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Examining Mediators to Physical Activity as a Link to Interventional Efforts Aimed at Increasing Activity Levels and Improving Physical Functioning in Older Adults

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EXAMINING MEDIATORS TO PHYSICAL ACTIVITY AS A LINK TO INTERVENTIONAL EFFORTS AIMED AT INCREASING ACTIVITY LEVELS AND IMPROVING PHYSICAL FUNCTIONING IN OLDER ADULTS

by

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ABSTRACT

EXAMINING MEDIATORS TO PHYSICAL ACTIVITY AS A LINK TO INTERVENTIONAL EFFORTS AIMED AT INCREASING ACTIVITY LEVELS AND IMPROVING PHYSICAL FUNCTIONING IN OLDER ADULTS

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Under the supervision of Scott J. Strath, Ph.D.

The number of older adults living in the United States is growing at an increasingly rapid rate, and is host to a high prevalence of chronic diseases and physical impairments. Physical activity and exercise have been shown to be beneficial in impacting such conditions, yet the majority of older adults remain inactive. The purpose of this dissertation was to employ a sequence of studies to investigate mediators to physical activity, leading to an intervention to increase activity and promote health.

The purpose of Project VOICE was to examine whether awareness and utilization of community resources to promote physical activity and exercise differed by residential spatial tiers of increasing distance from the resources. Results showed that approximately 50% of the sample was aware of the resources, yet utilization rates fluctuated around a paltry 3% (there were no differences across spatial tiers). The most notable barriers that influenced participation were interest in resources available, current health status, and transportation to and from community resources. Efforts are warranted to increase interest in using such resources, and/or developing interventions that overcome noted barriers.

Extending upon the results of Project VOICE, Project PACE employed a home-based intervention aimed at increasing physical activity and engagement in exercise, to improve physical functioning levels in community-dwelling older adults. An enhanced physical activity prescription of daily step goals (increasing 10% weekly) and resistance band exercises was provided for the intervention group, compared to a standard of care group who were prescribed 10,000 steps/day. The intervention group significantly increased the amount of steps taken daily, compared to the standard of care group, and improved physical functioning. These results were enhanced within those who had greater compliance to the prescribed intervention, however, this included only 25% of the total group sample. Future studies should include a larger sample size and a longer study design with follow up measurements, focusing on improving intervention adherence.

Considering the low utilization of community resources for physical activity and exercise, a low-cost, home-based intervention was successful in increasing physical activity and improving physical functioning, demonstrating the potential and advantages of programs easily translatable into everyday life.

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LIST OF ABBREVIATIONS

BMI: Body mass index
CBFR: Community-based fitness resources
CSRT: Choice step reaction time
EPA: Enhanced Physical Activity
MVPA: Moderate-vigorous physical activity
PA: Physical activity
PACE: Promoting activity in community elderly
PF: Physical functioning
SoC: Standard of Care
VOICE: Voicing opportunities in community elderly

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CHAPTER I: INTRODUCTION

Background

The demographics of the United States have shifted remarkably over the course of the previous century. Namely, the proportion of those aged ≥65 years of the total population has dramatically risen, resulting in an overall increase in the number of older adults. In 1900, the older adult population comprised 4% of the population, increasing to 13% in 2000, and is projected to reach 20% by 2050. Such trends are largely attributable to advancements in medical care and associated technology, which have resulted in a longer lifespan. Additionally, there have been observed spikes in birth rates at various points in the past century that have also contributed to the current "graying of America."

The growth of the older adult population is accompanied with important societal implications. In particular, the dramatic rise in the number of older adults will place an increased demand on public health and medical services. Health care expenditures are particularly high in the older adult population, due to degenerative health and the associated emergence of chronic diseases and conditions (i.e. heart disease, diabetes, hypertension, hypercholesterolemia, obesity, cancer, and osteoporosis). Overall, 88% of older adults have one chronic disease, and 65% have two or more (King, Rejeski, and Buchner, 1998; Lehnert et al., 2011). Providing care for these ailments carries a great economic burden, with an estimated 75% of health care expenditures spent on treatment of chronic diseases (Thrall, 2005). One of the most notable effects of chronic diseases is the associated decrease in physical functioning. It is estimated that over 40% of those with at least one chronic condition experience functional limitations (Federal Interagency Forum on Aging-Related Statistics, 2008). Physical functioning can be described as the ability for a person to engage in activities, including personal care, and has been shown to decline with increasing age. Often, this is categorized as activities of daily living (ADLs) and instrumental activities of daily living (IADLs), which consist of tasks necessary for self-maintenance and care, transportation, and other tasks engaged in throughout the day. Approximately 3.5% of those aged 65+ years report requiring assistance in their personal care, and this amount increases to 11.0% of those aged 75+ years (United States Department of Health and Human Services, 2011). Some of the main concerns associated with decreased physical functioning are the increased reliance on medical intervention, the necessity for others to provide assistance in daily activities, and decreasing one's overall health, which can lead to forced modifications to one's lifestyle.

Physical activity has long been acknowledged for its associated health benefits. As the field of scientific investigation has grown more complex, the understanding of how physical activity benefits a slew of health conditions has grown tremendously. Regular physical activity has been shown to be efficacious in ameliorating disease symptoms in diagnosed individuals, and in overall prevention of disease diagnosis (Haskell et al., 2007). The benefits of physical activity span various physiological mechanisms, contributing to a better overall quality of life and affecting biological mechanisms associated with numerous common chronic conditions, including coronary heart disease, peripheral vascular disease, hyperlipidemia, hypertension, obesity, diabetes, and osteoporosis (Nelson et al., 2007). Furthermore, an estimated 50% of the age-related decline in functioning that leads to disability may be preventable through physical activity intervention (Jackson, Beard, Wier, & Blair, 1995). Accordingly, the merit of engaging in physical activity in the older adult years cannot be understated or ignored, as the prevalence of chronic diseases and disability remains at high levels and their impact upon our health care system immense.

Given the high prevalence of chronic diseases and functional impairments in older adults and the associated health benefits of engaging in physical activity, the scientific community has sought to quantify levels of physical activity that are necessary to achieve such benefits. Current recommendations from the American College of Sports Medicine and American Heart Association state that in order to maintain general health, each person should aim to engage in 30 minutes of moderate intensity activity on most, preferably all, days per week, and/or 20 minutes of vigorous intensity activity on two or more days per week (Nelson et al., 2007). Additionally, guidelines exist for exercise behavior, defined as “a planned, structured, and repetitive movement with the intent on improving or maintaining one or more components of physical fitness,” with recommendations for resistance training in older adults to engage in weight training 2-3 times per week, exercising the main muscle groups over 8-10 exercises for 10-15 repetitions for 2-3 sets (Chodzko-Zajko, 2009). Despite clearly defined physical activity recommendations, engagement in such behaviors remains low in the older adult population, with estimations approximating 3.5% of the population meeting such goals (Troiano et al., 2008). Additionally, engagement in exercise behaviors mimic insufficient amounts of physical activity, with 10-15% of older adults report engaging in any form of resistance training (Winett, Williams, and Davy, 2009). Clearly, given low levels of engagement in physical activity and strengthening exercise behaviors, there is a strong scientific need to investigate determinants and barriers to such, and effective intervention strategies to elucidate change.

