that even beginners to yoga with modest practice over a short period of time can improve physical and mental health to some degree (Sherman, 2006). Sherman (2006) encourages yoga research to determine the "right amount" of yoga intervention for treatment to be effective.

Yoga or exercise must continue for positive effects to persist. Long-term adherence has been raised as an issue for continuing interventions for fall risk (Tinetti, 2003). An informational or awareness class requires limited participation as opposed to ongoing exercise classes. In the current study, the yoga participants had better adherence (less dropped participants) to the 8-week program then participants of balance training. Attendance to the weekly sessions by the participants that remained in the study for both groups was equal. Anecdotally, the yoga participants were less happy about needing to drop, and communicated multiple times by phoning the primary researcher about rejoining the activity as soon as possible. Participants of balance training needed to be phoned by the primary researcher after missing classes in order to determine their discontinuation. From the original sample, some potential participants decided not to be included because they were not chosen for the yoga group. It is not known whether the interest in yoga was due to its resurgence in popularity, or that participation was perceived to be more enjoyable, and thus easier, to maintain. The majority of study participants had not experienced yoga in the past.

Summary of Overall Results

The evaluation of yoga and balance training showed a reduction in the fall risk factors over the control. Both yoga and balance training resulted in improvement of postural control, visual search strategy, self-efficacy, reduction of fear, and environmental awareness. Statistically yoga and balance training had few significant results, and success was mixed between both exercise treatments. Additional descriptive analysis revealed time, treatment, and time by treatment effects.

Yoga resulted in higher standard mean difference effect sizes on participant's assessments that required an increase in physical ability (i.e., Neurocom, Performance Oriented Mobility Assessment, Steadiness Measures, Walking Trail Making Test, and Activity-specific Balance Confidence Scale). Thus, although not statistically significant, participants in yoga showed an increase in postural control, visual search, and confidence. With the largest percentage of fall prevention owed to postural control to move around in the environment, yoga may be more effective at decreasing fall risk, however, the current results cannot be conclusive in this regard. For the assessments that did not require an increase in physical ability, yoga participants did not show similar effects (i.e., Trail Making Test and Fear Efficacy Scale).

Generally, in the assessments evaluating psychological risk factors for falling, yoga was beneficial when an increase in ability was required along with an increase in attention or confidence. Yoga and balance training were more effective for participants than participants in the control group except in the assessment of fear and in environmental awareness. Exercise treatments contained classes in which a motor skill was learned by the participants. Participants in the control group, on the other hand, contained a class in which information, specifically about environmental hazards, was learned by the participants. The findings thus confirmed the effectiveness of learning about environmental hazards in the elderly for fall prevention.

General explanation to the study's findings

Most of the results of the present study can be explained by the Cognitive Behavioral Theory (CBT), or in combination with the social cognitive and learning theories. CBT states that mind and body not only have a connection, but a reciprocal relationship whereby one affects the other. Certainly results of the Neurocom, Performance Oriented Mobility Assessment, Steadiness Measures, Walking Trail Making Test, and Activity-specific Balance Confidence Scale may be explained with CBT.

Yoga consists of the combination of postures, breathing techniques, and meditation (Khalsa, 2006; Shapiro, 2006; Sherman 2006). Yoga may then be described as an integrated activity including both mind and body exercises. In the current investigation, participation in yoga and balance training required an integration of the body's postural control systems, and a level of concentration, focus and attention. CBT strives for the integration of mind and body in order to alleviate incongruence (Sarafino, 2006)). The participants of the exercise treatments would have been unable to perform the activities without mind and body integration. For example, in yoga, once a pose is achieved, it is necessary to focus attention on the body's position in the environment. If one's focus shifts away from the pose for even a second, typically postural control is lost, resulting in incongruence. The Steadiness Measure demonstrated the progression of the mind/body connection. Both yoga and balance training participants increased in steadiness throughout the intervention (i.e., the individual's ability to complete the poses properly and without support or recovery behaviors). This increase in steadiness is an objective measure of the increased ability of the mind and body interaction. The results showed that yoga participants improved in the Steadiness Measure more than did balance participants. Additionally, Neurocom and Performance Oriented Mobility Assessment scores would not have improved pre-post without mind/body interaction for either yoga or balance training. Results showed that both yoga and balance training improved over baseline in these measures, however, balance improved more in Neurocom measures while, and yoga improved more in Performance Oriented Mobility Assessment.

Although confidence is a measure of self-efficacy, the translating of the individual's knowledge that postural control has increased to the belief in one's capability requires a mind/body interaction. The individual through practice recognizes the increase in one's physical ability, and must also recognize that physical ability may transfer from classroom practice to the natural environment by making appropriate movements in prospective situations thus increasing belief in capability. The reciprocal is true as well; if an individual holds that one cannot increase physical ability or if he/she has not increased physical ability, then one will not believe one has the capability to make appropriate movements if needed. The participants in both yoga and balance training increased in their physical abilities as indicated by the results on the Performance Oriented Mobility Assessment, Neurocom, and Steadiness Measure. These same participants also increased their confidence in their balance ability as indicated on the Activity-specific Balance Confidence test.

The Walking Trail Making Test was a mind/body exercise. The results from the test showed that participants in yoga improved more on this test over participants in balance training. The test comprised a combination of walking (body movement) and thinking (mind activity) to traverse the pathway in proper order of the number and letters while not stepping on the 'unsafe' areas. The test required attention and visual search skills, while performing stepping maneuvers that required long and short strides and cross over moves. This timed test was the least liked of all the assessments performed by all groups. The overall commentary was that it made them think too much. The Walking Trail Making was also assessed for steadiness while completing the test. Scores were variable for all groups and showed no effects. However, yoga participants performed the task faster than the balance-training participants.

The Biopsychosocial model (BPS) is a three-factor model that serves as an application of CBT. In the current study, yoga was considered as a BPS intervention, and was shown to be associated with improvement in biological, psychological, and social factors related to fall risk.

The results of this study can also be viewed via the Observation Learning Theory (Coon, 2005). Learning plays a sound role in establishing yoga and balance training interventions. Observation Learning Theory states that by, observing a model and practicing, a participant may learn a new behavior or series of behaviors (Coon, 2005). In the current study, participants' increases in their Steadiness Measures demonstrated that learning was occurring throughout the course of the interventions. The behaviors taught by yoga and balance training in relation to reducing fall risk are the poses and the series of movement required to achieve the poses. Many of the movements simulate movements required to maintain postural control in the environment outside the practice of yoga. Special breathing techniques are also behaviors taught through yoga. The breathing techniques are relaxation breathing, and when combined with the poses or meditation, create an opportunity for increasing attention to one's body sensations. Purposeful thinking toward a particular sensation or attention is paid to the feeling of the air in and out of the nose and the feeling of the abdomen extending and contracting. Anecdotal evidence existed of the learning of the breathing and relaxation techniques through participant comments after class. Participants of the yoga treatment would comment on how relaxed and calm they felt.

The results of the Environmental Awareness Test also indicated that learning occurred in the control group through the Awareness class. The participants in the exercise interventions were not exposed to the information given in the Awareness class, as the control participants were not exposed to the exercise interventions. The participants in the control group scored higher on the Environmental Awareness Test over participants in both yoga and balance training. Information in the class was directly related to the items on the Environmental Awareness Test.

The results of this study can also be viewed in light of the Social Cognitive Theory and self efficacy (Bandura, 2001). Bandura stated, "To be an agent is to intentionally make things happen by one's actions." (p. 2) Primary features of agency, according to Bandura, are to let people play a role in their self-development, adaptation, and self-renewal with changing times. In the current study, the agreement of the participants to be involved in a study showed their willingness to improve themselves. Yoga participants can be an agent of change by practicing the integration of mind and body. In choosing yoga, the older adult may have the opportunity to improve physical abilities, and over time experience increase in capability. "Self-efficacy is the belief in one's capability to organize and execute the courses of action required to manage prospective situations" (Bandura, 1995). The results of the current investigation showed that participant's confidence scores in the Activity-specific Balance Confidence test increased, and thus self-efficacy may have increased for the participants of yoga and balance training.

Reduction in fear may be associated with an increase in self-efficacy (i.e., an increase in the belief that one has gained more capability). (Sattin et al., 2005; Tinetti et al., 1990). For the participant's in the balance training intervention, a reduction in fear was indicated along with an increase in confidence. The result showed that fear was not reduced as much in the yoga group, and in fact had a greater effect on the control participants who attended lectures. Self-efficacy may be gained through verbal persuasion (Bandura, 1977). Verbal persuasion is often in the form of an informational class like the Awareness class. Self-efficacy may be the mechanism for the reduction of fear in the control participants in the current study. The expectation would be that with the reduction of fear there would also be an increase in confidence yet, the results of the Activity-specific Balance Confidence test showed the control did not increase in confidence. This is to be expected because the control did not receive a treatment that would increase ability. However, the fear decrease is still likely to be a result of increased self efficacy.

