# THE INFLUENCE OF THE FORWARD HEAD POSTURE ON BALANCE, FALL SELF-EFFICACY, AND PHYSICAL ACTIVITY LEVEL IN COMMUNITY-DWELLING WOMEN AGE 60 AND OLDER; AND THE RELATIONSHIP OF THESE VARIABLES TO SELF-REPORTED FALL HISTORY


By

THERESA M. NEMMERS

Bachelor of Arts in Biology
Mount Marty College
Yankton, South Dakota
1971

Master of Physical Therapy
U.S. Army-Baylor University Graduate Program in Physical Therapy
Ft. Sam Houston, Texas
1972

Master of Arts in Physical Education
University of Maryland
College Park, Maryland
1979


Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF PHILOSOPHY
May, 2006

THE INFLUENCE OF THE FORWARD HEAD POSTURE

ON BALANCE, FALL SELF-EFFICACY, AND PHYSICAL ACTIVITY

LEVEL IN COMMUNITY-DWELLING WOMEN AGE 60 AND OLDER;

AND THE RELATIONSHIP OF THESE VARIABLES TO

SELF-REPORTED FALL HISTORY

Dissertation Approved:

Dr. Betty Edgley

Dissertation Advisor

Dr. Jerry Jordan

Dr. Tona Palmer-Hetzler

Dr. Janice Miller

Dr. A. Gordon Emslie

Dean of the Graduate College

## ACKNOWLEDGEMENTS

To my mother and father, Fern and John Nemmers...you were the center point of my youth, the unflagging supporters of all my dreams and endeavors. Through your love, your example, your constant and unconditional presence in my life...you made this accomplishment a reality. Mom, my role model, I so admire your ongoing zest for life and all it contains. I know that Dad remains close in all that I do, and his presence reminds me to embrace my life's journey with courage and unremitting faith.

To Dr. Betty Edgley, chairman of my doctoral committee...you were about to retire but decided to hang your hat on one more graduate student. How lucky for me. Your direction and friendship enabled this dream to become a solid foundation for future endeavors in research, education, and service to our elderly population.

To Dr. Janice Miller, my research mentor and committee member...you opened the wonderful world of research to me. Your sage advice and guidance are beacons in the world of a graduate student.

To Dr. Jerry Jordan, and Dr. Tona Hetzler, my dissertation committee members... I thank you both so much for your input, your insight, and your continued support throughout this entire process.

To Dr. Millee Jorge, Dean of the School of Physical Therapy, Langston University, my friend and colleague... a special thank you for the encouragement, faith, and support you so willingly offered to me during completion of this degree.

To Dr. Merrillyn Hartman, for your unwavering strength, your incredible editing skills, and your adept handling of that newfangled digital camera...you answered the call.

A special thanks to Charlotte Donoho, COTA, Dr. Mary Nole, Lynn Witzen, OTRL, and Dr. Scout Lee...you introduced me to an inspiring group of mature women who shared their time, their philosophies, and their rampant humor. Those ladies gave us a merry chase during data collection.

To Sassi and Bandit, for your unabashed nonchalance during my most trying days...you simply curled up into fuzzy balls and slept through the entire process.

And finally, to the birds of winter who flocked to my window feeders with such energy and chutzpah...you always gave me pause to reflect on the purity of a singular purpose.

TABLE OF CONTENTS

Chapter Page

LIST OF FIGURES

LIST OF TABLES

# CHAPTER 1

# INTRODUCTION

Falling, and the resulting consequences, constitutes one of the most common and serious problems facing our elderly population. Falls are the leading cause of injury deaths and nonfatal injuries in individuals over 65 years of age (Centers for Disease Control and Prevention [CDC], 2003), and approximately 30% of those individuals who fall will sustain moderate to severe injuries, resulting in reduced mobility, increased dependence on others, and the increased risk of premature death (Sterling, 2001). Current research predicts that over 40% of community-dwelling adults above the age of 65 will fall each year (Merck Institute of Aging and Health, & Gerontological Society of America, 2002), and the majority of these falls will occur while the elderly person is performing common dynamic activities of daily living such as standing upright from a sitting position, turning, sitting down, or walking up and down stairs (Norton et al., 1997).

Tinetti and Williams (1998) suggested that "falling is a health condition meeting all criteria for prevention: high frequency, evidence of preventability, and high burden of morbidity" (p. M112). Thus, the primary prevention of falls may well become one of the greatest challenges facing health care specialists and heath promotion professionals who serve the elderly. Identifying the specific risk factors, and understanding the specific components of these risk factors, are essential for the development of appropriate prevention strategies. Once these risk factors are determined and clearly understood, appropriate fall prevention programs can be developed and conducted within the community (McKenzie, Neiger, & Smeltzer, 2005).

Risk factors for falls have been categorized as either intrinsic or extrinsic in nature. Intrinsic risk factors are found within the individual, e.g., lower extremity weakness, poor grip strength, balance disorders, or cognitive impairment. Extrinsic factors are found external to the individual, e.g., environmental risks which include such elements as loose rugs, poor lighting, or polypharmacy (American Geriatrics Society, British Geriatrics Society, & American Academy of Orthopaedic Surgeons Panel on Falls Prevention [AGS], 2001).

Researchers focused on prioritizing individual risk factors within these categories have developed different classification systems resulting in both the uncertainty as to which risk factor poses the most serious problem, and the nature of the interrelationship among the factors (Bath et al., 2000). Also contributing to the complexity of the relationship of risk factors is the research limitation which limits the number of variables to be studied at any one time. Specifically, when the researcher pre-selects variables to include in a study, other potential risk factors may be excluded (Bath et al., 2000). Despite these limitations, major medical and professional organizations are attempting to categorize risk factors worthy of preventive measures (AGS, 2001).

The Guideline for the Prevention of Falls in Older Persons, a consensus report developed by a panel of experts in fall prevention (AGS, 2001), endorsed eleven primary risk factors for falls in the elderly. Presented in descending order of odds ratios (OR), those factors were: a) muscle weakness, OR 4.4; b) history of falls, OR 3.0; c) gait deficit, OR 2.9; d) balance deficit, OR 2.9; e) use of assistive device, OR 2.6; f) visual deficit, OR 2.5; g) arthritis, OR 2.5; h) impaired activities of daily living, OR 2.3; i) depression, OR 2.2; j) cognitive impairment, OR 1.8; and k) age greater than 80 years, OR 1.7. The goal for the panel of contributors was to develop a guideline that would provide evidence-based support for the development of intervention programs. Review of these primary risk factors for falls in the elderly suggested a significant interrelationship between the individual risk factors. For example, gait deficits or balance deficits could be related to muscle weakness, and impaired activities of daily living could be the result of all of the higher risk factors.

Postural deviations have been identified as key components of balance and gait deficits. For example, older women exhibiting thoracic kyphosis, a common posture deviation in elderly women with osteoporosis, tend to experience significant balance disturbances (Cook, 2002). The forward head posture, another common postural deviation, has been linked to chronic pain syndromes (Neumann, 2002), but not specifically to abnormalities in balance or gait. The forward head posture, however, may place the head near or outside the limits of the balance stability envelope (Kogler, Lindfors, Odkvist, & Ledin, 2000). Balance has been identified as a key risk factor for falling, and posture is a functional component of balance. However, the specific impact of the forward head posture on dynamic balance has yet to be identified in fall prevention research.

Fear of falling affects nearly 50% of elderly individuals, and this fear causes them to significantly alter or limit their lifestyles (Lachman et al., 1998; Powell & Myers, 1995). Elderly individuals who experience a particularly strong fear of falling tend to limit their physical activity to prevent a possible fall (Tinetti, Mendes de Leon, Doucette,

& Baker, 1994; Cumming, Salkeld, Thomas, & Szonyi, 2000). Elderly women remain at a higher risk for developing a fear of falling than are elderly men (Friedman, Munoz, West, Rubin, & Fried, 2002). In order to operationalize the fear of falling, Powell and Myers (1995) and Tinetti, Richman, and Powell (1990), developed the concept of fall self-efficacy, a concept which refers to an individual's personal belief in his ability to engage in activities of daily living without losing balance or falling. In the realm of fall risk research, fall self-efficacy instruments are commonly used as a measure of the fear of falling, and are also commonly used in the subsequent development of specific interventions created for fall prevention (Li et al., 2002; Li, Fisher, Harmer, & McAuley, 2005; Kressig et al., 2001).

The factors precipitating falls in the elderly are varied and often enigmatic. The complexity of the risk factors associated with falls in the elderly mandates a clear understanding of each risk factor, and once the entire spectrum of elements relating to each risk factor has been delineated, appropriate prevention programs can be developed and subsequently conducted. Unfortunately, fall intervention programs have demonstrated relatively mild success in the reduction of falls in the elderly (Hill-Westmoreland, Soeken & Spellbring, 2002), and additional studies are needed to improve the effectiveness of fall prevention programs, and to better understand the nature of each fall risk.

### *Purpose of the Study*

The purpose of this research was to investigate the influence of the forward head posture on dynamic balance, fall self-efficacy, and the physical activity level in healthy community-dwelling women age 60 and older, and to evaluate the relationship of these variables to fall history. Older women demonstrating a pronounced degree of forward head posture may exhibit difficulty with balance, may experience fear of falling, and as a consequence, may decrease their physical activity level. These women may also report that they have fallen several times. Identification of the forward head posture as a specific component contributing to decreased balance, a known risk factor for falling, will assist health professionals to plan more specific and effective intervention programs for older women at risk for falling.

***Research questions***

The following research questions will be tested:

1: Are the known risk factors for falling (balance deficits, low fall self-efficacy, decreased activity level) correlated, and are they correlated to fall history in healthy community-dwelling women age 60 and older?

2: Is there an inverse relationship between the degree of forward head posture and each of the known risk factors (balance deficits, low fall self-efficacy, decreased activity level, and a fall history) in healthy community-dwelling women age 60 and older?

3: After controlling for the known risk factors, does the degree of forward head posture predict fall history in healthy community-dwelling women age 60 and older?

***Delimitations***

1. The subjects will be limited to healthy women, 60 years and older, dwelling independently in the community.
2. Subjects will be recruited from both rural and urban areas in Oklahoma and South Dakota.

3. The only known risk factors evaluated were balance deficits, low fall self-efficacy, decreased activity level, and a positive history of falling. Other known risk factors, unaccounted for in this study, may have influenced those risk factors being measured.

### *Limitations*

1. The subjects will be drawn from a convenience sampling of volunteers.
2. The subjects will self-report the number of falls experienced over the previous year.
3. The subjects will self-report current medical status.

### *Assumptions*

1. The subjects will be cognizant of their personal health issues.
2. There will be no unknown underlying medical conditions which will directly or indirectly adversely affect their ability to successfully complete the BBS.

### *Definition of Terms*

ACTIVITIES OF DAILY LIVING (ADL): activities such as dressing, feeding, bathing.

ACTIVITY-SPECIFIC BALANCE CONFIDENCE SCALE (ABC): 16-item situation-specific measure of balance confidence (Powell & Meyers, 1995).

BALANCE: also called postural stability, describes the ability to maintain the body in equilibrium (Shumway-Cook & Wollacott, 2001).

BERG BALANCE SCALE (BBS): 14-item scale designed to measure static and dynamic elements of balance using common daily tasks (Berg, Wood-Dauphinne, Williams, & Make, 1992).

COMMUNITY-DWELLING: living independently in the community. May include private home, apartment, or retirement community.

DYNAMIC BALANCE: the ability to control the body's center of mass with respect to the base of support during movement (Dutton, 2004).

ELDERLY: Individuals age 60 and older (World Health Organization, 2002).

FALL: unintentionally coming to rest on ground or lower surface, but not the result of fainting, loss of consciousness, or blow (Lajoie, Girard, & Guay, 2002).

FALL SELF-EFFICACY: individual's belief that they can avoid a fall (Powell & Meyers, 1995; Tinetti, Richman & Powell, 1990).

FORWARD HEAD POSTURE: head is positioned anterior to the vertical postural line (Levangie & Norkin, 2005).

INSTRUMENTAL ACTIVITIES OF DAILY LIVING (IADL): includes activities such as housekeeping, shopping, or utilizing public transportation.

KYPHOSIS: "the normal sagittal plane posteriorly convex curves in the thoracic and sacral regions of the vertebral column"; abnormal increases in these curves are also called kyphotic (Levangie & Norkin, 2005, p. 496).

LORDOSIS: "the normal sagittal plane anteriorly convex curves in the cervical and lumbar regions of the vertebral column"; abnormal increases in these curves are also called lordotic (Levangie & Norkin, 2005, p. 496).

POLYPHARMACY: the use of four or more prescription medications (AGS, 2001).

POSTURAL SWAY: a constant swaying motion of the body during erect standing posture (Levangie & Norkin, 2005).

POSTURE: describes the alignment of the body and its segments (Levangie & Norkin, 2005).

RURAL AREAS: open country and settlements with fewer than 2,500 residents (USDA, 2003).

SELF-EFFICACY: an individual's belief in their capability to perform activities in a particular domain (Bandura, 1982).

STATIC BALANCE: the ability to control the body's center of mass with respect to the base of support while maintaining a position (Dutton, 2004).

TRAGUS: cartilaginous projection in front of the external meatus of the ear (Thomas, 1981).

URBAN AREAS: densely settled places and the areas around them (USDA, 2003).

# CHAPTER 2

# LITERATURE REVIEW

### *Introduction*

There are a number of topics of great interest to the gerontological research community, and among those interests are falls and fall-related injuries which occur in the elderly population. Investigations into the reduction of incidence, morbidity, and mortality associated with falls in older people constitute a large segment of the gerontological literature. In addition to identification of specific fall risks, researchers are interested in validating the unique contributions of individual risk factors as well as validating the various components which create those risk factors. Underpinning the results of fall-related research efforts is the efficacy of fall prevention programs, the heart of clinical and community programs designed to decrease injury deaths and nonfatal injuries in older individuals.

Many investigators are exploring the relationship between balance and specific postural components as they appertain to falls. The predominant biomechanical postural emphasis focuses on the “forward head” or kyphotic posture observed in most individuals experiencing advanced osteoporosis. Measuring the elderly individual’s fear of falling has also become an essential adjunct measure when investigators evaluate balance stability in the older individual. Fear of falling may actually increase the risk of falling by affecting an elderly person’s confidence. These, and other topics related to fall prevention, continue to provide researchers in gerontology with many avenues of investigation, and many questions on issues which are vital to the health of our older population.

This chapter will review the research literature specific to the following five areas of falls and fall prevention: (a) fall risk identification with emphasis on general risk factor identification, single-risk factor studies, predictive studies in fall research, and summative literature reviews of risk factors; (b) posture as a component of the risk factor "balance deficit" with emphasis on balance and posture relationships, the biomechanics of posture, and balance assessment instruments; (c) forward head posture with emphasis on the forward head position, the forward head posture and balance, and the measurement of the forward head posture; (d) fear of falling and fall self-efficacy with emphasis on the prevalence of fear of falling, relationship to other fall-risk factors, fall self-efficacy, and fall self-efficacy assessment instruments; and (e) physical activity and the elderly with emphasis on physical activity as a predictor for morbidity and longevity, physical activity as it relates to fall risks, and physical activity assessment instruments.

## ***Fall Risk Identification***

### *General Risk Factor Identification.*

Researchers attempting to identify risk factors for falls often rely on the prospective cohort methodology. This methodology seeks to identify a causal relationship between antecedents and effects over time. Such studies attempt to identify the population at risk, and formulate incidence rates and prevalence rates within the population. They subsequently determine the relative risk for the factor under study (Page, Cole & Timmreck, 1995).

In order to identify intrinsic risk factors within a prospective cohort study, Graafmans et al. (1996) constructed a risk profile which demonstrated the relative contribution of each factor to the risk of falling. The study included a large sample size of 354 subjects, and represented a relatively short-duration prospective study of 28 weeks. Community-dwelling individuals over 70 years of age comprised the population, and self-reported their number of falls during the study period. Those numbers reflected a fall rate of 36%. Baseline assessments were conducted at the start, and follow-up comparisons were made at the completion of the study. The authors concluded that mobility impairment constituted the most significant risk factor with an odds ratio of 2.6. Dizziness, recurrent falls, history of stroke, poor mental state, and postural hypotension were also identified as risk factors demonstrating significant odds ratios. Individuals exhibiting all of these risk factors would experience an 84% probability of recurrent falls over the 28-week period. The authors postulated that since impaired mobility tended to be the most significant risk factor, prevention programs based on mobility improvement would be most beneficial for those individuals at risk for falling.

Initiating a similar study utilizing a sample size of 311 community-dwelling individuals aged 70 and older, Stalenhoef, Diederiks, Knottnerus, Dester, and Crebolder (2002) examined individuals over a 36-week time period using baseline measures which included general physical parameters and six validated independent performance tests. The combination of baseline measures included both intrinsic and extrinsic factors. Thirty-three percent of this population sustained at least one fall during the study time frame. The main determinants for falls included abnormal postural sway with odds ratio of 3.9, two or more falls in previous year with odds ratio of 3.1, decreased grip strength with odds ratio of 3.1, and depression with odds ratio of 2.2. The authors concluded that individuals exhibiting three or more risk factors were at “high” risk for falling.

Another prospective cohort study commenced by Vellas, Wayne, Garry, and Baumgartner (1998) incorporated a longer time frame of 24 months. This study involved a group of 482 community-dwelling subjects with a mean age of 74 years. Baseline assessment for this group included general physical examination, balance and gait assessment, a self-assessment interview, and history of falls. This group of subjects experienced a 61% rate of falling, a much larger percent than reported in previously reviewed studies. Risk factors for injury-related falls identified in this population were age, history of fracture, low physical health, and low mobility. Inability to balance on one leg was associated with injury-related falls experienced by the female participants at a ratio rate of 3.0.

The cross-sectional study represents another type of study which lends itself to the identification of falls risk factors in a population. The cross-sectional study provides a “snap-shot” in time of the population of interest because data from the group is collected only once (Page et al., 1995).

de Rekeneire et al. (2003) conducted a cross-sectional analysis of 3075 healthy community-dwelling elders, black and white, aged 70-79 years. This particular sample was a sub-sample of a national prospective study investigating health conditions and functional decline due to age. The researchers assessed comprehensive physical function using both self-reported measures and performance measures. Participants’ health status factors included past and current diseases, medication use, and body composition. Within this healthy population, nearly 25 % of the women and 18 % of the men reported at least one fall in the year prior to the start of the study. The authors reported that the elderly who fell were more likely to be white females who experienced the following: more chronic diseases; use of more medications; and lower leg strength, lower muscle mass, poorer balance, and slower walk time.

Richardson, Hicks, and Walker (2002) reported risk factors identified in a specified population of 308 elderly living in the rural community. These authors identified four statistically significant risk factors for falling: age, use of high blood pressure medication, prescription painkillers, and arthritis medications. Increasing age was positively correlated with the likelihood of falling, as was use of high blood pressure medication and prescription painkillers. Use of arthritis medications was negatively associated with the likelihood of falling. The authors suggested that arthritis medications may relieve joint pain and thus give the individual more mobility which would decrease the likelihood of a fall (Richardson et al., 2002).

*Single Risk Factor Studies.*

Prospective cohort and cross-sectional methodologies are often utilized in studies focusing on a single risk factor. Investigators typically identify a risk factor from previously published literature, and subsequently expand the study population size while focusing on an isolated fall risk factor.

Central nervous system (CNS) medications and their effect on falling represent a single risk factor of interest to researchers. Ensrud et al. (2002) suggested that previous studies on the correlation between the use of CNS-active medications and the risk for falls in older individuals incorporated problematic drug classification schemes. In order to alleviate the possible classification problem, the researchers classified the CNS-active medications into the following four mutually exclusive categories: benzodiazepines, antidepressants, anticonvulsants, and narcotics. These authors conducted a prospective cohort study involving 8127 community-dwelling women, aged 65 and older, who self-reported their incidence of falls. Average follow up for this group was 12 months. The authors indicated that women who ingested CNS-active medications including benzodiazepines, antidepressants, and anticonvulsants showed increased risk for frequent falls. The findings also revealed that preferential use of selective serotonin-reuptake inhibitors did not reduce the falls risk for those women who took anti-depressants. The authors concluded that minimizing the use of CNS-active medications could result in reduced risk of falling.

Social integration as a single risk factor for falls constitutes another single risk factor which interests investigators. Faulkner, Cauley, Zmuda, Griffin, and Nevitt (2003) initiated a three-year prospective cohort study involving 6692 community-dwelling women, aged 65 and older. The researchers age-adjusted measures of social integration, medical disease, physical functioning, health impairment, and medication use, and subsequently compared the results according to quartiles of a social integration score. Falls were self-reported over the course of the study. The authors reported that the rate of falls was inversely correlated with family networks, interdependence, and composite social integration scores. They concluded that strong family networks may reduce the risk of falls in older community-dwelling adults.

Fear of falling is a single risk factor receiving considerable research attention as a predictor for falling, and as a modifier of behavior after falling. A more extensive review of literature pertaining to fear of falling will be offered in a subsequent section of this chapter entitled *Fear of Falling and Fall Self-efficacy* (page 34).

*Predictive Studies.*

Researchers often use fall risk factors as predictors for falling. These studies, typically case-control studies, use matched pairs of fallers and non-fallers to evaluate the predictive capability of a previously identified risk factor or combination of factors. If a single factor could be isolated as a valid predictor of falls, presumably that factor could be utilized as a screening tool to identify individuals in need of preventive measures.

The association between falls, chronic disease, and medication was explored by Lawlor, Patel, and Ebrahim (2003). These authors conducted a cross-sectional survey of 4050 elderly women using data from a larger cohort women's heart and health study. Falls rate was assessed via survey of participants, chronic disease status was determined by medical chart review, and drug use was assessed by interview. The authors used multiple logic regressions to identify associations. The mean age of the elderly women who fell was 70.1 years, while the mean age of the non-fallers was 68.6, resulting in a difference which was significant. The authors reported that the prevalence rate of falling increased with the number of simultaneous chronic diseases, but did not correlate with polypharmacy. Circulatory disease, chronic obstructive pulmonary disease, depression, and arthritis were associated with the highest odds ratios for falling, accounting for 30% of falls in this group. Only anxiloytics, hypnotics and antidepressants were independently associated with an increased rate of falls, each increasing the odds of falling by about 50%. Based on these findings, the authors concluded that chronic disease and multiple pathologies were better predictors of falling than the use of multiple drugs. They also suggested that interventions aimed at improving the indirect effects of chronic diseases, such as muscle weakness, reduced physical activity, and poor balance, might be most useful in reducing the number of falls (Lawlor et al., 2003).