Physical activity is a complex behavior, and much research has been conducted to further understand governing mediators to engagement in physical activity. Relevant influences to physical activity span factors specific to each individual person, including biologic and psychosocial factors, as well as a holistic perspective of the environmental. Such variables have unique influences on physical activity participation in the older adult population. Access to community resources that promote physical activity engagement has been one postulated mechanism to increase activity levels in older adults, and ultimately promote health. Community resources, such as those found in local senior centers serve to offer a venue to engage in physical activity and exercise, thus providing an environmental support, as well as a social support network. Given the widespread offerings of senior exercise classes and senior fitness facilities, little is known about their effectiveness to promote active behaviors. Further exploration of the effect of community resources on their impact to increase overall physical activity levels in older adults is warranted.

Given the importance of physical activity and exercise on older adult health, there is a burgeoning literature still focusing on interventions to increase these behaviors. Previous research has investigated the individual components of physical activity (frequency, intensity, duration, and mode), whereas others have focused on increasing overall volumes of physical activity, such as steps taken per day. Literature reviews (spanning middle-aged, older, healthy, and diseased populations) have shown the average increase in walking behavior observed from interventions approximates 2,000 steps/day (Bravata et al., 2007). However, such gains in activity often do not reflect associated health benefits. Possible explanations for inconsistent results are due to fluctuating activity levels within a person from day to day, the population of focus, and baseline activity levels. In an effort to achieve more consistent, positive results from physical activity interventions in older adults, researchers have implemented resistance training components to provide a more holistic approach to increasing physical activity, targeting additional components of physical fitness to improve exercise capacity and tolerance. Coinciding with this approach, there are two broad settings, supervised and unsupervised, for said interventions to occur.

Supervised physical activity interventions consist of employing a structured exercise program that is monitored and led by a given professional, and have shown effectiveness in increasing physical activity levels in older adults over the course of the previous 30 years (Kriska et al., 1986). Adherence to interventions is often dictated by duration of the intervention, with higher levels evident from short term intervention efforts (55-93%), compared to long term (36-84%) (van der Bij, Laurant, & Wensing, 2002). Despite the efficacy of supervised interventions, and high adherence rates, barriers exist to their wider implementation. For instance, transportation is needed to use structured programming, such programs often have a cost associated with use, and some investigations have reported an aversion to group-based exercise programs (Van Roie et al., 2010). Given this, other scientific work has investigated the effect of unsupervised physical activity interventions. Unsupervised physical activity interventions aim to achieve equal effectiveness in physical activity promotion by inducing behavior change in one's overall lifestyle. Typically, such interventions occur within one's home, or in surrounding environment. One notable difference, though, is that unsupervised interventions eliminate the necessity to travel to a meeting location or utilize expensive exercise equipment that is employed in supervised interventional approaches. To this end, it is postulated that unsupervised, lifestyle interventions possess greater generalizability for the broader older adult population to abide by and ultimately to increase physical activity levels. Unsupervised interventions have been shown to be effective in increasing physical activity in older adults (Hultquist et al., 2005; King et al., 2008; McMurdo et al., 2010; Strath et al., 2011). However, adherence to lifestyle unsupervised interventions has been shown to be low (Hultquist et al., 2005; van Stralen et al., 2009). Given the greater generalizability to lifestyle physical activity interventions for older adults, facets to improve upon adherence, encouraging compliance with both physical activity and strengthening exercise are warranted.

Chapter Summary

The older adult population is growing at rates that raise public health concerns. High rates of chronic disease, coupled with decreasing functional capacities, equate to high health care costs in this population. Physical activity has been shown to be an effective solution, however overall activity levels remain alarmingly low. In turn, efforts have been made to promote gains in physical activity, considering the vast mediators and barriers prominent in older adults. Provided the aforementioned information, the following chapters provide an in depth review of the literature, establishing the rationale for a sequence of ensuing studies, study one (Project VOICE [Voicing Opportunities in Community Elderly]) and study two (Project PACE [Promoting Activity in Community Elderly]).

Project VOICE

Statement of Purpose

The purpose of this study was to determine whether awareness and utilization of fitness resources and overall physical activity engagement differed depending on residential distance from community-based fitness resources (CBFR).

Specific Aims

This study had three specific aims: 1) To examine awareness of CBFR among those residing within ≤1, >1 to ≤2, and >2 to 5 miles around senior centers housing CBFR, 2) to examine utilization of CBFR among the same individuals, and 3) to examine if overall physical activity levels increased the closer one's proximity to CBFR.

Hypotheses

It was hypothesized that both 1) awareness and 2) utilization rates of CBFR would increase with each spatial tier of closer proximity to CBFR. It was also hypothesized that overall physical activity levels would follow the same trend (increase within successive spatial tiers located closer to CBFR).

Project PACE

Statement of Purpose

The purpose of this study was to examine whether an in-home, individually tailored intervention is efficacious in promoting meaningful increases in PA and improvements in physical functioning in low-active older adults.

Specific Aims

There were two specific aims: To examine if an enhanced physical activity intervention of individually tailored step goals and resistance training with bi-weekly telephone follow-up in low-active older adults 1) significantly increases physical activity (as assessed by steps/day), and 2) improves measures of physical functioning, as measured by choice step reaction time, balance, knee flexion/extension strength, maximal handgrip strength, and 8ft up-and-go test completion time significantly more than a standard of care group.

Hypotheses

It was hypothesized that the enhanced PA intervention group will 1) significantly increase steps/day and 2) improve choice step reaction time, balance, knee flexion/extension strength, maximal handgrip strength, and 8ft up-and-go test completion time compared to the standard of care group.

CHAPTER II: LITERATURE REVIEW

Introduction

In the previous 100 years, the older adult population (≥65 years) has experienced tremendous growth, both in terms of overall population numbers, as well as the average expected lifespan. This is of particular importance, as the prevalence of burdensome chronic diseases, such as hypertension, obesity, diabetes, osteoporosis, cancer, and hyperlipidemia remain high in this population. In older adults, the presence of such chronic diseases is linked to decrements in overall health and quality of life, as well as the ability to maintain functional independence. Furthermore, there is an increasing number of older adults that are living with multiple chronic diseases, which can further compound and exacerbate adverse health outcomes, including physical functioning. Accordingly, health care expenditures have soared in response to both treat newly diagnosed individuals with such ailments, as well as aid in the associated rehabilitation and recovery process.

