Falls are extremely common among the older adult population, account for substantial morbidity and mortality, and are often potentially preventable. It is estimated that 9 out of 10 of hip fractures in older adults occur as the result of a fall. The economic consequences of hip fractures are estimated at $10 to $15 billion annually in the United States alone. Adults aged 65 years and older are the fastest growing segment of the U.S. population; therefore falls in this population represent an increasing public health burden.

Physical activity has been identified as a lifestyle factor that helps to maintain physical functioning, balance, and mobility as we age, thereby reducing the incidence of falls. Activity levels are known to decline with advancing age so much that for many adults 65 and older, the normal activities
of daily living constitute the majority of their daily physical activity. Many older adults today are choosing to live in retirement communities that provide independent housing, housecleaning, laundry services, yard care, and meal preparation. This living situation may further reduce the activity level of its residents by performing many of the normal tasks of daily living for them.

Fear of falling has been used in the literature to describe a loss of confidence and voluntary restriction of activity occurring after a fall that may be out of proportion to any injuries sustained by the fall. This is prevalent among older adults and has been reported in as many as 50-60% of previous fallers and also in 20-46% of individuals who have never fallen. Fear of falling that occurs as a result of aging and/or restricted activity level, along with associated declines in mobility, function, and balance, undermines self-confidence and increases the fall risk in this population.

The aims of this study were to determine whether physical function and balance self-efficacy scores differed between older adults living in the community and those in retirement communities, to examine the relationships that exist between balance confidence, physical function, living situation, and fall status in this older adult population, and to develop an equation that could be used to predict older adults most likely to experience multiple falls.
The data used in this study were part of a longitudinal research study conducted at the Bone Research Laboratory at Oregon State University in Corvallis, OR. Participants consisted of 317 adults between 65 and 95 years of age (80.7 ± 5.7). This included 105 persons living in the local community, and 212 persons from retirement communities within a 70-mile radius. Community subjects were tested at the university laboratory one year and retirement subjects were tested on-site at their residence the following year. Participants were tested on hip abduction strength, Tandem Gait, Timed Up and Go, postural sway, lateral stepping velocity and reaction time, and also completed a Balance Self-Efficacy questionnaire. Falls incidence was tracked for 1 year following testing.

An ANOVA revealed differences between community residents and retirement residents, with community dwelling residents scoring better overall, and significantly better on the following physical function tests; Timed Up & Go, Tandem Gait, Quick Step reaction time and stepping velocity, tandem body sway, and Balance Self-Efficacy. Differences in scores between the two groups ranged from 6.7% to 33%. A correlation analysis between balance self-efficacy scores and physical function scores revealed a positive, moderate relationship between physical function and balance self-efficacy, with correlations that ranged from R = 0.113 to R = 0.559 (p < .005).
Fall numbers were negatively correlated to balance self-efficacy scores, but correlations were weak, from R = 0.102 to R = 0.126 (p < .005). Regression analysis resulted in an equation using one variable, medial-lateral body sway while standing comfortably with eyes open. The resulting logistic equation is:

\[
\log \left( \frac{\mu}{1-\mu} \right) = -0.728 + (2.851 \times \text{lateral sway, eyes open}).
\]

Using a ROC curve analysis, the model correctly classified 58.9% of individuals into the correct fall category (one-time vs. multiple fallers), with specificity of 73% and sensitivity of 43%.

In conclusion, significant differences in physical function and balance confidence occurred between subjects in the different residential settings, regardless of fall incidence. Correlations between BSE scores and physical function variables were statistically significant, reinforcing the differences in test scores noted between community and retirement subjects. BSE scores were negatively correlated to fall number although R-values were weak, indicating that in our population, self-efficacy scores were not strongly related to the number of falls one experienced. A regression equation correctly classified 58.9% of subjects as one-time or multiple fallers using the single variable of medial-lateral body sway.

Our study shows that community subjects had better physical function and balance self-efficacy than retirement subjects. The literature has reported a
strong relationship between physical activity level and functional ability, with reductions in physical activity leading to declines in function over time. Retirement communities may be set up with a safer external environment that may be helping to decrease fall incidence, however administrators must still plan appropriate physical activity programs in order to assist residents in maintaining a high level of function, thereby decreasing fall risk even more.
Relationships among Balance Confidence, Physical Function, Living Situation and Fall Status in Older Adults

by
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APPROVED:

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Dean of the Graduate School

I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

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Peggy E. Oberstaller, Author
ACKNOWLEDGEMENTS

They say it takes the support of a village to raise a successful person. It is certainly true that I had the support of numerous individuals to whom I owe a multitude of thanks.

To my committee members, Dr. Karen White, Dr. Donna Champeau, and Dr. Kathy Gunter: thank-you for your support and guidance throughout my graduate program. To Dr. Barbara Gartner, who served as my graduate representative, I appreciate the time you have given to participate in my education. Your cheerful e-mails of support and encouragement were very much appreciated.

Karen, as my major professor I especially want to thank you for accepting me as one of your first graduate students and guiding me through this process. You have had many stressful challenges in your life over the past few years. How you were able to remain focused and attentive to your students I will never know. You are amazing! Logan is very lucky to have you as his mom. I wish you lots of happiness in your new role as university first lady, or whatever else you choose to do. I know you will be successful.

Next, and most importantly, I want to thank my family. Mom, you have supported me through this long journey in every way imaginable, and never let me forget that Dad would have been proud of my choice. You are a strong,
feisty (I promised not to use stubborn again!) and loving woman; it has served you well through all the hurdles life has thrown in your path. I am very proud of you and all you have accomplished!

Liz & George, you are the best sister and brother a girl could ask for. I appreciate the fact that you never doubted I would be successful. Liz, thanks also for letting me “borrow” your children when I needed a time out to play and remember what is important in life.

Aunt Cynnie, what can I say? You were always there with a good kick in the butt when I starting whining because I was tired or overwhelmed. Your students must quake in their boots when they get sent to the principals’ office!

Thanks also to my favorite boy Bogie, who kept me company through long hours on the computer, and whose doggie antics kept me entertained and laughing through it all.

Last, but not least, I would like to express my gratitude and appreciation to my “second family” in the Health & PE Department at Lane Community College. You have been with me since I began this journey and supported my goals every step of the way. The instructors and staff here exemplify the true meaning of camaraderie and teamwork in the workplace. You are the best!
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DEDICATION

I would like to dedicate this thesis to my father, Eolos D. (ED) Vareldzis, and to my grandmother, Mary E. Xanthopoulos. My father wanted me to finish college and get my degree, and he would have been very happy that his nagging finally paid off. I wish you had lived to see this day.

Nana, you were my role model of a smart, savvy, self-taught woman. You always believed in me and loved me unconditionally, even if you sometimes thought I was “hopeless”. This is for you...
CHAPTER 1: INTRODUCTION

RELATIONSHIPS AMONG BALANCE CONFIDENCE, PHYSICAL FUNCTION, LIVING SITUATION AND FALL STATUS IN OLDER ADULTS

Background

Falls are extremely common among the older adult population, account for substantial morbidity and mortality, and are often potentially preventable. Tinetti, Speechley and Ginter (1988) describe a fall as: “an event that results in a person coming to rest inadvertently on the ground”. Each year, approximately one-third of the population aged 65 years and older who are living at home will fall at least once, and over two-thirds of persons living in nursing homes will fall, with 10-20% experiencing a serious complication as a result of the fall (Robbins et al., 1989).

Fall-related injuries are the leading cause of mortality from unintentional injuries among adults 65 and older in the United States. Falls are also the leading cause of non-fatal injuries such as lacerations, dislocated joints, sprains, and bruises in this population. An estimated 5-10% of those over age 75 visit a hospital emergency department each year for treatment of a fall-related injury (Sattin & al, 1990).
Statistics indicate that 90-95% of hip fractures occur subsequent to a fall (Lipsitz LA, 1991). These hip fractures are associated with increased mortality and disability. One in five patients is no longer alive 1 year following an osteoporotic hip fracture; fifty percent of those experiencing a hip fracture will be unable to walk again without assistance, and 28 percent will require long-term care (NIAMS, 2000).

The consequences of osteoporotic fracture, particularly of the hip, are often calculated in economic terms. In the United States alone, costs associated with recovery and rehabilitation from hip fractures may be as high as $10 to $15 billion per year (NIAMS, 2000). However, there are also other important considerations associated with falls that can affect an individual as much or more than the fall itself; these may include reductions in overall health status, functional status, and/or independence that contribute to a decreased quality of life and increased need for public assistance.

Currently there are 70 million people over the age of fifty, representing 25% of the adult population. Adults aged 65 years and older are the fastest growing segment of the U.S. population (US Bureau of the Census, 2000), therefore, falls in this population represent an enormous public health burden. In order to reduce the number of falls among older adults, researchers have attempted to identify and target the risk factors for prevention. These risk
factors are commonly discussed as being either intrinsic or extrinsic in nature.

Environmental hazards such as poor lighting, loose rugs, electrical cords, etc., are considered extrinsic factors, and may be easily corrected in many cases. Intrinsic factors tend to be more complicated and include such characteristics as gait disorders, muscle weaknesses, balance problems, and loss of confidence in one’s ability to function independently (Robbins et al., 1989). Several different tests have been developed to assess fall risk, and include tests of physical function (gait, balance, muscle strength, postural sway) and tests of mental confidence (Falls Efficacy Scale, Activities-Specific Balance Confidence Scale, Balance Self-Efficacy Scale) (Gunter, White, Hayes, & Snow, 2000; Lord & Fitzpatrick, 2001; Maki, Holliday, & Topper, 1991; Podsiadlo & Richardson, 1991; Powell & Myers, 1995; Rose, 2003; Tinetti, Richman, & Powell, 1990).

While physical and economic consequences of falls can be measured relatively easily, psychological effects on confidence and independence are less easily quantified. Myers et al. (1996) argued that attention should be given to the psychological factors involved with fall risk. Fear of falling has been used in the literature to describe a loss of confidence and voluntary restriction on activity occurring after a fall that may be out of proportion to any physical injuries sustained (Walker & Howland, 1991). Fear of falling is prevalent
among older adults and has been reported in as many as 50-60% of previous fallers and 20-46% of individuals who have not previously fallen (McAuley, Mihalko, & Rosengren, 1997).

Researchers have attempted to explain the connection between fear of falling and actual falls by linking fear of falling to activity restriction (Myers, Fletcher, Myers, & Sherk, 1998b; Myers et al., 1996; Powell & Myers, 1995). Data has supported this hypothesis, showing that a substantial number of older adults who experience fear of falling do indeed curtail their activities (Howland et al., 1998). This restriction of activity then leads to physical declines from de-conditioning such as loss of flexibility, strength, coordination, and balance, and ultimately to reduced health and physical functioning (Mihalko & McAuley, 1996; Myers et al., 1998b; Powell & Myers, 1995). These areas of function have been identified as closely related to falls, so it follows that declines in any or all of these functions could also contribute to fall risk. Along this same line, Myers et al. (1996) (Myers et al., 1996) pointed out that psychological considerations (such as fear of falling) may be precursors to, as well as consequences of falling.

A theoretical approach to understanding this psychological phenomenon is Bandura's Self-Efficacy Theory (1977). According to Bandura, self-efficacy cognitions represent the convictions or beliefs that one can
successfully execute a course of action and produce a certain result (Bandura, 1977). In simple terms, self-efficacy represents a form of situation-specific self-confidence. For example, an older adult may feel very confident of his or her ability to win at bridge, but be intimidated by the thought of walking unassisted around the block. These judgments of personal capabilities have been shown to be important determinants of an individual’s choice of activities, how much effort they expend in the activities, and how long they persist in the face of adverse conditions (Bandura, 1977). Assessment of these parameters, which may affect an individuals’ quality of life even more profoundly than an actual fall, is important in the evaluation of programs aimed at reducing fall incidence and consequences.