Limitations

The current study was intended to minimize methodological limitations, to be as conclusive as possible. However, some limitations were unavoidable, and are elaborated in the next section.

Groups' size. Group size is the primary limitation of this study. The treatment groups had 10 participants each at the beginning of intervention. Two participants dropped from yoga, 5 dropped from the balance training, and one from the control. Small sample decreases the power and the findings' generalizability. This resulted in inequality of the groups at baseline for three variables, (Neurocom Excursion, Neurocom Composite, and Activity-specific Balance Confidence test) despite the randomized procedure used.

Adherence and age population. Although the reasons for participants discontinuing were varied and valid, adherence to the program was another limitation. For the remaining participants throughout the study, high percentages of attendance shows that adherence was good. The older adult population produces a unique set of limitations. Generally, along with age comes the natural decline in health. Four out the eight of the current study's participants that discontinued, dropped due to declining health. Two out of the eight participants that dropped suffered injuries as a result of a fall. Of the remaining two participants, one had a spouse with declining health, and one lost interest. With sample size being a major issue for studies, particularly for yoga studies, it is important to maintain appropriate 'n' size. Additionally, when first selecting the groups, reasons for declining participation ranged from health considerations, refusing to leave the house, and driving during high traffic times. Other potential retired participants had schedules that were too full socially or with volunteer positions. The participants that refused to leave the house, or had declining health could benefit from interventions such as yoga, balance training, or the awareness class.

Instructor bias. The present study consisted of one instructor for both treatment interventions and for the fall risk awareness class. There may have been a similar teaching style, although two different types of exercises were taught. The instructor was the primary researcher, and thus not blind to the purposes of the study. Classes were taught following a set format, but personal bias may have been present. The primary researcher has been certified to teach group exercise, yoga, and classes for special populations for 13 years.

Assessments. The EAT was an assessment designed specifically for use in this study and the exact environment tested. It was based on Dynamic Visual Assessment, which has been assessed and assigned valid and reliable psychometric properties. Although, as expected, the EAT scores showed improvement in the control participants over the treatment groups, the EAT must be better psychometrically established, and be fit to specific environments.

The Steadiness Measure was operationally defined for use by the observers of the intervention, and was considered valuable in the current study. However, the Steadiness Measure as an instrument to evaluate an intervention was new, and thus can be regarded as a limitation.

Observer Training and Drift. Evaluating observable behaviors may be regarded as subjective. The risk of this was minimized by using clear operational definitions, providing extensive training in understanding its definitions, and conducting inter-observer agreement ratings. The observers of the current study underwent approximately 10 hours of training in recognizing the evaluated behaviors and scoring them accurately. Periodic refresher training was provided throughout the 5-month study to minimize observer drift, which is incorrect scoring due to observer bias to anticipated results.

Future Direction

Research for effective interventions to reduce fall risk for fall prevention in older adults should be continued. The present study showed support for the effectiveness of exercise as an intervention for both physiological and psychological risk factors, but not environmental awareness. The assertion that exercise would improve fall risk factors has already been well established. The purpose of the current study was to show that yoga resulted in superior effects in order to be considered a biopsychosocial intervention, and thereby a multifactorial intervention in and of itself. Essentially, yoga and balance showed equal results. Thus future research on fall risk using yoga could involve ameliorating inherent research limitations of yoga with older adults. Further investigation of yoga could include its practice in conjunction with other multifactorial interventions, such as environmental awareness training. Additionally, the Steadiness Measure and Trail Making Test could be examined for future use. In terms of application of yoga as a therapeutic treatment, Behavior Analysis may be useful in designing a behavior program.

Yoga research with older adults will likely continue be plagued with the same limitations (i.e. sample size, age related disability, and adherence). The strength in future yoga studies on particular topic areas, specifically with older adults, will come through replication. Yoga studies with older adults that have issues of postural control should maintain lower numbers in each class in order to assure safety of participants. Smaller numbers of participants would allow the yoga class content to be more traditional in nature in terms of standing and balance poses. In research, however, in order to have confidence in the results, smaller sample sizes require multiple treatment groups in the same study or replication of entire studies.

It may be possible to study how to increase participation and/or adherence in the yoga intervention programs. Adherence has long been an issue for exercise programs for weight management, and continues to be for older adults in fall risk interventions. The drops in the current study were 31% of the starting participants. The reasons for discontinuing were adequate but at least two participants with declining health could have continued to gain benefit from participation. Possible methods for maintaining adherence could be the training of participants in antecedent techniques, and use of reinforcement contingencies. Participants could be trained in personal prompting such as preparing the things needed for class the night before, or arranging their day in order for the intervention class to be more convenient. Reinforcement contingencies could include tangible reinforcers or pairing with a partner for social reinforcement.

Yoga as a fall risk intervention may be more successful if combined with an environmental awareness class. Yoga and balance both achieved some success in postural control, attention, visual search, confidence, and fear reduction. The control achieved success in the environmental awareness. The mixed results between yoga, balance, and the control signify the need for combinations of treatment. The most effective intervention may be a traditional yoga class modified for older adults and an awareness intervention that includes natural environment practice.

The use of the Environmental Awareness Test and the Walking Trail Making Test could be expanded. For environmental awareness training, a hazard obstacle course could be a useful training/assessment tool. The natural environment could be manipulated in a similar way to the Environmental Awareness Test, and actually require movement in the environment much like the Walking Trail Making Test. The Walking Trail Making Test could have its success criteria changed to include increased height of steps required or points off for stepping off of targets. Additionally, both assessments could be applied as interventions.

The Steadiness Measure may also be used in future research in order evaluate its usefulness on other types of exercise with older adults. Additionally, simple replication of Steadiness Measures with yoga and balance training may aid in establishing the Steadiness Measure's psychometric properties.

While conducting the Trail Making Test it was discovered that it might provide useful information about visual search and attention behaviors. In addition to the time score, measurable behaviors, such as latency between the connection points and frequency of times the pencil is lifted off the page or pivoted, showed visual search behavior. It was noted that participants with the highest scores (a lower score showed improvement) not only had long latencies between stimuli, but refrained from engaging in search skills such as pivoting the pencil and scanning the page. It may be possible to quantify further the lack of search skill, and thus determining a start point for training.

Yoga has been found to be a treatment with positive effects toward improving fall risk factors. If it is determined that yoga may be a useful individual intervention for fall risk treatment, single subject research methods of Applied Behavior Analysis may provide a framework for program formation. A single subject program design could include an extended baseline to stability for the chosen dependent variables. The yoga intervention could be started after a stable baseline and continued dependent variable probes could be conducted throughout the intervention period. As is appropriate for behavioral interventions, these probes would be monitored constantly in order to change the intervention as needed. Yoga is modifiable for older adults, and may be modified further by changing the difficulty and types of the poses. Stability of the intervention probes is expected. This would signify a need for a change in the intervention, or perhaps a ceiling of ability in the participant. The program would be considered completed at this point but as mentioned before, physical activity must be maintained in order to preserve physical ability. An individual participant would be encouraged to maintain participation in outside exercise classes with periodic dependent variable assessment.

Conclusion

The hypotheses set forth at the beginning of this study stated that yoga would show stronger improvement in physiological, psychological, and environmental fall risk factors. Yoga did not show greater changes over balance training but in fact, was shown to be equal to balance training in most measurements. Generally, the results of the present study reiterated the need for multifactorial interventions that is, interventions that include applications to train multiple systems associated with fall risk. It was hoped that yoga would be an intervention that positively and distinctly affected three of the risk factors to be considered a multifactorial intervention in and of itself. Yoga did have positive effects in ameliorating all the risk factors but did not significantly improve over the balance training. Yoga should not be abandoned but appreciated as another safe intervention option for older adults to maintain physical and mental health including increased postural control, increased attention, and increased self-efficacy.