Within the older adult population, chronic diseases have tremendous implications for health, lifestyle, and economic expenditures. Given the public health relevance of such issues, there is a growing interest in assessing the utility of methodologies employed in the prevention and treatment of chronic diseases. Physical activity has long been demonstrated to have a beneficial impact on a multitude of chronic conditions and diseases. Despite such evidence, older adults are one of the least active populations, and engagement in sedentary behaviors has been observed to become more prominent into the elder years. Physical activity promotional efforts have thus aimed to target contributing characteristics to engagement in such behaviors, spanning a spectrum of factors unique to individual persons.

Within the older adult population, one aspect that is of particular influence to engagement in physical activity is physical functioning capacity. Overall, physical functioning is the ability of a person to freely and successfully engage in any choice behavior. In aging populations, this commonly relates to the ability to perform activities of daily living (ADLs) and instrumental activities of daily living (IADLs), representing one's ability to maintain living independence. Additionally, physical functioning can be classified by physiological measures, spanning functional capacities of the muscular and cardiovascular systems. Impairments in physical functioning can be interpreted as a precursor to physical disability and fall risk, as well as a barrier prohibiting one to engage in sufficient amounts of physical activity necessary to promote health. Thus, the ability to maintain physical functioning is critical in the pursuit of optimal health across the lifespan.

The following chapter highlights the importance of physical activity, as it pertains to health in older adults. The beginning of the chapter will outline the growth of the older adult population and the associated economic impact, and how physical activity has the potential to reduce such burdens. Implanted within this, the prevalence and implication of impaired physical functioning, in particular, will be provided. Following will be an overview of the importance and current recommendations for physical activity, and the potential for physical activity to reduce/ameliorate the prevalence of chronic diseases relevant to older adults. Then, a review of prominent physical activity determinants and barriers will be provided, transitioning into the effectiveness of physical activity interventions in increasing overall physical activity levels and physical functioning abilities. The conclusion of this chapter will serve as a lead-in to a pair of studies examining: 1) the impact of environmental support, by way of community fitness resources, on locally residing older adults' awareness of resources and physical activity behavior and, 2) a home-based intervention aimed at increasing physical activity and physical functioning in older adults.

Growth of the Older Adult Population

Since the turn of the 20th century in the U.S., there has been a dramatic increase in the number of older adults. This trend is largely attributable to advancements in medicine and technology, highlighted by a heightened emphasis on disease prevention, resulting in an elongated lifespan. In 1900, there were approximately 3 million older adults out of the total population of 76 million, comprising 4% of the population (United States Department of Health and Human Services, 2011). The proportion of the elderly (≥85 years) were less, approximating 0.1% of the population (Ferrucci et al., 2008). By the year 2000, those aged ≥65 years and ≥85 years comprised 12.6% and 1.6% of the U.S. population, respectively (Ferrucci et al., 2008). Collectively, in one century the U.S. population experienced a growth of approximately 125%, whereas the older adult population experienced an eleven-fold increase (Ferrucci et al., 2008; Arndt & Travers, 2002).

The aforementioned growth trends in the older adult population are projected to continue. The U.S. Census Bureau estimates that within ten years, older adults will outnumber (for the first time) children under the age of five (Kinsella & He, 2009). Baby

Boomers (those born in 1946-1964) are now transitioning into older adulthood, which largely explains the rise in number of older adults in recent years. By 2050, the estimated U.S. population is predicted to eclipse the 400 million mark, with accompanying estimations for those 65 and 85 years and older approximating 20.3% and 4.8% of the total population, respectively (Ferrucci et al., 2008; Garret & Martini, 2007).

Directly correlated with the growing proportion of older adults of the overall national population is an increasing lifespan. In 1900, the life expectancies for men and women at birth were 48.3 years and 51.1 years, respectively (Arndt & Travers, 2002). By 2000, life expectancies had risen to 74.2 years for men and 79.9 years for women, representing increases in life expectancy of 66% and 71%, respectively (Ferrucci et al., 2008; Arndt & Travers, 2002; Kinsella, 1992). Accordingly, a longer expected lifespan allows for more individuals to experience life into the older adult years. In turn, the overall older adult population has experienced substantial numbers and longevity, with predictions anticipating further growth in overall population numbers.

The State of Older Adults' Health and Economic Impact

As the population of older adults continues to rapidly grow, the significance of health to this aging population and its impact upon society becomes of paramount importance. In particular, health care expenditures with the older adult population carry a tremendous burden on the U.S. health care system. In 1995, health care expenditures comprised 4% of the U.S. gross domestic product, and these amounts are expected to reach 10% by 2020 (Rice & Fineman, 2004). In aging populations, such immense economic expenditures are attributable, in part, to the combination of the high prevalence of chronic diseases and physical impairments, which have a detrimental impact on overall health status. Medicare and Medicaid are the major sources for covering treatment of chronic conditions, approximating $466 billion and $199 billion, respectively, in 2009 (Mechanic, 1999; Sisko et al., 2009). Of those receiving Medicaid, children and middle-aged adults are less costly, compared to older adults (Sisko et al., 2009). This trend of increasing health care costs across the lifespan is highlighted by categories of health care expenditures that are highly specific to older adults, including physician visits, hospital stays, pharmaceutical use, and out-of-pocket costs (Lehnert et al., 2011). Thus, such expenditure categories reflect a necessity to receive health care in across a variety of settings. Considering the older adult population is vast and growing, there are accumulating health and economic concerns that have a tremendous impact on society. Such statistics have garnered a heightened attention in the evaluation of current methodologies to treat prevalent health ailments in the older adult population.

Economic impact of prevalent health ailments.

There are a number of glaring health concerns that are prominent in the older adult population, namely chronic diseases and impairments in physical functioning, which contribute to soaring medical expenditures. Chronic conditions can have an increasingly debilitating impact on one's health, including increasing the reliance on medical intervention, imposing restrictions in the ability to perform daily activities, and reducing the ability to maintain living independence. Due to the increase in adverse health outcomes in the presence of chronic diseases, there is an inherent link between the prevalence of chronic diseases and impaired physical functioning. An estimated 25% of those with at least one chronic condition experience functional limitations (Federal Interagency Forum on Aging-Related Statistics, 2008). The World Health Organization's

International Classification of Functioning, Disability, and Health (ICF) recognizes that all people experience some sort of disability or limitation in their lives, but this varies on the basis of one's physical health, as well as the social and physical environments (Ustun et al., 2003). Overall, the aforementioned adverse outcomes related to chronic diseases and physical functioning impairments reflect negatively on one's physical health profile, predisposition to disability, and overall quality of life, often requiring some sort of health care.