Balance impairment is a common risk factor evaluated in predictive studies. Girardi, Konrak, Amin, and Hughes (2001) evaluated the fall risk predictive capability of computer dynamic posturography versus electronystagmography. The researchers conducted a retrospective investigation of 33 patients, average age of 78, presenting to a gait- and balance-disorder clinic. Because all subjects presented with a history of falls, this study attempted to identify which of the two tests proved to be better at predicting fallers. Analysis determined computer dynamic posturography to be more sensitive in identifying fallers; however, no attempt was made correlate these findings with a non-faller population. Additional literature on balance stability as a predictive factor will be offered in a subsection of this chapter subtitled *Posture as a Component of the Risk Factor "Balance Deficit"* (page 19).

In an effort to identify easily administered tests that would accurately predict the risk of falling, Stel, Schmidt, Pluijm, and Lips (2004) administered a battery of balance, strength, and performance tests to a population of 439 individuals with an age range between 69 and 92 years. Using a multivariate model, the authors reported that unsuccessful tandem standing and weak hand grip strength correlated strongly with recurrent falling. The authors concluded that these measures could be valuable in screening evaluations for fall risk factors.

*Risk Factor Summative Reviews.*

Given the ever increasing volume of research and information generated in the area of fall risk identification and fall prevention, several authors have developed summative reviews of the literature.

Rubenstein and Josephson (2002-3) published a multifactor analysis of the literature on fall risk factors, and reported the odds ratios for the top risk factors associated with falling. Those risk factors odds ratios were reported as follows: (a) lower extremity muscle weakness increased odds of falling by 4-fold; (b) history of past fall increased odds by 3-fold; (c) exhibiting a gait or balance disorder increased odds 3-fold; (d) use of an assistive gait devise increased odds by 2.6-fold; (e) visual impairments increased odds by 2.5-fold; (f) arthritis in one or more joints increased odds by 2.4-fold; and (g) functional impairments, cognitive impairments, depression, age greater than 80 years, and taking psychotropic medication all increased odds by 2-fold. The authors highlighted the interactive effect of the majority of the risk factors, e.g., the chance of a past fall may be related to any single risk factor, or to a combination of risk factors. The authors concluded, however, that elderly individuals who fell rarely demonstrated a single, isolated risk factor.

The Guideline for the Prevention of Falls in Older Persons (AGS, 2001) represented a consensus report developed by an international panel of experts in falls prevention. Using subject heading and free text searches, the literature search involved locating and analyzing systematic reviews, meta-analyses, randomized trials, controlled before-and-after studies, and cohort studies. After identifying and examining the results of 16 studies that investigated risk factors, the panel endorsed eleven fall risk factors.

These risk factors, in descending order of odds ratios (OR), were as follows: a) muscle weakness, OR 4.4; b) history of falls, OR 3.0; c) gait deficit, OR 2.9; d) balance deficit, OR 2.9; e) use of assistive device, OR 2.6; f) visual deficit, OR 2.5, g) arthritis, OR 2.4; h) impaired ADL, OR 2.3; i) depression, OR 2.2; j) cognitive impairment, OR 1.8; and k) age > 80 years, OR 1.8.

A criteria-based analysis of studies pertaining specifically to falls among community-living elderly revealed the main risk factors for falling in these individuals to be cognitive impairment, balance and gait disorders, the use of sedatives and hypnotics, a history of stroke, advanced age, arthritis of the knee, and a high level of dependence (Stalenhoef, Crebolder, Knottnerus, & VanDer Horst, 1997). This particular review excluded those studies which incorporated both community-living and residential- (assisted living and nursing homes) living elderly. The authors did not exclude those individuals living at home and receiving substantive care from a spouse or caregiver.

*Summary.*

Fall prevention depends upon accurate and comprehensive fall risk identification. Researchers endeavoring to identify the risks of falling have consistently attempted to find links between specific risk factors and the probability of falling. The sheer complexity of these individual risk factors, observed in combination or as a single factor, indicates that numerous factors must be addressed in fall risk assessment.

While the preceding studies in this literature review did not routinely incorporate identical baseline measures, some general risk factors evolved specific to the population studied. However, the shared commonality of some risk factors lends credence to the use of these common general risk factors in diverse populations as well.

Research on single risk factors does appear to be beneficial. A series of risk factors cannot be ranked in order of importance when these factors are studied only one at a time. However, the strength of the single fall risk factor, as evidenced by statistical analysis, does highlight the relative importance of including a single risk factor in a multi-factorial approach to fall risk screening, and a fall prevention program. Predictive studies continue to show promise in identifying fast, efficient and effective screening tools. However, the validity of using a single predictive factor as a fall predictive factor needs to be thoroughly assessed.

Balance deficits remain one of the top risk factors for falling. A thorough understanding of the totality of balance and its subcomponents is absolutely crucial for developing programs to improve balance. Individual postural alignment may contribute to balance instability; however, the literature is somewhat unclear as to the exact contribution, particularly of the forward-head posture. The role of the forward head posture in balance stability is the primary focus of this study.

### *Posture as a Component of the Risk Factor "Balance Deficit"*

*Balance and Posture Relationship*.

Balance, also called postural stability, is defined as the "the ability to maintain the projected center of mass within the limits of the base of support" (Shumway-Cook & Wollacott, 2001, p.165). Muscle contraction, joint movement, sensory feedback and neuro-integration are essential in the complex interaction between the musculoskeletal and neurological systems required for balance. In order to maintain balance, the body's center of mass must remain within its base of support. Postural stability is necessary when the body is at rest (static balance) and during movement (dynamic balance).

The term “posture” is used to describe either the orientation of the body to its surrounding environment, or the biomechanical alignment of the body (Shumway-Cook & Woollacott, 2001). The frame of reference for posture and balance is typically the vertical position. Postural sway represents a vertical multiplane component of balance in the static position, and researchers frequently quantify postural sway by using a moveable force platform. Researchers have also challenged subjects’ balance using graded movements of the moveable force platform to determine the limit of stability. Researchers have subsequently developed theories of movement strategies to accommodate the external perturbations caused by the moving platform (DiFabio & Emasithi, 1997; Shumway-Cook & Woollacott, 2001). An in-depth review of these postural sway theories exceeds the focus of this literature review.

The limit of stability represents the end point of postural sway. Postural sway occurs in response to perturbations in the base of stability. Once the sway exceeds the stability limits, a body movement or adjustment must occur in order to maintain balance. Age-related declines in stability have been identified using the postural sway-limit of stability model (Wollacott, 1993). Choy, Brauer, and Nitz (2003) reported significant decline in static postural stability in women over the age of 60. The postural sway-limit of stability model has also been used as the measurement tool to determine the efficacy of intervention programs developed to improve balance control (Rose & Clark, 2000).

*Biomechanics of Posture*.

Posture is also defined by the biomechanical alignment of the body. Ideal alignment as described by Kendall, McCreary, Provance, Rodgers, and Romani (2005) "involves a minimal amount of stress and strain and is conducive to maximal efficiency of the body" (p 59). Measurement of the ideal postural alignment is accomplished by utilizing a vertical plumb line aligned in the sagittal plane which represents the center of gravity of the body (Figure 1). The correct visual alignment of the plumb line with the body would occur as the plumb line passed through the external auditory meatus, midway through the shoulder joint, through the bodies of the lumbar vertebrae, slightly posterior to the center of the hip joint, slightly anterior to the axis off the knee joint, and slightly anterior to the lateral malleolus (Kendall et al., 2005).

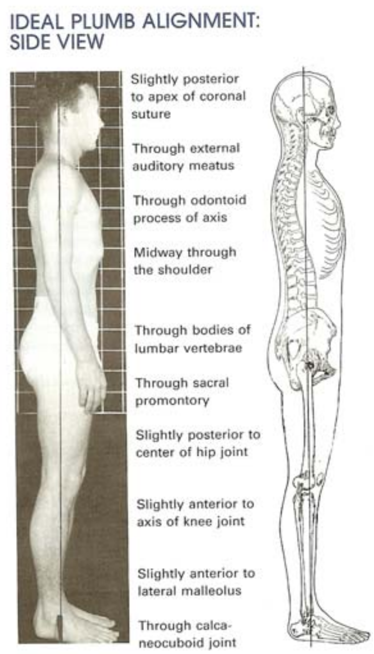



Figure 1. Ideal plumb alignment in the sagittal plane. Adapted from Kendall, F. P., McCreary, E. K., Provance, P. G., Rodgers, M. M., Romani, W. A. (2005). *Muscles Testing and Function with Posture and Pain, 5$^{th}$ Ed*. Baltimore: Lippincott Williams & Wilkins, page 60. Used with Permission.

Variations in skeletal alignment in the lumbar and thoracic regions have been associated with diminished balance in the elderly. O'Brien, Culham, and Pickles (1997) studied the differences between the sagittal postures of elderly women, age 65 and older living independently in the community, with and without a history of falling. Subsequent to assessment of balance stability between groups, the authors reported a significant difference between fallers and non-fallers in all balance measures tested, with fallers demonstrating diminished balance scores. A weak correlation between falling and the degree of incline of the thoracic spine occurred, thus indicating that frequent fallers demonstrated a greater incline of the thoracic spine. In a subsequent investigation, Cook (2002) evaluated the relationship between thoracic posture and balance in 52 elderly women experiencing osteoporosis, with a mean age of 69.4 years. He observed that the women who performed poorly on the balance test exhibited a statistically greater thoracic kyphosis than those who did not perform poorly. Controlling for age in his statistical analysis, he concluded that age was not a contributing factor for balance regardless of the degree of thoracic kyphosis.

Spinal flexibility, a measure combining soft tissue extensibility and structural alignment of the spine, was found to be a significant contributor to the balance in both well-elderly individuals and those with Parkinson's disease. According to Schenkman, Morey, and Kuchibhatla (2000), spinal flexibility accounted for 35% of the variation in the measure of forward reach, an established clinical measure of balance control.

Gait deviations and diminished functional abilities have been associated with postural deviations in the elderly. Hirose, Ishida, Nagano, Takahashi, and Yamamoto (2004) investigated the effect of sagittal plane postural deviations on gait. The investigators divided elderly individuals into two age groups, 65-79 years of age, and those over 80 years. Each age group was then further subdivided into five posture categories: normal, thoracic kyphosis, lumbar kyphosis, flat back, and lumbar lordosis. The normal posture group exhibited no significant differences between age groups for either gait parameters or functional performance. All of the abnormal posture groups demonstrated alterations in gait parameters and diminished functional abilities. These authors did not report the degree of severity of any of the postural deviation categories.

While many researchers attempt to differentiate between fallers and non-fallers with balance measures, Isles et al. (2004) suggested that test scores should be evaluated for age-related norms. These authors reported significant age-associated decline in balance scores in 456 community-dwelling, independently ambulating women, age 20-80 years, with no evidence of neurological or musculoskeletal disability. In a study designed to identify age and gender related normative values for functional tests, Lusardi, Pelleccia, and Schulman (2003) reported declining balance scores with increasing age in 76 males and females, age range from 60-101 years. Similar trends were reported by Steffen, Hacker and Mollinger (2002), and Steffen and Mollinger (2005). In contrast, Brotherton, et al. (2005) did not find age related decline in balance scores between 18 healthy young adults and 20 healthy older adults.

*Balance Assessment Instruments*.

When researching balance stability, two basic categories of measurement instruments are available for assessment. The first category of measurement instruments includes computerized measurements utilizing balance-force platforms. The computerized balance-force platforms are used primarily in research laboratories due to the high cost of the equipment and the technical expertise needed to operate the instruments. These sophisticated computerized instruments provide valuable information on balance using the concept of postural sway and limits of stability (Shumway-Cook & Woollacott, 2001).

The second category of measurement tools includes clinical assessment tools which are brief functional tests, validated within the clinical setting. Many clinical tools are available to the researcher; however, the Berg Balance Scale (BBS) is the most frequently cited test in the literature on falls (Kornetti, Fritz, Chiu, Light & Velozo, 2004). In addition to using the BBS as a balance measure in fall research, some authors have chosen the BBS as the "gold standard" against which to evaluate other balance measures (Bennie et al., 2003; Southard, Dave, Davis, Blanck, & Hofferber, 2005) .

The BBS is intended to measure the subject's ability to maintain balance while performing common daily tasks (Berg, Wood-Dauphinee, Williams & Maki, 1992). This 14-item test incorporates common daily activities, and sequences these activities from the simple to the more complex task. Performance on each item is scored using a range from "0" (cannot perform) to "4" (normal performance). The summation of individual item scores yields the final test score, with a maximum score of 56. Berg, Wood-Dauphinne, et al. (1992) conducted the original validation research using three groups: 113 elderly men and women (mean age 83.5 years) living in a nursing home, 70 elderly men and women (mean age 71.6 years) who had sustained a stroke within 14 days of testing, and a group of 31 healthy elderly men and women (mean age 83.0 years). The authors reported high levels of inter-rater and intra-rater agreement (ICCs = 0.98), and a high internal consistency ($\alpha = 0.96$). In a subsequent study of 31 elderly males and females recruited from residential care facilities and acute and chronic hospital care facilities, Berg, Maki, Williams, Holliday, and Wood-Dauphinne (1992) demonstrated strong correlations of the BBS to existing validated balance measures (r = 0.70 to 0.91). Berg, Wood-Dauphinne, et al. (1992) further proposed that a score below 45 was predictive of falls in the nursing home subjects; however, this recommendation was based upon a clinical opinion and not statistical findings.

Bogle-Thorbahn and Newton (1996) reported a 53% sensitivity of the BBS in predicting falls in 66 elderly residents of life-care communities, who ranged in age from 69-94 years with a mean age of 79.2 years. Subjects experiencing comorbidities possibly affecting balance were not excluded from this study. The sole source of fall documentation in this study was self-reported, and the authors suspected significant under-reporting of falls by the residents. These authors reported a cut-off score of 45 to be effective in separating fallers from those at risk for falling, but not as an effective predictor of falling.

When using community-dwellers as the population of interest, Shumway-Cook, Baldwin, Polissar, and Gruber (1997) reported that a low score on the BBS, less than 40 out of 54 points, predicted nearly a 100% probability for falling. This study involved 44 healthy subjects, aged 65 and older who were divided into two groups of fallers and non-fallers. The authors used a self-reported balance history which required a “yes” or “no” response on falls experienced. When using a cutoff score of 49, the BBS reflected a specificity of 86%, and a sensitivity of 77%. Combining the BBS score with the self-reported balance history resulted in the most successful model to predict future falls. This combination model demonstrated a sensitivity of 91% and a specificity of 82%. The BBS was the best single predictor of fall status. The authors further suggested a cutoff score of 40 on the BBS when making determination for the need for a fall intervention program.

O'Brien, Pickles, and Culham (1998) evaluated the efficacy of clinical measures of balance, including the BBS, to distinguish between fallers and non-fallers. Forty-eight community-dwelling elderly women were divided by fall history into two groups: a) fallers (n = 13) with mean age of 76 ± 6.7 years, and b) non-fallers (n = 23) with a mean age of 73.8 ± 4.1 years. The authors reported that fallers did not perform as well as non-fallers on all the tests; however, no single test identified a clear-cut threshold to differentiate fallers from non-fallers. The authors suggested that a possible reason for the lack of differentiation was that only some of the fallers in their study exhibited poor balance.

Boulgarides, McGinty, Willett, and Barnes (2003) concluded that five common clinical tests, including the BBS, were not predictive of falls in community-dwelling older adults. This study included 60 women and 39 men with an average of 74.02 years, SD = 5.64. These authors noted that the mean BBS score was nearly identical between the fallers (53.18) and the non-fallers (53.15). However, the range of the BBS scores was larger in the non-fallers (34-56) than in the fallers (46-56). The authors hypothesized that the large range in the non-fallers may have been due to high activity levels.

Brauer, Burns, and Galley (2000) also assessed the fall predictive capacity of common clinical measures, including the BBS, and laboratory measures. Their study included 100 women with a mean age of 73 ± 5 years with an age range from 65 to 85 years, and utilized strict exclusion criteria to obtain a healthy subject group. These authors found that the clinical measures could not predict falling in this population, and suggested that health status may limit the predictive value of commonly used clinical tests.

Researchers have suggested that decrements in the BBS score in the elderly populations may simply be related to age. In a study designed to identify age and gender related normative values for functional tests, Lusardi, Pelleccia, and Schulman (2003) reported declining BBS scores with increasing age in both males and females (age range from 60-101 years). Similar trends were reported by Steffen, Hacker, and Mollinger (2002), and Steffen and Mollinger (2005). Even with age related decrements in the BBS score, only the Lusardi et al. (2003) study reported BBS mean scores below the suggested cut-off score of 40 to identify elderly at risk for falling (Shumway-Cook et al., 1997). In contrast, Brotherton et al. (2005) did not find age-related BBS scores between healthy young adults and healthy old adults.

The Berg Balance Scale is frequently utilized as the measurement tool when investigating the fear of falling. Literature reflecting this measurement use will be reviewed at length in a subsequent section in this chapter subtitled *Fear of Falling and Fall Self-efficacy* (page 34).

*Summary.*

The relationship of postural sway to the function of balance constitutes an important research question in many studies. However, the biomechanical component of balance as it relates to the upright posture has tended to received marginal interest and consideration in the fall research community. Researchers investigating balance stability frequently utilize the Berg Balance Scale as a clinical tool due to its ease of administration and strong reliability and validity. Therefore, this assessment will be the balance performance instrument utilized in the present study.

### ***Forward Head Posture***

*Forward head position.*

The forward head position places the head anterior to the vertical ideal (Kendall et al., 2005; Neumann, 2002). After comparing the forward head position of healthy men and women, Hanten, Lucio, Russel, and Brunt (1991) reported that healthy women tended to hold their heads more forward within the available movement range than their male counterparts. These authors compared the head position of 218 healthy adults in four ten-year age cohorts from 20 to 60 years. The authors also found the resting head position to be different in both men and women when comparing the sitting to the standing position, and that men held their heads more forward while engaged in the standing position. No significant differences age effects were reported. In a subsequent study conducted by Hanten, Olson, Russell, Lucio, and Campbell (2000), similar gender effects on the forward head position were noted. Age effects were not addressed in the second study (Hanten et al., 2000).

The investigations of Raine and Twomey (1994, 1997) did not identify gender differences in the head and shoulder posture of healthy individuals, but did identify an age-related change in head posture which revealed that the head tended to move more forward of the vertical axis as age increased (1997). Additionally, these authors specifically noted that forward head posture was not associated with thoracic kyphosis or upper cervical spine extension (Raine & Twomey, 1997). Lack of consistent findings of gender differences in the aforementioned studies may be due to different head position measurement methodologies.

Braun (1991) evaluated the head and shoulder position of 20 men and 20 women, average age of 29 years for men and 33 years for women. During the course of this investigation no gender differences were noted in the head and shoulder positions of healthy individuals.

All of the previously mentioned studies demonstrated a range of resting positions in healthy adults rather than the specified static position described by Kendall et al. (2005). Exact value comparison can be made only with those studies utilizing similar measurement methodologies. Studies using similar methodologies reported a range of forward head posture from $51.9^o \pm 4.5^o$ to $59^o \pm 11.7^o$ in healthy adults (Braun, 1991; Greenfield et al., 1995; Evcik & Aksoy, 2000, Raine & Twomey, 1997). Age ranges in these studies varied considerably, possibly accounting for the differences in degrees of forward head posture. When comparing healthy adults with adults reporting facial, cervical, or shoulder pain, researchers found significant and consistent differences within those groups. Individuals experiencing pain demonstrated a more severe forward head position than those who did not experience pain (Braun, 1991; Greenfield et al., 1995; Evcik & Aksoy, 2000).

*Forward Head Posture and Balance*.

Relocation of a body segment causes a shift in the center of mass, and thus the line of gravity shifts in relation to the base of support (Levangie & Norkin, 2005). Postural deviations may then place the line of gravity near or outside the limits of the stability envelope which may impact balance. A study involving 12 healthy elderly subjects with an average age of 72 years indicated that postural instability tended to be significantly greater when the subjects flexed or extended their heads (Buckley, Anand, Scally & Elliott, 2005). These authors found that the head-flexed or head-extended position moved the center of mass of the body. However, a statistically significant change in the center of mass was noted only with the head-flexed position.

Kogler, Lindfors, Odkvist, and Ledin (2000) postulated that head position was essential for postural stability. Thirty-two healthy subjects, aging from 21 to 58, and ten subjects reporting soft tissue trauma in the neck, age range from 27 to 62, were evaluated for postural stability in four head positions: maximum extension, maximum flexion, maximum rotation to right, and maximum rotation to left. These researchers discovered that the maximum extension position of the head significantly diminished postural stability in both groups.

The literature review for the present study revealed only one study utilizing head position as a criterion measure for assessment of functional abilities in the elderly. Balzini et al. (2003) assessed a cohort of 60 elderly women who had been referred for rehabilitation due to chronic back pain. These women, age 70 to 93 years, lived independently in the community. The researchers investigated the influence of flexed posture on the skeletal frailty and the functional status of the women. Flexed posture was defined as the distance from the occiput to the wall as measured with the subject standing against the wall. The severity of the flexed posture was classified as mild, moderate, or severe. The authors reported significant differences in functional abilities, muscle strength, depression, and motivation between the mild- and the severe-flexed posture categories, but observed no differences in the severe- and moderate-flexed posture categories. The flexed posture definition in this study did not differentiate between spinal postural deviations; consequently, the flexed posture could have been the result of a forward head posture, a thoracic kyphosis, a combination of both, or some other type of spinal deviation.

*Measurement of the Forward Head Posture*.