APPENDIX A: HEALTH HISTORY FORM

HEALTH HISTORY

(Long Form)

Name:	Code:	Age:
Address:		Gender:
Telephone Nos. (daytime): (nighttime):		
Current Weight/Height:		
Personal Physician:		
Physician's Address:		

Directions: *Please answer the following questions to the best of your knowledge about yourself. Check below any medical condition, treatment or problems that concern you.*

I. HEART and CIRCULATORY

A. ______ Heart Attack, Heart disease or any other heart related problems
B. ______ Heart Valve Problems
C. ______ Heart Murmur
D. ______ Enlarged Heart
E. ______ Irregular Heart Beat
F. ______ Atherosclerosis
G. ______ Stroke
H. ______ High Blood Pressure (controlled)
I. ______ High Blood Pressure (uncontrolled)
J. ______ Rheumatic Fever
K. ______ Cardiac Surgery
L. ______ Coronary Bypass
M. ______ High Triglyceride Level
N. ______ High Cholesterol Level
O. ______ Varicose Veins
P. ______ Anemia
Q. ______ Hemophilia
R. ______ Diabetes (controlled)
S. ______ Diabetes (uncontrolled)
T. ______ Phlebitis, Emboli (blood clots)
U. ______ Other, Specify

II. RESPIRATORY

A. ______ Emphysema
B. ______ Bronchitis
C. ______ Pneumonia
D. ______ Asthma: ________ (childhood) __________ (currently)
E. ______ Lung Disease
F. ______ Other, Specify
____

III. OTHER DISEASE or ALIMENTS

A. ______ Hip Replacement
B. ______ Glaucoma
C. ______ Osteoporosis
D. ______ Back Injuries/Back Pain
E. ______ Epilepsy/Seizures (past or present)
F. ______ Allergies
G. ______ Liver Disease (Hepatitis, Jaundice)
H. ______ Kidney Disease
I. ______ Arthritis
J. ______ Orthopedic Leg, Arm or Joint Problems
K. ______ Neurologic Diseases
L. ______ Migraine Headaches/Other Frequent Headaches

Please explain any conditions you checked YES in I-III above:
____
____
____
____
____
____

IV. HAVE YOU RECENTLY HAD:

A. ______ A Fall
B. ______ Periods of Unbalance/Instability/Unsteadiness
C. ______ Chest Pain
D. ______ Shortness of Breath Upon Exertion
E. ______ Heart Palpitations
F. ______ Cough on Exertion
G. ______ Cough Up Blood
H. ______ Swollen, Stiff or Painful Joints
I. ______ Dizziness

J. ______ Lightheadedness
K. ______ Fainting
L. ______ Back Problems
M. ______ Gastrointestinal Disturbances (nausea, vomiting, diarrhea, abdominal pains)

Please explain any conditions you checked in IV above:

____
____
____
____
____
____

V. FAMILY MEDICAL HISTORY (Immediate Relatives)

A. ______ Heart Attack, Heart Disease or other heart related problems
B. ______ Stroke
C. ______ Atherosclerosis
D. ______ High Blood Pressure
E. ______ Diabetes
F. ______ Lung Disease
G. ______ Respiratory Problems
H. ______ Heart Surgery or
I. ______ Heart Related Surgery
J. ______ Other, Specify:

____

VI. TOBACCO

A. Do you currently smoke or use tobacco products? ______ Yes ______ No

B. What type? ______ Cigarette
______ Pipe
______ Cigar
______ Chewing tobacco

C. How long? ______

D. Amount smoked per day? ___________

E. If you do not currently smoke, have you ever? ______ Yes ______ No

F. If YES, how long ago did you quit? ___________

VII. EXERCISE

A. Do you exercise? ______ Yes ______ No

B. What kind of exercise do you presently engage in?

____
____
____
____

C. Is your level of effort: ______ minimal ______ moderate ______ high

D. How often do you exercise? ___________ days per week

E. How long do you exercise? ___________ minutes per day

Please list any prescription medications, vitamin/nutritional supplements, over-the-counter medications you are currently taking or have taken in the last 7 days (don't forget to include birth control pills, headache/migraine medications, etc.):

____
____
____
____

Please describe your present medical condition and anything we should be aware of concerning your health:

____
____
____
____
____
____

Date of last physical examination? ________________ Results: ______________________________

Date of last EKG ________________ Results: ____

I certify that my responses to the foregoing questionnaire are true, accurate and complete:

Signature: ____
Date: ________________________

APPENDIX B: INFORMED CONSENT FORM

Informed Consent Form
AN EVALUATION OF YOGA FOR THE REDUCTION OF
FALL RISK FACTORS IN OLDER ADULTS

I freely and voluntarily and without element of force or coercion, consent to be a participant in the research project entitled "An evaluation of yoga, balance training, and fall risk awareness training for the reduction of the fall risk factors."

This research is being conducted by Dawn M. Morris, doctoral candidate in Sport Psychology, the Department of Educational Psychology and Learning Systems at Florida State University. Gershon Tenenbaum, Ph.D., chairperson of the Sport Psychology program at Florida State University is supervising this research and serves as chair of Dawn M. Morris's doctoral committee.

I understand the purpose of Dawn M. Morris's research is to evaluate the effects of yoga, balance training, and fall risk awareness to improve the fall risk factors of poor balance, fear, loss of confidence, and decreased attention to environmental cues in older adults. I understand that if I participate in the project I will be filling in forms about my current health status, my experiences of physical unbalance, fear of falling, loss of confidence in my abilities, attention capabilities, and incidents of falling.

I understand that I will be participating in a modified yoga exercise program, balance training exercise program, or a fall risk awareness group conducted by a certified instructor. The total time commitment is 1-2 hours, 2 days per week, for a period of approximately 16 weeks. The first 4 weeks I will be evaluated, the next 8 weeks I will be involved in yoga, balance training, or an awareness instruction, and the remaining 4 weeks I will be re-evaluated. I should wear comfortable clothes that allow for freedom of movement to perform the exercises and the physical tests.

I understand that my balance will be tested by two methods. The first method involves 10 brief tests that will require me to stand with my eyes open, stand with my eyes closed, stand on one leg, stand on my toes, stand on my heels, sit down in a chair, arise from a chair, standing balance after arising, turn 360 degrees, reach up, and bend over. The second method will be conducted by trained technicians using the Neurocom Balance Master machine.

I understand that I will assessed by a walking test.

I understand that all aspects of this project will be conducted at Gulf Coast Medical Center Rehabilitation Center or the Gulf Coast Medical Center Health Happiness You (H2U) office or the Cherry Street center of H2U.

I understand that my participation is totally voluntary and I may stop participation at any time. All my answers to any and all assessments, questionnaires, health history forms, data collection forms, etc. will be kept confidential and identified by a participant code. My name will not appear on any of the results. Information obtained during the course of the study will remain confidential, to the extent allowed by law.

I understand there is a minimal amount of risk if I agree to participate in this study. Because this study includes physical exercise I might experience some tiredness and some minor muscle soreness. In addition, a research-related injury such as a muscle strain or other injury resulting from a fall may be possible. I understand that my risks will be minimized by the presence of trained research staff during all testing procedures and exercise instruction. These staff members will provide support to me in any instance of unsteadiness to prevent my falling.

I understand that there are benefits for participating in this research project. My own awareness of my abilities may be increased and perhaps my physical abilities overall. I will also be providing valuable information to exercise and rehabilitation professionals on the effects of incorporating yoga, balance training, and awareness training into a fall prevention program.

I understand that portions of my yoga, balance training, or physical assessments may be video taped. The purpose for taping is for the researchers to view the tapes after completion of the session to re-evaluate my performance during yoga, balance training, or assessments. The tapes will be stored with Dawn M. Morris in a locked file cabinet and will be kept for the period of three years after project completion. The tape and all project-associated data will be destroyed by December 31, 2010.

I understand that this consent may be withdrawn at any time without prejudice, penalty or loss of benefits to which I am otherwise entitled. I have been given the right to ask and have answered any inquiry concerning the study. Questions, if any have been answered to my satisfaction.

I understand that I may contact Dawn M. Morris, Florida State University, (850) 832-9569 for answers to any questions about this research or research-related injuries. I may also contact Dr. Gershon Tenenbaum, Florida State University, (850) 644-8791. For questions regarding my rights as a subject, I may contact the Florida State University Human Subjects Committee, (850) 644-8633. I will be briefed about the project periodically during the project and at the conclusion of the project.

I have read and understand this form.

____

(Participant) (Date)

APPENDIX C: HUMAN SUBJECTS APPROVAL LETTER

From: Human Subjects <humansubjects@magnet.fsu.edu>
To: njoymor@aol.com
Cc: tenenbau@mail.coe.fsu.edu
Subject: Use of Human Subjects in Research - Approval Memorandum
Date: Tue, 10 Jul 2007 7:58 am
Attachments: Morris_07.498.pdf (53K)

Office of the Vice President For Research
Human Subjects Committee
Tallahassee, Florida 32306-2742
(850) 644-8673 . FAX (850) 644-4392

APPROVAL MEMORANDUM

Date: 7/10/2007

To: Dawn Morris

Address: 7595 Yellow Bluff Road Panama City Florida 32404
Dept.: EDUCATIONAL PSYCHOLOGY AND LEARNING SYSTEMS

From: Thomas L. Jacobson, Chair

Re: Use of Human Subjects in Research
An Evaluation of Yoga for the Reduction of Fall Risk Factors in Older Adults

The application that you submitted to this office in regard to the use of human subjects in the research proposal referenced above has been reviewed by the Human Subjects Committee at its meeting on 6/13/2007 2:00:00 PM. Your project was approved by the Committee.

The Human Subjects Committee has not evaluated your proposal for scientific merit, except to weigh the risk to the human participants and the aspects of the proposal related to potential risk and benefit. This approval does not replace any departmental or other approvals, which may be required.

If you submitted a proposed consent form with your application, the approved stamped consent form is attached to this approval notice. Only the stamped version of the consent form may be used in recruiting research subjects.

If the project has not been completed by 7/1/2008 you must request a renewal of approval for continuation of the project. As a courtesy, a renewal notice will be sent to you prior to your expiration date; however, it is your responsibility as the Principal Investigator to timely request renewal of your approval from the Committee.