Prominent chronic diseases in older adults have a direct and harmful relationship with mortality risk and the onset of co-morbidities, resulting in high amounts of health care expenditures. An estimated 75% of total U.S. health care expenditures are spent on the treatment of chronic conditions, of which older adults and associated health disparities are responsible for a large segment of such allocations (Thrall, 2005). Health care costs increase in the presence of multiple chronic conditions, from $5,186 in those with no chronic conditions to $25,132 in those with five or more (Federal Interagency Forum on Aging-Related Statistics, 2008). For each additional chronic condition one has, there is an exponential increase in health care costs. One report from Schneider et al. (2009) stated that for Medicare beneficiaries with zero, one, two, and three chronic conditions had total health care costs of $3,079, $7,879, $16,402, and $35,701, respectively.

One reason why the economic impact of chronic diseases is so immense is the associated impact they have on a person's lifestyle and the activities they can participate in. It is difficult to quantify health care costs due to functional limitations, as there is a spectrum of adverse health outcomes that are influenced (in some capacity) by functional impairments. However, it is estimated that older adults who are dependent on others, based on functional limitations, account for 46% of total health care expenditures (Manini and Pahor, 2009). Staggeringly, this amount is comprised of only 20% of the older adult population, lending evidence to the severity and complexity of health problems associated with functional impairments (Manini and Pahor, 2009). Overall, health care expenditures are projected to increase into the future, due to the expansion of the aging population and the high prevalence of associated chronic diseases. The ensuing section will provide an overview on prominent chronic diseases, providing evidence for the large proportion of older adults that require special lifestyle considerations and are at risk for physical functioning impairments.

Prominent chronic diseases in older adults.

There are a plethora of chronic diseases that remain highly prevalent in the older adult population, including heart disease, diabetes, obesity, osteoporosis, cancer, hypertension, and hyperlipidemia. An estimated 88% of older adults currently live with one chronic condition, while approximately 65% are living with two or more (King, Rejeski, and Buchner, 1998; Lehnert et al., 2011). This carries immense public health relevance, as overall health, including physical functioning, steadily deteriorates in face of multiple chronic diseases, having a direct relationship on mortality risk and comorbidities, as well as health care expenditures.

Current estimates based on large-scale population data determine the most prevalent chronic diseases in older adults to be hypertension, heart disease, and cancer, which are related to the subsequent leading causes of death of heart disease, cancer, and stroke (Center for Disease Control, 2009). It is estimated that 58 million U.S. adults are living with hypertension (Pescatello et al., 2004). Among older adults, 44.6% of men and 51.1% of women report diagnoses of hypertension (Ferrucci, Giallauria, & Guralnik, 2008). Hypertension reflects an increased stress on cardiac function, which can eventually lead to heart disease. Approximately 17 million people are living with coronary heart disease, resulting in approximately 1.1 million myocardial infarctions per year, and 425,000 cardiac-related deaths per year (Sattelmair et al., 2011). Current estimations reflect 24.3% of older adult men and 16.5% of women reporting being diagnosed with coronary heart disease (Ferrucci, Giallauria, & Guralnik, 2008). Cancer is the third most common chronic disease in older adults. In 2011, there were approximately 575,000 cancer-related deaths (American Cancer Society, 2011). The most common cancer types for men are prostate, colon, and bladder, whereas breast, lung, and colon cancers are most common in women (Howlader et al., 2012). It is estimated that the lifetime risk of developing some form of cancer is 1 in 2 for men, 1 in 3 for women (Howlader et al., 2012). An estimated 23.2% of older adult men and 17.5% of women report living with any form cancer (Ferrucci, Giallauria, & Guralnik, 2008). Collectively, there are a large proportion of individuals living with a degenerative condition that influences their current health and physical abilities. The following section will provide an outline of the role impairments in physical functioning have on impacting individuals' activity levels and associated predisposition to chronic disease.

Physical functioning and limitations in older adults.

In the older adult population, one's physical functioning capabilities are vital in influencing the healthy aging process, enabling one to participate in their choice activities and maintain a high quality of life. Collectively, physical functioning is an outcome that can be used to categorize one's capacity to perform physical tasks, which often dictates one's overall lifestyle. According to Nagi's Physical Disability Model (1976), impairments in individual physiological systems influence decrements in total body functioning, which in turn, leads to an impairment to perform a specific action (i.e. ADLs or IADLs). When the inability to perform ADLs and IADLs becomes too great, one must increase reliance on others for assistance. Therefore, Nagi's model, represents an inward-out scheme to describe the linkages between impairments in individuals' bodily systems, physical impairments, and lifestyles. Such an approach places a high level of emphasis upon the individual, but may not to be truly representative of all the factors that influence physical limitations.

There are numerous other contributing factors to one's functional capacity to perform tasks. Namely, the environment in which one resides has influence on such abilities, spanning both the physical and social environments. Recognizing such influences have resulted in a more robust understanding on physical functioning and lifestyle engagement, as it relates to the disablement process. The World Health Organization's ICF projects a more comprehensive analysis on the relationships between health, our engagement, and our environments (Ustun et al., 2003). In particular, the ICF portrays functional capacity on the bi-directional relationship between health of an individual and the environment. In this approach, a person is examined on the basis of individual bodily systems, the whole body, and the body within the social environment. Such an approach provides a more comprehensive analysis of what constitutes physical functioning, as it relates to potential disability in a growing older adult population.

In older adults, physical functioning becomes an increasingly prominent health problem, due to declines in physiological functioning, including muscle degeneration, losses in bone density, increases in cognitive delay, and decrements in aerobic capacity. Collectively, there are 73.7 million U.S. adults who have difficulty in performing basic life activities (Federal Interagency Forum on Aging-Related Statistics, 2008). Regarding older adults, approximately 3.5% of those aged 65+ years report requiring assistance in their personal care, and this amount increases to 11.0% of those aged 75+ years (Federal Interagency Forum on Aging-Related Statistics, 2008). Further expanding on the prevalence of physical limitations across the older and elder years, Holmes and colleagues (2009) reported that there is a linear increase in the number of those reporting one, two, and greater than three physical limitations in each decade, beginning in the 50-59 year range. Such an immense number reflects limitations spanning multiple physiologic systems, but also provides insight to the number of individuals who are currently living with, or are at risk for, physical disabilities.

Approximately 20% of older adults aged ≥60 years have some type of chronic disablement (Manton, 2008). Common tasks used as identifiers of physical limitations include standing for prolonged periods of time, grasping objects, kneeling, bending, walking, and climbing steps (Federal Interagency Forum on Aging-Related Statistics, 2008). Declines in physical functioning, as defined by such tasks, have been shown to begin as early as the 40 year old time period, deteriorating across the lifespan (Huang et al., 1998). Across the older adult years, performance on a variety of physical functioning-related tasks has been shown to steadily decline (Wahl et al., 2010), including the ability to lift 10 kg, climb a flight of stairs, and walk city blocks (Janssen et al., 2004). Overall, those aged 80+ years are 2.5 times more likely to have at least one physical limitation than those aged 50+ years. Accordingly, there is a large period of time, extending into the elder years, where one can potentially be accumulating more functional limitations.