Several techniques of measuring the forward head posture have been reported in the literature. Griegel-Morris, Larson, Mueller-Klaus, and Otis (1992) utilized a plumb line and classified the head position in normal to severe categories based upon distance anterior to the plumb line. Classification was made using visual subjective assessments. In this study, interrater reliability was reported as .611, and intrarater reliability at .825. This methodology required that the subject remain in a static position.

Another technique required the measurement of the resting head position by requiring the subject to stand against a wall, or to sit in a chair placed a defined distance from the wall, and then measured the distance from the wall to the zygomatic arch (Hanten et al.,1991). The authors reported an intertester reliability coefficient of .93 for this measurement. In a subsequent study using the same methodology, the investigators again reported an intertester reliability coefficient of .93 (Hanten et al., 2000). This methodology also required the subject to remain stationary.

Garrett, Youdas, and Madson (1993) evaluated the reliability of the Cervical Range of Motion (CROM) device. The CROM incorporated two inclinometers (small instruments used to measure angular changes) which were attached to the head using a small plastic frame supported by the bridge of the nose. The authors reported an intertester reliability correlation of .93, and an intratester reliability correlation of .83. This device required direct visual observation of the inclinometer reading. The subject was allowed to move the head, but was required to remain in a stationary standing or sitting position.

Braun and Amundsen (1989) described a measurement of the sagittal plane head alignment as the acute angle between the line joining C7 to the tragus of the ear and the horizontal line at C7 (Fig. 2, A and B). The authors obtained side profile photographs and used a custom computer program to analyze the angle.

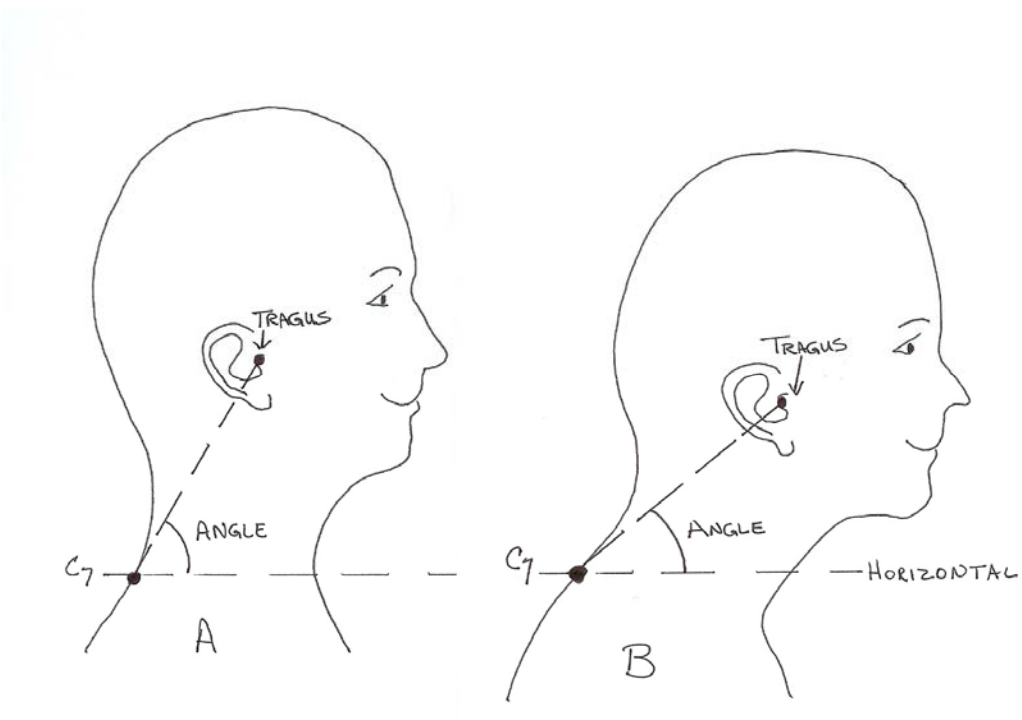



Figure 2. Tragus-C7-Horizontal Angle. A. Normal posture B. Forward Head Posture. Tragus-C7-Horizontal angle becomes smaller with the forward head posture.

Several other investigators have utilized the tragus-C7-horizontal angle measurement in assessing the forward head position (Braun, 1991; Evcik & Aksoy, 2000; Harrison, Barry-Greb, & Wojtowicz, 1996; Greenfield et al., 1995; Raine &

Twomey, 1994 & 1997). In both of their research studies, Raine and Twomey (1994, 1997) reported an interclass reliability coefficient of .88 for this measurement. Greenfield et al. (1995) reported an intrarater and interrater reliability of 100% ± $2^o$, while Braun (1991) and Evcik and Aksoy (2000) did not report the reliability of measurement. Harrison et al. (1996) reported and interrater reliability of .68; however, these authors utilized a manual measure of the angle on an actual subject while all other authors employing this method incorporated photographic analysis of the angle measurement.

The tragus-C7-horizontal angle measurement for the forward head position exhibited good reliability as demonstrated by photographic analysis. Photographic analysis is ideally suited for assessment of the head position during dynamic movement; therefore, this method will be the method utilized in this study.

*Summary.*

While it might seem intuitively obvious that a forward head posture could lead to a compromise of balance, a paucity of research evidence exists supporting this assumption. This reviewer was unable to locate studies directly relating to the influence of the forward head posture on dynamic balance and stability. However, the studies which related general posture to the fall risk factor of balance stability did demonstrate that alterations in the "normal" posture produced diminished balance stability. The forward head posture and its relationship to balance and subsequent risk for falling represents one of the research questions posed in this study.

### ***Fear of Falling and Fall Self-efficacy***

*Prevalence Rates of Fear of Falling.*

Fear of falling is common in community-dwelling elderly individuals. Prevalence rates of fear of falling have been reported to range from 40-73% in elderly who have actually fallen compared to 20-46% in elderly who have not fallen (Tinetti, Mendes de Leon, Doucette, & Baker, 1994; Lach, 2005; Murphy, Dubin, & Gill, 2003). Of the elderly individuals who had experienced one fall, over 73% maintained a fear of falling again (Lach, 2002-3). Aging individuals tended to develop an increase in their fear of falling, even though they had not fallen previously (Murphy et al., 2003). Lach (2005) reported that nearly 50% of elderly individuals over 80 years of age indicated a fear of falling, and women tended to be more fearful than men (McAuley, Mihalko, & Rosengren, 1997). Fear of falling is associated with decreased life satisfaction, increased rates of depression and decreased mobility (Arfken, Lach, Birge, & Miller, 1993).

*Relationship to Other Fall Risk Factors*.

During a one-year prospective cohort study, Murphy et al. (2003) assessed the development of fear of falling in 313 healthy community-dwelling women, aged 72 and older, who did not display a fear of falling at the beginning of the investigation. Twenty-seven percent of the subjects developed a fear of falling over the one-year period. These authors identified four predisposing factors which could lead to the development of the fear of falling: age of 80 or greater, visual impairment, sedentary life style, and lack of emotional support. The relative risk of falling after developing a fear of falling was 1.7 in this cohort of elder women.

In contrast to the findings of Murphy et al. (2003), Kressig et al. (2001) reported that age was not associated with fear of falling in individuals who were transitioning to frailty. This cross-sectional study included 278 elderly individuals with a mean age of 81 years, residing in senior living facilities. Using a multivariable regression model, the authors reported that depression, use of a walking-aid, slow gait speed, and being of African-American descent were directly related to a heightened fear of falling. This investigation did not relate the fear of falling to actual changes in the rate of falling exhibited in the study's population. Fear of falling as a risk factor for falls appeared to vary with the general health and well-being of the study population.

Decreased physical activity has been strongly associated with the fear of falling. After completion of a cross-sectional study of 1,103 community-living elderly, Tinetti et al. (1994) reported that 24% of those individuals who had recently fallen decreased their activity out of fear of additional falls, while 19% of those who had not fallen also decreased their activity level due to a fear of falling. Bruce, Devine, and Prince (2002) evaluated the relationship between recreational physical activity and a fear of falling in 1,500 healthy older women. The women were divided into three activity levels based on self-reported daily activities. The researchers found that a small percentage of active elderly women, 27%, demonstrated a fear of falling; however, a much higher percentage of inactive elderly women, 42%, demonstrated a fear of falling. The authors noted that this cross-sectional study did not allow a determination of direction of causality. The question as to whether the sedentary lifestyle created the fear of falling, or alternatively, whether fear of falling caused the sedentary lifestyle, was left unanswered (Bruce et al., 2002).

Fear of falling and subsequent avoidance of activities were significant predictors for a fall within a one year follow-up (Delbaere, Crombez, Vanderstraeten, Willems, & Cambier, 2004). These authors evaluated a population of 225 community-living elderly, both men and women between the ages of 61 and 92 years. Additional factors for fall prediction were found to be increased age and female gender.

Not all elderly who experience a fear of falling restrict their activities. Murphy, Williams, and Gill (2002) completed a cross-sectional study of 1,064 community-living elderly and noted that 57% of the subjects did not report a fear of falling. Of those individuals who did report a fear of falling, only 44% actually restricted their activity level. The investigators identified the factors associated with activity restriction as: a) a previous fall that caused an injury; b) slow time on physical performance tests; c) two or more chronic medical conditions; and d) depressive symptoms.

Diminished balance performance has also been associated with fear of falling. Utilizing a population of 50 community-dwelling subjects, aged 65-95, Hatch, Gill-Brody, and Portney (2003) estimated the role that balance performance played in balance confidence. Balance was measured using the Berg Balance Scale (BBS), and balance confidence was measured using the Activities-specific Balance Confidence Scale (ABC) of Powel and Meyers (1995). Additional functional and health variables were also evaluated. The authors reported that 57% of the variance in balance confidence was explained by balance performance alone. Functional measures and other health variables did not contribute significantly to balance confidence.

*Fall Self-efficacy.*

Many studies have focused on the elderly individuals' fear of falling, and researchers tend to measure this fear using one of several fall or balance self-efficacy scales. Tinetti et al. (1990) operationalized fear of falling by defining the concept of fall self-efficacy, a concept which described individuals' beliefs in their ability to perform daily tasks without falling. These researchers utilized the work of Bandera (1982) who asserted that the concept of self-efficacy related to an individual's perception in his ability to succeed in a particular domain. Additional research confirmed an inverse relationship between the fear of falling and fall self-efficacy. Thus, a heightened fear of falling was associated with low fall self-efficacy, and conversely, low fear of falling was associated with high fall self-efficacy. The results of a study conducted by Li et al. (2002) indicated that higher fall-related self-efficacy was associated with low levels of fear of falling, and better balance scores.

McAuley et al. (1997) recruited older individuals from the community who were either physically active or who were relative inactive. The researchers reported that the most physically active adults displayed less fear of falling, maintained better balance, and exhibited greater self-efficacy than those who were inactive. Martin, Hart, Spector, Doyl, and Harari (2005) reported that fear of falling in the young-old ($64.2 \pm 6$ years) was related more to reduced functional mobility than an actual psychological component of fear.

*Fall Self-efficacy Assessment Instruments*.

Several tools have been developed to measure fall self-efficacy. Tinetti et al. (1990) introduced the Falls Self Efficacy Scale (FES). The final version of this survey asked subjects, “How confident are you that you can…”, and listed ten common functional activities such as “take a bath or shower.” Subjects rated their confidence to perform each activity on a 1-10 scale with the number “1” denoting extreme confidence, and the number “10” denoting no confidence at all. Test-retest reliability for the FES was reported to be 0.71 for a time frame of four to seven days with a mean of five days.

A modified version of the FES was proposed by Hill, Schwarz, Kalogeropoulos, and Gibson (1996). The modified FES contained four additional activities, all of which were outdoor activities. The authors contended that the original FES did not contain a sufficient variety of activities to offer when administering the tool to high-functioning community-living elders. The authors validated their modified version on two groups of healthy elderly individuals, those with a mean age of 74 years who had not fallen, and those with a mean age or 79.2 years who reported a fall history or balance instability. Test-retest reliability was 0.93 and significant differences in test scores were noted between the groups. More recently, researchers suggested the FES exhibited a ceiling effect because the higher-functioning independent community-living elders tended to skew the scores toward 100 (Cumming, Salkeld, Thomas, & Szonyi, 2000).

Recognizing the limitations of the FES with community-living elders, Powell and Myers (1995) developed the Activities-specific Balance Confidence (ABC) Scale. The ABC is a 16-item survey which asks respondents to rate their level of confidence in performing situation-specific tasks. These tasks were designed to encompass a wider spectrum of daily tasks, some of which were more hazardous (disembarking from a moving escalator without using the hand rail, or walking on ice) than those found in the FES. Test-retest reliability for the ABC, spanning a two-week period, was 0.92, and there was high internal consistency with a Chronbach's alpha of 0.96. The authors demonstrated convergent and discriminant validity using the Physical Self-Efficacy Scale (a recognized valid and reliable scale), reporting a significant correlation with the physical abilities subscales for both ABC ($r = .63$; $p <.001$) and FES ($r = -.54$; $p < .001$). Discriminant validity was demonstrated with non-significant correlations between the general self-presentation subscale and both ABC ($r = .03$) and FES ($r = .12$). The authors further assessed the utility of the ABC and FES to discriminate between levels of mobility (high and low as defined by need for assistance). The authors reported that while both scales demonstrated a significant discrimination between high and low mobility subjects, the ABC demonstrated a greater range of scores between both groups while the FES was highly restrictive for the high mobility subjects, thus making the ABC a better discriminator of balance confidence in high mobility subjects. The summative conclusion of these authors indicated that the FES was adequate to assess balance confidence in frail elderly, but the ABC was more sensitive to potential robust scores of the healthy elderly (Powell & Myers, 1995).

A follow-up study with the same subject population as the 1995 study of Powell and Meyers demonstrated the stability of the ABC scores in high functioning adults, thus prompting Meyers, Fletcher, Myers, and Sherk (1998) to propose the following criterion scores on the ABC: a) a score of 50% or below indicated a very low functioning, a characteristic of individuals requiring significant assistance in activities of daily living; b) a score between 50% and 80% indicated a moderate level of functioning, a characteristic of individuals experiencing chronic medical conditions; and c) a score above 80% indicated a high level of functioning, a characteristic of a physically active healthy individuals. In populations of moderate- to high-level functioning community-living elderly, the ABC appeared to be a better discriminator between subjects with fear of falling than those who did not experience a fear of falling (Myers et al., 1998).

The BBS and the ABC have been used in consort to evaluate fall risks in the elderly. Lajoie, Girard, and Guay (2002) compared postural sway, reaction time, BBS, and ABC in 80 subjects, 40 fallers and 40 non-fallers. While there were significant differences ($p < .001$) in postural sway between groups, a step-wise multiple regression analysis revealed that the measures of reaction time, the BBS and the ABC, in combination, were significant predictors ($p < .001$) of fall status, accounting for approximately 73% of the variance. Lajoie and Gallager (2004) subsequently repeated the previous study (Lajoie et al., 2002) with an increased subject population consisting of 45 fallers and 80 non-fallers. Again, they found that reaction time, the BBS and the ABC in combination were significant predictors ($p < .01$) of falls with 89% sensitivity and 96% specificity. The authors further proposed cutoff scores for each measure: 46 for the BBS, 67% for the ABC, and 550 milliseconds or above for the reaction time measure. These cutoff numbers indicated the score most likely to be successful when classifying those at risk of falling.

*Summary.*

Fear of falling often creates a mindset effect in the elderly which can actually increase the risk of falling. Fear of falling may prompt individuals to decrease their activity level, even if they have never fallen. Fear of falling has become an essential adjunct measure when evaluating balance stability in the elderly, and evidence suggests the ABC is more sensitive to potential high scores of the healthy elderly. Therefore, the ABC will serve as the fall self-efficacy measure for the present study.

### *Physical Activity and the Elderly*

*Physical Activity as a Predictor for Morbidity and Longevity.*

A sedentary lifestyle is a behavioral risk factor for increased morbidity and mortality in the elderly (DiPietro, 2001). Recent national statistics indicate that only 20% of people age 65 and over engaged in regular leisure physical activity, and only 8% of the over-85 population engaged in leisure physical activity (Federal Interagency Forum on Aging-Related Statistics (FIF), 2004).

Gregg et al. (2003) conducted a large prospective cohort study with 7,553 elderly women, aged 65 and older. The investigators obtained baseline data, with follow-up data averaging 5.7 years after the baseline. The women were classified into the following four activity groups for analysis: a) continuously sedentary; b) physically active at baseline, sedentary at follow-up; c) sedentary at baseline, and active at follow-up; and d) physically active at both assessments. The authors found that those women with increased physical activity level exhibited decreased mortality rates from all causes. The best predictor for longevity was participation in current physical activity. This predictor was found within the group that was physically active for both assessment visits, and the group that was sedentary at baseline and active at follow-up.

*Physical Activity Related to Fall Risks.*

Perrin, Gauchard, Perrot, and Jeandel (1999) studied 65 healthy, independent community-living adults with a mean age or 71.8 years. The authors reported better balance control in those individuals who had been active in physical or sporting activities all their lives, and also in those elderly individuals who had started physical or sporting activities after retirement. These findings are similar to those of Gregg et al.(2003).

Current activity level was reported as playing a significant role in balance performance in older adults (Bulbulian & Hargan, 2000). These authors investigated the effect of previous athletic activity and current activity levels on static and dynamic balance in 56 older adults. Previous levels of physical activity demonstrated no protective effect on balance performance in this study. Although there was an age-related decline in dynamic balance in a study involving 153 healthy postmenopausal women (mean age 72 years), brisk physical activity was also significantly correlated with better dynamic balance (Karinkanta, Heinonen, Sievanen, Uusi-Rasi, & Kannus, 2005).

Twenty-two elderly individuals who walked regularly since retirement, average walk history of 14.1 years, demonstrated significantly better balance control than 121 elderly who did not walk on a regular basis (Melzer, Benjuya, & Kaplanski, 2003). Self-reported falling was significantly different between the walkers and non-walkers. None of the walkers reported falling, while 16 % of the non-walkers reported falling at least twice in the six months preceding the balance testing.

Stel, Smit, Pluijm, and Lips (2004) conducted a survey of 204 community dwelling elderly who had fallen at least once during the year prior to the investigation. The age range of this cohort was 69-92 years, and 21% of those responding to the survey were over 85 years. The authors reported that 15.2% of those who had fallen decreased their level of physical activity after the fall. Additionally, the strongest risk factors for decreased physical activity level after falling were female gender with odds ratio of 2.7, and depression with odds ratio of 1.9.

*Physical Activity Assessment Instruments.*

Researchers are generally in agreement that instruments developed to measure physical activity in the elderly must be specifically designed for the elderly, and should incorporate elements of leisure, household, and work/occupational activities. (Washburn, Smith, Gette, & Janney,1993; Washburn, 2000; Rikli, 2000). Two commonly used measures are the *Physical Activity Scale for the Elderly* (PASE), and the *Yale Physical Activity Survey for the Elderly* (YPAS).

The Physical Activity Scale for the Elderly (PASE) was designed specifically for use in epidemiological studies to assess physical activity in individuals over age 65 (Washburn et al.,1993). This instrument incorporated components of leisure, occupation and household activities in a 10-question survey. Question one related to sitting activities and was not used in the calculation of the PASE score. Question nine was subdivided into four parts, each receiving a separate activity score. The total PASE score was based upon 12 weighted items (questions two through ten with question nine subdivided into four parts). The PASE value for each activity was equal to the time spent in each activity (hours/week) or participation in an activity (yes/no) multiplied by a weighted value for that activity. The weighted value for each activity was derived from data collected from three physical-activity indicators: 3-day activity diary, global self-reported activity item, and a three-day Caltrac movement counter (Washburn et al., 1993). The sum of the individual weighted item values yielded the total PASE score.

Test-retest reliability was assessed using telephone interviews and self-administered mail-out surveys in a random sample of 277 community-dwelling older adults, mean age 73 years (Washburn et al.,1993). The test-retest time interval was three to seven weeks. Significant correlations were reported for both the interview version ($r = .68$; $p < .05$) and the self-administered version ($r = .84$; $p < .05$)

Validity was assessed indirectly with the sample of 222 community-dwelling older adults used to develop the PASE (Washburn et al., 1993). These authors reported significant associations ($p < .05$) between the PASE total score and several indicators of physical fitness: grip strength ($r = .37$), static balance ($r = .33$), leg strength ($r = .25$), resting heart rate ($r = -.13$), and age ($r = -.13$). Washburn, McAuley, Katula, Mihalko, and Boileau (1999) provided additional indirect evidence for validity of the PASE. Using 190 sedentary adults, mean age 66.5 years, these authors correlated the PASE scores with physiologic and physical performance measures, and reported significant correlations ($p = <.05$) of the PASE with peak oxygen uptake ($r - .2$), systolic blood pressure ($r = .18$) and balance scores ($r = .2$). Schuit, Schouten, Westerterp, and Saris (1997) confirmed the validity of the PASE using a metabolic analysis with doubly labeled water, considered the gold standard in measuring energy expenditure in human subjects. Twenty-one subjects were involved in this analysis. A significant correlation ($p <.01$) was demonstrated between the PASE score and the physical activity ratio, a ratio of total energy expenditure and resting metabolic rate, ($r = .68$); and between the PASE score and the residuals of regression with total energy expenditure as the dependent variable and resting metabolic rate as the independent variable ($r = .58$).

Preliminary normative values for the PASE were published by the copywrite holder of the PASE (New England Research Institutes, Inc. [NERI], 1991). A subsequent publication by Washburn et al. (1993) reported the mean PASE scores of the 193 subjects included in the development and validation research for the PASE. These mean scores corresponded to the preliminary normative values published by NERI (1991). Washburn et al. (1993) indicated that further studies with larger samples were necessary to develop true normative values. Washburn et al. (1993) further reported an age-related decline in the PASE scores and a gender bias, men tended to score higher than women. Schuit et al. (1997) reported that women reflected higher overall scores than men, but indicated the women's higher scores were linked to greater engagement in household tasks and caregiving rather than engagement in higher physical activity levels.