You are advised that any change in protocol for this project must be reviewed and approved by the Committee prior to implementation of the proposed change in the protocol. A protocol change/amendment form is required to be submitted for approval by the Committee. In addition, federal regulations require that the Principal Investigator promptly report, in writing any unanticipated problems or adverse events involving risks to research subjects or others.

By copy of this memorandum, the Chair of your department and/or your major professor is reminded that he/she is responsible for being informed concerning research projects involving human subjects in the department, and should review protocols as often as needed to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

This institution has an Assurance on file with the Office for Human Research Protection. The Assurance Number is IRB00000446.

Cc: Gershon Tenenbaum, Advisor

APPENDIX D: BAY COUNTY FLORIDA REVIEW BOARD WAIVER OF JURISDICTION

BAYMEDICAL

Office of the Joint Institutional Review Board of Bay County
Phone: 850-747-6269 **Fax: 850-747-6233**

June 18, 2007

Florida State University
Human Subjects Committee

Re: WAIVER OF JURISDICTION

Principal Investigator:	Dawn Morris
Title:	An Evaluation of Yoga for the Reduction of fall Ruisk Factors in Older Adults

To Whom It May Concem:

The Chairperson of the Joint Institutional Review Board of Bay County (JIRB) 2004 and reviewed the above captioned study and related informed consent documents and approved wiaver to the FSU IRB.

Per Title 21 of the Code of Federal Regulations, Part 56 and established local policy, the Joint Institutional Review Board of Bay County agrees to waive its right to review and approve the above-referenced study under the direction of Dawn Morris. The JIRB understands and agrees that the Florida State University Human Subjects Committee will review and approve the above-referenced study prospectus and applicable consent forms for Ms. Morris, and will have jurisdiction throughout the course of the study.

Per local policy in the interest of patient safety and protection, the JIRB will continue to maintain a file on this study. It will be the responsibility of Ms. Morris to submit copies of all available correspondence, revisions, amendments, changes, and reapprovals, etc. to both the Joint Institutional Review Board of Bay County and the Florida State University Human Subjects Committee.

Sincerely,
Linda Deneen RN, BSN, BC

Linda Deneen, RN, BSN, BC
Administrator, Joint Institutional Review Board of Bay County

CC: Dawn Morris

APPENDIX E: ASSESSMENTS

NEUROCOM BALANCE MASTER MACHINE

Participants are in a semi enclosed space and securely harnessed for all testing conditions.

11-item Performance-Oriented Mobility Assessment


(1) standing balance
eyes open
(2) standing balance
eyes closed


(3) one leg balance

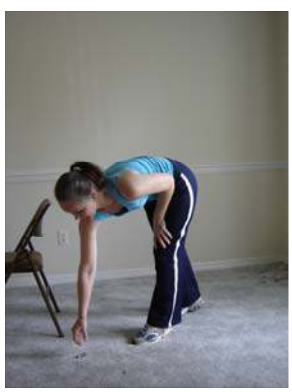

(4) toe stand


(5) heel stand


(6) sitting down
(7) rising from chair
(8) balance upon standing


(9) 360^{o} turn


(10) reaching up


(11) bending over

Fear Efficacy Scale

For each of the following please indicate the level of concern for falling when performing these activities.
Use the four-point scale ranging from 1 = not concerned at all to 4 = very concerned.

	not concerned at all			very concerned
1. Cleaning the house	1	2	3	4
2. Getting dressed or undressed	1	2	3	4
3. Preparing simple meals	1	2	3	4
4. Taking a shower or bath	1	2	3	4
5. Going to the shop	1	2	3	4
6. Getting in or out of a chair	1	2	3	4
7. Going up or down stairs	1	2	3	4
8. Walking around outside	1	2	3	4
9. Reaching up or bending down	1	2	3	4
10. Answering the telephone	1	2	3	4

Activities–Specific Balance Confidence Scale

For each of the following please indicate your level of confidence in doing the activity with out losing your balance or becoming unsteady by choosing one of the percentage points on a scale from 0% - 100%. If you currently do the activity in question, try and imagine how confident you would be if you had to do the activity. If you normally use a walking aid to do the activity or hold onto someone, rate your confidence as if you were using these supports. If you have any questions about answering any of these items, please ask the administrator.
For each activity indicate the percent of your level of **self-confidence** by choosing a number from this scale (0-100%).

0% 10 20 30 40 50 60 70 80 90 100%

no confidence completely confident

"How confident are you that you will not lose your **balance** or become unsteady when you…"

1. …walk around the house? ___%
2. …walk up or down stairs? ___%
3. …bend over and pick up a slipper from the front of a closet floor? ___%
4. …reach for a small can off a shelf at eye level? ___%
5. …stand on your tip toes and reach for something above your head? ___%
6. …stand on chair and reach for something? ___%
7. …sweep the floor? ___%
8. …walk outside the house to a car parked in the driveway? ___%
9. …get into or out of a car? ___%
10. …walk across a parking lot to the mall? ___%
11. …walk up or down a ramp? ___%
12. …walk in a crowded mall where people rapidly walk past you? ___%

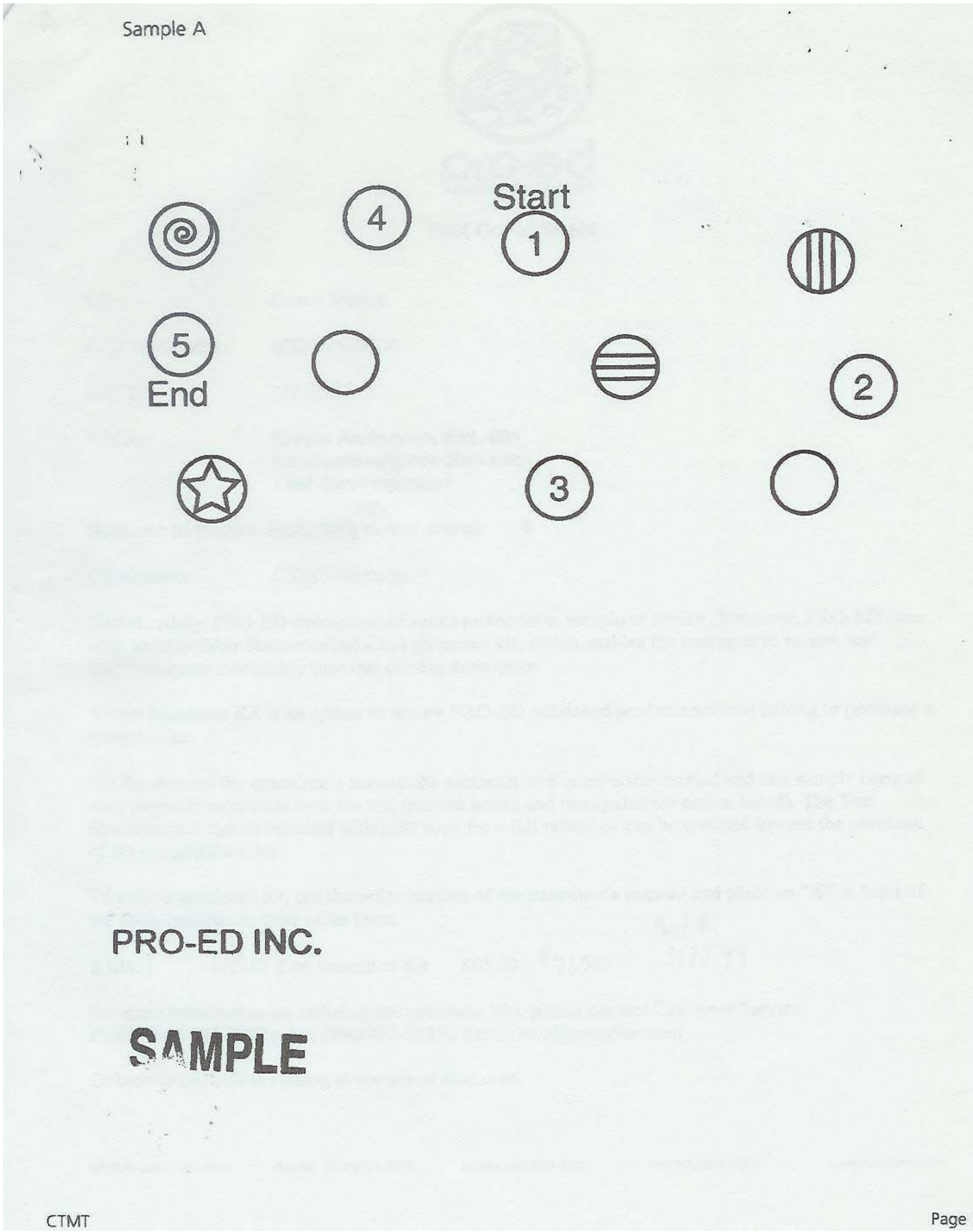
13. …are bumped into by people as you walk through the mall? ___%

14. …step onto or off of an escalator while holding the handrail? ___%

15. …step onto or off of an escalator while holding onto parcels such that you cannot hold onto the railing? ___%

16. …walk outside on icy sidewalks? ___%

SAMPLE TRAIL MAKING TEST



WALKING TRAIL MAKING TEST

A written description of the walking trail is provided in Chapter 2 on page 42.