Tinetti and colleagues first proposed conceptualizing fear of falling as fall-related self-efficacy (Tinetti et al., 1990). They hypothesized that when an individual has a high fear of falling, they must also have a low sense of personal efficacy related to falls. This was based on the social cognitive framework proposed by Bandura, in which he asserts that various forms of anxiety are related to self-efficacy, and that self-efficacy (or confidence in one’s abilities) is task specific and cannot be generalized from one task to other tasks (Bandura, 1986).
Three specific tests that have been developed to measure "fear of falling" or balance confidence in the older adult are the Falls Efficacy Scale (FES) (Tinetti et al., 1990), the Activities-Specific Balance Confidence Scale (ABC) (Myers, Fletcher, Myers, & Sherk, 1998a), and the Balance Self-Efficacy Scale (BSE) (Rose, 2003).

Tinetti et al. (1990) wanted to measure self-efficacy for older adults performing various tasks that are imperative for everyday functioning and independence. They developed the Falls Efficacy Scale (FES) to ask older individuals how confident they are that they will not fall while performing specific activities of daily living.

Powell and Myers (1995) developed a new scale, the Activities-Specific Balance Confidence Scale (ABC), similar to the FES, which measures balance confidence/self-efficacy. The ABC scale questions the subject's confidence in maintaining their balance versus being able to keep from falling. This scale may be more sensitive to healthy adults who have not fallen, but who do sometimes lose their balance.

Rose et al. (2003) further modified the ABC to tailor it for a slightly more active older population. Their version was renamed the Balance Self-Efficacy Scale (BSE).
Personal characteristics can affect psychosocial measures such as fear of falling and self-efficacy. Two demographic variables that have been looked at in the research are age and gender. Fear of falling has been shown to be higher in subjects who are older (Howland et al., 1998; Lachman et al., 1998). Myers et al. (1998) found that self-efficacy measures supported this trend as well. Gender has also been shown to affect fear of falling responses, with females generally more fearful of falling than males (Howland et al., 1998; McAuley et al., 1997; Myers et al., 1996). According to Tinetti, this might be attributed to underreporting in males due to potential stigmatization, an idea also supported by McAuley and colleagues (1977).

We know that there is more to preventing fracture than reversing age-related reductions in the strength of bones. In general, you don’t fracture your hip if you don’t fall. While physical activity, including both aerobic and weight training exercises, may be of value in improving bone strength, it may make an even greater contribution by improving balance, strength, and promoting the ability to walk and climb stairs without assistance, thereby reducing the risk of falls.

Theory supports the notion that exercise can be used to improve balance-related self-efficacy and fear of falling. One of the important principles of modifying self-efficacy beliefs according to Bandura (1977) is
that of "mastery". Mastering a particular activity has been shown to have a powerful impact on an individual's self-efficacy (Bandura, 1977). According to Myers et al. (1996) this means that older adults should be more confident with activities they engage in on a regular basis. Since the skills developed and used during exercise include balance, strength, coordination, and/or flexibility; and consistent exercise participation implies that these skills are practiced regularly, it follows that self-efficacy for these skills should increase and fear of falling decrease.

Exercise has been shown to decrease fall risk among older adults in several studies (American Geriatrics Society, 2001; Buchner et al., 1997; Campbell et al., 1997), and is known to benefit older adult's health in many ways (American College of Sports Medicine, 1998). Exercise physiologists contend that regular exercise participation leads to improvements in balance, strength, and/or flexibility in some form if the stimulus presented provides an overload effect. That is why results can vary significantly depending on the focus, mode, frequency, duration, and intensity of the exercise and the population being studied.

The physical risk factors for falls most commonly identified are loss of muscle strength and flexibility, and impaired balance and reaction time (American Geriatrics Society, 2001; Campbell et al., 1997).
Campbell et al. suggest that these may be the risk factors most amenable to interventions that can be carried out in primary care. There are several studies that have shown an exercise intervention to be successful in improving one or more of these variables (Campbell et al., 1997; Fiatarone, 1990; Mihalko & McAuley, 1996; Wolf et al., 1996).

The largest study that looked at the effects of exercise in the older population is the ‘Frailty and Injuries: Co-operative Studies of Intervention Techniques’, or FICSIT (The FICSIT Group, 1993). This multi-center study, involving seven sites across the United States, was designed so each site tested a different exercise intervention strategy in selected groups of older adults. Tinetti’s 1994 intervention program in which nurses assessed the risk factors of their subjects and then targeted interventions accordingly was one of the seven FICSIT sites, as was a study conducted by Wolfe and colleagues (1996). Using a sample of community dwelling adults aged 70 and above, Wolfe et al. evaluated the effects of either a computerized balance training program or a Tai Chi program versus an education only control group. They found that the Tai Chi program subjects reduced their risk of multiple falls by 47.5%. A major strength of the FICSIT study is that a common database was used across all sites, which allowed for comparisons of intervention potency. Meta-analysis of the data from the seven sites showed that subjects assigned to an exercise
intervention were less likely to fall in the follow-up period, and the incidence of falls was lower in subjects whose intervention included exercise to improve balance (Province, Hadley, Hornbrook, & al, 1995).

Using a home exercise program of strength and balance retraining exercises, Campbell et al. (1997) found that balance improved in an exercise group versus a control group after 6 months. Their sample consisted of women over 80 years of age living in the community. Mihalko and McAuley (1996) conducted an 8-week strength-training program with nursing home residents between the ages of 71 and 100 who had been sedentary for at least 6 months. They found significant increases in strength for the trained muscles.

Returning to the concept of mastery, it makes sense that when we improve one or more of the various risk factors that affect falls and maintenance of balance, the older adult will feel more confident in doing similar activities or activities which require similar skills. Ewart and Taylor (Ewart, Stewart, Gillilan, & Kelemen, 1986) hypothesize that the most powerful method for modifying self-efficacy is the direct, graduated exposure to a feared activity. Their 1986 study found self-efficacy for a given activity did not change until the individual acquired relevant new ability information by performing a task of that type. Based on these findings, we may expect an older adult who practices balance, coordination, agility, and/or maintenance of
range of motion with a formal walking program to be less afraid of losing his or her balance when walking through a mall or up an escalator.

Various measures have been used in the research to evaluate physical function and mobility. Some of the tests are conducted on laboratory equipment and focus on aspects of muscular strength, balance, and reaction time. Others require minimal time and equipment and evaluate an individuals' ability to carry out the activities of daily living. Specific balance and mobility factors that contribute to an increased risk of frequent falls have recently been reported and include poor hip abductor strength, poor performance on the Timed Up-and-Go and Tandem Walk tests, and poor postural control while standing with feet in the semi-tandem position (Gunter et al., 2002; Gunter et al., 2000; Lord, Clark, & Webster, 1991; Lord & Fitzpatrick, 2001).

Another possible risk factor for falls in the older adult population is the living situation. For an increasing number of older adults, over 55 retirement communities are seen as places of convenience where they are not responsible for the upkeep of a traditional home or apartment environment. In addition, many older adults find themselves widowed or isolated from family and desire the social connections associated with these facilities. Most of the adults who move to these facilities may turn over household chores and take advantage of
other services that are provided, even if they are still capable of performing these chores themselves, thus reducing physical activity.

Physical fitness is especially important as we age, in order to cope with everyday tasks and unforeseen demands on the aging body. Over the past 50 years, the increase in labor saving devices has drastically reduced the amount of daily activity we are required to do. The consequences of this increasingly sedentary lifestyle will be reflected in the overall health of adults 55 years and older, and contribute to an increased falls incidence in this population.

Several studies have looked at the individual differences in physical characteristics between independent older adults living in the community and those dependent and living in nursing homes (Brach, VanSwearingen, Newman, & Kriska, 2002; Nowalk, Prendergast, Bayles, D'Amico, & Colvin, 2001; Schroeder, 1998; Tinetti, Baker, McAvay, & al, 1994a; Walker & Howland, 1991). Schroeder, Nau, Osness, and Potteiger (1998) reported a significant difference in functional ability and physical characteristics among older adults living independently in the community and those living in nursing homes and assisted-living facilities. However, little is known about the characteristics and abilities of older adults living in retirement communities and how they compare to those adults living independently in the community or in nursing homes.
For many older adults, household chores and tasks of daily living make up the bulk of their daily physical activity. Taking away that small amount of activity puts them at risk of becoming even more sedentary. Through all the published research, the idea that muscle strength and fitness are critical to maintaining an independent lifestyle remains constant. Furthermore, having confidence in balance and movement and the fitness to get up unaided or correct a trip or stumble, are also vital to an independent life.
Purpose

Perhaps as important as identifying risk factors is appreciating the interaction and synergism between multiple risk factors. Several studies have shown that the risk of falling increases dramatically as the number of risk factors increases. Tinetti et al. surveyed community-dwelling elderly adults and reported that the percentage of persons falling increased from 27% for those with no or one risk factor to 78% for those with four or more risk factors (Tinetti & Williams, 1998). In another study, Nevitt et al. reported that the percentage of community-living persons with recurrent falls increased from 10% to 69% as the number of risk factors increased from one to four or more (Nevitt, Cummings, & Kid, 1989).

Given that 90-95% of hip fractures occur as a result of a fall (Lipsitz LA, 1991), and 78% of older adults incurring hip fractures will be either unable to walk again without assistance (50%) or require long-term care (28%) (NIAMS, 2000), it is extremely important to identify the combination of risk factors associated with multiple fallers, and then use this information to identify the older adult groups at highest risk. This would allow interventions to be targeted specifically to those individuals.
Therefore, the purposes of this study are to determine whether physical function and balance self-efficacy scores differ between subjects living in the community and those in retirement communities, to examine the relationships that may exist between balance confidence, physical function, living situation, and fall status in this older adult population, and to develop an equation that can be used to predict older adults most likely to experience multiple falls.
Specific Aims and Hypotheses

Research Question One:

Will balance self-efficacy and physical function scores differ between older adults living independently in the community versus older adults residing in retirement communities, after controlling for fall status?

Hypothesis One:

Balance self-efficacy and physical function scores for older adults living independently in the community will be higher compared to the same scores for adults in retirement communities, after controlling for fall status.

Aim One:

To test this hypothesis we will examine older adults (≥65 yrs), living independently in the local community and from retirement communities within a 70-mile radius. Balance self-efficacy scores will be determined using results from the BSE questionnaires. Scores from tests of agility, muscle strength, and static balance will be used to represent physical function. Balance self-efficacy and physical function scores for adults living independently will be compared against the same scores for adults in retirement communities, while controlling for fall status in the analysis.
Research Question Two:

Will balance self-efficacy scores positively correlate to physical function scores and negatively correlate to fall number after controlling for the living situation?

Hypothesis Two:

Those adults with high balance self-efficacy scores (≥80%) will also have high physical function scores and will be categorized as non-fallers or occasional fallers versus frequent fallers, when the living situation is controlled for.