The Yale Physical Activity Survey for Older Adults (YPAS), another frequently used instrument, was developed to asses exercise, recreational and household activities during a typical week within the past month (DiPietro, Caspersen, Ostfeld & Nadel, 1993). This survey was divided into two sections: first, an activity/time checklist indicating physical work, recreation, and exercise activity; and second, a checklist indicating participation in vigorous activity, leisurely walking, moving on feet, standing and sitting. The total YPAS score is a summation of the energy expenditure (kilocalories/week) from all dimensions measured. Recent research indicated the YPAS may overestimate energy expenditure in the elderly but may still be a useful measure of physical activity (Kruskall, Campbell, & Evans, 2004). During a comparative study utilizing both the PASE and the YPAS, the scores correlated well with each other, and demonstrated acceptable validity in measuring the activity level of healthy adults over the age of 65 (Harada, Chiu, King, & Stewart, 2001). Washburn (2000) and Rikli (2000) agreed that all physical activity measures for the elderly needed ongoing validity studies with various populations.

The level of physical activity of the individual plays a significant role in the elderly individual's fear of falling. Research in this area has been previously described in the section on *Fear of Falling and Fall Self-efficacy* (page 34).

*Summary*.

The level of physical activity in the elderly has been linked to their experience with falling, and to their fear of falling. Diminished activity levels have also been directly linked to balance deficits exhibited in elderly individuals. Elders who have fallen, or who experience a fear of falling, may tend to restrict their activity, possibly to minimize the potential for a fall. Assessing activity level in healthy elderly may offer insight as to the relative amount of physical activity needed to remain in the healthy state. The PASE, a well-validated and easily administered physical activity scale for the older individual, will be used in this study.

***Chapter Summary***

Fall risk identification and subsequent assessment is paramount to the creation of programs developed for fall reduction in the older individual. However, due to the complexity of individual risk factors, observed singly or in combination, fall risk assessments often address numerous risk factors within the evaluation.

As a result of fall research, several general risk factors, which include balance and posture, share commonality. This shared commonality lends credence to their use in older populations at risk for falling. Predictive studies, focusing predominantly on risk factors observed in combination, may identify fast and effective balance and posture-related screening tools. The validity and component structure of individual predictive factors need additional assessment.

Balance has been identified as a significant risk factor for falling. The effect of the forward head posture, a postural alignment which may contribute to balance instability, remains unclear as to its exact contribution in the role of overall balance stability. A paucity of research occurs in regard to the direct relationship of the forward head posture on dynamic balance.

Fear of falling and diminished physical activity level in older individuals often become intertwined as risk factors for falling. Fear of falling may actually initiate an increased risk for falling, while decreased physical activity level may relate directly to balance deficits exhibited in the older individual.

## CHAPTER 3

## METHODOLOGY

### *Introduction*

The purpose of this study was to investigate the influence of the forward head posture on dynamic balance, fall self-efficacy, and the physical activity level in healthy community-dwelling women age 60 and older, and to evaluate the relationship of these variables to fall history. Three research questions were developed:

1: Are the known risk factors for falling (balance deficits, low fall self-efficacy, decreased activity levels) correlated, and are they correlated to fall history in healthy community-dwelling women age 60 and older?

2: Is there an inverse relationship between the degree of forward head posture and each of the known risk factors (balance deficits, low fall self-efficacy, decreased activity levels, and a fall history) in healthy community-dwelling women age 60 and older?

3: After controlling for the known risk factors, does the degree of forward head posture predict fall history in healthy community-dwelling women age 60 and older?

The subsequent sections will discuss the following: a) the methods of subject selection, b) the testing locations, c) the survey instruments used to measure fall self-efficacy and activity level, d) the instrument used for balance measurement, e) the instrumentation utilized to measure the forward head posture, f) procedures for data collection, and g) the data analysis used in this study.

### *Subject Selection*

During the course of the present study, 112 women were tested. The average age of these women was 76.23 years (SD 8.68) with an age range from 60 to 95. The subject pool was comprised of women living independently in midwestern communities, who were 60 years of age and older, and who volunteered to participate.

The principle investigator (PI) solicited subjects from various senior citizen centers, senior-living communities, local senior wellness centers, and various private gatherings via short informational presentations developed for interested participants (script attached as Appendix B). After the informational presentations, those women who expressed an interest in participating were screened for eligibility by the PI during an individual interview. Potential volunteers were summarily excluded if they did not live independently in the community, or if they depended on others for self-care, shopping, meal preparation, or light housework. They were also excluded if they currently experienced problems with balance, or if they currently experienced a major medical problem which placed them under a doctor's care (See Appendix C, Post-presentation Subject Eligibility Screening Interview). Eligibility criteria were clearly defined during the informational presentation, and reviewed again individually after the presentation by personal interview between the potential volunteer and the PI.

Once identified as a research participant, the subject was provided with an individual appointment date, time, and location for data collection. The PI also advised the subject that proper apparel for the data collection would consist of flat walking shoes (no pumps or high heels), comfortable clothing, and a collarless top/blouse, (preferably a tank top), and that the testing would take approximately 30 minutes to complete. Subjects were scheduled every 45 minutes to allow for individual time variations, and to prevent prolonged waiting. Subjects were responsible for their own transportation to and from the test site.

***Testing Locations***

Subjects living in retirement communities were tested at the wellness center or multipurpose room of that particular community living center. Subjects living in close proximity to Oklahoma State University were tested at the Colvin Recreation Center, Academic Hallway, Room 183. Other subjects were tested at local senior citizens' centers, senior wellness or exercise centers, or private residences. Administrators of the private community locations granted permission to use the facilities prior to data collection (Appendix D). All test areas were well-lighted, and all testing was conducted on flooring without carpet.

***Survey Instruments***

The *Activity-specific Balance Confidence Scale* (ABC) is a survey consisting of 16 questions pertaining to a subject's confidence in completing various common mobility tasks without losing her balance. The ABC can be self-administered by the subject, or administered via interview with the PI. For purposes of this study, the ABC was self-administered. The average completion time of this survey was approximately ten minutes. The response to each question was scored on a 0-100% scale which reflected increments of 10%. The average of the individual responses represented the final score. Test-retest reliability for the ABC was 0.92, and internal consistency reported with a Cronbach alpha of 0.96 (Powell & Myers, 1995). Internal consistency reliability was determined for this sample of women. An alpha value of .928 suggests high reliability for this measure. The ABC was used in this study for analyses only and was not utilized as a fall-screening or fall-prediction tool for individual subjects. Additional information regarding the ABC can be found in the literature review (page 38). The complete ABC is located in Appendix F.

The *Physical Activity Scale for the Elderly* (PASE) is a ten-question survey consisting of occupational, household, and leisure activities over a one-week period. An exemplar question, the second leisure question, was "over the past 7 days, how often did you take a walk outside your home or yard for any reason? For example, for fun or exercise, walking to work, walking the dog, etc.?" The choices for answer include *Never, Seldom* (1-2 days), *Sometimes* (3-4 days), or *Often* (5-7 days). If the subject answered anything other than *Never*, then she was also asked to estimate "on average, how many hours per day did you spend walking?", and was given choices of *Less than 1 hour*, *1 but less than 2 hours, 2-4 hours,* or *More than 4 hours*. The PASE was designed to be self-administered, or administered via interview with the PI. For purposes of this study, the PASE was self-administered. The average completion time of this survey was approximately five minutes. The score was based on the sum of item weights as outlined in the scoring manual (NERI, 1991). For example, if the subject answered S*ometimes* on the second leisure question and further answered *1 but less than 2 hours*, the activity frequency value was 0.75. The activity frequency value was then multiplied by the activity weight (20 for question 2) to yield the individual item score which was 15 for this example. The matrix used for calculating activity frequency and activity weighting is located in Appendix H. The actual range of the PASE score was activity-level dependent.

Test-retest reliability for the PASE when self-administered was .84 (Washburn et al., 1993). However, it should be noted that Cronbach alpha calculated for the present study sample of women resulted in a value suggesting rather low reliability ($\alpha = .521$). Validity of the PASE when compared to direct measures of total energy expenditure and resting metabolic rate ranged was established through correlations, which were from .58 to .68 (Schuit et al., 1997). Significant associations ($p < .05$) were reported when comparing the PASE with indicators of physical fitness such as grip strength ($r = .37$), static balance ($r = .33$), leg strength ($r = .25$), and resting heart rate ($r = -.13$) (Washburn et al. 1993). Additional information regarding the PASE and the derivation of item weights can be found in the literature review (page 43). The reference source for the PASE is located in Appendix G.

***Balance Measurement***

The *Berg Balance Scale* (BBS) consists of 14 balance-specific activities common to normal daily living. These activities range from sit-to-stand to standing on one leg. The subject was asked to complete each task, and the PI judged the degree of success using a 5-point Likert scale with "0" representing the lowest score and "4" representing the highest score. Specific criteria for each rating on each task were printed on the test form. The PI, a licensed Physical Therapist, stood to the left side of each subject during the entire course of the BBT, providing assistance or reassurance if needed. Verbal directions were scripted on the test form. The PI administered the test using the same chairs and stepstool for all subjects, thereby maintaining continuity of test equipment throughout the study. The sum of all tasks culminated in a total possible test score of 56.

Inter-rater and intra-rater reliability for the BBS have been reported as high (ICCs = 0.98), and internal consistency also has been reported as high ($\alpha = 0.96$) (Berg, Wook-Dauphinne, et al., 1992). Internal consistency reliability for the present study sample of women ($\alpha = .643$) appeared adequate for this exploratory study. The BBS has also been reported to correlate strongly ($r = 0.70$ to 0.90) with existing validated balance measures (Berg, Maki, et al., 1992). The BBS was utilized for study analyses only and was not used as a fall screening or fall-prediction tool for individual subjects. Additional information regarding the BBS can be found in the literature review (page 24). The complete BBS is located in Appendix I.

***Forward Head Posture Measurement***

*Pre-test activities*.

Prior to the start of the BBS, a small plastic body marker, approximately one centimeter tall and one-half centimeter wide, was placed on the subject's skin directly over the seventh cervical spinous process (C7) using double-sided sticky tape (Figure 3). The marker was covered with photo-sensitive tape that glowed when the camera flash fired. The PI identified the C7 spinous process by palpating the cervical region. Anatomically, the C7 spinous process is the most prominent bony landmark in the cervical region and is readily palpable with slight neck flexion (Biel, 2001). The C7 marker allowed for landmark identification when measuring the forward head angle. For ease of identification during forward head position analysis, a small triangular white adhesive marker was placed on the subject's tragus of the right ear, a cartilaginous projection located in front of the external opening of the ear canal. The apex of the triangle was centered on the subject's tragus (Figure 3).


Figure 3. Illustration of body markers on subject: C7 marker and Tragus marker
(Photo used with written permission of subject)

The use of markers for landmark identification was consistent with the protocol described by Raine and Twomey (1994). The subjects were photographed during the performance of the seventh task (standing with feet together for one minute) of the BBS. Individual subjects were not informed of the timing of the photograph for two reasons: a) to insure the subject did not pose for the photograph with an exaggerated "perfect posture", and b) to insure the subject's attention was focused on a particular activity and thus the individual's typical posture would be captured. The seventh task was chosen because it required subject's attention to balance and allowed the subject to remain stationary for the photo. All photographs were taken from the subject's right side thus reflecting a right-sided profile.

*Camera.*

A Canon PowerShot A95 digital camera (Manufactured by Canon Inc., One Canon Plaza, Lake Success, NY 11042), a 5.0 megapixel camera with a real-image optical viewfinder, a 7.8-23.4mm lens with 3x optical zoom, and a built-in flash, was utilized for all photographic data collection. The camera was used in the "Automatic" mode which allowed for automatic adjustment of aperture setting, shutter speed, and focus. The resolution was set at "Large" (2592 x 1944 pixels), and the compression set at "superfine" for maximum image quality (Canon, 2004).

The camera was mounted on a Bogen/Manfrotto grip-action ball head with a quick-release plate, Model # 3265 (manufactured by Manfrotto, distributed by B&H Photo-Video-ProAudio, 420 Ninth Avenue, New York, New York 10001). This ball head featured a built-in circular, multiangle bubble level. The adjustable ball-head grip and multiangle bubble level allowed the photographer to level the camera in horizontal and vertical planes, regardless of possible distortions in the surface of the floor. The ball head camera mount was then locked onto a carbon fiber GITZO MK2 Mountaineer Reporter Tripod, Model # G1227 (manufactured by Gitzo and distributed by Bogen Imaging Inc., 565E Crescent Avenue, P.O. Box 506, Ramsey, New Jersey). The tripod featured a grooved, rapid-center column which was designed to prevent rotation of the camera, and increase stability of the camera. The tripod also featured a stainless steel weight hook attached to the base of the grooved center column which provided an exact center point on which to attach the plumb line designating the origin of the 5-foot measurement to the subject. The grooved-center column also allowed the photographer to vertically raise and lower the camera smoothly while adjusting to varied heights of the subjects.

The camera was positioned five feet from the subject. The five-foot floor measurement originated from the center column of the tripod (identified with a plumb-bob suspended from the tripod's center hook) and terminated at a marker five feet away.

During the task selected to be photographed the subject was asked to stand with the lateral border of her right foot touching a tape marker. The subject was photographed perpendicular to the right sagittal plane in order to obtain a sagittal view of the head and neck during the balance activity.

The zoom setting on the camera was set to full zoom in order to insure a consistent focal length identical for all subjects. The camera height was adjusted to the subjects' varying heights by elevating the tripod's grooved center column so that the top of each subject's head consistently appeared at the top of the picture frame. All camera adjustments and actual photographs taken during the test procedure were completed by the photographic assistant.

*Photographic analysis.*

The photographs were downloaded to a Gateway M500 Notebook (Manufactured by Gateway, Inc, 14303 Gateway Place, Poway, CA 92064) for cataloguing and subsequent printing. The Cannon Digital Solution for Windows software (Provided with the Canon PowerShot A95 digital camera, Manufactured by Canon Inc., One Canon Plaza, Lake Success, NY 11042) was utilized for downloading and printing. The photos were printed using the "Best" mode (resolution 1200 by 1200dpi) on a HP Photosmart 2610 all-in-one ( Manufactured by Hewlett-Packard Company, San Diego, CA), using Kodak Premium PhotoPaper, 61 pound, 8mil. high gloss paper (Manufactured by Eastman Kodak Company, Rochester, NY, 14650).

The bottom of each printed photograph represented a true horizontal line relative to the subject due to the tripod's ball-head camera mount which incorporated a horizontal-vertical bubble level. The PI drew a horizontal line through C7, and a line connecting the tragus of the right ear to the C7 marker on the printed photograph of each subject. The intersection of these lines defined the sagittal plane relationship between C7, the tragus of the right ear, and the horizontal, and was measured to the nearest ½ degree (Figure 4).

Figure 4. Forward head posture measurement on individual photo.
(Photo used with written permission of subject)

The sequence of identifying the landmarks and subsequent drawing of the measurement lines was identical for each subject. This sequence was as follows: a.) placed ink dot at the base of the C7 marker; b) placed ink dot at the tip of the apex of the tragus triangle marker; c) using a printer's stainless steel six-inch ruler (manufactured by General) marked in 1/32 of an inch increments, the PI measured the distance from the C7 ink dot to the bottom of the photograph; d) using that measurement, the PI then placed the six-inch ruler to the left and right 1/3 of the photo and placed another ink dot, thus providing three points of equal measure from the bottom of the photograph through which to draw the horizontal line; e) the PI then used a printer's steel straight-edge (manufactured by Manatua Metal Products) to draw the horizontal line across the entire picture; f) the PI used the six-inch printer's rule to draw the angular line intersecting the tragus ink dot and the C7 ink dot which intersected the horizontal line; g) the angle formed by these intersecting lines was measured using a Staedtler protractor, six-inch, 180 degree with ½ degree graduations. All measures were recorded to ½ degree. All ink dots and line drawings were made with a Sharpie ultra fine point permanent marker. A preliminary trial using this measurement method demonstrated that measurement accuracy of the PI on the same photo with ten measurements, each measured 24 hours apart was ± 0.47 degrees (Mean $50^{o}$, S.D. 0.47, range $49^{o}$-$51^{o}$).

Photographic analyses was conducted at the conclusion of all data collection for all subjects. All photographic analyses were completed over a consecutive two-day period.

### ***Procedures Preliminary to Data Collection***

*Presentation to Potential Volunteers.*

The PI presented an overview of the study, eligibility criteria, and specific data collection procedures to all potential volunteers (Appendix B). Presentations were delivered at local senior citizen centers, at senior-living communities, at local senior wellness centers, and at various private gatherings.

*Determination of Eligibility Interview.*

After each presentation, potential volunteers were interviewed by the PI to determine eligibility for the study (Appendix C). Those potential volunteers who meet eligibility criteria were given a scheduled time for data collection.

### ***Procedures For Data Collection***

*Initial Procedures.*

Upon arrival at the test site, each subject met with the PI to review the test procedures, and be given the opportunity to read and sign the informed consent form (Appendix E). All forms utilized in this study were approved by the Institutional Review Board (IRB) (Appendix A), Oklahoma State University prior to conducting the study.

*Test Site Preparation*.

Prior to the start of testing, the PI and the photographic assistant organized the test environment. Two straight-back chairs with a chair seat height of 18 inches were provided by the PI, and were used for all subjects for each BBS. A rectangular wooden step-stool, 7” tall with a step surface of 8 ½ ” by 11”, was used for all subjects for the step event in the BBS. This stool height was comparable to a standard step or curb height. Non-skid tape was attached to the legs of the stool to prevent slippage during the test. The camera was locked on the tripod five feet from the activity path of the subject, and was placed at a $90^{o}$ angle to the activity path. A non-skid tape marker was placed on the floor at the center point of the tripod and at the five foot mark from the tripod. The subject was asked to complete the seventh task (standing with feet together for one minute) with the lateral border of the right foot touching the marker.

Table and chairs were available for the subjects to use during the completion of the ABC and PASE survey instruments.

*Testing Sequence*.

Each subject was tested one time only on each instrument, thus no confounding practice effect was expected. The sequence of testing was varied for each subject using a counterbalanced strategy to minimize carry-over effects from one instrument to another (Keppel, 1991).

*Berg Balance Scale.*

Prior to starting the BBS, the investigator insured that the C7 marker and the tragus marker were clearly visible to the camera. The subject sat on the chairs provided, and the PI read the instructions for the BBS as scripted in Appendix I. The subject then completed each activity as directed, and the PI served as the scorer for the BBS. If needed, the subject was given the opportunity to rest briefly between tasks. The BBS is normally expected to be completed within 20 minutes, and all subjects fell within that time range.

*Activity-specific Balance Confidence Scale.*

Each subject was asked to sit on a chair at a table to complete the ABC survey. The PI provided directions as scripted on the survey, and was available to answer questions while the subject completed the survey. The PI also provided a pen and a survey form for each subject.

*Physical Activity Survey for the Elderly.*

Each subject was asked to sit on a chair at a table to complete the PASE. The PI provided directions as scripted on the survey, and was available to answer questions while the subject completed the survey. The PI also provided a pen and a survey form for each subject.

*Fall History Interview.*

After completion of the BBS, the ABC, and the PASE, the PI interviewed the subject regarding her fall history (Appendix J). This interview was completed at the end of all testing procedures to insure that no thought perseveration or bias regarding fall history transferred to any of the test instruments.

*Subject Feedback Following Testing.*

Each subject was advised of the scores she achieved on the BBS and the ABC at the conclusion of individual testing. If either score was considered in the low range as suggested in the literature, that subject was given a written report of her scores (Appendix K) along with a cover letter to her personal physician suggesting further detailed assessment as deemed appropriate by her physician (Appendix L). The subject was not given her specific PASE score since a normative cut-off score had not been identified in the literature.

*Data Storage.*

In order to maintain confidentiality of subject information, the PI maintained all forms, photographs, and photographic computer data in a locked filing cabinet located in the PI's office, Colvin Recreational Center, Room # 185, OSU. At the conclusion of this study, all paper records containing personal information were destroyed.

***Statistical Analyses Procedures***

Subject data were compiled and analyzed using the Statistical Package for the Social Sciences (SPSS® for Windows, v. 12.0, Chicago, IL). Descriptive statistics were performed to calculate means, standard deviations for subjects' age, height, weight, the scores on each of the three measures, and the forward head posture. The forward head measure was reverse scaled so that a higher score indicated a more severe forward head posture. Multiple ANOVA were completed using fall/no-fall as the grouping variable, and the physical parameters of height, weight and age as the dependent variables. This analysis was completed to evaluate the homogeneity of the subject pool.

Correlation coefficients between the measured variables were determined. Analysis, using hierarchical regression with block entering of the known fall risk variables (scores on BBS, ABC and PASE) followed by entering of the forward head posture value, was completed to assess the predictive value of the forward head posture for falling. The number of falls was the dependent variable for this regression.

# CHAPTER 4

# RESULTS AND DISCUSSION

### *Introduction*

The first section of this chapter will provide the demographics of the subjects tested in this study. The following sections will focus on the statistical results of data analyses, and a discussion of these statistical results as they relate to each of the research questions identified in Chapter 1.

### *Subject demographics*

During the course of the present study, 112 women were tested. The subjects self-reported all demographic information. The average age, height and weight of the subjects, including standard deviation, are displayed in Table 1. Additional data in Table 1 divides the demographic information into two groups, fallers and non-fallers. Seventy-two of the subjects (64%) reported no falls within the last year, while 40 of the subjects (36%) reported one or more falls within the year preceding data collection.

*Table 1.*

*Demographic information for sample (N=112)*

| | **Age (Years)** | **Height (Inches)** | **Weight (Pounds)** |
|---|---|---|---|
| **Total Sample Mean [SD]** | 76.23 [8.68] | 63.16 [2.65] | 149.76 [27.82] |
| | | | |
| **Fallers (n=40)** | 74.88 [8.99] | 63.16 [1.92] | 151.35 [28.37] |
| **Non-Fallers (n=72)** | 76.99 [8.46] | 63.17 [2.98] | 148.88 [27.67] |

Multiple ANOVAs were performed with the demographic variables age, height, and weight as dependent variables, and fall/no-fall as the grouping variable. These analyses were completed to assess whether significant differences in physical characteristics existed between those women who fell and those who did not fall. These analyses demonstrated no significant differences between the fallers and the non-fallers in age, height or weight (Table 2).