Environmental Awareness Test

False positives are ignored.

	Item identified (Circle)
<u>Outside:</u>	
1. Stair areas: step too high	Y / N
2. Stair handrails missing	Y / N
3. Ramp missing treads/non-skid, poor marking	Y / N
4. Raised threshold at doorway entrance	Y / N
<u>Kitchen:</u>	
5. Lighting	Y / N
6. Phone Cord	Y / N
7. News papers	Y / N
8. Inappropriate 'ladder' device for reaching high area	Y / N
<u>Bathroom:</u>	
9. Obstruction of walkway	Y / N
10. Obstruction of doorway	Y / N
11. Liquid spill	Y / N
12. Throw rug on slick surface	Y / N
<u>Living Room:</u>	
13. Power cord	Y / N
14. Extension Cord	Y / N
15. Magazines	Y / N
16. Low sitting chair	Y / N
17. Plant stand with vine hanging	Y / N
18. Throw rug wrinkled	Y / N

Score: _____/18

Steadiness Measure: Score: 2 1 0
(Circle score)

2pts steadiness: "performing the assessment without any incident of unsteadiness, reaching out for a person or an object to regain stability."

1 pt unsteadiness: "any time a participant must reach out and place a hand on an object or a person, or must step forward, side, or back to maintain stability and standing."

0 pts near falls or falls: "anytime a participant's downward movement stops at a plane lower than the plane they were originally" or "anytime a participant through downward movement ends resting on the floor."

STEADINESS MEASURE

Observation Protocol
Steadiness Scores

Assessments: POMA, W-TMT, EAT
Interventions: yoga, balance training

- Using the following guidelines a score will be assigned to each participant's performance.

2pts	steadiness: "performing the assessment or exercise without any incident of unsteadiness, reaching out for a person or an object to regain stability."
1 pt	unsteadiness: "any time a participant must reach out and place a hand on an object or a person, or must step forward, side, or back to maintain stability and standing."
0 pts	near falls or falls: "anytime a participant's downward movement stops at a plane lower than the plane they were originally" or "anytime a participant through downward movement ends resting on the floor."

- The observer must complete a training session prior to a scoring observation. The training session will include actual demonstration of the assessments and exercises to be performed.
- The observer is expected at the observation site at least 10 minutes prior to the start of the observation period. Observation times are to be announced.
- Observer will sit in a position behind the participant.
- During continuous observation of a given performance the highest level of unstability is the score recorded. For example if exercise 4 is performed steadily but has a near fall at the end, the score is recorded as a zero. Likewise, if an exercise has unsteadiness at the beginning but ends in a steady exercise, the score is 1.
- Observer will place the score in the appropriate cell of the recording form.

SELF REPORT FALLS CALENDAR

August 2007						
Please indicate information about your fall on the day it occurred:	activity location injury severity		1	2	3	4
5	6Group 1 Baseline start	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

Self Report Fall Assessment Interview

Subject ID: _______

		Fall	number	location(s)	activity(s)	injury(s)	severity
Interviewer	week	(yes/no)					
	1						
	2						
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						
	11						
	12						
	13						
	14						
	15						
	16						

APPENDIX F: INTERVENTIONS

Yoga Class
Standing poses
For all poses, a chair will be available to provide support.


mountain


standing lateral flexion (right/left)


warrior (right/left)


sun god


forward fold


forward fold (right/left)


chair


tree (right/left)

Yoga Class
Sitting and lying poses


cat/cow


overhead stretch


seated twist (right/left)


straddle


forward fold


superman (right/left)


knee squeeze


final relaxation
progressive muscle relaxation

Sample Balance Training class exercises
For all poses, a chair will be available to provide support.

Warm up:


walk in place


step side


step front toe and heel


step back


walk on toes


walk on heels


knees up


knee to side


elbow circles

shoulder rolls (not pictured)

Balance Drills:

Footprints: pressing feet into floor, gently rocking forward/back, side/side

ice cream cone

Romberg drill

functional reach

one-leg stance

Strength exercises: lower body

leg extension

side raise

back raise

squat

chair stand

Strength exercises: upper body


arm raise front


raise side


triceps press


row


tilt side to side


arm circles


wrist extension/flexion/circles


make fist/spread fingers

Stretching exercises:


chin to chest


chin to collar bone


side stretch


torso twist

shoulder rotation (not pictured)


seated hamstring stretch


ankle flexion/extension/rotation

SYLLABUS
Fall Risk Awareness Class
November 2, 2007 – December 21, 2007
1 hour per class

Class time TBA

Meeting/Date	Class Content	Handouts
1 11/2	fall risk factors	Why do people fall? Risk Factors for Falling
2 11/9	individual changes during aging	Who's at risk? What to do?
3 11/16	balance	Systems involved in balance Balance Bits
4 11/23	home safety	Home Safety Checklist
5 11/30	posture	Posture
6 12/7	exercise	The Importance of Exercise
7 12/14	walking/healthy feet	Walking For Your Feet
8 12/21	Summary	

APPENDIX G: STUDY TIMELINE

Study Timeline

Phases

Groups

Yoga	Y-BL (A)				Y-I (B) (C)	(B) (D)	(B) (C)	(B) (D)	(B) (C)	(B) (D)	(B) (C)	(B) (D)	Y-(PI)			Y-(F)								
Balance					BT BL (A)				BT -I (B) (C)	(B) (D)	(B) (C)	(B) (D)	(B) (C)	(B) (D)	(B) (C)	(B) (D)	BT-(PI)			BT (F)				
Control									A-BL (A)				A-I (B) (C)	(B) (D)	(B) (C)	(B) (D)	(B) (C)	(B) (C)	(B) (C)	(B) (D)	A-(PI)			A-(F)
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
2007	8/6				9/4				10/1				10/29				11/26				12/17			1/4

BL = baseline
I = Intervention
PI = post-intervention
F = Follow up

Groups: Y = yoga
BT = Balance Training
A = Awareness Training

Assessments:
(A) Baseline Battery: NC, POMA, W-TMT, TMT, FES, ABC, EAT, Falls Self Report
(B) Each week POMA, Falls Self Report
(C) Biweekly W-TMT
(D) Biweekly ABC/FES
(PI) Post intervention battery: NC, POMA, TMT, WTMT, ABC, FES, EAT, Falls Self Report
(F) Follow-up battery: POMA, W-TMT, TMT, FES, ABC, EAT, Falls Self-report

REFERENCES

Alexander, C.N., Langer, E.J., Newman, R.I., Chandler, H.M., & Davies, J.L. (1989). Transcendental meditation, mindfulness, and longevity: An experimental study with the elderly. *Journal of Personality and Social Psychology, 57(6),* 950-964.

Alexander, N.B., Ashton-Miller, J.A., Giordani, B., Guire, K., & Schultz, A.B. (2005). Age differences in timed accurate stepping with increased cognitive and visual demand: A walking trail making test. *Journal of Gerontology, 60A(12),* 1558-1562.

Alleger, I. (2002). The anti-aging exercise. *Townsend Letter for Doctors and Patients, 1,* 153 – 154.

American College of Sports Medicine (2003). Everyone benefits from yoga when properly executed and individually adapted. Health and Fitness Summit and Exposition: Reno, NV.

American Council on Exercise. (1996). *Instructor's Manual*. Boston, MA: Reebok University Press.

American Academy of Orthopaedic Surgeons. (2000/2002). Prevent Falls! Des Plaines, Ill: American Academy of Orthopaedic Surgeons. Accessed on June 9. 2006 from http://orthoinfo.aaos.org/fact/thr_report.cfmandtopcategory=InjuryPreventionandThread_ID=102.

American Geriatrics Society, British Geriatrics Society, and American Academy of Orthopaedic Surgeons Panel on Falls Prevention. (2001). Guideline for the prevention of falls in older persons. *Journal of the American Geriatrics Society, 49,* 664-672.

American Geriatrics Society Foundation for Health in Aging. (2005). Aging in the know: Falls. New York, NY: American Geriatrics Society. Accessed June 9, 2006 from http://www.healthinaging.org/agingintheknow

American Psychiatric Association. (2000). *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision.* Washington, DC: American Psychiatric Association.

Anders, M. (2005). Does yoga really do the body good? *ACE Fitness Matters, 11(5),* p. 7-9.

Arambula, P., Peper, E., Kawakami, M., & Gibney, K.H. (2001). The physiological correlates of Kundalini Yoga meditation: A study of a yoga master. *Applied Psychophysiology and Biofeedback, 26,* 147 – 153.

Avers, D. & Lindsey, C. (1999). What you need to know about balance and falls: A physical therapist's perspective. Alexandria, VA: American Physical Therapy Association.

