

**PHYSICAL ACTIVITY, NUMBER OF MEDICAL CONDITIONS, AND FALLS  
IN COMMUNITY-DWELLING OLDER ADULTS**

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A thesis submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Master of Arts in the Department Exercise and Sport Science (Exercise Physiology)

Chapel Hill  
2010

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## ABSTRACT

KATHLEEN A. TERRACINA: Physical Activity, Number of Medical Conditions, and Falls in  
Community Dwelling Older Adults  
(Under the direction of Dr. Bonita L. Marks)

The study examined relationships between concern for falling, number of medical conditions, physical activity (PA), and one-year fall rate in 60 community-dwelling older adults (24 male, 36 female;  $74.8 \pm 3.5$  years old). Falls rate was self-report. The Modified Baecke Questionnaire for Older Adults was used to code the amount of PA the subjects participated in over the same year as the fall history recall. The questionnaire categorized PA into household PA, leisure PA, and sport PA. A total PA score was calculated from the sum of the scores obtained for each of the three PA categories. Simple linear regression revealed an inverse, significant relationship between the total PA score and one-year fall rate ( $r = -0.273$ ,  $R^2 = 0.074$ ,  $p = 0.036$ ). No other significant relationships were found. Future research should focus on further exploring relationships between types of physical activity and falls.

## ACKNOWLEDGEMENTS

I am very excited to have completed this program, and especially this thesis, in such an exciting and busy time in life. Entering this program as an unmarried renter with no pets and no children, and leaving it as a married homeowner with a dog and a baby on the way has taught me a great deal about what I'm capable of with good time management and wonderful people surrounding me. I am thankful for my advisor, Dr. Bonita L. Marks, for generously leading me through this project as a great motivator and supporter. I am thankful to my committee, Dr. Ed Shields and Dr. Laurence Katz, for graciously giving their time and wisdom to help me navigate my way through this project. I am thankful for my friends in the program, especially Jamie Giffuni, for always having time to struggle together when things were difficult, and celebrate together when we were successful. I would also like to thank my wonderful family and dear friends for being an amazing support system whenever I was in need. And as always, I am thankful for my husband Adam, and the love and support he selflessly gives me every day. "I can do all things in Christ who strengthens me." Philippians 4:13.

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## **LIST OF ABBREVIATIONS**

HPA	Household Physical Activity
LPA	Leisure Physical Activity
SPA	Sport Physical Activity
TPA	Total Physical Activity
HHQ	Health History Questionnaire
MBQ	Modified Baecke Questionnaire for Older Adults



## **CHAPTER ONE**

### **Introduction**

The population of the United States over the age of 65 is increasing annually. The Center for Disease Control (CDC) projects that by the year 2030, the population 65 years or older will more than double to 71 million people, comprising approximately twenty percent of the United States population (CDC 2007). The health care cost of these individuals is three to five times greater than that of individuals under the age of 65, so the financial burden of the aged population is expected to increase as the population ages (CDC 2007).

Approximately one-third of adults aged 65 or older fall annually in the United States (Sherrington, Lord, & Finch 2004; Tinetti 2003; Hausdorf, Rios, & Edelber, 2001; Hornbrook, Stevens, Wingfield, Hollis, Greenlick & Ory 1994; Alexander, Rivara, & Wolf 1992). Falls are the leading cause of injury deaths, and the leading cause of non-fatal injuries and hospital admissions for trauma in the elderly (CDC 2007). According to Tinetti et al. (1988), nearly 40% of nursing home admissions are related to falls. In addition, the rate of fall-related injuries has increased significantly over the last decade (Stevens, Corso, Finkelstein, & Miller 2006). The direct medical costs of fatal (\$179

million) and of non-fatal (\$19 billion) falls are substantial and expected to increase, making the financial burden to society substantial (Stevens 2006).

Financial burden should not be the only factor encouraging the promotion of falls prevention; the quality of life and safety of aged individuals should be a priority in the health care system as the population ages. The risk of injury resulting from a fall increases with age, and falls can further limit independent living ability of a population already at risk for losing independence (Stevens & Sogolow 2005; Sterling, O'Connor, & Bonadies 2001; Alexander et al. 1992; Tinetti et al. 1988). The loss of independence for an elderly person can be mentally and emotionally devastating, but the addition of regular physical activity into a person's life can reduce the risk of losing independence and mobility (Sherrington et al. 2004; Spirduso & Cronin 2001; Hirvensalo, Rantanen, & Heikkinen 2000). In a study conducted by the Association for the Advancement of Retired Persons (AARP), less than half of older American adults participated in exercise, and even fewer enjoyed it, so there is a need to introduce exercise programs in this patient population (Korczyk 2002).

Stroke, anemia, diabetes, Parkinson's disease, poor vision, and other medical conditions are associated with falls (Schwartz, Miller, Sellmeyer, Resnick, Gregg, Ensrud et al. 2002; Gray & Hildebrand 2000; Herndon, Helmick, Sattin, Stevens, Devito, & Wingo 1997; Tinetti, Williams, & Mayesski 1986). In a prospective study with 79 intermediate care residents, Tinetti et al. found that as the number of medical conditions increased, the percentage of subjects who were frequent fallers also increased (Tinetti et al. 1986). In addition, the three primary risk factors associated with an increased risk of

frequent falling were disability of the lower extremities, sedative use, and cognitive impairment (Tinetti et al. 1988).

Physical activity reduces fall risk, improves general health, and may reduce the disability of chronic medical conditions, yet fear of falling can be reason enough for an older individual to decide against physical activity. This reduction in physical activity can lead to a reduction in physical fitness, which increases the risk of falling, and puts patients at risk for the development of other medical conditions (Warburton, Nicol, & Bredin 2006; Hirvensalo et al. 2000; Vellas, Wayne, Romero, Baumgartner, & Garry 1997). Education and simple assessment tools that provide older individuals with a better understanding of their risk of falling and modifiable factors that contribute to that risk can help these individuals make lifestyle decisions that ultimately reduce their risk of falling and help them maintain their independence.

### **Statement of the Problem**

Research suggests that physical activity can reduce the risk of falls, as well as other medical conditions (Nelson, Rejeski, Blair, Duncan, Judge, King, et al. 2007; Warburton et al. 2006). More research is needed to determine the type and volume of physical activity that is required to reduce falls risk. **The primary purpose of this study was to explore the relationships between concern for falling, falls history, number of medical conditions, and physical activity. A secondary purpose of this study was to determine the sensitivity and specificity of the independent variables (concern for falling, number of medical conditions, total physical activity, household activity, leisure activity, and sport activity) for correctly identifying fallers and non-fallers.**

## **Research Questions**

The research questions and null hypotheses are listed below:

**Research Question 1: What is the relationship between concern for falling and one-year fall history for the group as a whole and by gender?**

Ho<sub>1</sub>: There is no relationship between concern for falling and one-year fall history for the group as a whole or by gender.

**Research Sub-question 1a: Determine the sensitivity and specificity of “concern for falling” as a marker to distinguish fallers from non-fallers.**

Ho<sub>1a</sub>: “Concern for falling” is neither a sensitive or specific marker for distinguishing fallers from non-fallers.

**Research Question 2: What is the relationship between number of medical conditions and one-year fall rate?**

Ho<sub>2</sub>: There is no relationship between number of medical conditions and one-year fall rate.

**Research Sub-question 2a: Determine the sensitivity and specificity of “Number of medical conditions” as a marker to distinguish fallers from non-fallers.**

Ho<sub>2a</sub>: “Number of medical conditions” is not a sensitive or specific marker to distinguish fallers from non-fallers.