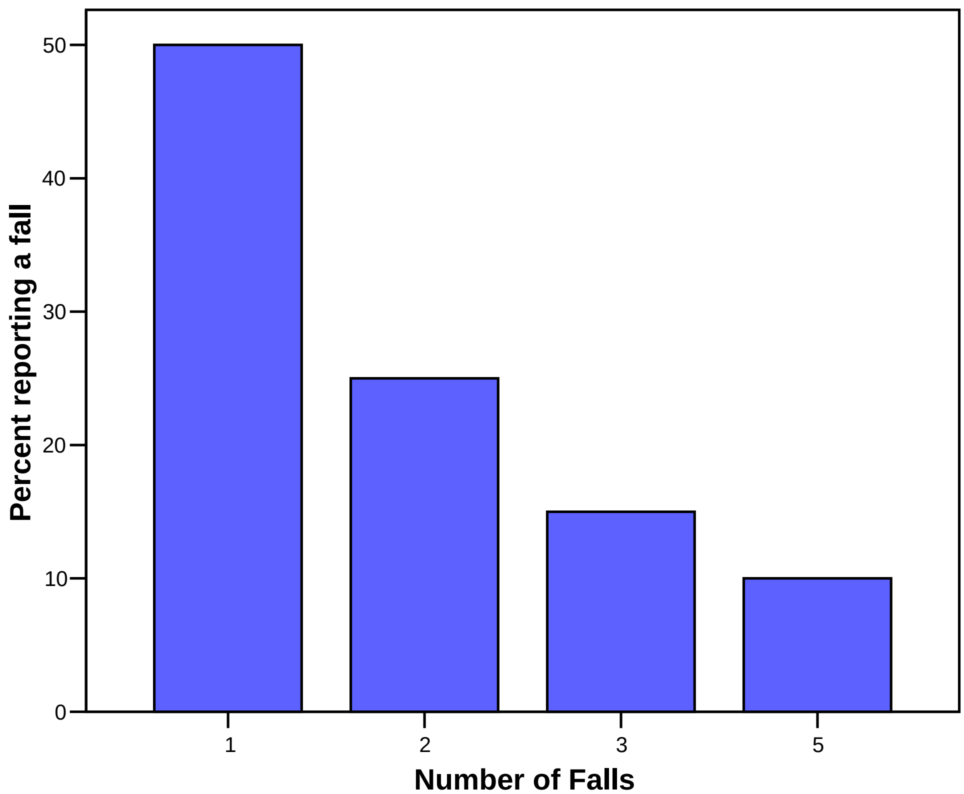
*Table 2.*

*ANOVA for Demographic Variables of Age, Height, and Weight with Fall / No-Fall as the grouping variable*

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| AGE | Between Groups | 114.603 | 1 | 114.603 | 1.530 | .219 |
| | Within Groups | 8239.361 | 110 | 74.903 | | |
| | Total | 8353.964 | 111 | | | |
| HT | Between Groups | .003 | 1 | .003 | .000 | .983 |
| | Within Groups | 777.774 | 110 | 7.071 | | |
| | Total | 777.777 | 111 | | | |
| WT | Between Groups | 155.753 | 1 | 155.753 | .200 | .656 |
| | Within Groups | 85770.211 | 110 | 779.729 | | |
| | Total | 85925.964 | 111 | | | |

One hundred three (92%) of the women reported Caucasian ancestry, eight (7 %) reported Native American ancestry, and 1 (0.9%) reported Hispanic ancestry. Due to the preponderance of subjects who reported Caucasian descent, no attempt was made to assess data on the basis of ethnicity. Of the 40 women who reported falling within the previous year, 20 (50%) reported only one fall, 10 (25%) reported two falls, 6 (15%) reported three falls, and 4 (10%) reported five or more falls (Figure 5).

**Figure 5. The frequency of falls among those reporting a positive fall history**




Among the 40 women who reported falling, 11 (27.5%) sought medical assistant for injuries related to falling, although none sustained significant injuries such as a fracture or joint dislocation. Five (12.5%) of those who reported falling changed their living arrangement or activity habits as a result of the fall.

*Discussion.*

The lack of differences in age, height, and weight between those subjects who reported falling and those who reported no falls were essential to the present study. This lack of differences demonstrated the physical similarity of the two groups, and thus future analysis involving the groups would not be confounded by differences in physical characteristics.

Subjects self-reporting their falls may have been a limiting factor in the present study, in that the number of falls may have been under-reported. The women recruited from the independent living component of retirement communities may have under-reported their fall history due to concern or fear of losing their independent status. Even with the assurance of confidentiality, they may have perceived the admission of a fall history as a risk to their independent status in the retirement community. The implied risk, loss of independent status due to falling, would result in their being required to move to assisted living. Errors in the subjects' memory recall of fall events may also have contributed to under-reporting (Bogle-Thorban & Newton, 1996; Boulgarides et al., 2002).

The proportion of women in the present study who had fallen, 40 of 112 or 36%, was difficult to compare to previous literature because no attempt was made in the current study to recruit subjects based upon fall history. However, O'Brien et al. (1998) reported a similar percentage of fallers (36%) in their convenience sample of 48 elderly women. Conversely, while Shumway-Cook et al. (1997) utilized a convenience sample, these authors recruited equal numbers of fallers and non-fallers. The fall percentage in the current study was similar to the national trend prediction of 40% rate of falling (Merck Institute of Aging and Health, & Gerontological Society of America, 2002).

***Research question 1: Are the known risk factors for falling (balance deficits, low fall self-efficacy, and decreased activity level) correlated, and are they correlated to fall history in healthy community-dwelling women age 60 and older?***

*Statistical Results of Data Analyses.*

The only known risk factors demonstrating a statistically significant correlation to fall history were low fall self-efficacy ($r$ = -.222) as measured by the ABC score, and decreased activity level ($r$ = .216) as measured by the PASE score. The means, standard deviations and correlation coefficients for all the measures of the known risk factors for falling and the variables age and fall history are detailed in Table 3. It should be noted that, as anticipated, all intercorrelations among the known risk factors for falling reached statistical significance. These r-values were all in the expected positive direction and ranged from .251 (6% shared variability) to .588 (35% shared variability).

*Table 3.*

Correlation matrix for the known risk factors of low fall self-efficacy (ABC), balance deficits (BBS), and decreased activity level (PASE); and the variables Age and fall history (Number of Falls)

| | **ABC** | **BBS** | **PASE** | **Age** | **Number of Falls** |
|---|---|---|---|---|---|
| **ABC** | 79.78 (17.05) | .588** ($p$ = .000) | .251** ($p$ = .004) | -.322** ($p$ = .000) | -.222** ($p$ = .009) |
| **BBS** | | 50.78 (6.25) | .459** ($p$ =.000) | -.513** ($p$ = .000) | .013 ($p$ = .448) |
| **PASE** | | | 135.52 (81.59) | -.463** ($p$ = .000) | .215* ($p$ = .012) |
| **Age** | | | | 76.32 (8.68) | -.178* ($p$ = .030) |
| **Number of Falls** | | | | | .70 (1.12) |

Note: Means (and standard deviations) are on the diagonal. Pearson bivariate correlations and exact $p$ values are on the upper off-diagonal.
** Correlation is significant at the $p \leq 0.01$ level
* Correlation is significant at the $p \leq 0.05$ level

Significant negative correlations ($p \leq 0.01$) were found between age and BBS ($r$ = -.513; 26% shared variance), between age and PASE ($r$ = -.463; 21% shared variance), and between age and ABC ($r$ = -.322; 10% shared variance). This indicated that as the age of the subjects increased, their scores on the BBS, ABC and the PASE decreased.

Significant positive correlations ($p \leq 0.01$) were found between PASE and BBS ($r$ = .468), between PASE and ABC ($r$ = .251), and between BBS and ABC ($r$ = .588). Thus, individuals who scored high on one test also tended to score high on the other tests as well. The correlation between BBS and ABC was the strongest ($r$ = .588), with about 35% of the variance between these two measures shared.

The ABC scores were negatively correlated ($p \leq 0.05$) with fall history ($r$ = -.222), which indicated that as the number of falls increased, the scores on the ABC decreased. This correlation was relatively small ($r$ = -.222) which suggested a fairly weak relationship, with only about 5% shared variance.

The PASE scores were positively correlated ($p \leq 0.05$) with fall history ($r$ = .216), which indicated that high PASE scores were associated with a high number of falls. The correlation was relatively small ($r$ = .216), suggesting a fairly weak relationship with only about 5% shared variance.

*Discussion.*

A balance deficit, as measured using the BBS, was not statistically correlated with fall history in this population. While this finding was not consistent with the previous work of Bogle-Thorbahn and Newton (1996), Shumway-Cook et al. (1997), or Lajoie and Gallager (2004), this finding was consistent with the findings of Boulgarides et al. (2003)

and Brauer et al. (2000). The explanation for this apparent inconsistency may be threefold: a) the characteristics of the subject pools were different, b) the internal reliability for the BBS with this subject population was low, and b) a “ceiling effect” may have limited the diagnostic value of the BBS in healthy elderly.

Bogle-Thorbahn and Newton (1996) did not exclude subjects on the basis of disability, and indicated that 38% of their subjects reported some type of neurological or orthopedic impairment. Consequently, while these authors indicated all 66 of their subjects were community-living, the inclusion of subjects with disabilities made comparison with the results of the present study incompatible because the present study specifically excluded subjects with disabilities. The study by Shumway-Cook et al.(1997) included both men and women (n = 44) in their subject population, while the present study (n = 112) included only women. Lajoie and Gallager (2004) included independent community-dwellers as well as residents of nursing homes and senior residences in their subject population (n = 125). The present study specifically excluded individuals residing in assisted-living and nursing homes, which again, made close comparisons between studies difficult.

The internal consistency reliability reported by the authors who developed the BBS was $\alpha = .96$ (Berg, Wood-Dauphinne, et al., 1992). A lower Cronbach alpha (.643) was found in the current study. This suggests that the internal reliability of the BBS was not as strong in this population as previously reported in the literature. Unique characteristics of this subject population may have accounted for this difference. Further assessment of the individual items in the BBS with a larger sample size with similar sample characteristics, i.e., healthy and highly active women 60 years and older, would be warranted.

The "ceiling effect" was proposed by both Boulgarides et al. (2003) and Brauer et al. (2002). In these investigations, the subject populations were healthy and apparently functioning at higher levels than subjects in the studies of Bogle-Thorbahn and Newton (1996), Shumway-Cook et al. (1997), or Lajoie and Gallager (2004), all of whom included subjects experiencing varying levels of functional or physical disability. Boulgarides et al. (2003) reported that 88% of their subject population (n = 99), mean age 74.02 years (SD 5.64), was involved in regular physical exercise, and further reported a mean BBS score of 53.18 (range 46 - 56) for fallers; and for non-fallers, a mean BBS score of 53.15 (range 34 - 56). Strict exclusionary criteria in the study of Brauer et al. (2002) resulted in a study population of 100 elderly women, mean age 73 ± 5 years, who were relatively healthy, and living independently in the community. These authors reported a mean BBS of 53.9, ± .06 for non fallers and 53.4 ± 0.9 for non-fallers. Consistent with the findings of Boulgarides et al., 2003, and Brauer et al., 2002, the mean BBS score of 50.78 (SD 6.25) reported in the present study was well above the recommended cut-off score of 45 for identifying an individual as being at risk for falling. Normative studies (Lusardi et al., 2003; Steffen et al., 2002; Steffen & Mollinger, 2005) have also demonstrated relatively high BBS scores in healthy independently-living older adults. High scores in both the faller and non-faller categories in the present study may have produced a "ceiling effect."

The cause of falling in the present study population may not have been intrinsically-related, and thus may not have been related to intrinsic balance measures utilized in the current study. A qualitative question on the Fall History Interview (Appendix I) asked those subjects who had fallen to describe the fall. Several subjects reported falling as a result of a slip or a trip while engaged in outdoor work, while others described a misstep while engaged in more demanding activity levels such as "pulling my suitcase through the airport terminal." The relatively high activity level of this subject population, which will be further discussed later, may have been the primary contributing factor to the number of falls rather than intrinsic balance deficits.

Low fall self-efficacy, as measured using the ABC scale, demonstrated a significant negative correlation with fall history. This correlation ($r$ = -.222; $p$ = .009) was supported within current literature. Studies incorporating a larger range of health status in the test subjects, i.e., both healthy subjects and those subjects experiencing medical issues contributing to some level of functional decline, demonstrated higher correlation coefficients of 0.80 (Lajoie & Galliger, 2004) and .752 (Hatch et al., 2003). The relatively low percentage of common variance ($r^2$ = .049; 5%) in the current study may have been due to the robust health status and activity level of the current study population which will be discussed in the following paragraphs. The overall finding was logical in that those subjects who had fallen tended to exhibit a greater fear of falling again, as evidenced by a lower ABC score. Cronbach alpha for the ABC in the present study was 0.928 which was similar to the alpha value of 0.96 reported by Powel and Meyers (1995).

The level of physical activity, as measured with the PASE, was positively correlated with a fall history ($r$ = .216; $p$ =.012). The interpretation of this relationship indicated that those who were more active tended to fall more. In this aged population, the literature tended to support the opposite relationship, i.e., those subjects who experienced more falls reported less physical activity. Although statistically significant, this relationship accounted for only 4 % of shared variance leaving nearly 96% of the variance unaccounted for. The present study population exhibited rather high physical activity scores. While national statistics indicated that only 20% of adults over 65 engaged in some form of leisure activity (FIF, 2004), the present study population reported a 98% participation in some form of leisure activity (questions 2-6 on the PASE). Boulgarides et al. (2003), while not specifically addressing activity level, also found that a large segment of their subjects (88%) reported regular physical activity.

Additionally, in the present study, the average PASE score for the group as a whole, 135.52 (SD 81.59), was higher than the average score of 102.9 (SD 64.1) for women as reported by Washburn et al. (1993), and the average score of 118.9 (SD 63.9) for a subject population (both men and women) over 65 years of age as reported by Washburn et al. (1999). This difference provided further support for the conclusion that the present study population maintained a more vigorous physical activity level than groups previously reported in the literature. Also of interest were the large standard deviations found within both the present study and the published averages. This rather large variability within age categories may suggest that the category divisions need further refinement, or that the survey itself may need further refinement in identifying actual activity levels in the very active elderly.

Cronbach alpha value for the PASE in the current study was .521. No alpha value for the PASE was found in the literature. Previous reliability values were based upon test-retest reliability (Washburn et al., 1993; Washburn et al., 1999) while previous validity was reported as construct validity, comparing PASE to physiologic and physical performance measures (Schuit et al., 1997, Washburn et al., 1993, Washburn et al., 1999). Disparity among the three factors comprising the PASE, i.e., leisure, household, and occupational activities, may have contributed to the alpha value found in the current study. Additional research, incorporating factor analysis, with a larger sample of healthy and highly active older women may be appropriate.

One factor of note about the present study, which was not incorporated in the data collected, was the number of subjects who were recruited from rural farming and ranching communities. Many of these women were still living on the farm or ranch, and although retired, were actively engaged in some of the farming and ranching activities, many of which were physically demanding. Another factor to consider when assessing the reported physical activity level was that data collection for the present study occurred during the winter months. During completion of the PASE, many women commented that they would have responded with much higher levels of activity had they taken the survey during the summer months. As such, the PASE score for these women might have been even higher.

The significant negative relationships between age and the BBS ($r = -.513$; $p = .000$), ABC ($r = -.322$; $p = .000$), and PASE ($r = -.463$; $p = .000$) were consistent with several previous studies (Isles et al., 2004; Lach, 2005; Lusardi et al., 2003; Murphy et al., 2003; Steffen et al., 2002; Steffen & Mollinger, 2005; Washburn et al., 1993; Washburn et al., 1999). The literature supported a unified agreement that these measures of balance, balance confidence, and physical activity levels did decline with age, and that this decline was more substantial in those aging individuals with medical or functional comorbidities. The strongest correlation in the present study occurred between age and the BBS, accounting for about 26% of the shared variability, yet neither age nor the BBS were significantly correlated with falling. Although this subject population followed the general trends reported in the literature, one particular trend, that a history of falling would be associated with decreased balance, was not found in this subject population.

The strong positive relationship between the risk factors (PASE & BBS, $r = .468$, PASE & ABC, $r = .251$, and BBS & ABC, $r = .588$), accounting for shared variability ranging from 6% with the PASE-ABC correlation to 35% with the BBS-ABC correlation, was consistent with previous literature. The BBS and the ABC were often used in concert within fall research, and have consistently demonstrated strong positive correlations ranging from 0.752 (Hatch et al., 2003) to 0.806 (Lajoie & Gallager, 2004). However, it must be noted that in these same studies, the correlations between BBS and ABC were also significantly associated with differences between faller and non-faller groups. In the present study, only the ABC was significantly correlated with fall history. Again, the potential ceiling effect of the BBS created by the apparently high activity level of the women in the present study may explain this finding.

The relationship between activity level and balance has been reported as positively correlated (Bulbulina & Hargan, 2000; Karinkanta et al., 2005). The strong correlation between PASE and BBS ($r = .588$) in the present study indicated that those women who were more active demonstrated better balance, which is consistently reported in the literature. Martin et al. (2005), in an investigation of fear of falling, incorporated the PASE and reported a significant association between fear of falling and a low (< 100) PASE score. The PASE scores for the present study demonstrated a stronger correlation with the BBS ($r$ = .486) than the ABC ($r$ = .251). The weaker correlation between PASE and ABC is of interest. The mean PASE score in the present study was well above the cutoff score of Martin et al. (2005). One would expect that with the more robust PASE scores, fear of falling would be lessened and thus these scores would reflect a stronger correlation. A more detailed analysis of the PASE score components and the ABC components in a study with a larger sample size may provide additional insight into this relationship.

In summary, the unexpected subject population characteristic of high activity level in the present study may have accounted for the lack of correlation between the BBS score and fall history. An underlying basic assumption of all analyses was that the number of falls reported was accurate. As previously discussed, under-reporting of falls may have been a limiting factor in the present study. Other common risk factors for falling, i.e., low balance confidence (ABC score) and activity level (PASE score), were correlated suggesting some subject characteristics similar to the majority of the literature. The correlations among the risk factors in the current study were consistent with relationships reported in the literature.

***Research question 2*: *Is there an inverse relationship between the degree of forward head posture and each of the known risk factors (balance deficits, low fall self-efficacy, decreased activity level, and a fall history) in healthy community-dwelling women age 60 and older?***

*Statistical Results of Data Analyses.*

Significant inverse relationships were found between the forward head posture (FHP) and each of the known risk factor measures: ABC ($r$ = -.274; p = .002), accounting for 7% of shared variability; BBS ($r$ = -.598; p = .000), accounting for 36% of shared variability; and PASE ($r$ = -.436; p = .000), accounting for 19% of shared variability. A significant positive relationship was found between FHP and age ($r$ = .422; p = .000), accounting for 17% of shared variability. These relationships indicated that as the age of the subjects increased, the severity in the forward head posture also increased; and that as the severity of the forward head posture increased, the scores on the ABC, BBS and PASE decreased.  No relationship was demonstrated between the FHP and number of falls. The correlation matrix is displayed in Table 4.

*Table 4.*

Correlation matrix for the known risk factors of low fall self-efficacy (ABC), balance deficits (BBS), and decreased activity level (PASE); and the variables Age and fall history (Number of Falls), with the addition of the variable Forward Head Posture (FHP)

| | **ABC** | **BBS** | **PASE** | **Age** | **Number of Falls** | **FHP** |
|---|---|---|---|---|---|---|
| **ABC** | 79.78 (17.05) | .588** (*p* = .000) | .251** (*p* = .004) | -.322** (*p* = .000) | -.222** (*p* = .009) | -.274** (*p* = .002) |
| **BBS** | | 50.78 (6.25) | .459** (*p* =.000) | -.513** (*p* = .000) | .013 (*p* = .448) | -.598** (*p* = .000) |
| **PASE** | | | 135.52 (81.59) | -.463** (*p* = .000) | .215* (*p* = .012) | -.436** (*p* = .000) |
| **Age** | | | | 76.32 (8.68) | -.178* (*p* = .030) | .422** (*p* = .000) |
| **Number of Falls** | | | | | .70 (1.12) | -.064 (*p* = .263) |
| **FHP** | | | | | | 48.45+ (11.50) |

Note: Means (and standard deviations) are on the diagonal. Pearson bivariate correlations and exact *p* values are on the upper off-diagonal.
** Correlation is significant at the $p \leq 0.01$ level
* Correlation is significant at the $p \leq 0.05$ level
+ The measured values of the forward head posture were recoded for analysis (See chapter 3 for details), thus the actual average value for the forward head posture in this study was 41.55 SD 11.44.

*Discussion.*

The FHP was significantly negatively correlated with the BBS ($r$ = -.598; 36% shared variance), indicating that the more severe forward head posture was related to diminished balance scores. This supports the fundamental rationale for the purpose of the present study, that the forward head posture places the head near or outside the limits of the balance stability envelope and will adversely influence an individual's balance capability. The lack of a significant relationship between the forward head posture and fall history was not surprising since the balance measure (BBS) was not significantly related to fall history. Apparently, even though an increased forward head posture was related to decreased balance scores, this effect was not strong enough to influence the relatively high balance scores, which did not discriminate between the fallers and the non-fallers. The high level of physical activity found within the present study population may be the factor that most influenced balance scores.

The negative relationship between the FHP and the ABC ($r$ = -.274; 7% of shared variance) and PASE ($r$ = -.436; 19% of shared variance) scores would be expected since the BBS, ABC and PASE were highly correlated. The strong interrelatedness of these risk factors makes isolation of one additional contributing factor, the FHP, difficult when that factor is also correlated with the risk factors. The positive relationship between FHP and age ($r$ = .422; 17% of shared variance), was expected and was consistent with interrelatedness of age with the risk factors. The positive relationship between age and FHP is consistent with the work of Raine and Twomey (1997) who reported that the forward head posture position increased with age.