There is clear evidence that the prevalence of those with physical disabilities increases across the lifespan. Chronic diseases, whose prevalence also increases across the lifespan, have a debilitating impact on health and physical capabilities. Based on the ICF model of disablement, physical functioning can be both the cause and result of one's lifestyle, current health status (chronic diseases), and surrounding environment. Physical activity is one method to intervene in the linkage between chronic disease and disablement to improve health and quality of life in older adults. The following section will outline such associations between physical activity engagement and health outcomes in the older adult population.

Physical Activity and Health Relationships in Older Adults

Physical Activity and Health Outcomes

Physical activity has numerous benefits across a variety of health conditions, both in ameliorating disease symptoms, and in overall prevention of disease diagnosis (Haskell et al., 2007). The benefits of physical activity span various physiological mechanisms, thus impacting overall quality of life. Physical activity has been shown to affect biological mechanisms associated with numerous common chronic conditions, including coronary heart disease, peripheral vascular disease, hyperlipidemia, hypertension, obesity, diabetes, and osteoporosis (Nelson et al., 2007). Additionally, physical activity has been shown to have beneficial relationships with various measures of physical functioning. The ensuing sections will provide a brief overview on the relationship between physical activity and prominent chronic diseases and conditions in the older adult population.

Heart disease.

The benefits of physical activity and exercise have long been established, in relation to heart disease. Specifically, energy expenditure has a beneficial impact on myocardial infarction (MI) risk. Numerous studies have shown coronary heart disease and MI risk to be lower when comparing highly active to sedentary individuals (Paffenbarger, Wing, & Hyde, 1978; Lee et al., 2000). Furthermore, engaging in high intensity activities is of additional benefit, decreasing MI risk up to 38%, compared to those engaging in lower intensity activities (Paffenbarger et al., 1978; Manson et al., 2002). Collectively, engaging in both high volumes and intensities of physical activity has been shown to be beneficial for both improving cardiovascular fitness, as well as protecting against heart disease.

Obesity.

Obesity and its associated health complications carry a tremendous burden on society. The increasing trend of excess fat and weight is largely attributable to energy balance, which relates to one's energy expenditure relative to their caloric intake. If one habitually ingests more energy than they expend, the excess energy is stored as fat. To offset this process, it is imperative to achieve a negative energy balance, which can be done through the processes of dieting and exercise. Regular engagement in physical activity is critical in thwarting the risk of obesity through energy expenditure. There is evidence to suggest that this caloric deficit from physical activity need not derive from vigorous intensity activities. Rather, the volume of energy expenditure is of greater importance to combat obesity. Therefore, participation in high duration and high intensity activities and exercises have a greater protective effect against obesity, with reference to short duration, light intensity activities, due to the increased energy expenditure. Such results have been shown in randomized controlled trials (Jakicic et al., 2003), as well as prospective studies (Williamson et al., 1993).

Diabetes.

Physical activity and exercise have demonstrated potential to have an impact on decreasing current diabetes symptom severity and future risk of diagnosis. Evidence supports that physical activity increases insulin sensitivity, weight loss, and improves glucose tolerance (Lynch et al., 1996). These causes have been investigated, guided by results of epidemiological studies showing that more active individuals have lower incidence rates of diabetes than less active counterparts (Zimmet et al., 1981). Similar to the effect of physical activity on obesity, the volume of physical activity engaged in is the most important factor related to diabetes prevention. There is strong evidence from prospective results to further demonstrate the protective role of physical activity (Hu et al., 1999), with the most active individuals having a relative risk of diabetes of 0.58 compared to the least active. However, low intensity activities, such as walking, have been shown to also decrease the risk of developing diabetes by as much as 30% (Jeon et al., 2007). Collectively, physical activity in modest amounts (150 minutes/week) has been shown to be efficacious in delaying the development of diabetes as part of the

Diabetes Prevention Program, providing merit to the public health relevance of maintaining an active lifestyle (Knowler et al., 2009).

Cancer.

There are numerous forms of cancer, and some are gender-specific. However, there is research to lend support that physical activity and exercise can reduce cancer-related mortality. Total energy expenditure is a governing factor for determining the protective benefits of physical activity towards cancer diagnosis (Slattery et al., 1996). Regular engagement of moderate intensity activity, compared to sedentary individuals, had a 30% reduced risk of developing cancer, with the protective benefit increasing the a 40% reduction in cancer incidence when engaging in vigorous intensity activities (Slattery et al., 1996). Overall, the amounts of activity necessary to achieve such benefits approximate 4-5 hours per week of moderate intensity activity (Lynch & Neilson, 2011).

Physical functioning, disability, and fall risk.

As previously outlined, regular physical activity and exercise have shown potential to lessen the burden that prominent chronic diseases present. This is extremely important, with reference to physical functioning, as the presence of chronic diseases is inversely related to one's physical functioning capacity. Given such associations, it is warranted to outline the associations between physical activity and exercise with outcomes related to physical functioning.

There is ample evidence that demonstrates that regular physical activity and exercise have beneficial relationships with measures of physical functioning. An estimated 50% of the age-related decline in functioning that leads to disability may be preventable through physical activity intervention (Jackson, Beard, Wier, & Blair, 1995). Functionality can be viewed as a precursor to physical disability and related to fall risk, thus, the effect of physical activity becomes increasingly important. Falls are one of the most serious events an older adult can experience, due to the high incidence of bone fractures, and subsequent lifestyle modifications as a result. Higher levels of physical functioning are associated with decreased fall risk (Wilson et al., 2011). Therefore, linkages exist between physical activity and corresponding levels of physical functioning and fall risk.

There are a variety of physiological measures that are linked to physical functioning ability that physical activity has a beneficial association with, including cardiovascular endurance and muscular strength and endurance (Kenny et al., 2011). Kannus and colleagues (2005) demonstrated that strength and balance training elicited improvements in much of the aforementioned variables, even in old and frail individuals. Such improvements in cardiovascular and muscular fitness have been observed in both a structured, fitness center setting, in addition to an in-home setting (Van Roie et al., 2010). Such results provide evidence that older adults are able to adhere to physical activity prescriptions independently. Furthermore, increases in physical functioning are shown to arise not only from exercise-activity training, but also from increasing lifestyle physical activity.