Aim Two:

To test this hypothesis we will examine older adults (≥65 yrs), living independently in the local community and from retirement communities within a 70-mile radius. Balance self-efficacy scores will be determined using results from the BSE questionnaires. Scores from tests of agility, muscle strength, and static balance will be used to represent physical function. Falls documented during a 1-year period following testing will be used to represent fall numbers. Correlation analysis will be used to identify relationships between balance self-efficacy scores, physical function scores and fall numbers, while controlling for the living situation.
**Research Question Three:**

Can the results of BSE questionnaires and physical function tests, as well as the living situation, be used to develop an equation that will discriminate between multiple fallers versus one-time fallers in this older adult population?

**Hypothesis Three:**

BSE scores, physical function scores, and the living situation can be used to develop an equation that will identify those adults most likely to be multiple fallers versus one-time fallers.

**Aim Three:**

To test this hypothesis we will examine older adults (≥65 yrs), living independently in the local community and from retirement facilities within a 70-mile radius. BSE scores will be determined using results from the Balance Self-Efficacy Scale questionnaires. Scores from tests of agility, muscle strength, and static balance will be used to represent physical function. Current living situation will be designated as follows: 1 = independent, 2 = retirement. Participants will be classified as one-time or multiple fallers.
CHAPTER TWO: RELATIONSHIPS AMONG BALANCE CONFIDENCE, PHYSICAL FUNCTION, RESIDENTIAL SETTING AND FALL STATUS IN OLDER ADULTS
Relationships among Physical Function, Balance Confidence, Residential Setting and Fall Status in Older Adults

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To be submitted to: Gerontology

Key Words: Falls, Balance Confidence, Living Situation, Older Adults
ABSTRACT

Background: Falls are extremely common among the older adult population, account for substantial morbidity and mortality, and are often potentially preventable. Activity levels are known to decline as we age, so for many older adults, activities of daily living make up the majority of their daily physical activity.

Objective: This study investigates relationships between physical function, balance confidence and residential setting as they relate to falls in adults 65 years of age and older.

Methods: Subjects included adults 65-95 years of age (80.7 ± 5.7) living independently in the local community (N=105) or in retirement communities (N=212). All were tested on measures of gait, postural sway, hip abduction strength, and lateral stepping velocity, and completed a Balance Self-Efficacy (BSE) Questionnaire. Fall incidence was tracked for 1 year after testing.

Results: Subjects living in the community had statistically better scores on the following tests: Timed Up & Go, Tandem Gait, Quick Step reaction time & stepping velocity, Tandem Sway, and BSE, with an average difference in scores between the groups of 13.8%. Correlations were moderate between BSE scores and physical function, but weak between BSE scores and fall number. A
regression equation correctly predicted 58.9% of subjects as one-time or multiple fallers. Sensitivity of the equation was 43%, and specificity was 73%.

**Conclusion:** Our study shows that community subjects had better physical function and balance self-efficacy than retirement subjects. The literature has reported a strong relationship between physical activity level and functional ability, with reductions in physical activity leading to declines in function over time. Retirement communities are designed with a safer external environment that may be helping to decrease fall incidence, however administrators must still encourage physical activity programs in order to assist residents in maintaining a high level of function, thereby decreasing fall risk even more.
INTRODUCTION

Falls are extremely common among the older adult population, account for substantial morbidity and mortality, and are often potentially preventable (22). Currently there are 70 million people over the age of fifty, with adults 65 years of age and older the fastest growing segment of the U.S. population (23). Therefore, falls in this demographic represent an enormous public health burden. Myers & Hayes reported that 9 out of 10 hip fractures in the elderly occur as the result of a fall (14). Individuals who fall frequently are likely to be at greater risk for injurious falls than those who only fall once. Other considerations associated with falls that may affect an individual as much or more than the fall itself include reductions in health status, functional status, or loss of independence that contribute to a decreased quality of life and increased reliance on public assistance.

Fear of falling is prevalent among older adults and has been reported in as many as 50-60% of previous fallers and 20-46% of individuals who have not yet fallen (12). Tinetti and colleagues (20) first proposed conceptualizing fear of falling as fall related self-efficacy, hypothesizing that when an individual has a high fear of falling, they must also have a low sense of efficacy related to falls. This was based on the social cognitive framework proposed by Bandura, in which he asserts that self-efficacy (or confidence in
one’s abilities) is task specific and that various forms of anxiety are related to self-efficacy (1).

We know from the research that physical function and mobility are important components of fall risk. Specific balance and mobility factors that have been reported to contribute to an increased risk of frequent falls include poor hip abductor strength, poor performance on the Timed Up-and-Go and Tandem Gait tests, and poor postural control while standing with feet in the semi-tandem position (4, 5, 8, 9).

Another potential risk factor for falls that has not yet been studied extensively is the residential setting. The advent of special communities developed with the needs of older adults in mind has allowed this population to forgo the responsibility for maintaining a traditional home environment. Retirement communities generally provide independent housing, cleaning and maintenance services, meal preparation, and social activities for their residents. For many older adults, the normal tasks of daily living and maintaining a household make up the bulk of their daily physical activity. Taking away some of those responsibilities puts them at risk of becoming more sedentary, and may contribute to an increased falls incidence in this population.

While identifying individual risk factors related to falls is an important and difficult process, even more challenging is attempting to understand the
interaction and synergism between multiple known risk factors. Several studies have shown that the risk of falling increases dramatically as the number of risk factors increases (15, 22). In addition, individuals who fall frequently are at a higher risk for injurious falls than those who only fall once. Because of the link between multiple risk factors and increased falls incidence, it is extremely important to identify the combination of risk factors to best predict multiple fallers, so interventions can be targeted to the individuals most at risk.

Therefore, the purposes of our study were to examine relationships between balance self-efficacy, physical function, the residential setting and fall number in an older adult population; and to develop an equation to accurately predict multiple fallers (vs. one-time fallers). We asked the following research questions: 1) Will balance self-efficacy and physical function scores differ between older adults living independently in the community and those in retirement communities? 2) Will balance self-efficacy scores positively correlate to physical function scores and negatively correlate to fall number? and 3) Can the results of balance self-efficacy questionnaires and physical function tests as well as the residential setting be used to discriminate between one-time vs. multiple fallers in this older adult population?
METHODS

Subjects

Participants in this study consisted of elderly adults between 65 and 95 years of age (M=61 F=256) who were part of an ongoing falls surveillance study (Table 1). Inclusion criteria for the study included: 65 years of age or older, ambulatory with or without an assistive device, and without physical or cognitive limitations that would prevent them from completing the tests. In addition, each of the community subjects had experienced a fall prior to their inclusion in the study.

The participants lived independently in the community (n=105), or were residents of a retirement community (n=212). Residents of the retirement communities lived in their own apartments, were served meals in a group dining room, and received some assistance with cleaning and household maintenance. The two populations were tested separately, with the community subjects tested in the university laboratory one year and the research team traveling to the retirement communities for testing the following year.

The Institutional Review Board approved the study, and all subjects gave written informed consent prior to participation.
Table 1. Subject Characteristics by Group (Mean ± SD)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Community (n=105)</th>
<th>Retirement (n=212)</th>
<th>Total (n=317)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>77.6 ± 4.8</td>
<td>82.2 ± 5.5</td>
<td>80.7 ± 5.7</td>
</tr>
<tr>
<td>Height (centimeters)</td>
<td>161.4 ± 8.7</td>
<td>161.6 ± 8.9</td>
<td>161.5 ± 8.9</td>
</tr>
<tr>
<td>Weight (kilograms)</td>
<td>69.1 ± 13.1</td>
<td>67.7 ± 12.6</td>
<td>68.2 ± 12.8</td>
</tr>
<tr>
<td>Falls (number)</td>
<td>183</td>
<td>187</td>
<td>370</td>
</tr>
<tr>
<td>Fallers (number) (% pop)</td>
<td>102 (97.1%)</td>
<td>95 (44.8%)</td>
<td>197 (62.1%)</td>
</tr>
</tbody>
</table>

*Procedures*

Subjects living in the local community were recruited from flyers or from other research studies that were ongoing in the lab. Subjects living in the retirement communities were recruited through presentations made at their facilities by the research staff.

Prior to testing, all participants completed a health history questionnaire, which included some general questions concerning health habits and daily physical activity. Height and weight were measured to the nearest cm and kg. Balance confidence was assessed using the Balance Self-Efficacy
Scale (18). The BSE consists of 18 questions asking respondents to rate the proportion of time they feel confident engaging in a particular task (I feel confident 0% of the time – I feel confident 100% of the time), and includes questions for rating confidence when performing tasks with assistance and then when performing the same tasks without assistance.

Testing for each subject was conducted on a single day. Participants were oriented to each task prior to being tested, and practice trials were allowed on the more complex tasks to make sure participants understood the directions. The order of testing was rotated among the study subjects, and subjects received verbal encouragement to complete all of the tasks to the best of their abilities. Participants were allowed to rest between testing stations (and during a test if needed) to minimize fatigue.

Physical function tests included measurements of agility, muscle strength, and static balance. The Timed Up-and-Go (16) and Tandem Gait (6) tests measure the time required for individuals to complete the test, with a faster time indicating better performance. During the Timed Up-and-Go, subjects rose from a seated position, walked forward three meters, turned around and returned to their chair, then sat back down, all as quickly as possible. For the Tandem Gait test, subjects walked heel-to-toe as fast as possible for 3.05 meters. At every step the heel of the stepping foot had to
make contact with the toe of the stance foot. If the subject failed to make heel-to-toe contact on more than three steps, the trial was repeated. The Timed Up-and-Go and Tandem Gait tests were each conducted twice, with the best score from the two trials used in subsequent analysis.

The Quick Step test (Orthopedic Biomechanics Laboratory, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA) was used to measure reaction and movement time while subjects stepped to the side (46). Subjects stood on pressure sensitive pads that controlled two timers. Upon a visual stimulus, subjects stepped to the side as quickly as possible. The distance of each step was also measured so that lateral stepping velocity could be calculated. Stepping in both directions was tested, and an average of five trials was used to determine results in each direction.

The Nicholas Manual Muscle tester (Lafayette Instruments, Lafayette, IN), a hand-held dynamometer, was used to measure isometric strength of the hip abductor of each leg (in kilograms). Subjects were positioned supine on the testing table with one side of their body against a wall for stabilization. The dynamometer was placed on the lateral aspect of the thigh three inches proximal to the knee joint. Subjects were instructed to lift their foot off the table approximately one centimeter and to keep their knee extended and their toes facing upward, pushing against the dynamometer as hard as possible.
Subjects completed three test trials on each leg, and the best score for each was used.

The Accu-Sway force platform (ACS-110, Advanced Medical Technology, Inc. Watertown, MA) was used to evaluate static balance by measuring body sway while in a standing position. Subjects stood as still as possible on a force platform during four trials, each lasting 20 seconds. The trial conditions included standing comfortably with eyes open, standing comfortably with eyes closed, and standing in a semi-tandem position with each foot in the forward position for one of the trials (eyes were open). The results of the left and right semi-tandem conditions were averaged. Sway was measured (in cm) during each of the conditions, with average sway defined as the standard deviation around the average center of pressure during each 20-second testing period.

As part of the ongoing falls surveillance study, participants were asked to record any falls they experienced during the course of one year after testing. Postcards were mailed to the community participants every three months asking if they had fallen during the previous months. Because we thought the retirement population might have trouble remembering details of a fall that occurred too far in the past, postcards were mailed to retirement subjects every two months. All subjects who responded in the affirmative were contacted by
phone by one of two researchers to determine the details of the fall. The researchers used a standard scripted set of questions to record the specific details of each fall. This information was documented in writing and added to the participants' history file. Subjects who did not return postcards within one month were also contacted by phone to determine their fall status.