**Research Question 3: What is the relationship between each of the following categories of physical activity and one-year fall rate: household physical activity, leisure physical activity, and sport physical activity?**

Ho<sub>3</sub>: There is no relationship between one-year fall rate and household physical activity, leisure physical activity, and sport physical activity.

**Research Sub-question 3a: Determine the sensitivity and specificity of household physical activity, leisure physical activity, or sport physical activity to distinguish fallers from non-fallers.**

Ho<sub>3a</sub>: Household physical activity, leisure physical activity, or sport physical activity is not a sensitive or specific marker to distinguish fallers from non-fallers.

**Research Question 4: What is the relationship between total physical activity and one-year fall rate?**

Ho<sub>4</sub>: There is no relationship between total physical activity and one-year fall rate.

**Research Sub-question 4a: Determine the sensitivity and specificity of total physical activity to distinguish fallers from non-fallers.**

Ho<sub>4a</sub>: Total physical activity is not a sensitive or specific marker to distinguish fallers from non-fallers.

### **Definition of Terms and Abbreviations**

Fall: An unintentional loss of balance resulting in a sudden landing on the ground or floor for any cause (Marks & Katz 2009).

Fall History: Answer to the questions “Have you fallen in the past year?”  
Answer choices were “yes” or “no.”

Fall Rate: Number of times an individual has fallen in the past year.

Concern for Falling: Answer to the question “Are you concerned about falling?”  
Answer choices were “yes” or “no.”

Health History Questionnaire (HHQ): A questionnaire detailing a subject's medical history, falls history, and physical activity history.

Number of Medical Conditions: The number of medical conditions the subject noted on the health history form (e.g. arthritis + hypertension = two medical conditions).

Modified Baecke Questionnaire for Older Adults (MBQ): A short questionnaire used to assess physical activity in the elderly. The assessment is separated into three sections: household physical activity, leisure physical activity, and sport physical activity (descriptions are listed below). Physical activity scores were calculated using a validated formula that includes metabolic equivalents (METs), and activity participation information (frequency, duration, intensity). Higher scores note greater amounts of physical activity while lower scores note lower amounts of physical activity (Voorrips, Favelli, Dongelmans, Deurenberg, & Van Staveren 1991). See Appendix A.

Household Physical Activity Score (HPA): The score calculated for the section of the MBQ that asks questions about amount of work or physical activity done in the house. The questions refer to chores, the number of individuals for which the subject keeps house, how many floors are in the house, how many rooms are kept clean, presence and use of stairs in the home, and transportation use. For this section, scores can range from zero to an infinite upper limit. Of the ten questions, six have a score range of zero to three; two have a range of zero to four; and two have a fill in the blank option with no upper limit.

Leisure Physical Activity Score (LPA): The score calculated for the section of the MBQ that asks questions about non-competitive, non-occupational, physical activities, that is, those activities which do not fit into either the

household or sport physical activity categories. Examples of activities able to be scored in this section include walking, formal exercise training, gardening, kayaking, or shopping. For this section, scores can be as low as zero, and do not have an upper limit for a score range. No limit is set for the number of leisure physical activities a subject could include in this section. For an individual activity, the score could range from 0.003 to 14.780.

*Sport Physical Activity Score (SPA):* The score calculated for the section of the MBQ that asks questions about participation in sports. Activities included in this section are typically done competitively, or activities during which a score is typically kept. Examples of activities scored in this section include, but are not limited to golf, tennis, or bocce ball. For this section, scores can be as low as zero and do not have an upper limit for a score range. No limit is set for the number of sport physical activities a subject includes in this section. For an individual activity, the score could range from 0.003 to 14.780.

*Total Physical Activity Score (TPA):* The sum of scores for the household physical activity, leisure physical activity, and sport physical activity sections of the MBQ. For this section, scores can be as low as 0.003, and do not have an upper limit for a score range. No limit was set for number of leisure or sport physical activities an individual could indicate.

### **Delimitations**

This was a secondary analysis on an existing dataset investigating falls risk in an older community dwelling population (Marks & Katz 2009). Subjects were 70-84 years

of age, community dwelling, able to walk (with or without assistive device), able to understand and respond to the written and spoken English language. Data for subjects used for this analysis was complete in regards to the variables of interest in this study: concern for falling, physical activity history (MBQ), one-year fall history, one-year fall rate, number of medical conditions.

### **Limitations**

This retrospective study used data from self-reports which was presumed to be accurate. While self-report data is not ideal, the questionnaires were reviewed personally with each subject by a researcher to limit the accidental errors inherent with self-report. The volunteer sample population was primarily Caucasian with at least a high school diploma.

### **Assumptions:**

1. Subjects recalled information regarding physical activity, medical conditions, and falls accurately.
2. Researchers appropriately reviewed the questionnaires with the subjects.

### **Significance of Study**

The risk of falling is one of the fastest growing public health concerns in the United States. As the “baby-boomer” generation ages, society will need more identification, prevention, and standard care for falls and fall risk. Knowing the relationships between concern for falling, fall history, fall rate, number of medical



conditions, and physical activity may help in the development of educational tools and fall risk awareness for health practitioners and aging individuals.

## **CHAPTER TWO**

### **Literature Review**

#### **Introduction**

Due to longer life expectancy and the aging baby boomers, the aged population (65 years and older) is rapidly growing. By 2030, older adults will account for 20% of the United States population. As the population grows, so do health care costs. The CDC predicts that these demographic shifts will result in a 25% increase in health care spending (CDC 2007). Currently, health care for a person over age 65 is three to five times more costly than for an individual younger than 65. Increasing incidence of falls and resulting injuries contribute greatly to that extra cost (CDC 2007). The direct medical cost for fatal falls has been as high as \$179 million, and \$19 billion for non-fatal falls (Stevens 2006).

Approximately one third of aged individuals fall annually (Tinetti 2003; Hornbrook et al. 1994). Falling is the leading cause of injury death in the aged, and the fall-related death rate in older adults has risen over the last ten years (Stevens 2006; CDC 2009).

In addition to the financial costs of falling, consideration must also be given to psychological and quality of living costs (CDC 2007). A traumatic fall or the

concern/fear of falling can result in the loss of independence for an older adult (CDC 2007; Hausdorff et al. 2001). The loss of independence can be one of the most feared events in a person's life. Injury from falls can lower a person's mobility and functionality, in turn decreasing quality of life (CDC 2007; Lach 2005). Falls are the leading cause of injury death, nonfatal injury, and hospital admissions in the aged. According to the CDC's 2005 database, in one year, over 15,000 people aged 65+ died from falls and 1.8 million were treated for nonfatal injury (CDC 2009).

If adult and geriatric professionals had a better idea of how to prevent falls in aged and aging populations, spending for the treatment of injuries or fatalities resulting from falls could be reduced, and quality of life could be improved or maintained through the aging process. Assessing the relationships between concern for falling, number of medical conditions, physical activity, and falls could shed new light on prevention strategies for falls, and contribute to a better standard of care for aging adults.

### **Concern/Fear of Falling**

Falling can have a great impact on the psychological wellness and social confidence of an older individual (CDC 2007). Estimates of prevalence of fear of falling range from 26-55% (Zijlstra, van Haastregt, van Eijk, van Rossum, Stalenhoef, & Kempen 2007; Lach 2005). Interestingly, up to 50% of the people experiencing a fear of falling haven't fallen, and in another study only 32% of the people who fell developed a fear of falling (Lach 2005; Vellas et al. 1997). Those who did develop a fear of falling had significantly more balance and gait disorders than those who did not (Vellas et al. 1997). The problem with fear of falling is that it often leads to an avoidance of physical

activity (Zijlstra et al. 2007; Lach 2005; Vellas et al. 1997). Individuals with a fear of falling had a greater increase in gait disorders over time, further increasing their actual fall risk (Vellas et al. 1997).