Similar to benefits of physical activity resulting from increasing exercise-type and lifestyle physical activity, there are a variety of type of measures of physical functioning that have been shown to be of benefit. In addition to physiological variables, there are performance-related tasks that are utilized as measures of physical functioning, including balance, gait, and flexibility assessment. Furthermore, timed tasks, such as the chair rise, timed up and go test, and 400 meter walk test have been used to identify those at risk for functional impairments (Guralnik et al., 1994; Newman et al., 2006). Physical activity has shown to be beneficial in improving both performance-related tasks, as well as time-based tasks in older adults. Accordingly, the benefits of physical activity in impacting physical functioning and disability risk are more holistic, and are not specific to individual physiological systems. There is evidence that even elderly and frail individuals are able to achieve such benefits, as evidenced by improvements in physiological variables and performance-related tasks. Physical activity is an important piece when initiating efforts to impact physical functioning, having the ability to help retain functioning levels and disability status with increasing age (Ip et al., 2012).

Accordingly, the importance of maintaining a physically active lifestyle across the lifespan cannot be understated. Not only does regular physical activity and exercise decrease the prevalence of prominent chronic diseases, but also helps improve physical functioning levels. This is highly beneficial, as the limitations experienced from poor health are minimized. However, given the prevalence of those with one or multiple chronic diseases and physical functioning impairments, it is likely that the vast majority of individuals are not achieving activity levels needed to promote related health benefits. The following section will detail what defines physical activity and exercise, what the recommendations are for maintaining general health, transitioning to the current prevalence rate of older adult physical activity behavior.

Physical Activity and Older Adults

Physical activity can be defined as any bodily movement that substantially increases energy expenditure (Caspersen et al., 1995). Current recommendations from the American College of Sports Medicine and the American Heart Association state that in order to maintain general health, each person should aim to engage in 30 minutes of moderate intensity activity on most, preferably all, days per week, and/or 20 minutes of vigorous intensity activity on two or more days per week (Nelson et al., 2007). In an effort to make such recommendations more feasible for older adults and other special populations to achieve, such amounts of physical activity can be accrued in smaller 8-10 minute bouts (Nelson et al., 2007). The World Health Organization more recently has released their recommendations for older adults to further simplify recommendations, stating that older adults should engage in 150 minutes/week of moderate intensity activity, or 75 minutes/week of vigorous intensity activity (United States Department of Health and Human Services, 2008). However, those who are capable should strive to reach 300 minutes/week of moderate intensity activity or 150 minutes/week of vigorous intensity activity, or a combination of both.

National Physical Activity Profile

Despite the known health benefits of regular physical activity, many people are not regularly active. With reference to older adults, the majority do not report engaging in regular physical activity, let alone meet physical activity recommendations. Large, national scale surveys of physical activity levels, including the National Health and Nutrition Examination Survey (NHANES) and the Behavioral Risk Factor Surveillance System (BRFSS), have had the goal of assessing the overall activity levels of the U.S., utilizing both subjective and objective assessment methodologies to quantify physical activity. Self-reported questionnaires show U.S. adults engage in approximately 6.5 hours/day in moderate intensity activity, and over an hour/day in vigorous intensity activities, based on 2005-2006 NHANES data (Tucker et al., 2011). Such reports may not be truly representative of activity levels, due to issues with memory recall and/or bias that often arise when completing physical activity questionnaires (Shephard, 2003). Accordingly, objective assessment methodologies, including pedometers and accelerometers aim to overcome such limitations by monitoring various aspects of ambulatory activity (Troiano et al., 2008). Tucker and colleagues (2011) presented accelerometer data on the same individuals mentioned previously, with engagement in moderate and vigorous intensities to 45 minutes/day and 18 minutes/day, respectively, representing less than 10% of individuals were shown to be meeting current physical activity recommendations. Others have approximated lower estimates of 3.5% of the population meeting such recommendations (Troiano et al., 2008). Accordingly, estimates for sedentary behavior have approximated 8.5 hours/day (Evenson, Buchner, and Morland, 2012).

Physical inactivity is a growing problem as one ages, with engagement in total activity, as well as activity in higher intensities, decreasing across the lifespan (Hawkins et al., 2009). Across those aged 46-64, 65-74, and 75+ years, the proportion of those who are primarily inactive increases from 16%, to 21-24%, to 30-40%, respectively (Centers for Disease Control and Prevention, 2007). Such increases in sedentary behaviors have tremendous implications, namely that inactive behaviors replace physical activity in greater proportions. Hansen and colleagues (2012) estimated that in the timeframe from 65 years to 85 years, engagement in sedentary behaviors increases approximately 1.5

hours, while participation in moderate-vigorous intensity activities decreases approximately 30 minutes. Accordingly, there is a shift in overall activity patterns, representing a trend towards an overall inactive lifestyle. Such trends are based on lifestyle activity, and not exercise-type behavior, which the ensuing section will outline.

Prevalence of Older Adults Engaging in Exercise

By definition, exercise is a behavior different than physical activity. Exercise is "a planned, structured, and repetitive movement with the intent on improving or maintaining one or more components of physical fitness" (Chodzko-Zajko, 2009). The individual components of physical fitness that exercise aims to impact include cardiovascular fitness, muscular strength, muscular endurance, flexibility, and body composition. When considering the definitions of physical activity and exercise, one can conclude that all exercise is physical activity, but not all physical activity can be considered exercise. The two main areas of exercise training include cardiovascular and resistance training. The physical activity recommendations in the aforementioned section largely represent engagement in cardiovascular activities, in which adherence to such recommendation is observed to be at low levels. Pertaining to resistance training, the American College of Sports Medicine recommends that older adults engage in weight training 2-3 times per week, exercising the main muscle groups over 8-10 exercises for 10-15 repetitions for 2-3 sets (Chodzko-Zajko, 2009).

The benefits of engaging in resistance are paramount in maintaining optimal levels of physical activity and functioning across the lifespan. Of chief importance is maximizing muscular strength and flexibility. Despite the potential benefits, it is estimated that a paltry 10-15% of older adults report engaging in any form of resistance training (Winett, Williams, and Davy, 2009). Such low participation can be explained, in part, due to the requirement and access to exercise equipment, instruction on proper use, supervision of safe execution of all exercises, and misinformation/negative connotations towards resistance training exercises (Winett, Williams, and Davy, 2009).

Summary on Older Adults, Health, and Physical Activity

Compared to 100 years ago, the average population has experienced a drastic increase in the expected lifespan, in addition to a spike in birth rates. Accordingly, the U.S. has experienced a tremendous growth in the number of older adults. The older population is subject to numerous chronic diseases and conditions (spanning multiple physiologic and psychological systems), many of which can be treated, through amelioration of symptoms and/or prevention of disease onset, through regular physical activity. Troubling, the vast majority of older adults remain sedentary, with only a small percentage of the population achieving quantities of physical activity that are protective against chronic diseases. Thus, increasing physical activity levels in older adults is of paramount importance in efforts to promote healthy living. As discussed previously across the aging lifespan, there is an observed shift in time spent in increasingly sedentary behaviors, and a decrease in overall physical activity levels. Engagement in physical activity has many contributing determinants. An overview of relevant factors influencing physical activity and exercise in older adults will be discussed in the following section.