In summary, the present study demonstrated a significant inverse relationship between the FPH and the known fall risk factors of balance deficits (BBS), low fall self-efficacy (ABC), decreased activity level (PASE), and additionally, a positive correlation with age. The negative relationship between FHP and BBS provided statistical support for the hypothetical construct of balance instability related to altered head posture. The FHP was not significantly related to fall history.

***Research Question 3: After controlling for the known risk factors, does the degree of forward head posture predict fall history in healthy community-dwelling women age 60 and older?***

*Statistical Results of Data Analyses.*

After controlling for the known risk factors, the forward head posture was not a significant predictor of falling in this population. A hierarchical regression with block entering of ABC, PASE, and BBS, followed by entering of FHP was performed for the purpose of evaluating the predictive potential of the forward head posture when the known risk factors were controlled. The block entering of ABC, PASE, and BBS served to control for these variables when evaluating the predictive potential of the FHP. The model demonstrated that the block (ABC, PASE, BBS) variables did account for 13.2% of the variability in number of falls ($p \leq 0.01$). The degree of $R^2$ change with the addition of FHP was less than 1% and was not statistically significant. These results are depicted in Table 5.

*Table 5.*

*Hierarchical Regression Model Summary*
*Block enter of ABC, BBS, PASE,*
*Followed by Enter of FHP*

| Model | R | $R^2$ | $R^2$ Change | F Change | Sig. F Change |
|---|---|---|---|---|---|
| 1 | .364[a] | .132 | .132 | 5.487 | .002 |
| 2 | .364[b] | .132 | .000 | .026 | .873 |

a. Predictors: (constant), ABC, PASE, BBS (known risk factors)
b. Predictors: (constant), ABC, PASE, BBS, FHP (addition of forward head)

When assessing the known risk factors individually, tests of the partial regression coefficients reached statistical significance for only two: ABC (t = -3.091; p = .003) and

PASE ($t = 2.534$; $p = .013$). Of these two, ABC was a stronger predictor ($\beta = -.343$) than was the PASE ($\beta = .256$), for this sample of women.

*Discussion.*

Since FHP was not correlated to the number of falls, it was not surprising that with hierarchal regression analysis, the FHP did not significantly contribute to the variance of the number of falls. In the present study's subject population, only the ABC and PASE were significantly correlated to fall history, and thus were the only variables to statistically contribute to the variance of the number of falls. Unfortunately the total variance accounted for by these variables was only 13.2%. Thus, the largest portion of variability in fall history in the present study's population was unaccounted for by the measured variables. This finding supports the hypothesis that an individual's fall history is multifaceted, and a large number of variables may be needed to fully account for the totality of fall history (O'Brien et al., 1998; Stalenhoef et al., 2002). Additionally, the high BBS scores and the robust PASE scores in the present study's population may also have contributed to the complexity of identifying factors that contribute to falling in this group.

### *Chapter Summary*

The findings of the present study support the interrelatedness of the known risk factors measured within the study. Significant correlations to fall history were demonstrated inversely with fall self-efficacy and positively with physical activity level. The lack of significance between fall history and balance stability may have been due to the high balance scores in this population, and thus a ceiling effect occurred. Associated with these high balance scores were vigorous activity levels, much higher than typically reported in this age group. It was possible that the subjects' high activity levels may have contributed to their high balance scores.

The forward head posture was significantly inversely correlated to the balance score, thus statistically supporting the underlying premise of the present study, that the forward head posture places the head near or outside the limits of the balance stability envelope and will adversely influence an individual's balance capability. This inverse correlation was also found between the forward head posture and fall self-efficacy and activity level. No relationship was demonstrated between forward head posture and fall history.

# CHAPTER 5

## SUMMARY, CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER STUDY

### *Introduction*

The purpose of this research was to investigate the influence of the forward head posture on balance, fall self-efficacy, and physical activity level in healthy community-dwelling women age 60 and older, and to evaluate the relationship of these variables to fall history. This chapter will provide a summary of the research findings related to the research questions, the conclusions drawn by the investigator, and recommendations for future research.

### *Summary*

The following research questions were tested:

1. Are the known risk factors for falling (balance deficits, low fall self-efficacy, and decreased physical activity level) correlated, and are they correlated to fall history in healthy community-dwelling women age 60 and older?

In the present study population, significant correlations to fall history were demonstrated inversely with fall self-efficacy and positively with physical activity level. The known risk factors were significantly positively correlated with each other, as consistent in the literature.

2. Is there an inverse relationship between the degree of forward head posture and each of the known risk factors (balance deficits, low fall self-efficacy, decreased activity level, and a fall history) in healthy community-dwelling women age 60 and older?

In the present study population, a significant inverse relationship was found between the degree of forward head posture and the known risk factors of balance deficits, low fall self-efficacy, and decreased activity level. No relationship was demonstrated between the forward head posture and fall history. Additionally, a significant positive relationship was noted between the forward head posture and age.

3. After controlling for the known risk factors, does the degree of forward head posture predict fall history in these healthy community-dwelling women age 60 and older?

After controlling for the known risk factors, the degree of forward head posture was not predictive for fall history in the present study. Only low fall self-efficacy and physical activity level were found to have predictive value.

### *Conclusions*

The basic premise of the influence of the forward head posture on balance stability, fall self-efficacy, and activity level was statistically validated. This finding held significant importance for those incorporating balance exercises in fall prevention programs. While rehabilitation professionals have intuitively believed in the importance of the posture-balance relationship, no research evidence could be found during the literature search for this study to specifically support a forward head posture-balance control interaction. While the present study cannot point to specific causality, i.e., that the forward head posture causes poor balance stability, such a strong relationship should not be ignored. Within the group of highly active older women who volunteered for this study, the posture-balance relationship was strong. Thus, the first conclusion for this study was that this finding provided a first tier of evidence to support the incorporation of postural exercises for head position in balance-training programs.

The high physical activity levels of the women volunteering for the present study may have played an unexpected role in balance, fall self-efficacy, and fall history**.** While high activity level may have resulted in occasional falls due to the activity, the benefit for improved balance and improved fall self-efficacy may have been worth the risk. The subjects' high activity levels may have ultimately yielded a protective effect in fall prevention by providing the individual with ongoing balance stability, and subsequently better fall self-efficacy. This finding supports the second conclusion of this study, that high activity level may improve balance and fall self-efficacy, and physical activity should be encouraged in the elderly.

The interrelatedness of the fall risk factors in the present study was consistent with the growing body of literature on fall risk factors and fall prevention. The unexpected lack of significance between balance stability and fall history supported the need for ongoing research in a variety of populations, and with a variety of assessment instruments. The balance instrument utilized in the present study, the "gold standard" Berg Balance Scale, did not discriminate between fallers and non-fallers in highly active elderly women. These findings support the third conclusion of this study, that those health professionals who regularly encourage exercise and physical activity for their elderly clients must be prepared to continually assess the changing climate of activity levels in the elderly.

The potential for a multiplicity of factors for falling has been demonstrated by the present study. While this finding was well documented in the literature, the unique physical activity characteristics of the women who volunteered for this study underscored the variability of these older women. This finding supports the fourth conclusion of this study, that health professionals who develop and conduct fall-prevention programs should provide ongoing assessment of the needs and characteristics of the populations they serve.

***Recommendations for further study***

Based upon the data collection process and the results of this research, the following recommendations for further studies are made:

1. Expand the current study by collecting longitudinal data. At six month intervals for an additional 2 years, measure the forward head posture and re-assess individual fall history. Additionally, at one year intervals, re-assess balance stability, fall-self efficacy and physical activity level.

2. Develop normative values for the Berg Balance Scale (BBS) in healthy and highly active elderly women.

3. Develop normative values for the Activity-specific Balance Confidence Scale (ABC) in healthy and highly active elderly women.

4. Develop normative values for the Physical Activities Scale for the Elderly (PASE) in healthy and highly active elderly women.

5. Assess the contribution the components of the Berg Balance Scale (BBS) to total balance in healthy and highly active elderly women, essentially evaluating the ceiling effect. Utilize a larger sample size for this investigation.

6. Evaluate the validity of current activity scales for the elderly in healthy and highly active populations of elderly with larger sample sizes.

7. Develop normative values for the forward head posture in healthy and highly physically active women 60 years and older.

8. Repeat the present study with African American women, Native American women, and Hispanic American women as the primary subject populations.

9. Repeat the present study with the frail elderly and those elderly transitioning into frailty to evaluate the role of the forward head posture in these populations.

10. Assess the contribution of the individual components of the ABC scale to fall confidence in healthy and highly physically active elderly populations.

11. Conduct a qualitative study to assess the relationship of falling to physical activity level and fall self-efficacy.

12. Assess the fall history predictive value of common balance stability instruments in healthy and highly active women 60 years and older.

13. In future studies of this nature, incorporate specific fall description parameters, specific detail about current lifestyle and dwelling location, e.g., urban vs. rural, and larger sample sizes.

14. Conduct longitudinal studies monitoring the actual fall history and fall parameters in healthy and highly active elderly populations.

15. Conduct intervention studies incorporating specific postural exercises using balance stability, fall self-efficacy and activity level as change measures in elderly populations.

16. Replicate the present study with data collection occurring in the summer months rather than winter months because activity level may differ in intensity as well as range of activity choices.

17. Replicate the present study with older men as the primary subject population, incorporating specific fall description parameters, specific detail about current lifestyle and dwelling location, e.g., urban vs. rural, and a larger sample size.

18. Replicate the present study with cross-sectional sampling of younger age cohorts to investigate potential age-specific relationships between the forward head posture, balance stability, and activity level.

## REFERENCES


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 American Geriatrics Society*, 49, 664-672.

Arfken, C. L., Lach, H. W., Birge, S. J., & Miller, J. P. (1994). The prevalence and correlates of fear of falling in elderly persons living in the community. *American Journal of Public Health*, 84, 565-570.

Balzini, L., Vannucchi, L., Benveuti, F., Benucci, M., Monni, M., Cappozzo, A., et al. (2003). Clinical characteristics of flexed posture in elderly women. *Journal of the American Geriatrics Society, 51*, 1419-1426.

Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist*, 37, 122-147.

Bath, P. A., Pendleton, N., Morgan, K., Clague, J. E., Horan, M. A., & Lucas, S. B. (2000). New approach to risk determination: Development of risk profile for new falls among community-dwelling older people by use of a genetic algorithm neural network (GANN). *The Journals of Gerontology, 55A*, M17-M21.

Bennie, S., Bruner, K., Dizon, A., Fritz, H., Goodman, B., & Peterson, S. (2003). Measurements of balance: Comparison of the timed “Up and Go” test and Functional Reach Test with the Berg Balance Scale. *Journal of Physical Therapy Science*, 15, 93-97.

Berg, K. O., Maki, B. E., Williams, J. I., Holliday, P. J., & Wood-Dauphinee, S. L. (1992). Clinical and laboratory measures of postural balance in an elderly population. *Archives of Physical Medicine and Rehabilitation*, 73, 1073-1080.

Berg, K. O., Wood-Dauphinee, S. L., Williams, J. I., & Maki, B. (1992). Measuring balance in the elderly: Validation of an instrument. *Canadian Journal of Publid Health, 83*(Supplement 2), S7-S11.

Biel, A., (2001). *Trail Guide to the Body, 2nd Ed*. Boulder, CO: Books of Discovery.

Bogle-Thorbahn, L. D., & Newton, R. A. (1996). Use of the Berg Balance Test to predict falls in elderly persons. *Physical Therapy, 76*, 576-585.

Boulgarides, L. K., McGinty, S. M., Willett, J. A., & Barnes, C. W. (2003). Use of clinical and impairment-based tests to predict falls in community-dwelling older adults. *Physical Therapy*, 83, 328-339.

Brauer, S. G., Burns, Y. R., & Galley, P. (2000). A prospective study of laboratory and clinical measures of postural stability to predict community-dwelling fallers. *The Journals of Gerontology*, 55A, M469-M476.

Braun, B. L. (1991). Postural differences between asymptomatic men and women and craniofacial pain patients. *Archives of Physical Medicine and Rehabilitation*, 72, 653-656.

Braun, B. L., & Amundsen, L. R. (1989). Quantitative assessment of head and shoulder posture. *Archives of Physical Medicine and Rehabilitation,* 70, 322-329.

Brotherton, S. S., Williams, H. G., Gossard, J. L., Hussey, J. R., McClenaghan, B. A., & Eleazer, P. (2005). Are measures employed in the assessment of balance useful for detecting differences among groups that vary by age and disease state? *Journal of Geriatric Physical Therapy*, 28, 14-19.

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 Geriatrics Society, 50*, 84-89.

Buckley, J. G., Anand, V., Scally, A., & Elliott, D. B. (2005). Does head extension and flexion increase postural stability in elderly subjects when visual information is kept constant? *Gait and Posture, 21*, 59-64.

Bulbulian, R., & Hargan, M. L. (2000). The effect of activity history and current activity on static and dynamic postural balance in older adults. *Physiology & Behavior*, 70, 319-325.

Canon. (2004). *Canon PowerShot A95 Digital Camera, Camera User Guide*. Lake Success, NY: Canon U.S.A. Inc.

Centers for Disease Control. (2003). *Public health and aging: nonfatal injuries among older adults treated in hospital emergency department, United States, 2001*. Retrieved October 25, 2003, from http://www.cdc.gov/mmrw/preview/mmwrhtml/mm5242a4.htm

Choy, N. L., Brauer, S., & Nitz, J. (2003). Changes in postural stability in women aged 20 to 80 years. *Journal of Gerontology, 58A*, 525-530.

Cook, C. (2002). The relationship between posture and balance disturbances in women with osteoporosis. *Physical & Occupational Therapy in Geriatrics, 20*(3/4), 37-49.

Cumming, R. G., Salkeld, G., Thomas, M., & Szonyi, G. (2000). Prospective study of the impact of fear of falling on activities of daily living, SF-36 scores, and nursing home admission. *The Journals of Gerontology, 55A*(5), M299-M305.

Delbaere, K., Crombez, G., Vanderstraeten, G., Willems, T., & Cambier, D. (2004). Fear-related avoidance of activities, falls and physical frailty. A prospective community-based cohort study. *Age and Ageing*, 33, 368-373.

Delbaere, K., Van den Noortgate, N., Bourgois, J., Vanderstraeten, G., Willems, T., & Cambier, D. (2006). The Physical Performance Test as a predictor of frequent fallers: A prospective community-based cohort study. *Clinical Rehabilitation*, 20, 83-90.

de Rekeniere, N., Visser, M., Peila, R., Nevitt, M. C., Cauley, J. A., Tylavsky, F. A., et al. (2003). Is a fall just a fall: correlates of falling in healthy older persons. The health, aging and body composition study. *Journal of the American Geriatrics Society, 51*, 841-846.

DiFabio, R. P., & Emasithi, A. (1997). Aging and the mechanisms underlying head and postural control during voluntary motion. *Physical Therapy, 77*, 458-475.

DiPietro, L. (2001). Physical activity in aging: Changes in patterns and their relationship to health and function. *The Journals of Gerontology, 56A*(Special Issue II), 13-22.

Dutton, M. (2004). *Orthopaedic Examination, Evaluation, & Intervention*. New York, NY: McGraw-Hill.

Ensrud, K. E., Blackwell, T. L., Mangione, C. M., Bowman, P. J., Whooley, M. A., Bauer, D. C., et al. (2002). Central nervous system-active medications and risk for falls in older women. *Journal of the American Geriatrics Society, 50*, 1629-1637.

Evcik, D., & Aksoy, O. (2000). Correlation of temporomandibular joint pathologies, neck pain and postural differences. *Journal of Physical Therapy Science*, 12, 97-100.

Faulkner, K. A., Cauley, J. A., Zmuda, J. M., Griffin, J. M., & Nevitt, M. C. (2003). Is social integration associated with the risk of falling in older community-dwelling women? *The Journals of Gerontology, 58A*, 954-959.

Federal Interagency Forum on Aging-Related Statistics. (2004). *Older Americans 2004: Key indicators of well-being*. Washington, DC: U.S. Government Printing Office.

Friedman, S. M., Munoz, B., West, S. K., Rubin, G. S., & Fried, L. P. (2002). Falls and fear of falling: Which comes first? A longitudinal prediction model suggests strategies for primary and secondary prevention. *Journal of the American Geriatrics Society, 50*, 1329-1335.

Garrett, T. R., Youdas, J. W., & Madson, T. J. (1993). Reliability of measuring forward head posture in a clinical setting. *Journal of Orthopedic and Sports Physical Therapy,* 17, 155-160.

Girardi, M., Konrak, H. R., Amin, M., & Hughes, L. F. (2001). Predicting fall risks in an elderly population: computer dynamic posturography versus electronystagmography. *The Laryngoscope, 111*, 1528-1532.

Graafmans, W. C., Ooms, M. E., Hofstee, H. M., 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, 1129-1136.

Greenfield, B., Catlin, P. A., Coats, P. W., Green, E., McDonald, J. J., & North, C. (1995). Posture in patients with shoulder overuse injuries and healthy individuals. *Journal of Orthopedic and Sports Physical Therapy*, 21, 287-295.

Gregg, E. W., Cauley, J., A., Stone, K., Thompson, T. J., Bauer, D. C., Cummings, S. R., et al. (2003). Relationship of changes in physical activity and mortality among older women. *Journal of the American Medical Association, 289*(18), 2379-2386.

Griegel-Morris, P., Larson, K., Mueller-Klaus, K., & Oatis, C. A. (1992). Incidence of common postural abnormalities in the cervical, shoulder, and thoracic regions and their association with pain in two age groups of healthy subjects. *Physical Therapy,* 72, 425-431.

Hanten, W. P., Lucio, R. M., Russell, J. L., & Brunt, D. (1991). Assessment of total head excursion and resting head posture. *Archives of Physical Medicine and Rehabilitation, 72*, 877-880.

Hanten, W. P., Olson, S. L., Russell, J. L., Lucio, M. S., & Campbell, M. S. (2000). Total head excursion and resting head posture: normal and patient comparisons. *Archives of Physical Medicine and Rehabilitation, 81*, 62-66.

Harada, N. D., Chiu, V., King, A. C., & Stewart, A. L. (2001). An evaluation of three self-report physical activity instruments for older adults. *Medicine and Science in Sports and Exercise, 33*, 962-970.

Harrison, A. L., Barry-Greb, T., & Wojtowicz, G. (1996). Clinical measurement of head and shoulder posture variables. *Journal of Orthopedic and Sports Physical Therapy*, 23, 353-361.

Hatch, J., Gill-Body, K. M., & Portney, L. G. (2003). Determinants of balance confidence in community-dwelling elderly people. *Physical Therapy, 83*, 1072-1079.

Hill, K. D., Schwarz, J. A., Kalogeropoulos, A. J., & Gibson, S. J. (1996). Fear of falling revisited. *Archives of Physical Medicine and Rehabilitation, 77*, 1025-1029.

Hill-Westmoreland, E. E., Soeken, K., & Spellbring, A. M. (2002). A meta-analysis of fall prevention programs for the elderly. *Nursing Research, 51*, 1-8.

Hirose, D., Ishida, K., Nagano, Y., Takahashi, T., & Yamamoto, H. (2004). Posture of the trunk in the sagittal plane is associated with gait in community-dwelling elderly population. *Clinical Biomechanics, 19*, 57-63.

Isles, R. C., Low Choy, N. L., Steer, M., & Nitz, J. C. (2004). Normal values of balance tests in women aged 20-80. *Journal of the American Geriatrics Society*, 52, 1367-1372.

Karinkanta, S., Heinonen, A., Sievanen, H., Uusi-Rasi, K., & Kannus, P. (2005). Factors predicting dynamic balance and quality of life in home-dwelling elderly women. *Gerontology*, 51, 116-121.

Kendall, F. P., McCreary, E. K., Provance, P. G., Rodgers, M. M., & Romani, W. A. (2005). *Muscles Testing and Function with Posture and Pain, 5th Ed*. Baltimore, MD: Lippincott Williams & Wilkins.

Keppel, G. (1991). *Design and Analysis, A Researcher's Handbook, 3rd Ed*. Upper Saddle River, NJ: Prentice Hall.

Kogler, A., Lindfors, J. , Odkvist, L. M., & Ledin, T. (2000). Postural stability using different neck positions in normal subjects and patients with neck trauma. *Acta Otolaryngology, 120*, 151-155.

Kornetti, D. L., Fritz, S. L., Chiu, Y., Light, K. E., & Velozo, C. A. (2004). Rating scale analysis of the Berg Balance Scale. *Archives of Physical Medicine and Rehabilitation, 85*, 1128-1135.

Kressig, R. W., Wolf, S. L., Sattin, R. W., O'Grady, M., Greenspan, A., Curns, A., & Kutner, M. (2001). Associations of demographics, 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.

Kruskall, L. J., Campbell, W. W., & Evans, W. J. (2004). The Yale Physical Activity Survey for older adults: Predictions in the energy expenditure due to physical activity. *Journal of the American Dietetic Association, 104*, 1251-1257.

Lach, H. W. (2002-3). Fear of falling: An emerging public health problem. *Generations, Winter*, 33-37.

Lach, H. W. (2005). Incidence and risk factors for developing fear of falling in older adults. *Public Health Nursing, 22*(1), 45-52.

Lachman, M. E., Howland, J., Tennstedt, S., Jette, A., Assmann, & S., Peterson, E. W. (1998). Fear of falling and activity restriction: The survey of activities and fear of falling in the elderly (SAFE). *The Journals of Gerontology, 53B*(1), P43-P50.

Lajoie, Y., Girard, A., & Guay, M. (2002). Comparison of the reaction time, the Berg Scale and the ABC in non-fallers and fallers. *Archives of Gerontology and Geriatrics, 35*, 215-225.

Lajoie, Y., & Gallager, S. P. (2004). Predicting falls within the elderly community: Comparison of postural sway, reaction time, the Berg Balance Scale and the Activities-specific Balance Confidence (ABC) scale for comparing fallers and non-fallers. *Archives of Gerontology and Geriatrics, 38*, 11-26.