Individuals experiencing a fear of falling share several characteristics. Several researchers have reported high association between having two or more falls, or being aged 80 years or older (Zijlstra et al. 2007; Murphy, Dubin, & Gill 2003). Other noted risk factors for the development of a fear of falling include visual impairment, sedentary lifestyle, poor perceived health, lack of emotional support, feeling unsteady, the female sex, cognitive compromise, and economic status (Zijlstra et al. 2007; Lach 2005; Murphy et al. 2003; Vellas et al. 1997).

Community-dwelling older adults are more forthright in admitting a “concern” rather than a “fear” of falling, thus the reason for using the term “concern” over “fear” when assessing fall rate and fall history in the present study.

### **Medical Conditions and Falls Risk**

As individuals age, they typically develop more medical conditions. Several studies have assessed the associations between fall risk and specific medical conditions (Schwartz et al. 2002; Gray & Hildebrand 2000; Herndon et al. 1997). Tinetti et al. (1986) evaluated the relationship between number of chronic disabilities and fall risk in patients at an intermediate care facility. As the number of disabilities increased, the percentage of individuals who were recurrent fallers also increased. In addition, several medical conditions have been shown specifically to increase the risk of falling: weaker lower body strength, sedative use, and cognitive impairment (Tinetti et al. 1988). Other

specific medical conditions associated with an increased fall risk are arthritis, depression, orthostasis, poor vision, poor balance, impaired gait, and the use of four or more medications. In addition, the risk of falling increases with the number of these risk factors (Marks & Katz 2009; Tinetti 2003).

To differentiate from Tinetti's body of work, this present study utilized community dwelling elderly rather than frail elderly in its quest to examine potential relationships between the number of medical conditions, physical activity patterns, and annual fall rate.

### **Physical Activity and Falls**

Concern for falling can deter older individuals from engaging in physical activity, but in fact, the benefits of physical activity outweigh the risks, especially in older populations (Warburton et al. 2006). Zijlstra et al. (2007) showed the following variables to be associated with the avoidance of physical activity: aged 80 years or older (OR = 1.92, 95% CI = 1.59-2.32), poor perceived general health (OR = 11.91, 95% CI = 8.38-16.95), and two or more falls (OR = 4.64, 95% CI = 3.73-5.76). In a review paper, Sherrington et al. (2004) state that evidence exists supporting structured exercise as a prevention method for falling in the elderly. Thus, older individuals with poor health and multiple falls may obtain greater health and fitness benefits from physical activity appropriate for their health status and should not avoid it.

For older individuals, independence can be an important life goal, and for that goal, musculoskeletal fitness may be more important than aerobic fitness. Older individuals may find improvements in their general health with improvements in their

musculoskeletal fitness (Warburton et al. 2006). The American College of Sports Medicine and American Heart Association recommend 20-30 minutes of moderate to vigorous aerobic activity three to five days per week, two sessions of strength training involving 10-15 repetitions of eight to ten exercises, and total body flexibility exercises at least twice/week (Nelson et al. 2007). Unfortunately, these recommendations may seem daunting to an older individual and lead to an avoidance of physical activity. To address this issue, Lee & Skerrett (2001) suggested that approximately half of the currently recommended volume of exercise may be sufficient for health benefits, especially for deconditioned, frail, elderly individuals. Warburton et al. (2006) reviewed the literature and concluded that less rigorous weekly exercise may indeed be associated with health benefits.

Physical activity can be achieved in various ways, not just through formal exercise. Physical activity can be attained in the home, for fun, or for competition. Tromp, Pluijm, Smit, Deeg, Bouter, & Lips (2001) reported that inactive individuals, defined as devoid of even light household activities were at a greater risk for falling one time (OR = 1.3, 95% CI = 0.9-2.0) and tripled their risk for becoming a frequent faller (95% CI = 1.7-4.5) compared to more active counterparts. Chan, Marshall, Winters, Faulkner, Schwartz, & Orwoll (2007) reported an association between household physical activity and falls, but no association between leisure physical activity and falls. However, Chan et al. (2007) included sport activities within leisure physical activities, whereas Voorrips et al. (1991) treated those two categories separately. Since there can be relatively large discrepancies between metabolic requirements of leisure versus sport activities, the present study chose Voorrips' methodology and investigated the

relationships between annual fall rate and each of the three physical activity categories (household, leisure, sport) as well as their combined total score.

### **Summary and Conclusions**

Regular physical activity can be instrumental in reducing the risk of falling, and the development of a concern for falling. Some types of physical activity also increase the risk of falling simply because of the nature of the activity (e.g. playing sports). Chan et al. (2007) reported that individuals in the higher three quartiles of physical activity had an increased risk of falling, but Warburton et al. (2006) reported that physical activity is related to a reduction in the risk of falling.

These conflicting reports suggest that more research is necessary to better determine the specific types and volumes of physical activity necessary to reduce falls in older adults. Therefore, the present study further elucidates relationships between falls and specific physical activity categories in community dwelling older adults. In addition, the present study contributes to the falls risk literature by exploring the relationship between the number of medical conditions, concern for falling, and annual fall rate.

## CHAPTER THREE

### Methodology

The present study is a secondary analysis of the study entitled: *The Utility of a Falls Risk Self-Assessment Tool* (PI: Bonita L. Marks, PhD, Biomedical IRB #: 07-1667). The purpose of that study was to validate a falls risk assessment tool in community dwelling older adults. This secondary analysis investigated relationships between the following: (1) concern for falling and one-year fall history, (2) number of medical conditions and one-year fall rate, and (3) physical activity and one-year fall rate. Sensitivity and specificity were calculated to accurately identify fallers and non-fallers for the following variables: (1) concern for falling, (2) number of medical conditions, (3) household physical activity score, (4) leisure physical activity score, (5) sport physical activity score, and (6) total physical activity score.

### Subjects

Data for approximately 60 subjects aged 70-84 (24 males, 36 females) was analyzed. Inclusion criteria required participants to be community-dwelling, ambulatory (with or without a walking assistive device), not on supplemental oxygen, able to



participate in low intensity fitness assessments, understand and sign a consent form in English, and follow simple instructions. Written informed consent was obtained prior to study participation.

### **Instrumentation**

The following instruments were evaluated for this secondary analysis:

1. *Modified Baecke Questionnaire for Older Adults*: a questionnaire used to determine a general level of physical activity based on household activities, leisure time activities, and sport activities. Validity was reported as 0.78 and 0.72; reliability was reported as 0.89 (Voorrips et al. 1991). The questionnaire was scored according to Voorrips et al. 1991 (See Appendix A).
2. *Health History Questionnaire*: the following information was collected on this questionnaire: personal information, physician information, educational level, medical conditions, current medications, fall history/rate, and physical activity.

### **Procedures**

Subjects from the community volunteered to participate in the study. Upon arrival, each subject was escorted from the parking lot to the Exercise Science Teaching Laboratory. The consent form was reviewed and signed by the subject and principle investigator. Then the health history questionnaire was reviewed and signed by the subject and principle investigator. Following the review of consent and health history, the subject completed a battery of cognitive function screenings as well as functional fitness tests. At the end of the appointment (approximately two hours),

each subject received \$40 compensation and parking tokens to pay for parking time. For the purpose of this secondary analysis, the health history questionnaire was analyzed for the following specific variables: number of medical conditions, one-year fall history, and one-year fall rate. The Modified Baecke Questionnaire for Older Adults was scored for the following physical activity variables: household physical activity (HPA), leisure physical activity (LPA), sport physical activity (SPA), and total physical activity (TPA; the sum of HPA, LPA, and SPA). Details about scoring are contained in Appendix A.