**Data Analysis**

The participant database was verified to make sure all test values were recorded. Any participants with missing test scores or fall documentation were excluded before statistics were run. A total of 317 participants were included in the statistical analysis, made up of 105 independent community dwellers and 212 retirement community dwellers.

Balance self-efficacy scores were categorized as follows: BSE average score, BSE average score on questions using assistance, BSE average score on questions not using assistance, and BSE average score on neutral questions (those not specifying with or without assistance). In order to calculate the scores, we added the subject's responses for each question assigned to a particular category and then divided by the total number of questions in that category. For our final research question, we looked at only the 197 individuals who had experienced a fall between the initial testing date and the end of the l-
year follow-up period. Half of these subjects had experienced a single fall (n=99), and half had incurred 2 or more falls (n=98). For our regression analysis we used the categories of one-time versus multiple fallers.

Descriptive statistics were used to examine normality, linearity, and homogeneity of variance for all measures. Data were analyzed using Statistical Package for the Social Sciences (SPSS) Version 11.0 (SPSS Inc, Chicago, IL, USA). A One-Way Analysis of Variance (ANOVA) was used to evaluate the relationship between balance self-efficacy and physical function scores in the older adults living in the community versus those living in retirement communities. We controlled for fall status in the analysis in order to assess differences between the two residential settings. Correlation analyses were run to determine if relationships existed between balance self-efficacy scores versus physical function scores and fall number, while controlling for the residential setting. Stepwise logistic regression was used to determine the subject variables most strongly associated with falling and to derive a predictive equation to identify individuals likely to be multiple fallers. To determine which variables should be considered in the regression analysis, we used an ANOVA to identify the variables that tended to differ (p < 0.1) between the falling groups. The ANOVA identified 10 qualified test variables to enter into the regression analysis (Table 2). We also entered participant
height, weight, age, and gender as potential variables. The regression analysis was run using a stepwise/forward condition, with inclusion and exclusion at p ≤ 0.1. The size of our population (n=317) greatly increased the chances of detecting a significant effect, if one truly existed in our population.

Table 2. Variables identified by ANOVA analysis as different between the falling groups, used in the stepwise regression analysis (p < 0.1)

<table>
<thead>
<tr>
<th>Variable</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tandem Gait</td>
<td>.000</td>
</tr>
<tr>
<td>Eyes Open Sway (Lat)</td>
<td>.009</td>
</tr>
<tr>
<td>Tandem Sway (Lat)</td>
<td>.005</td>
</tr>
<tr>
<td>Tandem Sway (A/P)</td>
<td>.014</td>
</tr>
<tr>
<td>Tandem Sway (Velocity)</td>
<td>.007</td>
</tr>
<tr>
<td>QS Reaction Time</td>
<td>.011</td>
</tr>
<tr>
<td>QS Velocity</td>
<td>.000</td>
</tr>
<tr>
<td>BSE Average Score</td>
<td>.000</td>
</tr>
<tr>
<td>BSE Score (No Assist)</td>
<td>.000</td>
</tr>
<tr>
<td>BSE Score (Neutral)</td>
<td>.013</td>
</tr>
</tbody>
</table>
RESULTS

The ANOVA revealed significant differences (p < .05) in physical function and balance confidence between individuals in the two residential settings. Specifically, the scores for individuals living in the community were significantly better than the scores for individuals in retirement communities on the following test variables: Timed Up & Go, Tandem Gait, Quick Step reaction time & stepping velocity, body sway while standing in a semi-tandem position, and BSE scores (Table 3). A correlation analysis between BSE scores and physical function scores revealed that 75% of the physical function scores were significantly correlated (p < .05) to the balance self-efficacy scores, with R values that ranged from R = 0.113 to 0.559.

Fall numbers were significantly correlated (p < .05) to BSE scores 25% of the time, although correlations were weak, with R-values ranging from R = 0.102 to 0.126. The logistic regression model that best differentiated one-time and multiple fallers included only one variable, medial-lateral sway while standing comfortably with eyes open. The resulting logistic equation is:

Log (μ/ (1-μ)) = -.728 + (2.851 * lateral sway, eyes open).

The signs of the equation indicate that older adults are likely to experience multiple falls if they have a high amount of medial-lateral sway while standing comfortably with their eyes open.
Table 3. Physical function and BSE differences between community and retirement residents. Items in **bold** are significant at *p < .05.*

<table>
<thead>
<tr>
<th>Variable</th>
<th>M ± SD (Community)</th>
<th>M ± SD (Retirement)</th>
<th><em>p</em> Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gait Variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timed Up &amp; Go</td>
<td>9.09 ± 2.74</td>
<td>10.1 ± 3.93</td>
<td>.022</td>
</tr>
<tr>
<td>Tandem Gait</td>
<td>18.3 ± 10.5</td>
<td>27.4 ± 15.3</td>
<td>.000</td>
</tr>
<tr>
<td><strong>Strength/Speed/Reaction Time Variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quick Step Reaction Time</td>
<td>0.56 ± 0.16</td>
<td>0.68 ± 0.28</td>
<td>.000</td>
</tr>
<tr>
<td>Quick Step Velocity</td>
<td>89.5 ± 27.7</td>
<td>67.7 ± 23.7</td>
<td>.000</td>
</tr>
<tr>
<td>Manual Muscle L/R Avg.</td>
<td>18.2 ± 5.75</td>
<td>17.9 ± 6.79</td>
<td>.574</td>
</tr>
<tr>
<td><strong>Body Sway Variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eyes Open Sway (Lateral)</td>
<td>0.24 ± 0.17</td>
<td>0.29 ± 0.27</td>
<td>.055</td>
</tr>
<tr>
<td>Eyes Open Sway (Ant/Post)</td>
<td>0.41 ± 0.17</td>
<td>0.47 ± 0.43</td>
<td>.427</td>
</tr>
<tr>
<td>Eyes Open Sway Velocity</td>
<td>1.65 ± 0.79</td>
<td>1.84 ± 1.57</td>
<td>.134</td>
</tr>
<tr>
<td>Eyes Closed Sway (Lateral)</td>
<td>0.31 ± 0.17</td>
<td>0.36 ± 0.38</td>
<td>.184</td>
</tr>
<tr>
<td>Eyes Closed Sway (Ant/Post)</td>
<td>0.53 ± 0.28</td>
<td>0.58 ± 0.45</td>
<td>.257</td>
</tr>
<tr>
<td>Eyes Closed Sway Velocity</td>
<td>2.34 ± 1.28</td>
<td>2.37 ± 1.66</td>
<td>.258</td>
</tr>
<tr>
<td>Tandem Sway (Lateral)</td>
<td>0.68 ± 0.21</td>
<td>0.76 ± 0.40</td>
<td>.020</td>
</tr>
<tr>
<td>Tandem Sway (Ant/Post)</td>
<td>0.59 ± 0.34</td>
<td>0.69 ± 0.42</td>
<td>.028</td>
</tr>
<tr>
<td>Tandem Sway Velocity</td>
<td>3.83 ± 1.51</td>
<td>4.52 ± 2.43</td>
<td>.025</td>
</tr>
<tr>
<td><strong>Balance Self-Efficacy Variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BSE Scores (average)</td>
<td>81.2 ± 18.1</td>
<td>70.1 ± 19.3</td>
<td>.000</td>
</tr>
<tr>
<td>BSE Scores (with assistance)</td>
<td>87.2 ± 16.5</td>
<td>81.4 ± 17.3</td>
<td>.017</td>
</tr>
<tr>
<td>BSE Scores (no assistance)</td>
<td>71.5 ± 23.6</td>
<td>52.7 ± 27.1</td>
<td>.000</td>
</tr>
<tr>
<td>BSE Scores (neutral)</td>
<td>87.6 ± 16.5</td>
<td>80.8 ± 17.9</td>
<td>.004</td>
</tr>
</tbody>
</table>

A Relative Operating Characteristic (ROC) curve analysis was used to verify the correct classification of one-time and multiple fallers (Figure 1). ROC curves are useful in evaluating the performance of classification schemes for which there are two categories by which subjects are classified, in our case,
one-time vs. multiple fallers. A ROC curves evaluates how well the logistic regression equation performs. The model correctly predicted 58.9% of the participants, (using a cut point of 0.5). Specificity (the ability to correctly predict one-time fallers) was 73%, and sensitivity (the ability to correctly predict fall category. Area under the curve = 0.634 (p < .001)

Figure 1. ROC Curve analysis of regression equation using medial-lateral sway to predict fall category. Area under the curve = 0.634 (p < .001)
predict multiple fallers) was low at 43%. The area under the curve was 0.634 (p < .001), indicating that the model was significantly better at classifying fallers than chance alone.
DISCUSSION

The aim of this study was to explore relationships among physical function, balance self-efficacy, fall status and residential settings in adults 65 years of age and older. We reported that several physical function and balance self-efficacy scores were significantly different for older adults who lived in the community vs. older adults who lived in retirement communities, with better scores noted for the community dwellers as hypothesized. Balance self-efficacy scores and physical function scores were positively correlated and balance self-efficacy scores and fall number were negatively correlated, also in line with our hypothesis. A regression equation that included medial-lateral sway while standing comfortably with eyes open correctly predicted the fall status of 58.9% of participants, and indicated that a high medial-lateral sway measurement would be predictive of a multiple faller. This was consistent with our hypothesis, although we expected that more variables would have been included in the equation, as it is well documented that the prediction of fall risk encompasses multiple factors.

This study had several strengths. First, we were one of the first to compare older adults living in the community against those living in retirement communities for differences in physical function, balance self-efficacy and fall
number. Very little has been reported about the retirement community population and how residents of these communities may differ from those in other residential settings. The inclusion of fall data for one year from the testing date is a major strength of our study. We had two researchers who shared the duty of responding to postcard mailings and collecting fall data from participants (using scripted questions), increasing the reliability of our data. Our study population included both men and women between the ages of 65 and 95, which is the demographic most at risk for experiencing falls and substantial injuries as a result of their falls. The large sample size (N=317) and inclusion of both men and women allows us to generalize our results across a wide population of older adults of both genders.

Our study had limitations as well. Subjects were tested initially on physical function and balance self-efficacy, and then followed for one year to document fall data. Because subjects were not re-tested at the conclusion of the follow-up period, we were unable to determine whether changes in physical function or balance self-efficacy had occurred that could have affected the incidence of falls or fall-related injuries.

Another limitation is that subjects in the two residential settings were tested at different times. The community population was tested one year, and the retirement community population was tested the following year. One of the
requirements for inclusion in the study for the community dwelling subjects was the occurrence of a fall during the six months prior to the start of the study. This was not the case for the retirement population, and we do not have data indicating whether or not they incurred a fall prior to beginning our study. Therefore, our community dwelling population included no true "non-fallers", even though we did have a very small number (3 out of 105) who did not experience any additional falls throughout the follow-up period. This may help explain the very high fall incidence within our community dwelling subjects compared to what has been reported in the literature (Table 1). We believe that individuals who had never experienced a fall may have scored even higher on balance self-efficacy and physical function tests than those who were one-time or multiple fallers, potentially increasing the gap in ability and self-efficacy levels between the two groups.

Other data that would have enhanced our study include the length of time participants lived in their current setting (community or retirement) prior to entering the study. Without this data we were unable to differentiate between individuals who recently moved versus those who lived in their current residence for months or years. This may have been an important factor to consider, as we believe the residential setting may influence the overall activity level of its residents. Long-term residents of each residential setting
would be the most likely candidates to assess for differences in activity levels, physical function, and balance confidence. In addition, we did not collect data on the level of assistance, if any, community dwelling subjects received with cleaning, meal preparation or yard maintenance, assuming that they performed their own chores. Finally, we did not factor in the use of medications that may have contributed to instability in some subjects.