Bandura, A. (1995). *Self-efficacy in Changing Society*. New York: Cambridge University Press.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84,* 191-215.

Bandura, A. (2001). Social Cognitive Theory: An agentic perspective. *Annual Review of Psychology, 52*, 1-26.

Barnes, B.L. & Nagarkar. (1989). Yoga education and scholastic achievement. *Indian Journal of Clinical Psychology, 16*, 96-98.

Barnes, D.E., Yaffe, K., Satariano, W.A., & Tager, I.B. (2003). A longitudinal study of cardiovascular fitness and cognitive function in healthy older adults. *Journal of the American Geriatrics Society, 51,* 459-465.

Bell, R. (1999). *Yoga: Les techniques simples du bien-etre*. Paris, France: Solar Publishing.

Berger, B.G. & Owen, D.R. (1988). Stress reduction and mood enhancement in four exercise modes: Swimming, body conditioning, hatha yoga, and fencing. *Research Quarterly for Exercise and Sport, 59,* 148 – 159.

Berger, B.G. & Owen, D.R. (1992). Mood alteration with yoga and swimming: Aerobic exercise may not be necessary. *Perceptual and Motor Skills, 73,* 1331-1343.

Bixby, W.R., Spaulding, T.W., Haufler, A.J., Deeny, S.P., Mahlow, P.T., Zimmerman, J.B., & Hatfield, B.D. (2007). The unique relation of physical activity to executive function in older men and women. *Medicine & Science in Sports & Exercise, 39,* 1408-1416.

Blaszczyk, J.W., Prince, F., Raiche, M., & Hebert, R. (2000). Effect of aging and vision on limb load asymmetry during quiet stance. *Journal of Biomechanics, 33,* 1243-1248.

Bonura, K.B. (2007). The impact of yoga on psychological health in older adults. Unpublished manuscript, Florida State University, Tallahassee.

Bonura, K.B., Aloe, A., Becker, B.J., & Tenenbaum, G. (2007). A meta-analysis on the effects of yoga on psychological health and well-being: Does it justify its reputation? Unpublished manuscript, Florida State University, Tallahassee.

Bovre, S. (2001). *Balance Training: A program for improving balance in older adults*. Tucson, AZ: Desert Southwest Fitness, Inc.

Brauer, S.G., Woolacott, M., & Shumway, A. (2001). The interacting effects of cognitive demand and recovery of postural stability in a balance impaired elderly person. *Journal of Gerontology: Medical Sciences, 56A(8),* M489-M496.

Broota, A & Sanghvi, C. 1994. Efficacy of teo relaxation techniques in examination anxiety. *Journal of Personality and Clinical Studies, 10,* 29-35.

Brown, L.A., Sleik, R.J., Polych, M.A., & Gage, W.H. (2002). Is prioritization of postural control altered in conditions of postural threat in younger adults and older adults? *Journal of Gerontology, 57A(12),* M785-M792.

Bruce, D.G., Devine, A., & Prince, R.L. (2002). Recreational physical activity levels in healthy older women: The importance of fear of falling. *Journal of the American Geriatric Society, 50,* 84-89.

Buchner, D.M., Cress, M.E., de Lateur, B.J., Esselman, P.C., Margherita, A.J., & Price, R. (1997). The effect of strength and endurance training on gait, balance, fall risk, and health services use in community-living older adults. *Journals of Gerontolgy Series A: Biological Sciences and Medical Sciences, 52(4),* M218-M224.

Burbank, P.M., Reibe, D., Padula, C.A., & Nigg, C. (2002). Exercise and older adults: Changing behavior with the transtheoretical model. *Orthopedic Nursing, 21,* 51 – 63.

Campbell, A.J., Robertson, M.C., Garner, M.M., Norton, R.N., Tilyard, M.W., & Buchner, D.M. (1997). Randomised controlled trial of a general practice programme of home based exercise to prevent falls in elderly women. *Student British Medical Journal, 5,* 422.

Carter, N.D., Khan, K., McKay, H.A., Petit, M.A., Waterman, C., Heinonen, A. et al. (2002). Community-based exercise program reduces risk factors for fall in 65 to 75-year-old women with osteoporosis: Randomized controlled trial. *Canadian Medical Association Journal, 167(9),* 997-1004.

Centers for Disease Control, National Center for Injury Prevention and Control. (2006). Falls and hip fractures among older adults. Accessed on June 6, 2006 from http://www.cdc.gov/ncipc/fact_book/15_Falls_Among_Older_Adults.htm

Centers for Disease Control, National Center for Injury Prevention and Control. (2002). Falls among older adults. In: Injury Fact Book, 2000-2001. Retrieved October 14, 2003, from http://www.cdc.gov/ncipc/factsheet/Falls.htm

Centers for Disease Control, Department of Health and Human Services. (2002). Promoting active lifestyles among older adults. Retrieved October 14, 2003, from http://www.cdc.gov/nccdphp/dnpa

Chang, J.T., Morton, S.C., Rubenstein, L.Z., Mojica, W.A., Maglione M., & Suttorp, M.J. (2004). Interventions for the prevention of falls in older adults: Systematic review and meta-analysis of randomized clinical trials. *British Medical Journal, 328,* 680-683.

Coon, D. (2005). *A Journey.* Belmont, CA: Thomson Wadworth.

Cumming, R.G. (1998). Epidemiology of medication-related falls and fractures in the elderly. *Drugs and Aging, 12(1),* 43-53.

Cusumano, J. & Robinson, S. (1993). The short-term psychphysiological effects of hatha yoga and progressive relaxation on female Japanese students. *Applied Psychology: An International Review, 42*(1), 77-90.

Daley, M.J. & Spinks, W.L. (2000). Exercise, mobility, and aging. *Sports Mediine, 29,* 1-13.

Daubenmier, J. (2005). The relationship of yoga, body awareness, and body responsiveness to self-objectification and disordered eating. *Psychology of Women Quarterly, 29*, 207-219.

Ducic, I., Short, K.W., & Dellon, A.L. (2004). Relationship between loss of pedal sensibility, balance, and falls in patients with peripheral neuropathy. *Annnals of Plastic Surgery, 52(6),* 535-540.

Edwards, D.J., Edwards, S.D., & Basson, C.J. (2004). Psycological well-being and physical self-esteem in sport and exercise. *International Journal of Mental Health Promotion, 6,* 25 – 32.

Garfinkel, M.S., Schumacher, H.R., Hsain, A., Levy, M., & Reshetar, R.A. (1994). Evaluation of a yoga based regimen for treatment of osteoarthritis of the hands. *Journal of Rheumatology, 21,* 2341 – 2343.

Graafmans, W.C., Ooms, M.E., Hofstee, H.M.A., Bezemer, P.D., Bouter, L.M., & Lips, P. (1996). Falls in the elderly: A prospective study of risk factors and risk profiles. *American Journal of Epidemiology, 143 (11),* 1129-1136.

Hausdorf & Yogev. (2006). Cognitive function may be important for fall injury prevention trials. *Journal of the American Geriatric Society, 54(5),* 865.

Hay, L., Bard, C., Fleury, M, & Teasdale, N. (1996). Availability of visual and proprioceptive afferent messages and postural control in elderly adults. *Brain Research, 108,* 129-139.

Hornyik M. & Harter, R. (2001). Reliability of limits of stability testing: A comparison of two dynamic postural stability evaluation devices. *Journal of Athletic Training, 36*, S-77-S78.

Hsiao, E.T. & Robinovitch, S.N. (2001). Elderly subjects' ability to recover balance with a single backward step associates with body configuration at step contact. *Journal of Gerontology: MEDICAL SCIENCES, 56A (1),* M42-M47.

Ivers, R.Q., Cumming, R.G., Mitchell, P., & Attebo, K. (1998). Visual impairment and falls in older adults: The blue mountains eye study. *Journal of the American Geriatrics Society, 46, (1),* 58-64.

Ivers, R.Q., Norton, R., Cumming, R.G., Butler, M., & Campbell, A.J. (2000). Visual impairment and risk of hip fracture. *American Journal of Epidemiology, 152*, (7), 633-639.

Janakiramaiah, N., Gangahar, B.N., Murthy, P.J., Harish, M.G., Subbakrishna, D.K., Vedamurthachar, A. (2000). Antidepressant efficacy of Sudarshan Kriya yoga (SKY) in melancholia: A randomized comparison with electroconvulsive therapy (ECT) and imipramine. *Journal of Affective Disorders, 57,* 255-259.

Jeandel, C. & Vuillemin, A. (2000). Effects of physical activities on postural control in the elderly. *Science & Sports, 15,* 187-193.

Jorstad, E.C., Hauer, K., Becker, C., & Lamb, S.E. (2005). Measuring the psychological outcomes of falling: A systematic review. *The Journal of the American Geriatric Society, 53,* 501-510.

Kaliappan, L. & Kaliappan, K.V. (1992). Efficacy of yoga therapy in the management of headaches. *Journal of Indian Psychology, 10,* 41 – 47.