### **Research Design and Statistical Analyses**

The present study was a cross-sectional study with three independent variables: (1) concern for falling, (2) number of medical conditions, and (3) physical activity (household, leisure, sport, and total). The dependent variables were fall history and fall rate. Descriptive statistics (means, SD), and median splits (when relevant) were used to summarize individual characteristics and group characteristics for each variable. Gender distribution for one-year fall rate, concern for falls and medical conditions was also evaluated with chi squares as part of the descriptive statistics. To answer the research questions, chi-squares, sensitivity and specificity percentages, simple linear regressions, and multiple regression were used. A value of 70% was considered acceptable for the sensitivity and specificity parameters (Thompson, Gordon, & Pescatello 2010; Gibbons Balady, Bricker, Chaitman, Fletcher, Foelicher et al. 2002). Statistical significance was set a priori at the  $p < 0.05$  level with correction for multiple comparisons.

**Research Question 1: What is the relationship between concern for falling and one-year fall history for the group as a whole and by gender?**

Ho<sub>1</sub>: There is no relationship between concern for falling and one-year fall history for the group as a whole or by gender.

Statistical Analysis: Chi-square test for independence with a Yates Continuity Correction was used to explore the relationship between concern for falling and one-year fall history (i.e., concern for falling [Y/N] versus fall history [Y/N]) for the entire group, and by gender.

**Research Sub-question 1a: Determine the sensitivity and specificity of “concern for falling” as a marker to distinguish fallers from non-fallers.**

Ho<sub>1a</sub>: “Concern for falling” is not a sensitive or specific marker for distinguishing fallers from non-fallers.

Statistical Analysis: A percent accuracy was computed to determine the sensitivity and specificity as indicated in the chart below.

	Concerned about Falling	Not Concerned about Falling
Faller	a	b
Non-faller	c	d

*Where:*

Sensitivity =  $a / (a + c) \times 100$ ; the ability of concern for falling to correctly identify fallers. Specificity =  $d / (b + d) \times 100$ ; the ability of no concern for falling to correctly identify non-fallers (Thompson et al. 2010).

**Research Question 2: What is the relationship between number of medical conditions and one-year fall rate?**

Ho<sub>2</sub>: There is no relationship between number of medical conditions and one-year fall rate.

Statistical Analysis: A simple linear regression was used to determine the relationship between number of medical conditions and one-year fall rate.

**Research Sub-question 2a: Determine the sensitivity and specificity of “Number of medical conditions” as a marker to distinguish fallers from non-fallers.**

Ho<sub>2a</sub>: “Number of medical conditions” is not a sensitive or specific marker to distinguish fallers from non-fallers.

Statistical Analysis:

	High # of medical conditions	Low # of medical conditions
Faller	a	b
Non-faller	c	d

*Where:*

Sensitivity =  $a / (a + c) \times 100$ ; the ability of a high number of medical conditions to correctly identify fallers. Specificity =  $d / (b + d) \times 100$ ; the ability of a low number of medical conditions to correctly identify non-fallers (Thompson et al. 2010). High and low number of medical conditions were determined via median split. The median was included in the “high” category.

**Research Question 3: What is the relationship between one-year fall rate and each of the following categories of physical activity: household physical activity, leisure physical activity, and sport physical activity?**

Ho<sub>3</sub>: There are no relationships between one-year fall rate and household physical activity, leisure physical activity, or sport physical activity.

Statistical Analysis: Multiple regression was used to determine the relationships between one-year fall rate and household physical activity, leisure physical activity, and sport physical activity.

**Research Sub-question 3a: Determine the sensitivity and specificity of household physical activity, leisure physical activity, or sport physical activity to distinguish fallers from non-fallers.**

Ho<sub>3a</sub>: Household physical activity, leisure physical activity, or sport physical activity is not a sensitive or specific marker to distinguish fallers from non-fallers.

Statistical Analysis: A percent accuracy was computed to determine the sensitivity and specificity as indicated in the chart below.

	Low HPA, LPA, or SPA	High HPA, LPA, or SPA
Faller	a	b
Non-faller	c	d

*Where:*

Sensitivity =  $a / (a + c) \times 100$ ; the ability of low HPA, LPA, or SPA scores to correctly identify fallers. Specificity =  $d / (b + d) \times 100$ ; the ability of high HPA, LPA, or SPA scores to correctly identify non-fallers (Thompson et al. 2010). High and low physical

activity scores were determined via median split. The median was included in the “high” category.

**Research Question 4: What is the relationship between total physical activity and one-year fall rate?**

Ho<sub>3</sub>: There is no relationship between total physical activity and one-year fall rate.

Statistical Analysis: A simple linear regression was used to determine the relationship between total physical activity and one-year fall rate.

**Research Sub-question 4a: Determine the sensitivity and specificity of total physical activity to distinguish fallers from non-fallers.**

Ho<sub>4a</sub>: Total physical activity is not a sensitive or specific marker to distinguish fallers from non-fallers.

Statistical Analysis: A percent accuracy was computed to determine the sensitivity and specificity as indicated in the chart below.

	Low TPA	High TPA
Faller	a	b
Non-faller	c	d

*Where:*

Sensitivity =  $a / (a + c) \times 100$ ; the ability of a low TPA score to correctly identify fallers.

Specificity =  $d / (b + d) \times 100$ ; the ability of a high TPA score to correctly identify non-fallers (Thompson et al. 2010). High and low physical activity scores were determined via median split. The median was included in the “high” category.

## CHAPTER FOUR

### Results

#### Subjects

Sixty older adults (24 males, 36 females) completed the Modified Baecke Questionnaire for Older Adults and the Health History Questionnaire. The age (mean  $\pm$  SD) of the subjects was  $74.8 \pm 3.53$  years. The subjects were generally very well educated. Thirty-eight subjects (63.3%) completed graduate school, 11 (18.3%) completed a college degree, 9 (15%) completed some college, and 2 (3.3%) completed high school. Fifty-six subjects (93.3%) were Caucasian, 2 subjects (3.3%) were African American, 1 subject (1.7%) was Asian, and 1 subject's (1.7%) ethnicity was not reported. Table 1 shows the means  $\pm$  SD for each variable. The most common medical conditions reported were arthritis (46.7%), high cholesterol (41.7%), cataracts (35%), cancer (33.3), and other bone/joint problems (26.7%).

<b>Variable</b>	<b>Subject n</b>	<b>Mean <math>\pm</math> SD</b>	<b>CV</b>	<b>Range</b>
One-year fall rate	60	1.02 $\pm$ 2.03	1.99	0 - 13
# of Medical Conditions	60	5.18 $\pm$ 3.23	0.62	0 - 15
HPA Score	60	1.94 $\pm$ 0.42	0.22	0.9 – 2.86
LPA Score	60	5.28 $\pm$ 4.41	0.84	0 – 14.93
SPA Score	59	1.07 $\pm$ 2.30	2.15	0 – 8.06
TPA Score	59	8.28 $\pm$ 4.89	0.59	0.9 – 20.55

Table 1. Descriptive summary of physical activity scores; HPA = household physical activity; LPA = leisure physical activity; SPA = sport physical activity; TPA = total physical activity. CV = coefficient of variation (SD/mean).