We found significant differences in physical function (gait, speed, reaction time, sway and strength) and in BSE scores between the subjects living in the community vs. those in retirement communities. Individuals living in the community scored better overall, and significantly better over 61% of our test categories. Our findings align with those of Schroeder, Nau, Osness and Potteiger (19), who reported significant differences in functional ability, dynamic balance, lower body strength, and flexibility between similarly aged older adults living either in nursing facilities, assisted-care facilities, or in the community. Their research also reported better physical function in those subjects living in the community. Among our community dwelling subjects, we required the occurrence of a fall for inclusion in our study. If we had included community subjects with no fall history, the results of our analysis between the two residential settings may have been even more dramatic.
The results of the Balance Self-Efficacy Scale also were significantly different between community dwelling adults and those in retirement communities. In our study, the average BSE score for those living in the community was 81% (out of 100), versus a 70% average score for those individuals living in retirement communities. A difference of 18% (72% vs. 53%) was noted between the two groups on specific BSE questions relating to performing tasks using no assistance (hands, stabilizing bars, handrails, etc). These differences in physical function and self-efficacy indicate that the community subjects as a group had better physical function and also higher self-efficacy related to their functional abilities.

Myers et al (13) and Powell & Myers (17) hypothesized that the connection between fear of falling and actual falls may be the result of activity restriction. Howland et al. (7) supported this, reporting that a substantial number of older adults who experience fear of falling do curtail their physical activities, resulting in a decline in physical functioning over time. Our study, which compared community dwelling older adults with retirement community dwellers using the same test variables, also found that the older adults living in the community scored higher on tests of physical function and balance self-efficacy than those in retirement communities. We believe this measurable difference between function and confidence may be the result of community
dwelling adults maintaining a more active lifestyle. We also found significant though moderate, positive correlations between balance self-efficacy and physical function scores. The tests with the strongest relationship to BSE included the Timed Up & Go (R = 0.559, p < .000), Quick Step reaction time (R=0.406, p < .000), and hip abductor strength (R=0.409, p < .000).

Self-efficacy as defined by Bandura (1) is an individuals' belief they can successfully complete a course of action, and as such is a dynamic belief that can change over time as the individual changes. We would expect it to remain stable unless a stimulus is added to change it, such as exercise, a dramatic change in health status, or an increasingly sedentary lifestyle. Self-efficacy and skill are related but independent qualities that can be affected by numerous circumstances. Our study looked specifically at the relationship between self-efficacy and physical function, and did not include other factors that have been shown to affect balance self-efficacy, such as medication use, changes in health status, vision problems or injuries. In addition, we picked only a small number of tests to measure what we considered to be the most important physical variables, those of agility, sway, strength, and speed/reaction time. Using other test protocols may have produced very different results, so we were pleased that our correlation between function and balance self-efficacy was moderate and significant. Our findings are in support
of those by Gunter et al. (4), who reported that BSE scores were moderately predictive of functional tests such as the Timed Up & Go, Tandem Gait and lateral sway. Cumming et al. (3) reported that older adults with low self-efficacy scores showed greater declines in the ability to perform activities of daily living without assistance, and were also at higher risk for future falls. Tinetti & Williams (22) hypothesized that poor confidence or efficacy in performing daily tasks was a potent determinant of decline in activities of daily living among individuals who also declined on key balance and gait measures.

Our BSE scores were negatively correlated to fall number, although the correlation was weak, at R=0.102 to 0.126 (p < .05). Most researchers have reported that individuals with low self-efficacy scores tend to have a higher number of falls than those with high self-efficacy scores (3, 4, 20). Gunter et al. (4) reported in a study of elderly adults that balance self-efficacy scores distinguished fallers from non-fallers. Because our community group was made up of individuals who had all fallen at least once, they may have started out with lower self-efficacy related to falling and therefore gave us a different test result. With the inclusion of some community subjects with no fall history, we might expect to find a wider gap in test scores between the two residential settings, and a stronger negative correlation between BSE scores and fall numbers.
Our regression analysis resulted in an equation that used medial-lateral sway while standing comfortably with eyes open as the best predictor of multiple fallers. Although medial-lateral sway was included in the regression equations of other research studies, it was not the only variable used in their equations. Lateral stability has been reported to play an important role in mobility (4, 8, 10, 11, 24), however, it is only one of the many variables that may affect fall risk.

In conclusion, significant differences in physical function and balance self-efficacy were found between subjects in the different residential settings, regardless of fall incidence. Subjects living in the community had significantly better scores on the variables of gait, speed and reaction time, body sway, and balance self-efficacy. In addition, positive correlations were found between balance self-efficacy scores and physical function variables, reinforcing the idea that function and confidence are related.

BSE scores were negatively correlated to fall number although R-values were weak, indicating that in our population, self-efficacy scores were not strongly related to the number of falls one experienced. A regression equation correctly classified 58.9% of subjects as one-time or multiple fallers using the single variable of medial-lateral sway. Research has already shown the assessment of fall risk to be complicated and include multiple factors of
risk, so it is not surprising that our equation using only one function variable did not predict the majority of multiple fallers correctly.

We know that there is a strong relationship between overall physical activity level and functional ability, and that for the majority of older adults who do not participate in recreational physical activity on a regular basis; household chores make up a large part, if not all, of their daily physical activity. It is less important to determine which occurs first, the inactivity or the functional decline; but to acknowledge that each of these conditions will perpetuate the other, leading to a vicious cycle of increasing inactivity and diminishing function.

In our study, the retirement population incurred a much lower percentage of falls overall than our community population, despite having poorer function and lower balance self-efficacy. Most likely this is a result of the safer external environment that comes with living in a retirement community. However, this population may also be adopting an increasingly sedentary lifestyle that places them at risk for declines in function and higher falls incidence. We strongly encourage retirement facility administrators to take this into account when planning activities and programs for their residents. It is important to keep them active pursuing enjoyable and
appropriate activities that will allow them to maintain their independence for as long as possible.

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REFERENCES


CHAPTER THREE: CONCLUSION

Falls are extremely common among the older adult population and account for substantial morbidity and mortality (42). Since adults aged 65 and older are the fastest growing segment of the U.S. population, it follows that falls in this demographic will present an enormous public health burden.

Fear of falling is prevalent among adults 65 and older, and has been reported in as many as 50-60% of previous fallers and 20-40% of those who have not yet fallen. Physical function and mobility are also important components of fall risk. Another factor that may also contribute to increased fall risk is the living situation. Several studies have looked at the differences in physical characteristics between independent older adults living in the community, and those in assisted-living facilities or nursing homes (30, 37, 39, 40, 45). However, little has been reported about the characteristics and abilities of older adults in retirement communities, where they have their own living space, but may receive assistance with cleaning and maintenance, and are served at least one meal per day in a group dining room. For many older adults, tasks of daily living make up the majority of their physical activity. Taking away the need for that activity puts them at risk of becoming increasingly sedentary, and may result in a decline in physical function over time.
Our study found significant differences in physical function (gait, speed, reaction time, body sway and strength) and in BSE scores between the subjects living independently vs. those in the retirement community; with individuals living in the community scoring significantly better on 61% of our functional tests. The average BSE score was also higher for those living in the community, with the largest difference between the two groups on the category of BSE questions relating to performing tasks using no assistance (hands, stabilizing bars, handrails, etc). These differences in physical function and self-efficacy indicate that the community subjects as a group had better physical function and also higher self-efficacy related to their functional abilities. We believe this measurable difference between function and confidence is the result of community dwelling adults maintaining a more active lifestyle.

The physical function tests with the strongest correlation to BSE scores included the Timed Up & Go (R= 0.559, p=.000), Quick Step reaction time (R=0.406, p=.000), and hip abductor strength (R=0.409, p=.000). Because we looked specifically at the relationship between self-efficacy and physical function, we did not include other factors that have been shown to affect balance self-efficacy, such as medications, changes in health status, vision problems or injuries. Our result of positive moderate correlations between
physical function variables and balance self-efficacy showed that there was a measurable relationship between function and self-efficacy in our population.

Our BSE scores were negatively correlated to the number of falls an individual experienced (R=0.102 to 0.126, p < 0.02), however this correlation was weak. As a result of the inclusion criteria for our study, the community group did not include any true non-fallers. If our study had included subjects who had never experienced a fall vs. subjects who had experienced one or more falls, I believe that the true non-fallers would score higher on balance self-efficacy than any of the other subjects. Since our community group was made up of individuals who had all fallen at least once, they may have started out with self-efficacy that had been affected by these initial falls, and therefore gave us a test result that was different from what has been published in other research studies. Interestingly, our community group also had a higher than expected number of falls over the 1 year follow-up period (n=105, falls=183). This is a puzzling result given that the community population had higher balance self-efficacy than our retirement subjects. There were only 3 subjects in the community group who did not experience any additional falls during the follow-up period, in contrast with 117 out of 212 retirement subjects with no fall incidence. It may be that the retirement community, being set up specifically with the needs of older adults in mind, included fewer
environmental hazards and therefore helped this group to move around with less risk of falling. It may also be that through self-selection, frail or inactive older adults who are not confident in their ability to live independently will move into retirement communities where help is available to them. Individuals who believe they are frail are less likely to replace the activities of daily living they used to perform with some other type of physical activity. This may help to explain why our retirement subjects included many individuals who did not experience any falls during the 1 year follow-up period.

Many of the community subjects reported falls that occurred as a result of slips and trips over garden hoses, curbs, tools, cords, or other objects in their path, but for some reason, even though 97.1% of subjects reported at least one fall in the year following testing, they still had better self-efficacy related to falls as a group than the retirement subjects. It is possible they think of their falls not as a serious problem but a natural part of the activities involved in maintaining a household, and so they remain confident in their abilities. I don’t know the answer but I feel it deserves further consideration as a research topic.

Our regression analysis resulted in an equation that used medial-lateral body sway while standing comfortably with eyes open as the best predictor of multiple fallers. Medial-lateral stability has been reported to play an important
role in mobility (12, 18, 22, 40, 46), however, it is only one of the many variables that may affect fall risk. Because it is well documented that multiple factors are involved in the assessment of fall risk, I am not surprised that our equation, using only one variable, did not prove to be a good predictor of multiple fallers.

In conclusion, significant differences in physical function and balance confidence occurred between subjects in the two living situations, regardless of fall incidence. Positive moderate correlations between BSE scores and physical function scores supported the hypothesis that function and confidence were related in our population. BSE scores were negatively related to fall number with a weak correlation, indicating that our subject's self-efficacy scores were not predictive of the number of falls they experienced. Our regression equation correctly classified 58.9% of subjects as one-time or multiple fallers using the single variable of medial-lateral body sway, with specificity of 73% and sensitivity of 43%.

We know that there is a strong relationship between overall physical activity level and functional ability, and that for the majority of older adults who do not participate in recreational physical activity on a regular basis, household chores make up a large part if not all of their daily physical activity. Taking away even that small amount of activity can lead to a decrease in
function over time. I believe more research is needed on the population of older adults in retirement communities, who although they live independently, may be adopting a sedentary lifestyle that places them at risk for declines in physical function and increases in falls incidence. Many of these older adults are still mostly mobile and in good health, and would be an appropriate group to target for interventions to reduce fall risk. I would encourage retirement facility administrators to purposefully plan activities and programs to keep their residents as active as possible, in order to maintain their function and allow them to remain independent for as long as possible.
BIBLIOGRAPHY


Appendix A: Informed Consent Form A

(Retirement Community Population)
Side Fall Risk Index Experiments: Informed Consent Form

Purpose: In the United States, nearly 300,000 hip fractures occur each year, and 90% of them are associated with falls. Although not every fall has serious consequences, a fall which results in a hip fracture ranks amongst the most serious of medical conditions. Previous work has indicated that the type of fall a person takes can increase the risk of hip fracture. Specifically, a sideways fall increases the risk of hip fracture 6 to 30 times.