Determinants of Physical Activity and Exercise

As previously stated, overall physical activity engagement in older adults remains at insufficient levels to promote health and prevent chronic disease across the lifespan. Additionally, regular physical activity has the potential to improve various measures of physical functioning that result in reductions of barriers to an active lifestyle. Given the known benefits of a physically activity lifestyle, much research has been invested in examining governing mediators to engagement in physical activity. Physical activity is a complex behavior, with numerous contributing factors. The compilation of multiple barriers and determinants of physical activity can lead to a heightened promotion of physical activity, or increase the level of deterrence from engaging in those healthy behaviors.

Central influences to physical activity span factors specific to each individual person, including biologic and psychosocial factors, as well as a holistic perspective of the environment. Reviewing what factors are influential in physical activity behavior change provides insight on how to improve upon current interventional efforts of physical activity adoption. The following sections will provide an overview on the biological, psychosocial, and environmental determinants and barriers that mediate physical activity in older adults.

Biological Determinants

Gender.

There are a number of factors that influence participation in physical activity that are linked to physiologic mechanisms. Some of these factors are modifiable, whereas others are non-modifiable, including gender and age. Among all biologic determinants of physical activity, gender and age have the strongest association with physical activity levels (Koeneman, Verheijen, Chinapaw, Hopman-Rock, 2011). Males have been shown to be generally more active than their female counterparts in numerous studies (Burton et al., 1999; Morey et al., 2003; Shimada et al., 2007; Yasunaga et al., 2008), whereas other studies have shown the impact of gender on physical activity to be negligible (Touvier et al., 2010; Jancey et al., 2007; Finkelstein et al., 2008; Emery et al., 1992; McAuley et al., 2007; Oka et al., 1995; King et al., 1997; Garcia and King, 1991). Due to the inconsistent evidence of gender on physical activity, it is likely that the role of other more potent mediators of physical activity highlight the discrepancy, or lack thereof, in activity levels between genders.

Age.

Another biological variable that is integral in influencing one's physical activity level is age. Overall, there is an observed decrease in physical activity levels with increasing age (Hirvensaleo et al., 2000; Shaw and Spokane, 2008; Williams and Lord, 1995; Yasunaga et al., 2008). There are multiple physiologic changes that occur during the inevitable aging process, including decreases in cardiovascular and muscular strength and endurance, and delayed cognitive function (Buchner et al., 1997; Paulo et al., 2011). Of particular importance, decrements in such variables negatively influence one's ability to successfully and safely engage in physical activity. Efforts to target maintenance of cardiovascular and muscular strength across the lifespan are critical in providing the aging body with the physical capabilities to be physically active.

It is important to note that older adults are still capable of achieving physiological benefits and adaptations as the result of regular physical activity and exercise, but few older adults subject themselves to the same physical activity-related stresses that possess the potential to elicit such benefits. Given the capacity for older adults to physiologically respond and adapt to physical activity, numerous interventions and observational studies have showed that age has no effect on physical activity levels (Boyette et al., 1997; Garcia and King, 1991; King et al., 1997; McAuley et al., 2007; Emery et al., 1992; Finkelstein et al., 2008; Jancey et al., 2007; Kahana et al., 2005; Morey et al., 2003; Nitz and Choy, 2007). It should be noted that these studies focused on primarily healthy older adults. Therefore, it is likely that diseased populations experience health and activity limitations that are increasingly exacerbated across the lifespan, which contribute to the generally accepted inverse relationship between age and physical activity levels.

Ethnicity and body mass index.

Other biological determinants of physical activity have been shown to have mixed results for their association with physical activity. Mainly, the evidence for ethnicity and body mass index (BMI; kg/m^2) has produced equivocal results. While Caucasian populations have been shown to have higher physical activity levels (relative to other ethnicities) in younger populations (Mathews et al., 2010), this trend appears to be attenuated in the older adult population (King et al., 1998). One of the main reasons for the disparity amongst ethnicities in physical activity levels in younger populations is due to differences in socioeconomic status, which represents one's education and resources for physical activity and health benefits (Mathews et al., 2010). There is less of a gap in physical activity levels in older adults, which can be attributable to overall decreases in physical activity across the lifespan amongst all ethnicities (Bravata et al., 2007).

Body mass index is a measure used primarily to categorize weight to identify those at risk for health issues related to obesity. There is evidence that shows BMI to be inversely related to physical activity levels in older adults (Chale-Rush et al., 2010), while others have shown BMI to have no association with total engagement in physical activity (Masaki et al., 1997). Although measurements of BMI are commonly used in large scale studies, it may not be the most appropriate measure to classify health risks related to body fat, as BMI measures do not differentiate between muscle and fat weight. Such information is pertinent when investigating associations with physical functioning, as muscle is highly related to performance ability on various functional assessment methodologies (Lord et al., 1995; Gudlaugsson et al., 2012). Nonetheless, the inconsistent conclusions regarding the relationships between ethnicity and BMI with physical activity levels provide justification for investigating other variables for their influence on physical activity.

Health Status

In addition to the aforementioned biological factors influencing physical activity levels, one's health status is important to recognize, in relation to activity levels. There are numerous diseases and conditions that are inversely related to physical activity engagement. In the previous sections, prevalent diseases in older adults were presented. These chronic diseases, in turn, have negative physiological impacts that make a physically active lifestyle more difficult. For example, coronary heart disease can result in enlarged ventricular wall thickness, reducing the amount of blood able to be ejected with each heart beat (Ciccone et al., 2011). Type 2 diabetes can lead to atherosclerosis and insufficient carbohydrate uptake by exercising muscle (Beckman, Creager, & Libby, 2002). In the presence of multiple diseases, the adverse health outcomes can compound, leading to related outcomes that further have detrimental health effects. Namely, as one becomes burdened with chronic diseases, their activity levels have been shown to decrease (Kriska et al., 1986). Also, physical functioning ability becomes impaired, which is a key contributor to low activity levels (Ip et al., 2012). Thus, physical functioning represents a key link in the associations between chronic disease and physical activity levels. The ensuing section provides justification for improving physical functioning, with the overall goal to increase physical activity levels.

Physical functioning.

In accordance with the relationship between the adverse physiologic outcomes and decreased physical activity in the presence of diseases, physical functioning plays a crucial role in influencing an individual's activity levels, particularly in older adults. As an individual begins to experience difficulty with performing tasks integral to daily life and self-maintenance, the need for outward assistance has been observed to increase. In turn, those who do not seek assistance with such tasks experience accumulating difficulties and can begin to become withdrawn from society, both physically and socially (Hamdorf et al., 1992). This pathway leading to reclusive behaviors is largely influenced by physical disability, which literature suggests can be largely preventable (King et al., 2000).