### **Relationship between concern for falling and one-year fall history**

*The null hypothesis for Research Question 1 stated that there would be no relationship between concern for falling and one-year fall history for the group as a whole or by gender.* A Chi-square test for independence with a Yates Continuity Correction was used to explore the relationship between concern for falling and one-year fall history. Table 2 shows the number of subjects in each of the four Chi-square analysis categories. Five subjects' concern for falling data were excluded because they did not answer the question "Do you have a concern for falling?"

	<b>Concerned about falling</b>	<b>Not concerned about falling</b>
<b>Faller</b>	n = 15	n = 10
<b>Non-faller</b>	n = 11	n = 19

Table 2. Number of fallers and non-fallers who indicated a concern for falling.



A Chi-square test for independence (with Yates Continuity Correction) indicated no significant association between concern for falling and fall history,  $\chi^2 = 2.116$  (1, n = 55),  $p = 0.146$ ,  $\phi = 0.223$ . Similarly, Chi Square Tables 3 and 4 below show that there were no significant gender differences for concern for falling or self-report of falling in the past year.

	<b>Concerned about Falling</b>	<b>Not Concerned about Falling</b>
<b>Males</b>	n = 10	n = 13
<b>Females</b>	n = 16	n = 18

Table 3. Impact of gender on concern for falling.  $\chi^2 = 0.042$  (1, n = 55),  $p = 0.838$ ,  $\phi = -0.064$ .

	<b>Have you fallen in the past year?</b>	
	<b>Yes</b>	<b>No</b>
<b>Males</b>	n = 12	n = 12
<b>Females</b>	n = 16	n = 20

Table 4. Impact of gender on one-year fall history.  $\chi^2 = 0.025$  (1, n = 60),  $p = 0.874$ ,  $\phi = 0.055$ .

*The null hypothesis for Research Sub-question 1a stated that concern for falling would not be a sensitive or specific marker for distinguishing fallers from non-fallers.* Sensitivity and specificity were calculated as described in Chapter Three. Table 5 shows the sensitivity and specificity values of concern for falling for distinguishing fallers from non-fallers.

	<b>Calculated Value</b>	<b>Acceptable?*</b>
<b>Sensitivity</b>	57.6%	No
<b>Specificity</b>	65.5%	No

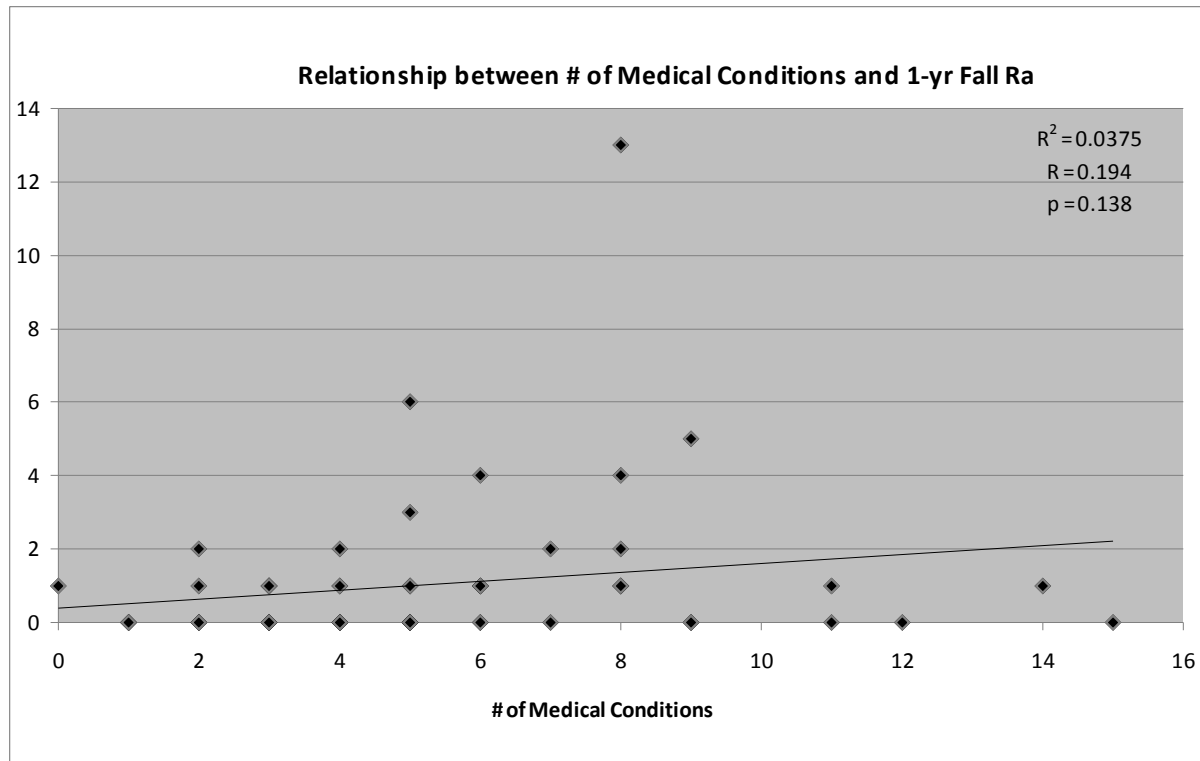
**Table 5. Concern for Falling:** sensitivity represents the percentage of individuals with a concern for falling that were also fallers. Specificity represents the percentage of individuals who did not have a concern for falling who were non-fallers.

\*Acceptable percentage= 70%.

### **Relationship between number of medical conditions and one-year fall rate**

*The null hypothesis for Research Question 2 stated that there would be no relationship between number of medical conditions and one-year fall rate.* A simple linear regression was used to determine the relationship between number of medical conditions and one-year fall rate.

As shown in [Figure 1](#), a simple linear regression indicated a weak, but non-significant relationship between number of medical conditions and one-year fall rate. Only 3.75% of the variance in fall rate was explained by number of medical conditions.



**Figure 1.** Simple linear regression for number of medical conditions and one-year fall rate with the line of best fit. The line of best fit equation was:  $y = 0.1217x + 0.3861$ .

Table 6 contains additional descriptive information about the number of medical conditions per the median split, where a “low” number of medical conditions was categorized as four or fewer, and a “high” number of medical conditions was categorized as five or more. A Chi-square revealed that there was not a significant gender difference with number of medical conditions;  $\chi^2 = 0.000$  (1,  $n = 60$ ),  $p = 1.00$ ,  $\phi = -0.014$ .

# of Medical Conditions	Mean $\pm$ SD 1-yr Fall Rate	Subject n
0-4 (Low)	0.43 $\pm$ 0.63	28
5+ (High)	2.00 $\pm$ 2.63	32

**Table 6.** Number of medical conditions and one-year fall rate per median split of 5 or more.

*The null hypothesis for Research Sub-Question 2a stated that number of medical conditions would not be a sensitive or specific marker for distinguishing fallers from non-fallers.* Sensitivity and specificity were calculated as described in Chapter Three. Table 7 shows the sensitivity and specificity values of number of medical conditions in distinguishing fallers from non-fallers.

	<b>Value</b>	<b>Acceptable?*</b>
<b>Sensitivity</b>	56.3%	No
<b>Specificity</b>	64.3%	No

Table 7. *Medical Conditions*; sensitivity represents the percentage of individuals with a high number of medical conditions who were fallers. Specificity represents the percentage of individuals with a low number of medical conditions who were non-fallers. \*Acceptable percentage= 70%.

**Relationship between household, leisure, or sport physical activity and one-year fall rate**

*The null hypothesis for Research Question 3 stated that there would be no relationship between one-year fall rate and each of the following categories of physical activity: household, leisure, or sport.* Multiple regression analysis was used to determine the relationships between one-year fall rate and household physical activity, leisure physical activity, and sport physical activity. One subject’s data for sport physical activity was not reported because the data was missing.