This series of experiments have been developed to assist in identifying people at risk for a sideways fall. Several risk factors for falling will be examined including balance, mobility, and strength.

Subjects: I have been invited by Dr. Christine Snow or Dr. Karen White (Co-Principal Investigators) to participate in this study. I understand that the purpose of this longitudinal study is to identify physical characteristics that may predict a sideways fall.

I have been selected as a subject in this study because I am greater than 70 years old, I can ambulate independently with or without the help of a walking aid, and I am considered at high risk for a fall based upon my medical history. I will be asked to fill out a questionnaire regarding my general health and another on my confidence in my balance abilities. I am able to participate in physical activity and I agree to inform the investigator of any condition that may affect my performance in this series of experiments.

Testing Protocol: I will participate in the series of measurements that follow:

1. Reaction and Movement Time: I will stand in a relaxed position in front of a light signal. When the light turns red I will step to the side as quickly as possible. The test will be repeated 5 times on each leg.

2. Physical Function: I will be asked to walk heel to toe as quickly as possible and to stand up walk a short distance then return to my seat as quickly as possible.

3. Strength: I will have my hip strength measured with a simple device that I will press the side of my leg against.

4. Balance: I will be asked to stand on a stationary platform, with my feet in various positions, while computer sensors under the platform measure how much I sway.

One-Year Record of Falls: After the initial testing session, I agree to record my falls over a one-year period and share this information with the study investigators. I understand that I will receive a postcard from the investigators every two months asking whether I have experienced a fall during that period. I am to return the postcard.
indicating whether I've had a fall or not. If I have experienced a fall, one of the investigators will call me to learn the details about how and why I fell, with particular emphasis on learning about the direction of the fall and what part of my body I landed on.

Risks and Benefits: It has been explained to me that the benefit of participating in this study is to help identify simple procedures to predict men and women who may be at risk for a side fall.

I understand that the risk involved in the performance of these tests is small. To further minimize the risk I will be assisted by a trained "spotter" at all times. Also, due to the physical nature of these tests I may experience some minor muscle soreness. This should clear up completely in a day or two. I understand that Oregon State University does not provide a research subject with compensation or medical treatment in the event a subject is injured or as a result of participation in the research project.

Confidentiality
I understand that my confidentiality will be maintained and that only the researchers will have access to my results. I have been informed that the results of this study may be published in scientific literature, and that these data will not reveal my name.

Participation and Questions
I understand that participation is voluntary and that I may stop doing a test if it is uncomfortable or may withdraw at any time without penalty. The researchers have offered to answer any questions that I may have. I understand that my participation is voluntary and that I may withdraw without penalty at any time. I understand that any questions I have about the research study and/or specific procedures should be directed to Dr. Karen White at 541-737-8198, 125 Women's Building, Oregon State University or Dr. Snow at 541-737-6788, 106 Women's Building, Oregon State University. Any other questions that I have should be directed to the Sponsored Programs Officer, OSU Research Office, 541-737-0670.

I have read the above consent form and I agree to participate.

Subject Signature____________________________________ Date________________

Investigator's Signature________________________________ Date________________
Appendix B: Informed Consent Form B

(Community Dwelling Population)
Side Fall Risk Index Experiments: Informed Consent Form

Purpose: In the United States, nearly 300,000 hip fractures occur each year, and 90% of them are associated with falls. Although not every fall has serious consequences, a fall that results in a hip fracture ranks among the most serious of medical conditions. Previous work has indicated that the type of fall a person takes can increase the risk of hip fracture. Specifically, a sideways fall increases the risk of hip fracture 6 to 30 times.

This series of experiments has been developed to assist in identifying people at risk for a sideways fall. Several risk factors for falling will be examined including balance, mobility, and strength.

Subjects: I have been invited by Dr. Christine Snow (Principal Investigator) or Dr. Karen White (Research Associate) to participate in this study. I understand that the purpose of this study is to identify physical characteristics that may predict a sideways fall. I have been selected as a subject in this study because I am greater than 70 years old, I can ambulate independently with or without the help of a walking aid, and I have fallen at least once in the past six months. I am both physically and mentally able to participate in the tests in this study and I agree to inform the investigator of any condition that may effect my performance in any of the tests.

Protocol: I will participate in the series of tests that follow:

1. Quick Step Test: I will stand in a relaxed position in front of a light signal. When the light turns red I will step to the side as quickly as possible. The test will be repeated 5 times on each leg.

2. Physical Function: I will walk in a straight line at normal speed then as quickly as possible for 4 other tests of walking, a heel to toe, wide and narrow stance and a curved path. I will be asked to stand up from a seated position as quickly as possible, and to stand up walk a short distance then return to my seat as quickly as possible. I will also be asked to ascend three steps as quickly as possible.

3. Strength testing: I will have my leg strength measured with a simple device that I will press against in different directions. I will also have my ankle strength measured by strapping my foot to a foot plate and pressing against it in different directions. Each test will be repeated 3 times.

4. Muscle power testing: I will have my leg power tested on a seated leg press machine and be asked to press as hard as possible against a foot pedal. The test will be repeated 5-10 times on each leg.

5. Balance Testing: I will stand on a stationary platform, with my feet in various positions, while computer sensors under the platform measure how much I sway.

6. Questionnaires: I will fill out a questionnaire regarding my general health and another on my confidence in my balance abilities.
Risks and Benefits: It has been explained to me that the benefit of participating in this study is to help identify simple physical performance measures that can predict men and women who may be at risk for a side fall.

I understand that the risk involved in the performance of these tests is small. To further minimize the risk I will be assisted by a trained "spotter" at all times. Also, due to the physical nature of these tests I may experience some minor muscle soreness. This should clear up completely in a day or two. I understand that Oregon State University does not provide a research subject with compensation or medical treatment in the event a subject is injured, or as a result of participation in the research project.

Confidentiality: I understand that my confidentiality will be maintained and that only the researchers will have access to my results. I have been informed that the results of this study may be published in scientific literature, and that these data will not reveal my name.

Participation and Questions: I understand that participation is voluntary and that I may stop doing a test if it is uncomfortable or may withdraw at anytime without penalty. The researchers have offered to answer any questions that I may have. I understand that my participation is voluntary and that I may withdraw without penalty at any time. I understand that any questions I have about the research study and/or specific procedures should be directed to Dr. Karen White at 541-737-8198, 125 Women's Building, Oregon State University or Dr. Christine Snow at 541-737-6788, 106 Women's Building, Oregon State University. Any other questions that I have should be directed to Mary Nunn, Sponsored Programs Officer, OSU Research Office, 541-737-0670.

I have read the above consent form and I agree to participate.

Subject Signature________________________________ Date_____________________

Investigator's Signature_______________________________ Date_____________________


Appendix C: Health History Questionnaire A

(Retirement Community Population)
OREGON STATE UNIVERSITY BONE RESEARCH LABORATORY
Health History Questionnaire

Last name ___________________ First name ___________________ Middle ___________________ Date of birth ___________________

Address, street ____________________________________________________________ City, State ___________________

Phone work/home ___________ Phone home ___________ Email address ___________

Weight _______ pounds   Height _______ ft _______ inches

Please list your present medications and dosages
(include birth control pills/vitamins):

PAST HISTORY (Check if yes)                        FAMILY HISTORY (Check if yes)

Have you ever had?                        Have your grandparents, parents or siblings had?

High cholesterol ___________   Diabetes ___________   Heart attacks ___________

Rheumatic fever ___________   Heart attacks ___________   High blood pressure ___________

Heart murmur ___________   High blood pressure ___________   High cholesterol ___________

High blood pressure ___________   High cholesterol ___________   Congenital heart disease ___________

Heart trouble ___________   Congenital heart disease ___________   Heart operations ___________

Disease of arteries ___________   Heart operations ___________   Varicose veins ___________

Lung disease ___________   Varicose veins ___________   Other ____________________

Diabetes ___________   Other ____________________   Epilepsy ___________

Heart trouble ___________   Epilepsy ___________   Other musculoskeletal injury

other problems ___________   Other musculoskeletal injury ___________   Date of last medical exam? _________

High blood pressure ___________   Date of last medical exam? _________   High blood pressure ___________

Other_________________________   High blood pressure ___________   Varicose veins ___________

Other_________________________   Varicose veins ___________   Lung disease ___________

If yes to any of the above, please explain: ____________________________

Which describes your racial/ethnic identify? (Please check all that apply)

____ White, European American, Non Hispanic   ____ North African or North African American

____ Asian, Asian American   ____ Pacific Islander

____ Black, African American, Non Hispanic   ____ Hispanic of Latino American

____ Middle Eastern or Middle Eastern American   ____ American Indian or Alaskan Native

____ If none of the above choices apply to you, please use your own description:

____ Decline to respond
PRESENT SYMPTOMS REVIEW (Check if yes)

Have you recently had?
- Chest pain
- Shortness of breath
- Heart palpitations
- Cough on exertion
- Coughing blood
- Back pain
- Painful, stiff or swollen joints

Other___________________

HEALTH HABITS

Smoking

Do you smoke? YES NO

Cigarettes

How many/day? How many years?

Cigar

How many/day? How many years?

Pipe

Times/day? How many years?

If you have quit smoking, when did you quit? How many yrs did you smoke?

Alcohol Consumption

Do you drink alcohol daily? Y N (circle one) If yes, how many drinks/week?

Consumption of calcium-rich daily products

How many 8 oz glasses of milk do you drink per day? per week?

How many servings of cheese (1 oz) do you eat per day? per week?

How many servings of yogurt (1 cup) do you eat per week?

Body Weight

What was your weight 1 month ago? What was your weight 2 months ago?

Cola Beverages

How many cola beverages do you drink daily?

How many years have you been drinking cola beverages on a regular basis?

Activity History

I. In high school, would you describe yourself as:

____ active _______moderately active _______not active (please check one)

Were your activities predominately swimming or cycling? (if yes, circle one)

If not, please describe:

II. Since high school, would you describe yourself as:

____ active _______moderately active _______not active (please check one)

Were your activities predominately swimming or cycling? (if yes, circle one)

If not, please describe:
OSTEOPOROSIS RISK FACTORS

Please circle true or false for the following. If you think a statement may apply to you but are not sure, place a question mark (?) by that statement.