Lawlor, D. A., Patel, R., & Ebrahim, S. (2003). Association between falls in elderly women and chronic diseases and drug use: Cross sectional study. *British Medical Journal, 327*, 712-717.

Levangie, P. A., & Norkin, C. C. (2005). *Joint Structure & Function, A Comprehensive Analysis* (4th ed.). Philadelphia, PA: F. A. Davis Company.

Li, F., McAuley, E., Fisher, K. J., Harmer, P., Chaumeton, N., & Wilson, N. (2002). Self-efficacy as a mediator between fear of falling and functional ability in the elderly. *Journal of Aging and Health, 14*(4), 452-466.

Li, F., Fisher, K. J., Harmer, P., & McAuley, E. (2005). Falls self-efficacy as a mediator of fear of falling in an exercise intervention for older adults. *The Journals of Gerontology, 60B*(1), P34-P40.

Lusardi, M. M., Pellecchia, G. L., & Schulman, M. (2003). Functional performance in community living older adults. *Journal of Geriatric Physical Therapy*, 26, 14-22.

Martin, F. C., Hart, D., Spector, T., Doyle, D. V., & Harari, D. (2005). Fear of falling limiting activity in young-old women is associated with reduced functional mobility rather than psychological factors. *Age and Ageing*, 34, 281-287.

McAuley, E., Mihalko, S. L., & Rosengren, K. (1997). Self-efficacy and balance correlates of fear of falling in the elderly. *Journal of Aging and Physical Activity, 5*, 329-340.

McKenzie, J. F., Neiger, B. L., & Smeltzer, J. L. (2005). *Planning, implementing & evaluating health promotion programs* (4th ed.). New York, NY: Benjamin Cummings.

Melzer, I., Benjuya, N., & Kaplanski, J. (2003). Effects of regular walking on postural stability in the elderly. *Gerontology, 49*, 240-245.

Merck Institute of Aging & Health and The Gerontological Society of America. (2002). *The state of aging and health in America*. Retrieved March 30, 2004, from http://www.agingsociety.org/agingsociety/publications/state/index.html

Murphy, S. L., Dubin, J. A., & Gill, T. M. (2003). The development of fear of falling among community-living older women: Predisposing factors and subsequent fall events. *The Journals of Gerontology, 58A*, 943-947.

Murphy, S. L., Williams, C. S., & Gill, T. M. (2002). Characteristics associated with fear of falling and activity restriction in community-living older persons. *Journal of the American Geriatrics Society, 50*, 516-520.

Myers, A. M., Fletcher, P. C., Myers, A. H., & Sherk, W. (1998). Discriminative and evaluative properties of the Activities-specific Balance Confidence (ABC) Scale. *The Journals of Gerontology, 53A*, M287-M294.

Neumann, D. A. (2002). *Kinesiology of the Musculoskeletal System, Foundations for Physical Rehabilitation*. St. Louis, MO: Mosby, Inc.

New England Research Institutes, Inc. (1991). *PASE Physical Activity Scale for the Elderly, Administration and scoring instruction manual*. Watertown, MA.

Norton, R., Campbell, A. J., Lee-Joe, T., Robinson, E., & Butler, M. (1997). Circumstances of falls resulting in hip fractures among older people. *Journal of the American Geriatrics Society*, 45, 1108-1112.

O'Brien, K., Culham, E., & Pickles, B. (1997). Balance and skeletal alignment in a group of elderly female fallers and nonfallers. *The Journals of Gerontology, 52A*, B221-B226.

O'Brien, K., Pickles, B., & Culham, E. (1998). Clinical measures of balance in community-dwelling elderly female fallers and non-fallers. *Physiotherapy Canada*, 50, 212-221.

Page, R. M., Cole, G. E., & Timmereck, T. C. (1995). *Basic Epidemlogical Methods and Biostatistics*. Boston, MA: Jones and Bartlett Publishers.

Perrin, P. P., Gauchard, G. C., Perrot, C., & Jeandel, C. (1999). Effects of physical and sporting activities on balance control in elderly people. *British Journal of Sports Medicine, 33*, 121-126.

Powell, L. E., & Myers, A. M. (1995). The Activities-specific Balance Confidence (ABC) Scale. *The Journals of Gerontology, 50A*(1), M28-M34.

Raine, S., & Twomey, L.T. (1994). Posture of the head, shoulders and thoracic spine in comfortable erect standing. *Australian Journal of Physiotherapy*, 40, 25-32.

Raine, S., & Twomey, L.T. (1997). Head and shoulder posture variations in 160 asymptomatic women and men. *Archives of Physical Medicine and Rehabilitation, 78*, 1215-1223.

Richardson, D. R., Hicks, M. J., & Walker, R. B. (2002). Falls in rural elders: An empirical study of risk factors. *Journal of the American Board of Family Practitioners*, 15, 178-182.

Rikli, R. E. (2000). Reliability, validity, and methodological issues in assessing physical activity in older adults. *Research Quarterly for Exercise and Sport, 71*, 89-96.

Rose, D. J., & Clark, S. (2000). Can the control of bodily orientation be significantly improved in a group of older adults with a history of falls? *Journal of the American Geriatrics Society, 48*, 275-282.

Rubenstein, L. Z., & Josephson, K. R. (2002-3). Risk factors for falls: A central role in prevention. *Generations, Winter*, 15-21.

Schenkman, M., Morey, M., & Kuchibhatla, M. (2000). Spinal flexibility and balance control among community-dwelling adults with and without Parkinson's disease. *The Journals of Gerontology, 55A*, M441-M445.

Schuit, A. J., Schouten, E. G., Westerterp, K. P., & Saris, W. H. M. (1997). Validity of the Physical Activity Scale for the Elderly (PASE): According to energy expenditure assessed by the doubly labeled water method. *Journal of Clinical Epidemiology*, 50, 541-546.

Shumway-Cook, A., Baldwin, M., Polissar, N. L., & Gruber, W. (1997). Predicting the probability for falls in community-dwelling older adults. *Physical Therapy, 77*, 812-819.

Shumway-Cook, A., & Wollacott, M. H. (2001). *Motor Control Theory and Practial Applications* (2nd ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Southard, V., Dave, M., Geiger-Davis, M., Blanco, J., & Hofferber, A. (2005). The Multiple Tasks Test as a predictor of falls in older adults. *Gait & Posture*, 22, 351-355.

Stalenhoef, P. A., Crebolder, H. F., Knotterus, J. A., & Van der Horst, F. G. (1997). Incidence, risk factors and consequences of falls among elderly subjects living in the community. *European Journal of Public Health*, 7, 328-334.

Stalenhoef, P. A., Diederiks, J. P. M., Knottnerus, J. A., Kester, A. D. M., & Crebolder, H. F. (2002). A risk model for the prediction of recurrent falls in community-dwelling elderly. *Journal of Clinical Epidemiology, 55*, 1088-1094.

Steffen, T. M., Hacker, T. A., & Mollinger, L. (2002). Age- and gender-related test performance in community-dwelling elderly people: Six-Minute Walk Test, Berg Balance Scale, Timed Up & Go Test, and gait speeds. *Physical Therapy*, 82, 128-137.

Steffen, T. M., & Mollinger, L. A. (2005). Age- and gender-related test performance in community-dwelling adults. *Journal of Neurological Physical Therapy*, 29, 181-188.

Stel, V. S., Smit, J. H., Pluijm, S. M., & Lips, P. (2004). Consequences of falling in older men and women and risk factors for health service use and functional decline. *Age and Ageing, 33*, 58-65.

Sterling, D. A., O'Connor, J. A., & Bonadies, J. (2001). Geriatric falls: Injury severity is high and disproportionate to mechanism. *Journal of Trauma*, 50, 116-119.

Thomas, C. L. (Ed.) (1981). *Taber's Cyclopedic Medical Dictionary, 14th Ed.* Philadelphia: F. A. Davis Company.

Tinetti, M. E., & Richman, D., & Powell, L. (1990). Falls efficacy as a measure of fear of falling. *Journal of Gerontology*, 45, P239-P243.

Tinetti, M. E., Mendes de Leon, M., Doucette, J. T., & Baker, D. I. (1994). Fear of falling and fall-related efficacy in relationship to functioning among community-living elders. *Journal of Gerontology, 49*, M140-M147.

Tinetti, M. E., Williams, C.S. (1998). The effect of falls and fall injuries on functioning in community-dwelling older persons. *The Journals of Gerontology, 53A*(2), M112-M119.

Vellas, B. J., Wayne, S. J., Garry, P. J., & Baumgartner, R. N. (1998). A two-year longitudinal study of falls in 482 community-dwelling elderly adults. *The Journals of Gerontology, 53A*, M264-M274.

United States Department of Agriculture. (2003). Measuring rurality: What is rural? Retrieved March 14, 2006 from: http://www.ers.usda.gov/Briefing/Rurality/WhatisRural/

Washburn, R. A., Smith, K. W., Jette, A. M., & Janney, C. A. (1993). The Physical Activity Scale for the Elderly (PASE): Development and evaluation. *Journal of Clinical Epidemiology, 46*, 153-162.

Washburn, R. A., McAuley, E., Katula, J., Mihalko, S. L., & Boileau, R. A. (1999). The Physical Activity Scale for the Elderly (PASE): Evidence for validity. *Journal of Clinical Epidemiology, 52*, 643-651.

Washburn, R. A. (2000). Assessment of physical activity in older adults. *Research Quarterly for Exercise and Sport, 71*(2), 79-88.

Wollacott, M. H. (1993). Age-related changes in posture and movement. *Journal of Gerontology, 48*, 56-60.

World Health Organization. (2002). *Active ageing: A Policy framework*. Retrieved September 9, 2005, from http://whqlibdoc.who.int/hq/2002/WHO_NMH_NPH_02.8.pdf

# APPENDICES

# APPENDIX A

# INSTITUTIONAL REVIEW BOARD APPROVAL

## Oklahoma State University Institutional Review Board

| | |
|---|---|
| Date: | October 12, 2005 |
| IRB Application No: | ED-06-34 |
| Proposal Title: | The Influence of the Forward Head Posture on Balance, Fall Self-efficacy, and Physical Activity Level in Community-Dwelling Women age 60 and Older; and the Relationship of These Variables to Self-Reported Fall History |
| Reviewed and Processed as: | Expedited |

**Status Recommended by Reviewer(s): Approved Protocol Expires: 10/12/2006**

Principal Investigator(s):

| | |
|---|---|
| Theresa M. Nemmers<br>9519 E. Meadowbrook Ln.<br>Stillwater, OK 74075 | Betty Edgley<br>4615 N. Britton Drive<br>Stillwater, OK 74075 |

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 415 Whitehurst (phone: 405-744-5700,
beth.mcternan@okstate.edu).

Sincerely,

Sue C. Jacobs

Sue C. Jacobs, Chair
Institutional Review Board

## APPENDIX B

## SCRIPT FOR SUBJECT RECRUITMENT PRESENTATIONS

## SCRIPT FOR SUBJECT RECRUITMENT PRESENTATIONS

Hello. I am Teri Nemmers, a doctoral candidate at Oklahoma State University. My field of study is Health and Human Performance with an emphasis in Health Promotion. I am here today to give you an overview of my dissertation study and invite you to participate in this research related to balance in older women. As you well know, falling is an important issue as we age. Breaking a bone during a fall can be life altering. Avoiding a fall may not be foremost on your mind today but certainly is somewhere in your thoughts. Participating in an effective fall prevention program could literally be lifesaving. The key word is "effective." Unfortunately research has not yet answered the question as to what is the most effective program to prevent falling. This is because the risk factors for falling are very complex.  More research is needed to identify as many components of the risk factors for falling as possible.

I am a licensed Physical Therapist, and have been working in the physical therapy field for 33 years. During my career I have worked with countless numbers of older women who had fallen and subsequently experienced significant consequences of that fall. Those consequences may have included a fracture, the need to change their living arrangements, or a change in their level of independence. Without exception, each woman indicated that she wished she had known how to help prevent the fall before it happened.

Fall prevention programs are being developed at a rapid pace in locations nationwide. Most programs are based on our current knowledge of specific fall risk factors. Some elements in your environment that might cause a fall would be loose rugs or poor lighting in the home. Other risk factors are related to the individual person such as the number of medications one is taking, or muscle weakness. One of the key personal risk factors is diminished balance stability. We also know that individuals who believe that their balance is “not as good as it used to be” tend to lose confidence in their ability to perform daily tasks, consciously or unconsciously, and also they also tend to decrease their activity level. Planning effective programs require that the planners thoroughly understand the reasons underlying each risk factor.

Researchers have completed many studies which analyze balance in older adults. My interest is the specific contribution of the head position to balance. One of the postural changes observed with aging in some individuals is the gradual change of the head position from fully upright to a more forward position. Is the forward head position part of the normal aging process? If an individual exhibits a forward head position, does this position influence balance stability, balance confidence, or activity level? Is the forward head posture related to falling? The purpose of my research study is to evaluate these questions as they apply to healthy women 60 years of age or older. I am seeking women volunteers 60 years of age or older who are living independently in the community, who currently do not experience balance difficulties, and who are in good health. Living independently in the community means you do not need assistance for routine daily activities such as dressing, preparing meals, or shopping. If you have experienced balance difficulties, you typically hold on to objects in the home for steadiness. “In good health” means that you have no major medical problems that currently require frequent physician visits.

I will be asking women volunteers to participate in three tests. The first is a 15-20 minute balance test. This test involves 14 activities that you would be doing everyday. These include activities such as getting up from a chair, sitting down on a chair, moving from chair to chair, standing still, standing with your eyes closed, stepping up on a step, turning around, sitting still, standing with your feet together, standing with one foot in front of the other, and standing on one leg. Some activities are timed, but the entire test is not timed as a whole. The longest timed activity, standing still, is 2 minutes. If you begin to feel tired, you may rest between activities.

There is no physical risk anticipated for you with this research because the physical activities you will do during the balance test are those activities you already do every day. Additionally, as a licensed Physical Therapist I have completed this test frequently in my routine professional practice, and I will be standing at your side during these activities should you feel the need for assistance or reassurance.

Prior to the start of the balance test, I will place a small suction marker on the skin at the back of your neck at the level of your seventh cervical vertebra. Your right ear must also be clearly visible during the balance test and I will put a small adhesive marker on the cartilage that protrudes from your ear. This is needed for the video analysis. During the balance test there will be an assistant who will video tape your performance on one of the activities. The video will provide the information necessary to assess your head position. Because it is natural for an individual to "stand tall" when someone is looking at their posture, you will not know which portion is being videotaped. Measuring your normal posture, not a temporary upright posture, is critical to this research. The video tape will be analyzed at a later date using special motion analysis software.

After the balance test I will ask you to complete two short surveys. One survey will measure your confidence in doing some specific daily activities such as: sweeping the floor, getting into or out of a car, or walking in a crowed mall. The second survey will ask you about your normal activity level. Each of these surveys will take about 5-10 minutes to complete.

At the completion of your data collection I will give you feedback on your individual scores. This research is not designed nor intended to serve as a medical screening session. However, if you should score low on the balance test or the balance confidence test, I will prepare a letter of explanation that you could present to your personal physician and discuss the findings.

After the research study is complete, I will return to your organization/group and present the findings if desired. This research is important to me personally. I have shifted my professional focus from taking care of those who have fallen and sustained a fracture to assisting in developing programs for the prevention of falls. To be effective in developing fall prevention programs, we must understand all the components that contribute to the fall. I believe this research will add to that understanding.

That completes my presentation, and I would now like answer any questions you might wish to ask about my research.

# APPENDIX C

## POST-PRESENTATION
## SUBJECT ELIGIBILITY SCREENING INTERVIEW

Appendix C

**POST-PRESENTATION**
**SUBJECT ELIGIBILITY SCREENING INTERVIEW**

Interviewer: **Thank you for your willingness to participate in this research**. As you may recall from my presentation, volunteers for this study need to be women 60 years of age or older who are living independently in the community. Additionally, I indicated that any women currently experiencing problems with their balance, or currently under their doctor's care for a major medical problem could not participate. I would like to clarify these criteria with you with the next few questions.

[The following questions are exclusionary in nature, i.e., if a subject responds to any one of the four questions with an answer which automatically excludes them from the study, the interview is stopped and I thank the subject for her willingness to participate.]

**1. What is your age? __________**

**2. Are you currently living independently in the community? Yes / No**
*Living independently could be: living alone in own home/apartment, living with spouse in own home/apartment, living in retirement center- independent living component, or living with family?)
*If not living independently in the community (e.g., subject is residing in assisted care facility), the subject is automatically excluded from study

**3. Are you independent with self-care, shopping, meals, light housework? Yes / No**
*If "YES", continue; if "NO", volunteer is excluded from study

**4. Do you currently have problems with your balance? Yes / No**
*If "NO", continue; if "YES", volunteer is excluded from study

**5. Are you currently under a doctor's care for a major medical problem? Yes / No**
*If "NO", continue; if "YES", volunteer is excluded from study

For anyone who is excluded: Interviewer will conclude the interview with, "thank you so much for your willingness to participate, but I must exclude you in this study because [interviewer will explain to the subject which of the preceding answers resulted in exclusion from the study.]. I certainly appreciate your generosity with your time.

For eligible volunteers: Interviewer will give volunteer an appointment for data collection.

**For those eligible: Name: ______________________________________________**
**Phone Number: ______________________________________**
**Test appointment time and date: ________________________**

# APPENDIX D

# CONSENT FORM FOR FACILITY ADMINISTRATOR

## Consent Form for Facility Administrator

I, ______________________ hereby authorize Theresa M. Nemmers to conduct her dissertation research with volunteer participants at this facility. This research is entitled: The influence of the forward head posture on balance, falls self-efficacy, and physical activity in community-dwelling women, age 60 and older; and the relationship of these variables to self-reported fall history.

I understand that Theresa M. Nemmers will speak to a gathering of women of this community to explain her research and to solicit volunteers. Further, if women from this community volunteer, data collection will take place in an appropriate location on these premises. I understand that the volunteers will participate in a balance test which includes normal and typical activities of daily living, will complete two written questionnaires, and will be photographed during one portion of the balance test. The entire data collection process for each individual will take about 45-60 minutes.

I understand that the facility proper name will not be used, and no volunteer's name will be used or published.

I understand that human subjects approval was given by the Oklahoma State University Institutional Review Board, and all rules and regulations pertaining to such will be followed.

I may contact Theresa M. Nemmers at the following telephone number and/or address: (405) 744-7677; Colvin Recreation Center, Academic Wing # 185, Oklahoma State University, Stillwater, OK 74078.

I have read and fully understand this form. I sign it freely and voluntarily. A copy has been given to me on behalf of the facility.

Printed Name of Facility: ________________________________________________

Signed: ______________________________________________ Date: __________

I certify that I have personally explained all elements of this form to the facility representative before requesting that he/she sign the form.

Signed: ______________________________________________ Date: __________
Theresa M. Nemmers, PT, MPT, MA

# APPENDIX E

## INFORMED CONSENT TO VOLUNTARY PARTICIPATION IN RESEARCH

**INFORMED CONSENT TO VOLUNTARY PARTICIPATION IN RESEARCH**

Title:

The influence of the forward head posture on balance, fall self-efficacy, and activity level in community-dwelling women 60 years of age and older; and the relationship of these variables to self-reported fall history.

Investigators:

This research study will be conducted by Theresa M. Nemmers, PT, MPT, MA; assisted by Merrillyn D. Hartman, Ed.D. as photographer; and supervised by Betty Edgley, Ed.D., dissertation advisor. The data collected by Theresa M. Nemmers during this study will be used to fulfill the requirements necessary for the completion of a doctoral program of study in Health Promotion in the School of Applied Health and Educational Psychology at Oklahoma State University in Stillwater, OK.

Purpose:

The purpose of this research study is to assess the influence of your head position (forward head posture) on your ability to perform tasks of normal daily living, on your confidence that you can perform selected normal daily tasks, and on your typical weekly activity level. This information will also be correlated to your fall history. It is anticipated that the results of this study will enable health care planners to develop comprehensive exercise programs that include a postural correction component for promotion of good balance in the elderly, and thereby serve as a prevention program for falling. Written surveys, a physical balance test and a posture photograph will be used as data sources, and all data will be collected in one session.

Procedures:

Theresa M. Nemmers will first conduct a brief interview with you to review this informed consent document and the testing procedures. During this interview you will have the opportunity to ask any questions and then sign this document. Once you have decided to participate in this investigation, and have signed this document, the testing protocol will begin.

Prior to the start of the balance test, Theresa M. Nemmers will place a small white adhesive marker on the skin at the back of your neck at the level of your seventh cervical vertebra. Your right ear must also be clearly visible during the balance test, and she will place a small adhesive marker on the cartilage of your ear. These markers are needed during the Berg Balance Test for the photographic analysis. During the balance test

Dr. Hartman will photograph a selected activity. The photograph will provide the information necessary to assess your head position. Because it is natural for an individual to "stand tall" when someone is looking at their posture, you will not know which portion is being photographed. Measuring your normal posture, not a temporary upright posture, is critical to this research. The photograph will be analyzed at a later time.

The following items are the specific tests to be used:

> The Berg Balance Test is a test of 14 activities, each of which is a common physical activity of daily living. The 14 activities are: sitting to standing, standing unsupported, sitting unsupported, standing to sitting, transferring from one chair to another, standing with eyes closed, standing with feet together, reaching forward with outstretched arm, retrieving object from floor, turning to look behind, turning 360 degrees, placing alternate foot on stool, standing with one foot in front of the other, and standing on one foot. Some of these activities are timed, however none are longer than two minutes. Theresa M. Nemmers will give you directions for each activity and score your performance. The usual time to complete this test is 15-20 minutes.
>
> The Activity-specific Balance Scale is a 16 question survey. This survey will ask you to grade your level of confidence in performing selected tasks. These are typical tasks that you might perform throughout a normal day. You will be asked to sit at a table to complete this survey. Theresa M. Nemmers will give you directions for the survey and will be available if you should have any questions while you complete the survey. Usual time to complete this survey is 5-10 minutes.
>
> The Physical Activity Scale for the Elderly is a 10 item survey asking you to recall your leisure, household, and occupational or volunteer activities over the past week. You will be asked to sit at a table to complete this survey. Theresa M. Nemmers will give you directions for the survey and will be available if you should have any questions while you complete the survey. The usual time to complete this survey is 5-10 minutes.