Standard multiple regression analysis indicated that there is a weak, but non-significant relationship between household physical activity scores, leisure physical activity scores, sport physical activity scores, and one-year fall rate (Table 8).

	R	R <sup>2</sup>	R <sup>2</sup> Adj.	df	F	P value
Model Summary	0.280	.078	.028	3, 59	1.556	.210

Independent Variables	Standard Coefficients			Correlations	
	Beta	Crit. t	p value	Semi-Partial	Squared
HPA	-.023	-.181	.857	-.024	.0006
LPA	-.226	-1.737	.088	-.228	.0520
SPA	-.179	-1.379	.174	-.183	.0334

**Table 8.** Standard multiple regression for HPA, LPA, and SPA on 1-yr FR.

While relationships were not shown to be significant, Tables 9-11 show a trend for higher HPA, LPA, and SPA scores to have a lower mean one-year fall rate.

HPA Score	Mean $\pm$ SD 1-yr Fall Rate	Subject n
0.9 – 1.974 (Low)	1.13 $\pm$ 2.67	30
1.975+ (High)	0.9 $\pm$ 1.09	30

**Table 9.** Household physical activity score and mean one-year fall rate per median split of 1.975 or more.

LPA Score	Mean $\pm$ SD 1-yr Fall Rate	Subject n
0 – 4.43 (Low)	1.53 $\pm$ 2.73	30
4.44+ (High)	0.50 $\pm$ 0.63	30

**Table 10.** Leisure physical activity score and mean one-year fall rate per median split of 4.44 or more.

<b>SPA Score</b>	<b>Mean <math>\pm</math> SD 1-yr Fall Rate</b>	<b>Subject n</b>
0 (Low)	1.24 $\pm$ 2.26	46
0.1+ (High)	0.31 $\pm$ 0.48	13

**Table 11.** Sport physical activity score and mean one-year fall rate per median split of 0.1 or more.

*The null hypothesis for Research Sub-Question 3a stated that household physical activity, leisure physical activity, or sport physical activity would not be a sensitive or specific marker for distinguishing fallers from non-fallers.* Sensitivity and specificity were calculated as described in Chapter Three. Tables 12-14 show the sensitivity and specificity values of household, leisure, and sport physical activity (respectively) in distinguishing fallers from non-fallers.

	<b>Value</b>	<b>Acceptable?*</b>
<b>Sensitivity</b>	33.3%	No
<b>Specificity</b>	40%	No

**Table 12. Household Physical Activity:** sensitivity represents the percentage of individuals with a low household physical activity score who were fallers. Specificity represents the percentage of individuals with a high household physical activity score who were non-fallers.

\*Acceptable percentage= 70%.

	<b>Value</b>	<b>Acceptable?*</b>
<b>Sensitivity</b>	50%	No
<b>Specificity</b>	56.7%	No

**Table 13. Leisure Physical Activity:** sensitivity represents the percentage of individuals with a low leisure physical activity score who were fallers. Specificity represents the percentage of individuals with a high leisure physical activity score who were non-fallers.

\*Acceptable percentage= 70%.

	<b>Value</b>	<b>Acceptable?*</b>
<b>Sensitivity</b>	52.1%	No
<b>Specificity</b>	69.2%	No

Table 14. Sport Physical Activity: sensitivity represents the percentage of individuals with a low sport physical activity score who were fallers. Specificity represents the percentage of individuals with a high sport physical activity score who were non-fallers.

\*Acceptable percentage= 70%.

### **Relationship between total physical activity score and one-year fall rate**

*The null hypothesis for Research Question 4 stated that there would be no relationship between total physical activity and one-year fall rate.* A simple linear regression was used to determine the relationship between total physical activity and one-year fall rate. One subject's data for total physical activity was excluded because the data was missing.

As shown in Figure 2, a simple linear regression analysis indicated a significant inverse relationship between total physical activity score and one-year fall rate

( $r = -0.273$ ;  $p = 0.036$ ).

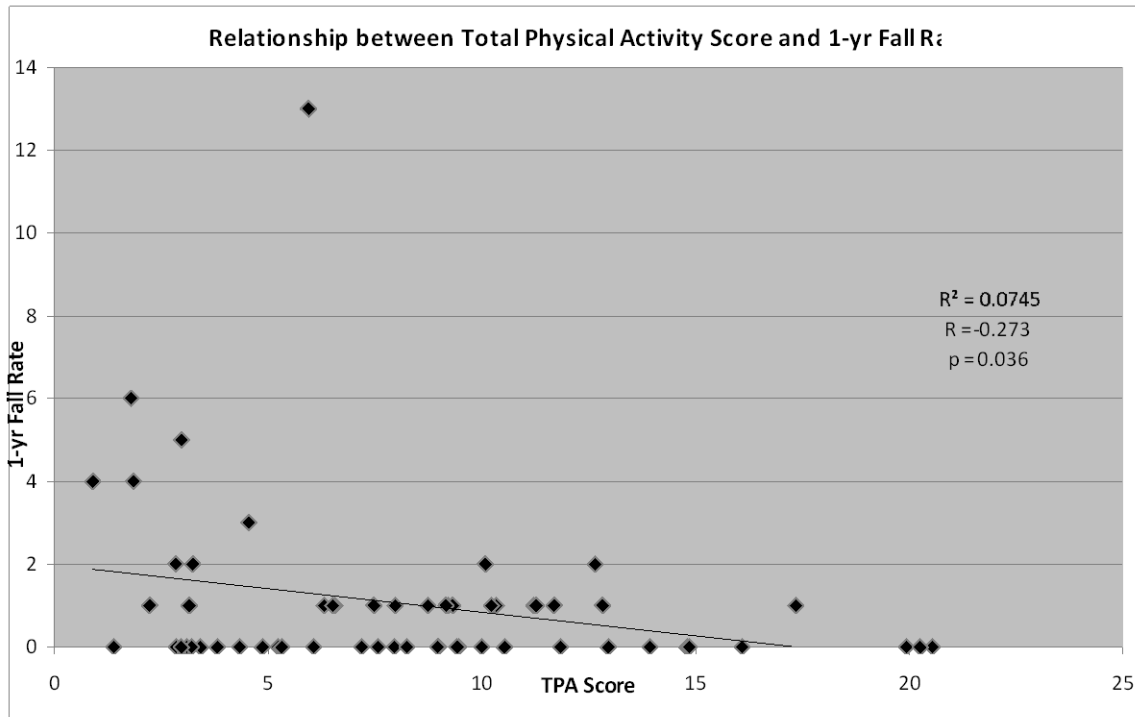


Figure 2. Simple linear regression for total physical activity score and one-year fall rate with the line of best fit. The line of best fit equation was:  $y = -0.114x + 1.9774$ .

The descriptive data noted in Table 15 shows that close to 58% (34/59 subjects) of the study sample fell into the “high” total physical activity group per the median split of 7.97+ or greater for their score. As such, those in the higher TPA group had a lower mean one-year fall rate.

TPA Score	Mean $\pm$ SD 1-yr Fall Rate	Subject n
0.0 – 7.96	1.55 $\pm$ 2.77	29
7.97+	0.53 $\pm$ 0.63	30

Table 15. Total Physical Activity score and mean one-year fall rate per median split of 7.97 or more.



*The null hypothesis for Research Sub-Question 4a stated that total physical activity would not be a sensitive or specific marker for distinguishing fallers from non-fallers.* Sensitivity and specificity were calculated as described in Chapter Three. Table 16 shows the sensitivity and specificity values of total physical activity in distinguishing fallers from non-fallers.