Kellogg International Work Group. (1987). *Danish Medical Bulletin, 34* (Supplement 4)*,* 1-24.

Keysor, J.J. & Jette, A.M. (2001). Have we oversold the benefit of late-life exercise? *Journal of Gerontology: Medical Sciences, 56A(7),* M412-M423.

Koceja, D.M., Allway, D., & Earles, D. R. (1999). Age differences in postural sway during volitional head movement. *Archives of Physical Medicine and Rehabilitation, 80,* 1537-1541.

Kressig, R.W., Wolf, S.L., Sattin, R.W., O'Grady, M., Greenspan, A., Curns, A., et al. (2001). Associations of demographic, functional, and behavioral characteristics with activity-related fear of falling among older adults transitioning to frailty. *Journal of the American Geriatrics Society, 49,* 1456-1462.

Kurlan, R. (2005). "Fear of falling" gait: A potentially reversible psychogenic gait disorder. *Cognitive Behavioral Neurology, 18,* 171-172.

Leung, Y. & Singhal, A. (2004). An examination of the relationship between qigong meditation and personality. *Social Behavior and Personality, 32,* 313-320.

Li, F., Fisher, K.J., Harmer, P., McAuley, E., & Wilson, N.L. (2003). Fear of falling in elderly persons: Association with falls, functional ability, and quality of life. *Journal of Gerontology: Psychological Sciences, 58B (5),* P283-P290.

Li, J.X., Hong, Y., & Chan, K.M. (2001). Tai chi: Physiological characteristics and beneficial effects on health. *British Journal of Sorts Medicine, 35,* 148 – 156.

Lord, S.R. & Fitzpatrick, R.C. (2001). Choice stepping reaction time: A composite measure of falls risk in older people. *Journal of Gerontology, 56A,* M627-M632.

Ludt, R. & Goodrich, G.L. (2002). Change in visual perceptual detection distances for low vision travelers as a result of dynamic visual assessment and training. *Journal of Visual Impairment and Blindness, January,* 7-21.

Luskin, F., Newell, K., Griffith, M., Holmes, M., Telles, S., & DiNucci, E. et al. (2000). A review of mind/body therapies in the treatment of musculoskeletal disorders with implications for the elderly. *Alternative Therapies in Health and Medicine, 6*, 46-56.

Maki, B.E., Edmondstone, M.A., & McIlroy, W.E. (2000). Age-related differences in laterally directed compensatory stepping behavior. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 55*, M270-M277.

Mayo Foundation for Medical Education and Research. (2004). Falls: Reduce your risk. Mayo Clinic. Accessed June 9, 2006 from http://www.mayoclinic.com/health/fallprevention/HQ00657

McMurdo, M.E.T., Millar, A.M., & Daly, F. (2000). A randomized contolled trial of fall prevention strategies in old peoples' homes. *Gerontology, 46,* 83-87.

Medell, J.L. & Alexander, N.B. (2000). A clinical measure of maximal and rapid stepping in older women. *Journal of Gerontology: Medical Sciences, 55A,(8),* M429-M433.

Nashner, L.M. (1980). Balance adjustments of humans perturbed while walking. *Journal of Neurophysiology, 44 (4),* 650-664.

National Institute on Aging. (2004). Falls and fractures. Gaithersburg, MD: National Institute on Aging. Accessed on June 9, 2006 from http://www.niapublications.org/agepages/falls.asp

National Institutes of Health Osteoporosis and Related Bone Diseases. (2005). Once is enough: A guide to preventing future fractures. Bethesda, MD: National Institute of Arthritis and Musculoskeletal and Skin Diseases. Accessed on June 9, 2006 from http://www.niams.nih.gov/bone/hi/prevent_fracture.htm

National Institutes of Health Osteoporosis and Related Bone Diseases. (2005). Preventing falls and related fractures. Bethesda, MD: National Institutes of Health Osteoporosis and Related Bone Diseases. Accessed on June 9, 2006 from http://www.osteo.org

Neef, N. A., Bill-Harvey, D., Shade, D., Iezzi, M., & DeLorenzo, T. (1995). Exercise participation with videotaped modeling: Effects on balance and gait in elderly residents of care facilities. *Behavior Therapy, 26,* 135-151.

NeuroCom International, Inc. (1997). NeuroCom System. http://www.balanceandmobility.com

Newberg, A., Alavi, A., Baime, M., Pourdehnad, M., Santanna, J., & d'Aquili, E. (2001). The measurement of regional cerebral blood flow during the complex cognitive task of meditation: A preliminary SPECT study. *Psychiatry Research: Neuroimaging Section, 106,* 113-122.

Owsley, C., Ball, K., & Keeton, D.M. (1995). Relationship between visual sensitivity and target localization in older adults. *Vision Research, 35 (4),* 579-587.

Province, M.A., Hadley, E.C., Hornbrook, M.C., Lipsitz, L.A., Miller, J.P., & Mulrow, C.D. (1995). The effects of exercise on falls in elderly patients. A preplanned meta-analysis of the FICSIT trials. Frailty and injuries: Cooperative studies of intervention techniques. *Journal of the American Medical Association, 273 (17),* 1341-1347.

Rankin, J.K., Woollacott, M.H., Shumway-Cook, A., & Brown, L.A. (2000). Cognitive influence on postural control: A neuromuscular analysis in young and older adults. *Journal of Gerontology, 55A,* M112-M119.

Raub, J. (2002). Psychphysiologic effects of hatha yoga on musculoskeletal and cardiopulmonary function: A literature review. *Journal of Alternative and Complimentary Medicine, 8*, 797-812.

Ray, W.A., Taylor, J.A., Brown, A.K., Gideon, P., Hall, K., Arbogast, P. et al. (2005). Prevention of fall-related injuries in long-term care: A randomized controlled trial of staff education. *Archives of Internal Medicine, 165,* 2293- 2298.

Redfern, M.S., Muller, M.L., Jennings, J.R., & Furman, J.M. (2002). Attentional dynamics in postural control during perturbations in young and older adults. *Journal of Gerontology, 57A (8),* B298-B303.

Reynolds, C. (2002). Comprehensive Trail Making Test. Austin TX: Pro-Ed Publishing.

Rizzo, J.A., Baker, D.I., McAvay, G., & Tinetti, M.E. (1996). The cost-effectiveness of a multifactorial targeted prevention program for falls among community elderly persons. *Medical Care, 34,* 954-969.

Robitaille, Y., Laforest, S., Fournier, M., Gauvin, L., Parisien, M., Corriveau, H., Trickey, F., et al. (2005). Moving forward in fall prevention: An intervention to improve balance among older adults in real-world settings. *American Journal of Public Health, 95 (11),* 2049-2056.

Rogers, M.W., Hedman, L.D., Johnson, M.E., Cain, T.D., & Hanke, T.A. (2001). Lateral stability during forward-induced stepping for dynamic balance recovery in young and older adults. *Journal of Gerontology: Medical Sciences, 50A (9),* M589-M594.

Sahajpal, P. & Ralte, R. (2000). Impact of induced yogic relaxation training (IYRT) on stress-level, self-concept, and quality of sleep among minority group individuals. *Journal of Indian Psychology, 18,* 66-73.

Sarafino, E.P. (2006). *Health Psychology Biopsychosocial Interactions* (5th ed.). New York: John Wiley & Sons, Inc.

Sattin, R.W. (1992). Falls among older persons: A public health perspective. *Annual Review of Public Health, 13,* 489-508.

Sattin, R.W., Easley, K.A., Wolf, S.L., Chen, Y., & Kutner, M.H. (2005). Reduction in fear of falling through intense tai chi exercise training in older, transitionally frail adults. *Journal of the American Geriatrics Society, 53,* 1168-1178.

Schmidt, R.A. & Lee, T.D. (2005). *Motor Control and Learning: A Behavioral Emphasis*. Champaign, IL: Human Kinetics.

Schneider, R.H., Staggers, F., Alexander, C.N., Sheppard, W., Rainforth, M., Kondwani, K., et al. (1995). A randomized control trial of stress reduction for hypertension in older African Americans. *Hypertension, 26,* 820 – 827.

Seidler, R.D. & Martin, E.M. (1997). The effects of short term balance training on the postural control of older adults. *Gait and Posture, 6,* 224-236.

Shapiro, D. (2006). Is the yoga world ready? An academic perspective. *International Journal of Yoga Therapy, 16,* 7-8.

Sharma, H., Sen, S., Singh, A., Bhardwaj, N.K., Kochupillai, V., & Singh, N. (2003). Sudarshan Kriya practitioners exhibit better antioxidant status and lower blood lactate levels. *Bilogical Psychology, 63,* 281-291.

Shaw, B. (2001). *YogaFit.* Champaign, IL: Human Kinetics.

Sheldon, J. (1963). The effect of age on the control of sway. *Gerontologia Clinica, 5,* 129-138.