After completing the three tests, Theresa M. Nemmers will interview you to collect information on your history of falling. She will ask you to recall, over the past year, if you have fallen, and if so, how many times and what was the nature and consequences of the fall. The entire test series and fall interview is anticipated to last approximately 60 minutes.

Risks of Participation:

There are no known risks associated with this project which are greater than those ordinarily encountered in daily life. The Berg Balance Test requires repeated activities, however the test as a whole is not timed and you may rest if needed during the test.

Benefits:

You will derive no specific personal benefit from participation in this research. If any of your scores on the three measures are considered in the low range, you will be given that information along with a cover letter for your personal physician suggesting further detailed assessment. This feedback will be given to you at the completion of your individual data collection session.

Confidentiality:

At no time will your name or identity be disclosed in any publication or presentation of the results of this study. Only Ms. Nemmers and Dr. Edgley will view any information associated with your name obtained through this study. Documents containing personal information will be kept in hard copy, and will be secured in locked file cabinets in Theresa M. Nemmers' office, Colvin Recreation Center, Academic Wing # 185. Computer data files will contain only subject number codes, and will be maintained on password protected computer software. At the conclusion of this study, all materials containing personal information such as your name will be destroyed. The OSU IRB has the authority to inspect consent records and data files to assure compliance with approved procedures.

Compensation:

You will receive no personal financial compensation for your participation in this study.

Contacts:

If you have any questions regarding this research study or your participation in it, please feel free to contact Theresa Nemmers at (405) 744-7677 or teri.nemmers@okstate.edu , or Dr. Betty Edgley at (405) 744-9337 or bedgley@cox.net. This research project has been reviewed by the Institutional Review Board of Oklahoma State University. You may request information from this Board about your rights as a research subject. For information on subjects' rights, contact Dr. Sue Jacobs, Institutional Review Board Chair, 415 Whitehurst Hall, 405-744-1676.

Participant Rights:

Your participation in this study is entirely voluntary. If you decide to participate, you are free to withdraw your consent and stop participating at any time during the course of the study without prejudice or consequences.

Consent Documentation:

I have read and fully understand the consent form. I sign it freely and voluntarily. A copy of this form has been given to me.

__________________________ _________________________ ________________

Printed Name of Participant    Signature of Participant    Date

I certify that I have personally explained this document before requesting that the participant sign it.

_________________________ ________________

Theresa M. Nemmers    Date
Primary Investigator

## APPENDIX F

## ACTIVITY-SPECIFIC BALANCE CONFIDENCE SCALE (ABC)

**Activity-specific Balance Confidence Scale**

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

| 0% | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% |
|---|---|---|---|---|---|---|---|---|---|---|
| No confidence | | | | | | | | | | Completely confident |

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

1. …walk around the house? _____%
2. …walk up or down stairs? _____%
3. …bend over and pick up a slipper from the front of a closet floor? _____%
4. …reach for a small can off a shelf at eye level? _____%
5. …stand on your tip toes and reach for something above your head? _____%
6. …stand on a chair and reach for something? _____%
7. …sweep the floor? _____%
8. …walk outside the house to a car parked in the driveway? _____%
9. …get into or out of a car? _____%

10…walk across a parking lot to the mall? _____%

11…walk up or down a ramp? _____%

12…walk in a crowed mall? _____%

13…are bumped into people as you walk through the mall? _____%

14…step onto or off of an escalator while you are holding onto a railing? _____%

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? _____%

If you do not currently do the activity in question, try and imagine how confident you would be if you had to do the activity.

## APPENDIX G

## PHYSICAL ACTIVITY SCALE FOR THE ELDERLY (PASE)

Physical Activity Scale for the Elderly

Permission to use the Physical Activity Scale for the Elderly (PASE) in this study, for data collection only, was obtained from the copywrite holder, New England Research Institutes, Inc. 9 Galen Street, Watertown, MA 02472.

A sample of the complete test may be found in:

Kriska, A.& Capersen, C. Eds. (1997). A collection of physical activity questionnaires for health-related research. *Medicine and Science in Sports and Exercise*, 29, S123-S129.

## APPENDIX H

## PASE Scoring Codes

## PASE SCORING FORM

| PASE Item | Type of Activity | Activity Weight | Activity Frequency | Weight times Frequency |
|---|---|---|---|---|
| 2. | Walk outside home | 20 | a. | |
| 3. | Light sport / recreational activities | 21 | a. | |
| 4. | Moderate sport / recreational activities | 23 | a. | |
| 5. | Strenuous sport / recreational activities | 23 | a. | |
| 6. | Muscle strength / endurance exercises | 30 | a. | |
| | | | | |
| 7. | Light housework | 25 | b. | |
| 8. | Heavy housework or chores | 25 | b. | |
| 9a. | Home repairs | 30 | b. | |
| 9b. | Lawn work or yard care | 36 | b. | |
| 9c. | Outdoor gardening | 20 | b. | |
| 9d. | Caring for another person | 35 | b. | |
| | | | | |
| 10. | Work for pay or as volunteer | 21 | c. | |
| | | | PASE SCORE: | |

Activity Frequency Values:

a. Use hours per day conversion table below
b. 1 = activity reported in past week, 0 = activity not reported
c. Divide work hours reported in Item 10.1 by seven; if no work hours or if job involves mainly sitting with slight arm movements (Item 10.2 = 1), then activity frequency = 0.

## ACTIVITY TIME TO HOURS PER DAY CONVERSION TABLE

| Days of Activity | Hours Per Day of Activity | Hours Per Day |
|---|---|---|
| 0. Never | - | 0 |
| 1. Seldom | 1. Less than 1 hour | .11 |
| | 2. 1-2 hours | .32 |
| | 3. 2-4 hours | .64 |
| | 4. More than 4 hours | 1.07 |
| 2. Sometimes | 1. Less than 1 hour | .25 |
| | 2. 1-2 hours | .75 |
| | 3. 2-4 hours | 1.50 |
| | 4. More than 4 hours | 2.50 |
| 3. Often | 1. Less than 1 hour | .43 |
| | 2. 1-2 hours | 1.29 |
| | 3. 2-4 hours | 2.57 |
| | 4. More than 4 hours | 4.29 |

New England Research Institutes, Inc. (1991). *PASE Physical Activity Scale for the Elderly, Administration and scoring instruction manual*. Watertown, MA., p.3.

## APPENDIX I

## BERG BALANCE SCALE
## (BBS)

## BERG BALANCE SCALE

**Subject Number**__________________

| ITEM | DESCRIPTION | SCORE (0-4) |
|---|---|---|
| 1. | Sitting to standing | _____ |
| 2. | Standing unsupported | _____ |
| 3. | Sitting unsupported | _____ |
| 4. | Standing to sitting | _____ |
| 5. | Transfers | _____ |
| 6. | Standing with eyes closed | _____ |
| 7. | Standing with feet together | _____ |
| 8. | Reaching forward with outstretched arm | _____ |
| 9. | Retrieving object from floor | _____ |
| 10. | Turning to look behind | _____ |
| 11. | Turning 360 degrees | _____ |
| 12. | Placing alternate foot on stool | _____ |
| 13. | Standing with one foot in front | _____ |
| 14. | Standing on one foot | _____ |
| | **TOTAL** | _____ |

**GENERAL INSTRUCTIONS FOR TESTOR**

Please demonstrate each task and/or give instructions as written. When scoring, please record the lowest response category that applies for each item.

Subjects should be told to maintain their balance for each test. Which leg to stand on is the choice of the subject.

1. **SITTING TO STANDING**
INSTRUCTIONS: Please stand up. Try not to use your hands for support.

( ) 4 able to stand without using hands and stabilize independently
( ) 3 able to stand independently using hands
( ) 2 able to stand using hands after several tries
( ) 1 needs minimal aid to stand or to stabilize
( ) 0 needs moderate or maximal assist to stand

2. **STANDING UNSUPPORTED**
INSTRUCTIONS: Please stand for two minutes without holding.

( ) 4 able to stand safely 2 minutes
( ) 3 able to stand 2 minutes with supervision
( ) 2 able to stand 30 seconds unsupported
( ) 1 needs several tries to stand 30 seconds unsupported
( ) 0 unable to stand 30 seconds unassisted

***If a subject is able to stand 2 minutes unsupported, score full points for sitting unsupported. Proceed to item #4.***

3. **SITTING WITH BACK UNSUPPORTED BUT FEET SUPPORTED ON FLOOR OR ON A STOOL**
INSTRUCTIONS: Please sit with arms folded for 2 minutes.

( ) 4 able to sit safely and securely 2 minutes
( ) 3 able to sit 2 minutes under supervision
( ) 2 able to sit 30 seconds
( ) 1 able to sit 10 seconds
( ) 0 unable to sit without support 10 seconds

4. **STANDING TO SITTING**
INSTRUCTIONS: Please sit down.

( ) 4 sits safely with minimal use of hands
( ) 3 controls descent by using hands
( ) 2 uses back of legs against chair to control descent
( ) 1 sits independently but has uncontrolled descent
( ) 0 needs assistance to sit

5. **TRANSFERS**
INSTRUCTIONS: Arrange chairs(s) for a pivot transfer. Ask subject to transfer one way toward a seat with armrests and one way toward a seat without armrests. You may use two chairs (one with and one without armrests) or a bed and a chair.

( ) 4 able to transfer safely with minor use of hands
( ) 3 able to transfer safely definite need of hands
( ) 2 able to transfer with verbal cueing and/or supervision
( ) 1 needs one person to assist
( ) 0 needs two people to assist or supervise to be safe

6. **STANDING UNSUPPORTED WITH EYES CLOSED**
INSTRUCTIONS: Please close your eyes and stand still for 10 seconds.

( ) 4 able to stand 10 seconds safely
( ) 3 able to stand 10 seconds with supervision
( ) 2 able to stand 3 seconds
( ) 1 unable to keep eyes closed 3 seconds but stays steady
( ) 0 needs help to keep from falling

7. **STANDING UNSUPPORTED WITH FEET TOGETHER**
INSTRUCTIONS: Place your feet together and stand without holding.

( ) 4 able to place feet together independently and stand 1 minute safely
( ) 3 able to place feet together independently and stand for 1 minute with supervision
( ) 2 able to place feet together independently and to hold for 30 seconds
( ) 1 needs help to attain position but able to stand 15 seconds feet together
( ) 0 needs help to attain position and unable to hold for 15 seconds

8. **REACHING FORWARD WITH OUTSTRETCHED ARM WHILE STANDING**
INSTRUCTIONS: Lift arm to 90 degrees. Stretch out your fingers and reach forward as far as you can. (Examiner places a ruler at end of fingertips when arm is at 90 degrees. Fingers should not touchthe ruler while reaching forward. The recorded measure is the distance forward that the finger reach while the subject is in the most forward lean position. When possible, ask subject to use both arms when reaching to avoid rotation of the trunk.)

( ) 4 can reach forward confidently >25 cm (10 inches)
( ) 3 can reach forward >12.5 cm safely (5 inches)
( ) 2 can reach forward >5 cm safely (2 inches)
( ) 1 reaches forward but needs supervision
( ) 0 loses balance while trying/ requires external support

9. **PICK UP OBJECT FROM THE FLOOR FROM A STANDING POSITION**
INSTRUCTIONS: Pick up the shoe/slipper which is placed in front of your feet.

( ) 4 able to pick up slipper safely and easily
( ) 3 able to pick up slipper but needs supervision
( ) 2 unable to pick up but reaches 2-5cm (1-2 inches) from slipper and keeps balance independently
( ) 1 unable to pick up and needs supervision while trying
( ) 0 unable to try/needs assist to keep from losing balance or falling

10. **TURNING TO LOOK BEHIND OVER LEFT AND RIGHT SHOULDERS WHILE STANDING**

INSTRUCTIONS: Turn to look **directly** behind you over toward left shoulder. Repeat to the right.

Examiner may pick an object to look at directly behind the subject to encourage a better twist turn.

( ) 4 looks behind from both sides and weight shifts well
( ) 3 looks behind one side only other side shows less weight shift
( ) 2 turns sideways only but maintains balance
( ) 1 needs supervision when turning
( ) 0 needs assist to keep from losing balance or falling

11. **TURN 360 DEGREES**

INSTRUCTIONS: Turn completely around in a full circle. Pause. Then turn a full circle in the other direction.

( ) 4 able to turn 360 degrees safely in 4 seconds or less
( ) 3 able to turn 360 degrees safely one side only in 4 seconds or less
( ) 2 able to turn 360 degrees safely but slowly
( ) 1 needs close supervision or verbal cueing
( ) 0 needs assistance while turning

12. **PLACING ALTERNATE FOOT ON STEP OR STOOL WHILE STANDING UNSUPPORTED**

INSTRUCTIONS: Place each foot alternately on the step/stool. Continue until each foot has touched the step/stool four times.

( ) 4 able to stand independently and safely and complete 8 steps in 20 seconds
( ) 3 able to stand independently and complete 8 steps >20 seconds
( ) 2 able to complete 4 steps without aid with supervision
( ) 1 able to complete >2 steps needs minimal assist
( ) 0 needs assistance to keep from falling/unable to try

13. **STANDING UNSUPPORTED ONE FOOT IN FRONT**

INSTRUCTIONS: (DEMONSTRATE TO SUBJECT)

Place one foot directly in front of the other. If you feel that you cannot place your foot directly in front, try to step far enough ahead that the heel of your forward foot is ahead of the toes of the other foot. (To score 3 points, the length of the step should exceed the length of the other foot and the width of the stance should approximate the subject's normal stride width)

( ) 4 able to place foot tandem independently and hold 30 seconds
( ) 3 able to place foot ahead of other independently and hold 30 seconds
( ) 2 able to take small step independently and hold 30 seconds
( ) 1 needs help to step but can hold 15 seconds
( ) 0 loses balance while stepping or standing

14. **STANDING ON ONE LEG**

INSTRUCTIONS: Stand on one leg as long as you can without holding.

( ) 4 able to lift leg independently and hold >10 seconds
( ) 3 able to lift leg independently and hold 5-10 seconds
( ) 2 able to lift leg independently and hold = or >3 seconds
( ) 1 tries to lift leg unable to hold 3 seconds but remains standing independently
( ) 0 unable to try or needs assist to prevent fall

**( ) TOTAL SCORE (Maximum = 56)**

## APPENDIX J

## SUBJECT FALL HISTORY INTERVIEW

## SUBJECT FALL HISTORY INTERVIEW

Subject Name ___________________________________ Subject # ________

Age: ______ Height: ________ Weight: ________

Race: Caucasian/African American/Native American/Asian/Hispanic/Other _________

**Interviewer:** for this study a fall is defined as "an episode of unintentionally coming to rest on the ground or lower surface that was not the result of dizziness, fainting, loss of consciousness, sustaining a violent blow or other overwhelming external factor."

Have you fallen within the last year? YES / NO

If YES continue:

How many times in the past year have you fallen? _____

If more than 6: how often did you fall? ______(per day/week/month)

What were the circumstances of those falls? _________________________

_____________________________________________________________

(e.g. trip, slip, misstep, imbalance)

Did any of these falls require medical attention: YES / NO

If YES – what type? Hospital/surgery/ER visit/routine MD visit/

other_________________________

Have your changed your living situation or activities because of the falls?

# APPENDIX K

## SAMPLE OF INDIVIDUAL SCORE REPORT

Sample of Individual Score Report

Name: ____________________________

Thank you for participating in my dissertation research study entitled "The influence of the forward head posture on balance, fall self-efficacy, and physical activity level in community-living women age 60 and older; and the relationship of these variables to self-reported fall history."

Your scores for the two tests were:

Berg Balance Scale: _________.
A score below 40 suggests that you MAY be at risk for falling. I suggest that you consult with your physician for further evaluation as he/she deems appropriate. I have attached an explanatory letter to give to your personal physician.

OR

Congratulations, that's a good score!

Activity-specific Balance Confidence scale: ________
A score below 67% suggests that you MAY be at risk for falling. I suggest that you consult with your physician for further discussion regarding appropriate means to improve your balance confidence. I have attached an explanatory letter to give to your personal physician.

OR

Congratulations, that's a good score!

Thank you,

Theresa M. Nemmers
Ph.D. Candidate and Primary Researcher
(405)372-7819

## APPENDIX L

## SAMPLE OF PHYSICIAN INFORMATION LETTER

Sample of Physician Information Letter

DATE

Dear Physician,

_________________________ has recently participated in a Ph.D. dissertation research study entitled "The influence of the forward head posture on balance, fall self-efficacy, and activity level in community-living women aged 60 and older; and the relationship of these variables to self-reported fall history." The Berg Balance Test (a clinical tool to assess balance stability), the Activity-specific Balance Confidence Scale (a survey designed to measure balance confidence) and the Physical Activity Scale for the Elderly (a self-reported activity level with a weighted score) were measures utilized in this research.

Her score for _________________________ was at or below the criterion score, as identified in the research literature, suggesting the possibility that she may be at risk for falling. Since this research study was not a medical screening for the risk of falling, I have suggested that she obtain an appointment with you, her personal physician, for further discussion and evaluation as you deem appropriate.

I have assured her that low scores on any one of these tests are not absolute predictors of falling, rather many contributing factors must be considered.

Thank you,

Theresa M. Nemmers, PT, MPT, MA
Ph.D. Candidate and Principle Investigator
School of Applied Health and Educational Psychology
Oklahoma State University
Stillwater, OK 74078
teri.nemmers@okstate.edu
405-744-7677

VITA

Theresa M. Nemmers

Candidate for the Degree of

Doctor of Philosophy

**Dissertation**: THE INFLUENCE OF THE FORWARD HEAD POSTURE ON BALANCE, FALL SELF-EFFICACY, AND PHYSICAL ACTIVITY LEVEL IN COMMUNITY-DWELING WOMEN AGE 60 AND OLDER; AND THE RELATIONSHIP OF THESE VARIABLES TO SELF-REPORTED FALL HISTORY

**Major Field**: Health, Leisure, and Human Performance with option in Health Promotion

**Biographical:**

**Personal Data**:

Lieutenant Colonel, Retired, U.S. Army Medical Specialist Corps. Awarded Legion of Merit, 1984.
Guild Certified Feldenkrais Practitioner®.
Licensed Physical Therapist.

**Education:**

Bachelor of Arts in Biology, Mount Marty College, Yankon, S. D. 1971.
Master of Physical Therapy, U.S. Army-Baylor University Graduate Program in Physical Therapy, Ft. Sam Houston, TX, 1972.
Master of Arts in Physical Education with specialization in Biomechanics, University of Maryland, College Park, MD, 1979.
Completed the Requirements for Graduate Certificate in Gerontology, Gerontology Institute at Oklahoma State University in May 2006
Completed the Requirements for the Doctor of Philosophy degree in Health, Leisure and Human Performance – Health Promotion option - at Oklahoma State University in May 2006.

**Experience**:

Twenty-three years active duty service, U.S. Army Medical Specialist Corps, serving a Physical Therapist in variety of clinical, educational and leadership positions,1971-1994.

Private clinical practitioner in physical therapy, Eugene, OR, 1995-2000

Director of Acute Therapies and Orthopedic Nursing, 1997-1998 and Supervisor of Acute Therapies 1995-1997, Sacred Heart Hospital, Eugene, OR.

Adjunct Instructor, Health and Human Performance, Oklahoma State University, 2002-Present.

Assistant Professor, School of Physical Therapy, Doctor of Physical Therapy Program, Langston University, Langston, OK 2003-Present.

**Professional Memberships**:

American Physical Therapy association (APTA)
Oklahoma Physical Therapy Association (OPTA)
Geriatric Section of APTA
Orthopedic Section of APTA
Education Section of APTA
American Geriatrics Association
American Educational Research Association
North American Feldenkrais Guild®
Partnerships for Aging
Rocky Mountain Educational Research Association

Name: Theresa M. Nemmers Date of Degree: May, 2006

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: THE INFLUENCE OF THE FORWARD HEAD POSTURE ON BALANCE, FALL SELF-EFFICACY, AND PHYSICAL ACTIVITY LEVEL IN COMMUNITY-DWELING WOMEN AGE 60 AND OLDER; AND THE RELATIONSHIP OF THESE VARIABLES TO SELF-REPORTED FALL HISTORY

Pages in Study: 132 Candidate for the Degree of Doctor of Philosophy

Major Field: Health, Leisure and Human Performance with option in Health Promotion

Scope and Method of Study: This research assessed: a) the relationships among risk factors for falling in a healthy population of women 60 years and older, and b) the predictive potential of these risk factors for falling in this population. Subjects were recruited from a variety of women's groups, and public and private organizations. Recruitment efforts yielded 112 women volunteers ranging in age from 60 to 95 years. Individual subject ages were well-distributed throughout the age variable of the study. The subjects completed two surveys, a balance stability test, and a fall history interview. The forward head position was assessed via analysis of a profile photograph taken during the balance test. Data analysis included descriptive indices, multi-factor ANOVA, and hierarchical multiple regression analysis.

Findings and Conclusions: The forward head posture was significantly inversely correlated to the balance score; i.e., a more severe forward head posture was associated with diminished balance stability. This relationship statistically supported the underlying premise of the present study which postulated that the forward head posture places the head near or outside the limits of the balance stability envelope, and would adversely influence an elderly individual's balance capability. This inverse correlation was also found between the forward head posture and the variables of balance confidence and activity level. Only balance confidence and physical activity levels were related to fall history. Subjects' high activity levels may have contributed to high balance scores, subsequently influencing the relationship between balance and positive fall history. The conclusions were: a) this study provided a first tier of evidence to support the incorporation of postural exercises for head position in balance training programs, b) the findings also supported the potential protective effect of high activity levels on balance stability and fall self-efficacy, and c) the findings provided further justification for health care professionals to conduct ongoing assessments of the needs and characteristics of the elder populations they serve.

ADVISER'S APPROVAL: Betty Edgley, Ed.D