	<b>Value</b>	<b>Acceptable?*</b>
<b>Sensitivity</b>	48.3%	No
<b>Specificity</b>	55.2%	No

Table 16. Total Physical Activity: sensitivity represents the percentage of individuals with a low total physical activity score who were fallers. Specificity represents the percentage of individuals with a high total physical activity score who were non-fallers.

\*Acceptable percentage= 70%.

## **CHAPTER FIVE**

### **Discussion**

The primary purpose of the present study was to explore the relationships between concern for falling, fall history, number of medical conditions, and physical activity. The secondary purpose of this study was to determine the sensitivity and specificity of the independent variables (concern for falling, number of medical conditions, household physical activity, leisure physical activity, sport physical activity, and total physical activity) for correctly identifying fallers and non-fallers. A significant relationship was found between total physical activity score and one-year fall rate ( $p = 0.036$ ). No other statistically significant relationships were found. None of the independent variables were found to be sensitive or specific in predicting fall rate at the pre-determined level of acceptance. The following discussion focuses on the aforementioned results followed by a review of limitations in the study.

#### **Relationship between Concern for Falling and One-year Fall History**

The present study demonstrated that 47.3% of the sample population had a concern about falling, regardless of their fall status. This rate is comparable to the

literature on fear of falling, thereby suggesting the phrase “concern for falling” may be interchangeable with the term “fear of falling.” Both Zijlstra et al. (2007) and Lach (2005) stated that the prevalence of fear of falling is estimated to be between 26 and 55%. Furthermore, of the individuals with a concern for falling, more than half (57.7%) reported falling in the past year, whereas only 34.5% of those who did not report a concern for falling fell in the past year. Thus, the query, “Are you concerned about falling?” correctly identified 60% of the fallers. Despite these promising falls prevalence estimates, the sensitivity calculations for predicting fallers due to concern for falling with at least a 70% accuracy was not attained, suggesting querying about one’s concern for falling is not as precise as this current study required. While the prevalence data appears to be in disagreement with Vellas et al. (1997) who stated that only 32% of fallers had a fear of falling, the calculated sensitivity data for the present study suggest that 42.3% of the cases would have been missed by both this study as well as Vellas et al. (1997) on the basis of just asking if one had a concern for falling.

Studies by Friedman, Munoz, West, Rubin, & Fried (2002), and Lach et al. (2005) found falls and fear of falling to be highly related in community dwelling populations. Conversely, this present study found no significant association between concern for falling and fall history ( $p = 0.146$ ). Part of this discrepancy may be due to the present study not differentiating fallers from frequent fallers or multiples causes of falls. It needs to be noted that a concern for falling can be associated with many variables not analyzed in the present study, such as balance/gait disorders, visual disorders, sedentary lifestyle, and poor perceived health (Zijlstra et al. 2007; Lach 2005; Murphy et al. 2003; Vellas et al. 1997).

### **Relationship between Number of Medical Conditions and One-year Fall Rate**

Adults typically develop more medical conditions as they age, and several studies have assessed the associations between fall risk and specific medical conditions (Schwartz et al. 2002; Gray & Hildebrand 2000; Herndon et al. 1997). Tinetti et al. (1986) evaluated the relationship between number of medical conditions and fall risk in an intermediate care facility. To distinguish itself from these previous studies, the present study compared the number of medical conditions to the self-reported one-year fall rate in community dwelling older adults and found a weak, non-significant relationship between number of medical conditions and one-year fall rate ( $p = 0.138$ ). In fact, in a previous report, Marks & Katz (2009) found no significant relationship between any medical condition and fall rate in the past year. These findings are contrary to Tinetti et al. (1986) who claimed that as the number of medical conditions increased, the percentage of individuals who were recurrent fallers increased as well. This disagreement may be due to the differences between the two populations studied- Tinetti et al.'s subject population being more frail than the present study. Although recurrent falls were not evaluated in the present study, it was noted that the average fall rate for those with five or more medical conditions was more than quadruple that for those with four or fewer medical conditions.

According to Tinetti et al. (1988), several medical conditions are shown specifically to increase the risk of falling, including weaker lower body strength, sedative use, and cognitive impairment. In addition to these primary risk factors, other risk factors, like arthritis and poor vision, are shown to be associated with an increase in risk of

falling. Even though arthritis and poor vision (cataracts) were among the most prevalent medical conditions in this sample, only a weak statistical trend was found between number of medical conditions and one-year fall rate. Furthermore, based upon the sensitivity and specificity estimates, number of medical conditions was not found to be a suitable marker for correctly identifying fallers or non-fallers based on the predetermined accuracy level of 70%.

### **Relationship between One-year Fall Rate and Physical Activity Scores**

The total physical activity score (TPA) was significantly related to one-year fall rate ( $p = 0.036$ ), in that the more physical activity one reported, the fewer falls one experienced over the one-year period. This result compares favorably with Warburton et al. (2006) who also showed a positive relationship between total physical activity and fall rate. Together, these findings suggest a reduction in fall risk for more active individuals. However, these findings both disagree with Chan et al. who suggested that individuals with higher amounts of physical activity had an increased risk of falling.

Despite the overall significant inverse relationship found between TPA and one-year fall rate, none of the component physical activity scores for TPA (i.e., HPA, LPA, SPA) were significantly related to one-year fall rate ( $p = 0.210$ ). Nor were any of the physical activity scores acceptable markers for distinguishing fallers from non-fallers. That said, the relationship between LPA scores and one-year fall rate did approach significance with a p-value of 0.088. This finding tends to support Sherrington et al.'s (2004) supposition that structured exercise can help prevent falls in the elderly. In the present study, LPA scores included structured exercise as well as other activities (e.g.,

gardening, walking the dog, ushering basketball games, etc.). While this finding is worth looking into further, it's important to remember that in this case the statistical significance is only applicable when LPA is analyzed with HPA and SPA. Further research is needed to determine the impact of falls due to only the LPA score as well as the individual impact of the various physical activities that comprise the LPA score.

The probable reason why the present study could not better determine which specific type(s) of physical activity was related to having fewer falls was likely due to the skewed nature of activity participation. For instance, 78% of the sample population reported no engagement in any type of SPA.

### **Limitations**

The present study had a few limitations that need to be acknowledged. First, the present study was based on self-report, which is not ideal. Certain measures were taken to avoid error in self-report, but there is inherent error nonetheless. Second, the volunteer population was primarily Caucasian and well educated which narrowed the generalizability of the results. Third, the medical condition query section requested the subject to record past and current history of his/her medical condition without noting which conditions were current. Thus researchers were not able to determine which medical conditions coincided with the current fall history- a one-year report.

## **CHAPTER SIX**

### **Summary and Conclusions**

#### **Summary**

The purpose of this thesis was to explore relationships between concern for falling, fall history, number of medical conditions, and physical activity. The secondary purpose of the study was to determine the sensitivity and specificity of the independent variables (concern for falling, number of medical conditions, total physical activity, household physical activity, leisure physical activity, and sport physical activity) for correctly identifying fallers and non-fallers. Data from 60 community dwelling adults (24 males, 36 females) aged 70-84 was analyzed retrospectively to determine these relationships. The subjects were able to walk independently (with or without assistive device), and able to understand and respond to the written and spoken English language. Each subject had earned at least a high school diploma.

The study found a significant inverse relationship between TPA scores and one-year fall rate, wherein those who were more physically active overall had lower reports of falls over the past year. No other significant relationships were found. None of the independent variables proved to be sensitive or specific markers for distinguishing fallers from non-fallers with at least 70% accuracy.