1. true false I have a history of rheumatoid arthritis.
2. true false I have been treated with cortisone or similar drugs.
3. true false I have a close relative with osteoporosis.
4. true false I have a history of an overactive thyroid gland.
5. true false I have a history of overactive parathyroid gland.
6. true false I have a history of alcoholism.
7. true false I have a history of chronic liver disease.
8. true false I have a history of multiple myeloma.
9. true false I have a history of the blood tumor, leukemia.
10. true false I have a history of stomach ulcers.
11. true false I have lactase deficiency (inability to digest milk).
12. true false Some of my stomach has been surgically removed.
13. true false I take anabolic steroids now or have in the past.
14. true false I avoid milk and other dairy products.
15. true false I usually eat meat at least twice a day.
16. true false I drink more than 2 cups of coffee or tea daily.
17. true false On average, I drink 2 or more soft drinks daily.
18. true false I have about 3 or more alcoholic beverages daily.
19. true false I follow a vegetarian diet and have so for years.
20. true false I am not very physically active most of the time.
21. true false I have lost more than 1 inch in height.
22. true false I have or have taken thyroid hormone pills.
23. true false I took phenobarbital or dilantin for over a year.
24. true false I use Maxloix or Mylanta antacids frequently.
25. true false I have taken furosemide (Lasix) for over one year.
26. true false I have been treated with lithium for over one year.
27. true false I have been treated with chemotherapy for cancer.
28. true false I have or have taken cyclosporin A (Sandimmune).
29. true false I have received an organ transplant (kidney, etc.).
30. true false I have had trouble with anorexia nervosa or bulimia.

(Women only)
31. true false I lost my period for a year or more before it came back.
32. true false I have had irregular menstrual periods.
33. true false My menstrual period did not begin until age 16.
34. true false I have a medical history of endometriosis.
35. true false I lost my periods when I was exercising heavily.
36. true false I have had both ovaries surgically removed.
37. true false I have breast fed a baby for one month or more.
38. true false I have taken tamoxifin as treatment for breast cancer.
39. true false I went through menopause before age 50.
40. true false I have received estrogen treatment after menopause.

If you take estrogen, for how many years? ________
How many children have you given birth to? ________
What was the date of your last menstrual period? ________
Appendix D: Health History Questionnaire B

(Community Dwelling Population)
OREGON STATE UNIVERSITY BONE RESEARCH LABORATORY
Health History Questionnaire

<table>
<thead>
<tr>
<th>Last Name</th>
<th>First Name</th>
<th>Middle Init.</th>
<th>Date of Birth</th>
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<table>
<thead>
<tr>
<th>Street Address</th>
<th>City, State, Zip</th>
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</table>

<table>
<thead>
<tr>
<th>Phone Number</th>
<th>Email Address</th>
<th>Occupation</th>
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</table>

**Which describes your racial/ethnic identity? (Please check all that apply)**

- White, European American, Non Hispanic
- North African or North African American
- Black, African American, Non Hispanic
- Middle Eastern or Middle Eastern American
- Other:
- Asian, Asian American
- Pacific Islander
- Hispanic or Latino American
- American Indian or Alaskan Native
- Decline to Respond

Please list your present medications (include vitamins and minerals):

- 
- 
- 
- 
- 

**PAST HISTORY** Have you ever had? (Check if yes)

- High blood pressure
- Heart trouble
- Disease of the arteries
- Lung disease
- Orthopedic operations

- Back injury
- Cancer
- Stroke
- Broken bones

**PRESENT SYMPTOMS** Have you had in the past 6 months? (Check if yes)

- Chest pain
- Shortness of breath
- Heart palpations
- Cough on exertion
- Coughing up blood
- Painful, stiff or swollen joints

- Dizziness
- Fainting
- Poor balance
- Poor vision
- Back pain

If you answered “yes” to any of the above, please elaborate:

- 
- 
- 


HEALTH HABITS

Alcohol Consumption
Do you drink alcohol daily? YES NO If "yes", How many drinks/week? ______

Smoking
Do you now smoke? YES NO If "yes", what do you smoke?____________
How many per day? ______ For how many years? ______
If you have quit, when did you quit? ______ How many years did you smoke? ______

DAILY ACTIVITIES

How much assistance do your typically require with the following activities?
*Please check (✓) the appropriate box

<table>
<thead>
<tr>
<th>Activity</th>
<th>None (I do all myself)</th>
<th>Occasional/Minimal (I do most myself)</th>
<th>Frequent/Moderate (I do some, but also have help)</th>
<th>Always/Maximum (I do very little/none)</th>
<th>Not Applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doing laundry</td>
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<td></td>
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<tr>
<td>Preparing meals</td>
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<tr>
<td>Washing dishes</td>
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<tr>
<td>Vacuuming</td>
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<tr>
<td>Making bed</td>
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<tr>
<td>Shopping</td>
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<tr>
<td>Bathing &amp; grooming</td>
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<tr>
<td>Driving</td>
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<tr>
<td>Walking outdoors</td>
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<tr>
<td>Climbing stairs</td>
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What type of leisure activities do you routinely participate in? How often?

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

Do you routinely engage in physical activities? YES NO (please circle)
If "yes", what type of activities do you participate in and how often?

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
Appendix E: Balance Self-Efficacy Scale – Version II

(Both Populations)
Balance Self-Efficacy Scale – Version II

Listed below are a series of tasks which you may encounter in daily life. Please indicate how confident you are today that you can complete each of these tasks without losing your balance. Your answers are confidential. Please answer as you feel, not as you think you should feel. Circle the NUMBER that corresponds to your level of confidence, NOT, the wording below the numbers.

1. How confident are you that you can get up out of a chair (using your hands) without losing your balance?

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<th>10%</th>
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<th>30%</th>
<th>40%</th>
<th>50%</th>
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<th>80%</th>
<th>90%</th>
<th>100%</th>
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<td>not at all</td>
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<td>confident</td>
<td>absolutely</td>
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2. How confident are you that you can get up out of a chair (not using your hands) without losing your balance?

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<th>0%</th>
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3. How confident are you that you can walk up stairs (using the handrail) without losing your balance?

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<th>10%</th>
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4. How confident are you that you can walk up the stairs (not using the handrail) without losing your balance?

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5. How confident are you that you can get out of bed without losing your balance?

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<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>not at all</td>
<td>somewhat</td>
<td>confident</td>
<td>absolutely</td>
<td>confident</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6. How confident are you that you can get into or out of a shower or bathtub (with the assistance of a handrail or support wall) without losing your balance?

- 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
- not at all  somewhat  absolutely
- confident  confident  confident

7. How confident are you that you can get into or out of a shower or bathtub (with no assistance from a handrail or support wall) without losing your balance?

- 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
- not at all somewhat absolutely
- confident  confident  confident

8. How confident are you that you can walk down a flight of ten stairs (using the handrail) without losing your balance?

- 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
- not at all somewhat absolutely
- confident  confident  confident

9. How confident are you that you can walk down a flight of ten stairs (not using the handrail) without losing your balance?

- 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
- not at all somewhat absolutely
- confident  confident  confident

10. How confident are you that you can remove an object from a cupboard located at a height that is level with your shoulder without losing your balance?

- 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
- not at all somewhat absolutely
- confident  confident  confident
11. How confident are you that you can remove an object from a cupboard located at a height that is above your head without losing your balance?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
not at all somewhat absolutely
confident confident confident

12. How confident are you that you can walk across uneven ground (with assistance) when there is good lighting available without losing your balance?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
not at all somewhat absolutely
confident confident confident

13. How confident are you that you can walk across uneven ground (with no assistance) when there is good lighting available without losing your balance?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
not at all somewhat absolutely
confident confident confident

14. How confident are you that you can walk across uneven ground (with assistance) at night without losing your balance?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
not at all somewhat absolutely
confident confident confident

15. How confident are you that you can walk across uneven ground (with no assistance) at night without losing your balance?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
not at all somewhat absolutely
confident confident confident
16. How confident are you that you can stand on one leg (with support) while putting on a pair of trousers without losing your balance?

<table>
<thead>
<tr>
<th>Percentage</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confidence</td>
<td>not at all</td>
<td>somewhat</td>
<td>confident</td>
<td>absolutely</td>
<td>confident</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

17. How confident are you that you can stand on one leg (with no support) while putting on a pair of trousers without losing your balance?

<table>
<thead>
<tr>
<th>Percentage</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confidence</td>
<td>not at all</td>
<td>somewhat</td>
<td>confident</td>
<td>absolutely</td>
<td>confident</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

18. How confident are you that you can complete a daily task quickly without losing your balance?

<table>
<thead>
<tr>
<th>Percentage</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confidence</td>
<td>not at all</td>
<td>somewhat</td>
<td>confident</td>
<td>absolutely</td>
<td>confident</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Finally, we are interested in understanding what factors affect your confidence levels. Please provide reasons why you answered the way you did on questions 1 through 18 on the lines below. For example, if you were not very confident, why do you feel that way? If you were not very confident about an activity because you no longer do it very often (e.g. climb stairs) we would like to know that also.

__________________________________________________________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________________________________
Appendix F: Falls Surveillance Survey

(Both Populations)
FALL SURVEILLANCE SURVEY

Completed by: ____________________________
Date: ____________________________

SUBJECT INFORMATION

Unit No: ____________________________
Name (last, first): ____________________________
Address: ____________________________
City: __________________ State: ______ Zip code: ______
Telephone: __________________
Birth date: __________________
Sex: M F
Height (inches): ____________ Weight (pounds): ____________
Mental status: __________________
1 = normal 3 = moderate impairment
2 = mild impairment 4 = severe impairment

Residence: __________________
1 = designated senior housing center 3 = other home
2 = apartment building (>3 stories) 4 = nursing home

Previous fracture history: __________________
1 = hip 5 = spine
2 = pelvis 6 = other
3 = humerus 7 = none
4 = distal radius 8 = unknown

FRACTURE INFORMATION

Did subject fracture hip? __________________
1 = yes 2 = no
IF NO, GO TO THE NEXT SECTION
Date of the fracture: ____________/__________/__________
Time of fracture: ____________ (24 hour clock)

Affected side (circle one) RIGHT LEFT

Fracture type: __________________
1 = cervical 3 = subtrochanteric
2 = intertrochanteric 0 = unknown

Associated injuries: __________________

How did the fracture occur? __________________
1 = fall 3 = possible spontaneous fracture
2 = accident other than fall (motor vehicle accident, etc.) 4 = other

IF SPONTANEOUS FRACTURE OR TRAUMA OTHER THAN FALL, STOP HERE
FALL CHARACTERISTICS

Description of fall:

______________________________________________________________
______________________________________________________________
______________________________________________________________
______________________________________________________________
______________________________________________________________
______________________________________________________________
______________________________________________________________
______________________________________________________________
______________________________________________________________

Fall was: __________________________________________________
1 = witnessed  
2 = un witnessed  
3 = unknown  

Have you fallen in the previous year:  ______________________
1 = yes  
2 = no  
3 = unknown  

Events at the onset of fall:

Activity at time of fall: _________________________________
1 = lying still  
2 = sitting still  
3 = standing still  
4 = transferring or changing position  
5 = slow walk  
6 = fast walk  
7 = ascending steps or curb  
8 = descending steps or curb  
9 = Vigorous recreational activity  
10 = other: _________________________________  
0 = unknown  

Fall height: __________________________________________________
1 = fall in horizontal position from bed (18")  
2 = fall from seated position (chair, toilet, seated position on stairs 17")  
3 = fall from standing height  
4 = standing fall from height of one step (8")  
5 = standing fall from height of two steps (16")  
6 = standing fall from chair or stool (18-20")  
7 = standing fall from height greater than chair or stool (estimate height _____________)  
0 = unknown  

Was there any warning prior to the fall? ______________________________
1 = no  
2 = dizziness  
3 = weakness  
4 = limp  
0 = unknown
Events during the fall

Fall direction:
1 = forward
2 = sideways
3 = backward
4 = other
0 = unknown/don't know

Did you attempt to break the fall by putting hand or arm out in front?
1 = yes
2 = no
0 = unknown

Did you grab onto something as you fell?
1 = yes
2 = no
0 = unknown

Did you attempt to recover from the fall with stumbling movements of the feet?
1 = yes
2 = no
0 = unknown