Sheridan P.L., Solomont, J., Kowall, N., & Hausdorff, J.M. (2003). Influence of executive function on locomotor function: Divided attention increases gait variability in Alzheimer's disease. *Journal of the American Geriatrics Society, 51,* 1633-1637.

Sherman, K. (2006). Reflections on researching yoga. *International Journal of yoga Therapy, 16,* 9-10.

Shumway-Cook, A., Woollacott, M., Kerns, K.A., & Baldwin, M. (1997). The effects of two types of cognitive tasks on postural stability in order adults with and without a history of falls. *Journal of Gerontology, 52A (4),* M232-M240.

Speechley, M. & Tinetti, M.E. (1991). Falls and injuries in frail and vigorous community elderly persons. *Journal of the American Geriatric Society, 39,* 46-52.

Tinetti, M.E. (1986). Performance-oriented assessment of mobility in elderly patients. *Journal of the American Geriatric Society, 34,* 119-126.

Tinetti, M. (1991, June 4). Summary information on performance measures used in research projects. Presented at National Institute of Health sponsored workshop on performance measures template. Received from Mary Tinetti, Yale University School of Medicine on November 10, 2003.

Tinetti, M. (2003). Preventing falls in the elderly. *New England Journal of Medicine, 348,* 42-49.

Tinetti, M. E., Baker, D. I., McAvay, G., Claus, E. B., Garrett, P., Gottchaulk, M., et al. (1994). A multifactorial intervention to reduce the risk of falling among elderly people living in the community. *The New England Journal of Medicine, 331,* 821-827.

Tinetti, M.E., Speechley, M., & Ginter, S.F. (1988).Risk factors for falls among elderly persons living in the community. *The New England Journal of Medicine, 319 (26),* 1701-1707.

Tinetti, M.E. & Willians, C.S. (1997). Falls, injuries due to falls, and the risk of admission to a nursing home. *New England Journal of Medicine, 337 (18),* 1279-1284.

Tinetti, M. E., Williams, T. F., & Mayewski, R. (1986). Fall risk index for elderly patients based on number of chronic disabilities. *The American Journal of Medicine, 80,* 429-434.

Tsang, W.H., Cheung, L., & Lak, D.C.C. (2002). Qigong as a psychosocial intervention for depressed elderly with chronic physical illnesses. *International Journal of Geriatric Psychiatry, 17,* 1146 – 1154.

Tsang, H.W.H., Mok, C.K., Au Yeung, Y.T., & Chan, S.Y.C. (2003). The effect of qigong on general and psychsocial health of elderly with chronic physical illnesses: A randomized clinical trial. *International Journal of Geriatric Psychiatry, 18,* 441 – 449.

Uma, K., Nagendra, H., Nagarathna, R., Vaidehi, S. & Seethalakshmi, R. (1989). The integrated approach of yoga: A therapeutic tool for mentally retarded children: A one-year controlled study. *Journal of Mental Deficiency Research, 33*, 415-421.

Vempati, R.P. & Telles, S. (2002). Yoga-based guided relaxation reduces sympathetic activity judged from baseline levels. *Psychological Reports, 90,* 487 – 494.

Verghese, J., Buschke, H., Viola, L., Katz, M., Hall, C., Kuslansky, G., et al. (2002). Validity of divided attention tasks in predicting falls in older individuals: A preliminary study. *Journal of the American Geriatrics Society, 50,* 1572-1576.

Vishal, Singh, A. & Madhu (1987). A study of the effect of yogic practices on certain psychological parameters. *Indian Journal of Clinical Psychology, 14,* 80-83.

Waelde, L.C., Thompson, L., & Gallagher-Thompson, D. (2004). A pilot study of a yoga and meditation intervention for dementia caregiver stress. *Journal of Clinical Psychology, 60,* 677-687.

Wallmann, H.W. (2001). Comparison of elderly nonfallers and fallers on performance measures of functional reach, sensory organization, and limits of stability. *Journal of Gerontology: Medical Sciences, 56A,* M580-M583.

Walsh, R. & Shapiro, S. (2006). The meeting of meditative disciplines and western psychology: A mutually enriching dialogue. *American Psychologist, 61,* 227-239.

Weatherall, M. (2004). Prevention of falls and fall-related fractures in community-dwelling older adults: A meta-analysis of estimates of effectiveness based on recent guidelines. *Internal Medicine Journal, 34,* 102-108.

Weuve, J., Kang, J.H., Manson, J.E., Breteler, M.M., Ware, J.H., & Grodstein, F. (2004). Physical activity, including walking, and cognitive function in older women. *Journal of the American Medical Association, 292,*1454-1461.

Wolf, S.L., Barnhart, H.X., Kutner, N.G., McNeely, E., Coogler, & C., Xu, T. (1996). Reducing frailty and falls in older persons: An investigation of Tai Chi and computerized balance training. *Journal of the American Geriatrics Society, 44,* 489-497.

Wolf, S.L., Sattin, R.W., O'Grady, M., Freret, N., Ricci, L., Greenspan, A.I., et al. (2001). A study design to investigate the effect of intense tai chi in reducing falls among older adults transitioning to frailty. *Controlled Clinical Trials, 22,* 689 – 704.

Wolfson, L.,Whipple, R., Derby, C., Judge, J., King, M., Amerman, P., et al. (1996). Balance and strength training in older adults: Intervention gains and Tai Chi maintenance. *Journal of the American Geriatrics Society, 44,* 498-506.

Wong, A.K. & Cheung. S. (2001). Balance ability and fear of falling in elderly with various exercise participation levels. *Research Quarterly Supplement, March,* A-106.

Woolacott, M.H. (2000). Systems contributing to balance disorders in older adults. *Journal of Gerontology: Medical Sciences, 55A*, M424-M428.

Yellin, D. (1983). Left brain, right brain, super brain: The holistic model. *Reading World, 23*, 36-44.

Yuille, J. & Sereda,L. (1980). Positive effects of meditation: A limited generalization? *Journal of Applied Psychology, 65*, 333-340.

Zipkin, D. (1985). Relaxation techniques for handicapped children: A review of literature. *Journal of Special Education, 19*, 283-289.

BIOGRAPHICAL SKETCH

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EDUCATION

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MA-1996, University of Arkansas at Little Rock, Little Rock, Arkansas
Applied Psychology, Health Psychology

BS-1985, University of West Florida, Pensacola, Florida
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ACADEMIC EMPLOYMENT

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Florida State University, Panama City, FL

Coordinator of Clinical Programs, Master's Program in Applied Behavior Analysis, 2005 – 2008
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Adjunct Faculty, Social Sciences, 2005 – present
Gulf Coast Community College, Panama City, FL

Adjunct Faculty, Psychology Department, 2002 - 2003
University of Arkansas at Little Rock, Little Rock, AR

Student Development Specialist/Coordinator, Donaghey Student Center, Wellness Program, 1995 - 2002
University of Arkansas at Little Rock, Little Rock, AR

Research Assistant, Behavioral Medicine, 1997 - 1998
University of Arkansas for the Medical Sciences, Little Rock, AR

CERTIFICATIONS

Board Certified Behavior Analyst, Certification Board for Behavior Analysts, 2005 – present
Certified Group Exercise Instructor, American Council on Exercise, 1996 – present
Certified Personal Trainer, American Council on Exercise, 1999 – present
Certified Arthritis Aquatic Instructor, Arthritis Foundation, 2002
Certified Health and Safety Instructor, American Red Cross, 1987 - present

PROFESSIONAL PRESENTATIONS

Ellis, S. & Morris, D. (2007). Poster: Awareness training and contingency contracting on nutrition and exercise. *Florida Association for Behavior Analysis Conference,* Jacksonville, Florida.

Morris, D. (2006). The effects of yoga on balance in older adults for fall prevention. *Florida Association for Behavior Analysis Conference,* Daytona, Florida.

Elwood, C., Lloyd, L., Morris, D., Tofte, A. & Zandecki, M. (2004). Best Overall Poster Award: Pre-designation of designated drivers. *Florida Association for Behavior Analysis Conference,* Sarasota, Florida.

Beaton, S., Stevenson, M., Morris, D. & Murphy, H. (2003). The effects of goal setting, feedback, training instruction, self-recording, and incentives on exercise behaviors. *Florida Association for Behavior Analysis Conference,* St. Petersburg, Florida.

Morris, D. (2003). Research ideas in the fitness setting. *National Fitness Institute Symposium,* San Diego, California.

Morris, D. (2000). Yoga presentation. *National Intramural Recreational Sports Association Conference,* Providence, Rhode Island.

Morris, D. (1998). Stress reduction and relaxation techniques. *Arkansas Supreme Court Coordinator's Conference,* Little Rock, Arkansas.

PUBLICATION

Elwood, C., Lloyd, L., Morris, D., Tofte, A. & Zandecki, M. (2004). Increasing pre-designation drivers: An extension of a prompt and incentive intervention package. *OBMNetwork.* Retrieved November 3, 2005, from http://www.obmnetwork.com/resources/newsletters/1903/alcohol.html