## **Conclusions**

Based on the results of the present study, the following research questions and null hypotheses were addressed:

### **Research Question 1: What is the relationship between concern for falling and one-year fall history for the group as a whole and by gender?**

Ho<sub>1</sub>: There is no relationship between concern for falling and one-year fall history for the group as a whole or by gender.

*The null hypothesis was **accepted** because of the non-significant results of the Chi-square analysis (with a Yates Continuity Correction).*

### **Research Sub-question 1a: Determine the sensitivity and specificity of “concern for falling” as a marker to distinguish fallers from non-fallers.**

Ho<sub>1a</sub>: “Concern for falling” is neither a sensitive or specific marker for distinguishing fallers from non-fallers.

*The null hypothesis was **accepted** because concern for falling was found neither to be a sensitive or specific marker for distinguishing fallers from non-fallers with at least 70% accuracy.*

### **Research Question 2: What is the relationship between number of medical conditions and one-year fall rate?**



Ho<sub>2</sub>: There is no relationship between number of medical conditions and one-year fall rate.

*The null hypothesis was **accepted** because the simple linear regression showed a non-significant relationship between number of medical conditions and one-year fall rate.*

**Research Sub-question 2a: Determine the sensitivity and specificity of “Number of medical conditions” as a marker to distinguish fallers from non-fallers.**

Ho<sub>2a</sub>: “Number of medical conditions” is not a sensitive or specific marker to distinguish fallers from non-fallers.

*The null hypothesis was **accepted** because the number of medical conditions was found neither to be a sensitive or specific marker for distinguishing fallers from non-fallers with at least 70% accuracy.*

**Research Question 3: What is the relationship between each of the following categories of physical activity and one-year fall rate: household physical activity, leisure physical activity, and sport physical activity?**

Ho<sub>3</sub>: There is no relationship between one-year fall rate and household physical activity, leisure physical activity, and sport physical activity.

*The null hypothesis was **accepted** because the standard multiple regression revealed no significant relationships between one-year fall rate and any of the categories of physical activity.*

**Research Sub-question 3a: Determine the sensitivity and specificity of household physical activity, leisure physical activity, or sport physical activity to distinguish fallers from non-fallers.**

Ho<sub>3a</sub>: Household physical activity, leisure physical activity, or sport physical activity is not a sensitive or specific marker to distinguish fallers from non-fallers.

*The null hypothesis was **accepted** because none of the categories of physical activity were shown to be sensitive or specific markers for distinguishing fallers from non-fallers with at least 70% accuracy.*

**Research Question 4: What is the relationship between total physical activity and one-year fall rate?**

Ho<sub>4</sub>: There is no relationship between total physical activity and one-year fall rate.

*The null hypothesis was **rejected** because a simple linear regression revealed a significant inverse relationship between total physical activity scores and one-year fall rates. An increase in total physical activity was significantly related to a lower self-reported fall rate.*

**Research Sub-question 4a: Determine the sensitivity and specificity of total physical activity to distinguish fallers from non-fallers.**

Ho<sub>4a</sub>: Total physical activity is not a sensitive or specific marker to distinguish fallers from non-fallers.

*The null hypothesis was **accepted** because total physical activity score was found neither to be sensitive or specific in distinguishing fallers from non-fallers with at least 70% accuracy.*

### **Practical Applications and Suggestions for Future Research**

Although the present study did not reveal a statistically significant relationship between number of medical conditions and falls, further research in this area is warranted. More in depth queries regarding current medical conditions combined with more precise recordings of physical activity participation need to be used. While evaluating falls is important, it is also important to evaluate relationships between physical activity, medical conditions, and injurious falls. Injurious falls are the ones that are traumatic, expensive, and potentially life threatening. Future research should differentiate between injurious falls and non-injurious falls. This will enable researchers to more accurately quantify dose-response exercise relationships to fall risk.

While several studies recognize the importance of physical activity in preventing falls and reducing falls risks, more research needs to be done to determine the type and volume of physical activity necessary to elicit these results. Most critical, the present study suggests that the type of activity is less important than the overall volume of physical activity in reducing falls. This concept is in line with the American College of Sports Medicine and American Heart Association's joint recommendation that Americans should strive to accumulate 30 minutes of activity throughout the day, regardless of type (Haskell, Lee, Pate, Powell, Blair, Franklin et al. 2007). Admittedly, these current physical activity suggestions can be daunting to an older individual

unaccustomed to regular physical activity participation. Therefore, it is important to have achievable, reasonable suggestions presented to the growing aged population if healthcare professionals are going to make a substantial impact on reducing falls and rising medical costs associated with falls.

## APPENDIX A

### Modified Baecke Questionnaire for Older Adults

Voorrips L.E., Favelli A.C.F., Dongelmans P.C.A., Deurenberg P., Van Staveren W.A. (1991). A physical activity questionnaire for the elderly. *Medicine & Science in Sports & Exercise*, 23:974-979.

The information in this Appendix is presented in order to help the reader understand the scoring methods used to calculate physical activity scores (household, leisure, sport, and total). Please see the original article for more details regarding scoring methods.

### SCORING METHODS

#### Household Physical Activity

Ten multiple choice questions about household activities are asked, and a point value is given for each choice. Questions include topics of household cleaning, transportation, presence and use of stairs, for how many people the subject keeps house.

Examples of responses are:

0. Never (< once a month)
  1. Sometimes
  2. Mostly
  3. Always
- 
0. I never go out
  1. Car
  2. Public Transportation
  3. Bicycle
  4. Walking

The corresponding number for each answer is added together to calculate the household physical activity score. For example, if a subject answered the two sample questions “2. Mostly” and “1. Car,” his/her score so far would be three ( $2 + 1 = 3$ ).

### Leisure Physical Activity

Each subject answered the question “Do you have any other physically active activities?” by filling in the following blanks: name, intensity, hours per week, and period of year. A code is given for the responses to intensity, hours per week, and period of year. For each activity, the product of all the codes represents that activity’s score. The sum of each activity noted in the section represents the Leisure Physical Activity Score.

For example:

CATEGORY	ANSWER	CODE
Activity	Walking the dog	
Intensity	Walking, hand or arm movements	1.368
Hours per Week	3 - <4 hours/week	3.5
Period of Year	More than 9 months/year	0.92
SCORE		$1.368 \times 3.5 \times 0.92 = \mathbf{4.405}$

CATEGORY	ANSWER	CODE
Activity	Gardening	
Intensity	Standing, body movements, and walking	0.890
Hours per Week	2 - <3 hours/week	2.5
Period of Year	More than 9 months/year	0.92
SCORE		$0.890 \times 2.5 \times 0.92 = \mathbf{2.047}$

Leisure Physical Activity Score = 4.405 + 2.047 = **6.452**

### Sport Physical Activity

Each subject answered the question “Do you play a sport?” by filling in the following blanks: name, intensity, hours per week, and period of year. A code is given for the responses to intensity, hours per week, and period of year. For each activity, the product of all the codes represents that activity’s score. The sum of each activity noted in the section represents the Sport Physical Activity Score.

For example:

CATEGORY	ANSWER	CODE
Activity	Tennis	
Intensity	Walking, body movements, cycling, swimming	1.890
Hours per Week	1 - <2 hours/week	1.5
Period of Year	More than 9 months/year	0.92
SCORE		$(1.890 + 1.5 + 0.92) = \mathbf{2.608}$

Sport Physical Activity Score = **2.608**

### Total Physical Activity Score

Total physical activity score is calculated by adding together the household, leisure, and sport physical activity scores.

For example:

If HPA score = 10, LPA score = 6.452, and SPA score = 2.608, then TPA score =  $10 + 6.452 + 2.608 = \mathbf{19.06}$ .

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