Characteristics of the impact

Impact surface:
1 = thick, padded rug/carpet
2 = rug without padding
3 = bare wood floor
4 = linoleum or soft tile
5 = ceramic tile
6 = concrete, cement, asphalt
7 = dirt/grass
8 = ice/snow
9 = other
0 = unknown

Impact location:
1 = head
2 = neck
3 = shoulder
4 = arm/hand
5 = chest/ribs
6 = abdomen
7 = back
8 = hip or side leg
9 = buttocks
10 = groin
11 = front of legs
12 = back of legs
13 = knee
14 = other
0 = unknown

Second impact location:
1 = head
2 = neck
3 = shoulder
4 = arm/hand
5 = chest/ribs
6 = abdomen
7 = back
8 = hip or side leg
9 = buttocks
10 = groin
11 = front of legs
12 = back of legs
13 = knee
14 = other
0 = unknown
Injury screening

<table>
<thead>
<tr>
<th>Injury location</th>
<th>type of injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>01 = no injury</td>
<td>01 = not applicable</td>
</tr>
<tr>
<td>02 = face</td>
<td>02 = abrasion – scraping of skin</td>
</tr>
<tr>
<td>03 = back of head</td>
<td>03 = laceration – skin tear</td>
</tr>
<tr>
<td>04 = right side of head</td>
<td>04 = bruise – swelling (black and blue)</td>
</tr>
<tr>
<td>05 = left side of head</td>
<td>05 = fracture</td>
</tr>
<tr>
<td>06 = neck</td>
<td>06 = dislocation</td>
</tr>
<tr>
<td>07 = right shoulder</td>
<td>07 = right shoulder</td>
</tr>
<tr>
<td>08 = left shoulder</td>
<td>08 = left shoulder</td>
</tr>
<tr>
<td>09 = right arm</td>
<td>09 = right arm</td>
</tr>
<tr>
<td>10 = left arm</td>
<td>10 = left arm</td>
</tr>
<tr>
<td>11 = right hand</td>
<td>11 = right hand</td>
</tr>
<tr>
<td>12 = left hand</td>
<td>12 = left hand</td>
</tr>
<tr>
<td>13 = chest (front)</td>
<td>13 = chest (front)</td>
</tr>
<tr>
<td>14 = back</td>
<td>14 = back</td>
</tr>
<tr>
<td>15 = abdomen</td>
<td>15 = abdomen</td>
</tr>
<tr>
<td>16 = right flank</td>
<td>16 = right flank</td>
</tr>
<tr>
<td>17 = left flank</td>
<td>17 = left flank</td>
</tr>
<tr>
<td>18 = right hip</td>
<td>18 = right hip</td>
</tr>
<tr>
<td>19 = left hip</td>
<td>19 = left hip</td>
</tr>
<tr>
<td>20 = buttocks</td>
<td>20 = buttocks</td>
</tr>
<tr>
<td>21 = right thigh</td>
<td>21 = right thigh</td>
</tr>
<tr>
<td>22 = left thigh</td>
<td>22 = left thigh</td>
</tr>
<tr>
<td>23 = right knee</td>
<td>23 = right knee</td>
</tr>
<tr>
<td>24 = left knee</td>
<td>24 = left knee</td>
</tr>
<tr>
<td>25 = right shin (calf)</td>
<td>25 = right shin (calf)</td>
</tr>
<tr>
<td>26 = left shin (calf)</td>
<td>26 = left shin (calf)</td>
</tr>
<tr>
<td>27 = right foot</td>
<td>27 = right foot</td>
</tr>
<tr>
<td>28 = left foot</td>
<td>28 = left foot</td>
</tr>
<tr>
<td>29 = pelvis</td>
<td>29 = pelvis</td>
</tr>
<tr>
<td>30 = prosthesis</td>
<td>30 = prosthesis</td>
</tr>
</tbody>
</table>

Injury 1: __________
Injury 2: __________
Injury 3: __________

Fill out with code for injury location and then code for injury type. If there was a hip fracture, put it as Injury 1.
Appendix H: Additional Analyses
Additional Analysis 1

A second logistic regression analysis was performed to see if changing the entry/exit values and cut point would allow more variables to be entered into our regression equation. For this analysis we used a cut point of 0.045, with entry/exit criteria at 0.2. This analysis resulted in a regression equation using two variables: medial-lateral body sway with eyes open and Quick Step stepping velocity. The equation correctly predicted 59.4% of our population into the correct fall category (one-time vs. multiple fallers), with specificity of 50% and sensitivity of 67%. The resulting equation for this analysis is:

\[
\log \left( \frac{\mu}{(1-\mu)} \right) = -1.502 + (0.009 \times \text{Quick Step stepping velocity}) + (3.186 \times \text{Lateral Sway Eyes Open}).
\]

This overall prediction rate of 59.4% for this equation is very similar to our first equation at 58.9%. Adding a second variable did not make this equation more accurate at predicting fallers overall. Raising the entry/exit level from 0.1 to 0.2 allowed an additional variable to be entered into the equation, and by also moving the cut point to 0.045 we were able to correctly predict more of the multiple fallers. We could have adjusted the cut point from our original equation to predict a higher percentage of multiple fallers; however, it would not have changed the overall effectiveness of our prediction equation. So, in
the end we chose to use the entry/exit value of 0.1 and the default cut point of 0.5 in our original analysis for the research paper.

Figure 2. Results of second ROC analysis using new fall status (one time vs. multiple fallers), entry and exit values of 0.2, and a cut point of 0.045. Area under the curve = 0.631 (p=.001).
Additional Analysis 2

For research Question 1, I wanted to determine whether physical function and balance self-efficacy scores differed between older adults living in the community and those in retirement communities. I knew that I would have to control for fall status so that it would not be a confounding factor in the analysis. I started out by using the fall categories that were identified by Dr. Kathy Gunter of the OSU Bone Lab in a study of older adults living in the community (those shown in Cat 1). I then ran two more ANOVA's to see whether changing criteria for the fall status categories would affect the analysis results. It was determined from these ANOVA’s that the differences between the two groups were nearly identical no matter what criteria were used to designate the fall status.
P-values for the different ANOVA’s are shown in the table. Significant results (p < .05) are listed in **bold** type.

<table>
<thead>
<tr>
<th>Test Variable</th>
<th>Cat 1</th>
<th>Cat 2</th>
<th>Cat 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timed Up &amp; Go</td>
<td>.034</td>
<td>.020</td>
<td>.055</td>
</tr>
<tr>
<td>Tandem Gait</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>Manual Muscle R/L avg</td>
<td>.336</td>
<td>.176</td>
<td>.410</td>
</tr>
<tr>
<td>QS reaction time</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>QS stepping velocity</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>Lateral Sway eyes open</td>
<td>.237</td>
<td>.073</td>
<td>.152</td>
</tr>
<tr>
<td>A/P Sway eyes open</td>
<td>.366</td>
<td>.445</td>
<td>.227</td>
</tr>
<tr>
<td>Sway Velocity eyes open</td>
<td>.210</td>
<td>.201</td>
<td>.421</td>
</tr>
<tr>
<td>Lateral Sway eyes clsd</td>
<td>.022</td>
<td>.024</td>
<td>.017</td>
</tr>
<tr>
<td>A/P Sway eyes clsd</td>
<td>.195</td>
<td>.023</td>
<td>.285</td>
</tr>
<tr>
<td>Sway Velocity eyes clsd</td>
<td>.318</td>
<td>.187</td>
<td>.656</td>
</tr>
<tr>
<td>Lateral Sway tandem</td>
<td>.002</td>
<td>.000</td>
<td>.006</td>
</tr>
<tr>
<td>A/P Sway tandem</td>
<td>.002</td>
<td>.000</td>
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<tr>
<td>Sway Velocity tandem</td>
<td>.008</td>
<td>.005</td>
<td>.005</td>
</tr>
<tr>
<td>BSE sum</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>BSE average</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>BSE no assist</td>
<td>.019</td>
<td>.004</td>
<td>.000</td>
</tr>
<tr>
<td>BSE assist</td>
<td>.000</td>
<td>.000</td>
<td>.018</td>
</tr>
<tr>
<td>BSE neutral</td>
<td>.004</td>
<td>.001</td>
<td>.005</td>
</tr>
</tbody>
</table>

**Table Legend:**

**Cat 1** = controlling for fall frequency (0= non-faller, 1= occasional faller, 2= frequent faller)

**Cat 2** = controlling for actual fall number

**Cat 3** = controlling for one-time or multiple fallers (0= 1 fall, 1=>1 fall)
For research Question 3, I wanted to see if a logistic regression analysis could identify an equation to correctly predict those older adults likely to be multiple fallers in our population. To prepare for the regression analysis, I ran ANOVA's to determine those characteristics that tended to differ (p < 0.1) between the falling groups. Because we knew that all of our community subjects had experienced a fall prior to inclusion in the study, but did not have data on prior fall experience for the retirement subjects, we chose to exclude all participants listed in the database as non-fallers. By doing this, we had 1 year of fall data for all subjects that we could verify to be correct. After excluding all subjects identified as non-fallers, we were left with 197 total subjects. I ran two separate ANOVA's on this group, using the following fall group categories: 1-2 falls vs. 3 or more falls, and 1 fall vs. 2 or more falls. The results of the 2 ANOVA's were essentially the same. We chose the second grouping for our research paper because it divided our participants in half and would maximize our power to determine a significant effect, if one existed in our population.
Variables that tended to differ between the falling groups:

<table>
<thead>
<tr>
<th>ANOVA 1</th>
<th>P Value</th>
<th>ANOVA 2</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tandem Gait</td>
<td>.000</td>
<td>Tandem Gait</td>
<td>.000</td>
</tr>
<tr>
<td>Timed Up &amp; Go</td>
<td>.035</td>
<td>Timed Up &amp; Go</td>
<td>.117*</td>
</tr>
<tr>
<td>QS reaction time</td>
<td>.028</td>
<td>QS reaction time</td>
<td>.011</td>
</tr>
<tr>
<td>QS velocity</td>
<td>.000</td>
<td>QS velocity</td>
<td>.000</td>
</tr>
<tr>
<td>Lateral Sway eyes open</td>
<td>.012</td>
<td>Lateral Sway eyes open</td>
<td>.009</td>
</tr>
<tr>
<td>Tandem Sway Lateral</td>
<td>.009</td>
<td>Tandem Sway Lateral</td>
<td>.005</td>
</tr>
<tr>
<td>Tandem Sway A/P</td>
<td>.016</td>
<td>Tandem Sway A/P</td>
<td>.014</td>
</tr>
<tr>
<td>Tandem Sway Velocity</td>
<td>.007</td>
<td>Tandem Sway Velocity</td>
<td>.007</td>
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<tr>
<td>BSE sum</td>
<td>.000</td>
<td>BSE sum</td>
<td>.000</td>
</tr>
<tr>
<td>BSE average</td>
<td>.000</td>
<td>BSE average</td>
<td>.000</td>
</tr>
<tr>
<td>BSE no assist</td>
<td>.000</td>
<td>BSE no assist</td>
<td>.000</td>
</tr>
<tr>
<td>BSE neutral</td>
<td>.015</td>
<td>BSE neutral</td>
<td>.013</td>
</tr>
</tbody>
</table>

LEGEND:

ANOVA 1: 1-2 falls (n=158) vs. 3 or more falls (n=39)
ANOVA 2: 1 fall (n=99) vs. 2 or more falls (n=98)

* Timed Up & Go was not significantly different (p < 0.1) between the falling groups of one-time or multiple fallers