There is an inherent relationship between physical activity and functional capacity, representing a pathway in which to lessen the prevalence and severity of physical disabilities. Physical activity can lead to beneficial adaptations across various physiological systems, heightening the ability to engage in all types of movement, both those pertaining to ADL and physical activity. However, for those with a growing list of physical limitations, the risk of future or current disability increases. Such individuals are likely to be largely inactive, as a result of their physical and/or social limitations. Accordingly, there is a tremendous need to target individuals who are at risk of future functional limitations and disabilities. However, this is one viewpoint in examining the link between low physical activity levels and health. There are other factors which are integral in influencing regular physical activity patterns.

Psychosocial Factors

There are several key psychosocial factors that have an influence on one's physical activity participation. Pertinent psychosocial factors relating to physical activity engagement include social support, self efficacy, motivation, feedback, and goal setting (McAuley et al., 2007; Mathews et al., 2010; Conn et al., 2003). These factors are unique in the manner in which they have an influence on individual persons' attitudes towards engagement in physical activity, and the maintenance of such behaviors. Investigating these factors individually can provide insight as to what interventional strategies are most efficacious in promoting initial increases in physical activity levels. Furthermore, such factors are integral in addressing maintenance of physical activity behaviors longitudinally.

Social support.

Social support is a measure of the social interaction one has with their family, friends, or peers. Emotional support from family, specifically spouses, and friends has been shown to be the strongest sources of social support (Peterson et al., 2008; Sherwood & Jeffery, 2000). However, the influences of social support on health have been examined in more depth. Berkman and colleagues (2000) developed a model to explain the role of social support on health over multiple aspects of social networks, including social support, social influence, and access to materials. Losses in such measures of social capital in older adults are related to poor self-rated health (McMurdo et al., 2012). The model suggested by Berkman and Glass encompasses factors integral in both beginning and maintaining behavior changes relevant to physical activity. Social support can provide individuals with interaction to share future goals and fears in the initiation of an activity program as well as a means of accountability and enjoyment in the maintenance of the behavior.

Programs offered through community centers present an excellent approach to foster a setting conducive to developing social support in older adults. Successful environments include community fitness settings, allowing individuals to seek out social interaction with their peers on their own. Also effective, structured activity classes bring people together during specific times, where all are engaging in the same behaviors. Collectively, these services act as enablers to physical activity participation amongst older adults, which are critical in the maintenance of physical activity long term (Mathews et al., 2010). Despite the autonomy given to an individual to establish social connections, there are like-minded individuals congregating in the same environment, creating social cohesion that is beneficial in promoting physical activity.

Others, however, do not necessarily rely as much on social cohesion to maintain physical activity habits. These individuals are comfortable in engaging in physical activity and exercise behaviors on their own, and do not find the benefit of the added social interaction offered through fitness centers or group activity classes. There is evidence to support that aging adults who regularly exercise on their own have ample education and motivation to adhere to an activity regimen on their own (Conn et al., 2003). For those who do not have such knowledge or motivation, other mediators of physical activity must be targeted during interventions in an in-home setting, to compensate for the lack of social support. In particular, knowledge of what constitutes physical activity and how to incorporate it into everyday life, and the motivation and confidence to sustain elevated activity levels may be more important, as opposed to social support. Accordingly, the subsequent sections will outline the impact such factors have in the adoption of new physical activity behaviors.

Self efficacy.

Self efficacy is a measure of one's confidence to perform an activity, and has been shown to be one of the strongest and most consistent mediators of physical activity for older adults (Sherwood & Jeffery, 2000). Albert Bandura's Social Cognitive Theory posits that individuals' forethought towards an action is dictated by self efficacy and expected outcomes (Perkins et al., 2008). Older adults often avoid certain physical activities because they are uncertain of their ability to successfully perform the activity, or have fear of injury (Mathews et al., 2010). Self efficacy is critical in determining adherence to behavior change, as those who have a higher sense of efficacy in performing a behavior are likely to continue to realize the benefits of that healthy behavior, given the potential barriers that may arise. This process of assigning weight to perceived benefits and detriments to a given activity is known as one's decisional balance. Decisional balance can be intertwined to the aspect of expected outcomes posed by Bandura's Social Cognitive Theory. Those with higher self-efficacy are more apt to perceive more benefits of engaging in physical activity, against the disadvantages of maintaining an active lifestyle.

Within the older adult population, identifying one's self efficacy is instrumental in understanding adherence to physical activity and exercise programs. Lack of determination and motivation have been reported as key barriers to physical activity in older adults (Matthews et al., 2010), and improving one's confidence in such activities is one way to improve maintenance of such behaviors. Furthermore, self efficacy has been shown to be a key link in exercise adherence in diseased populations, which consist of many older adults (McAuley et al., 1994). It has been previously discussed that limitations in physical functioning is integral in the onset of chronic diseases. McAuley and colleagues (2006) showed that increases in physical activity, which has highly correlated with self efficacy, improved physical functioning performance, yielding fewer functional limitations. Such results highlight the role of self efficacy in the adoption of physical activity and the delay of physical limitations. Self efficacy, in turn, can be enhanced through other interventional variables.

Feedback and establishing goals.

Social support and self efficacy can provide a strong social environment that can promote a sense of confidence and support. In terms of physical activity engagement in older adults, both factors are important in initiating behavior change towards a more physically active lifestyle (McAuley et al., 1994). The maintenance of such behaviors in the long term, however, is a problem many struggle with. Strategies to increase motivation in the long term, such as providing goals and feedback, have been shown to be effective (McAuley et al., 1994). Goal setting is an effective starting point in initiating a physical activity intervention because individuals can anticipate the outcome that they are working towards. In order to assist a person throughout an intervention, providing feedback is effective in retaining adherence to the intervention stimulus. Strath and colleagues (2011) conducted a study that examined the difference in increases in steps walked per day across four intervention groups: a control group, a group prescribed 10,000 steps per day, a group with individualized step goals, and a group with individualized step goals with biweekly telephone follow up calls. It was reported that the amount of steps taken per day increased with each increasing stimuli across the groups. A review by Conn et al. (2003) on physical activity interventions in older adults highlights the benefits of education, feedback, and goal setting, with increases in physical activity rising with accumulating interventional stimuli. Collectively, this highlights the importance and benefit of utilizing various methodologies to provide instruction and feedback to promote physical activity in older adults.

Environmental Factors

In the aforementioned section, the influence of one's social surroundings on physical activity levels was discussed. This can be interpreted as the social environment's role in activity levels. However, there is a growing body of evidence that suggests more macro-level characteristics of the built environment have an increasingly important role in determining physical activity levels. There are numerous factors in our physical surroundings that facilitate and obstruct physical activity engagement (Wendel-Vos et al., 2007). Among such factors include accessibility to exercise facilities and parks (green spaces), presence of trails and sidewalks, traffic, crime, housing density, and land-use mix. Collectively, these factors influence neighborhood walkability (Strath et al., 2012), which is important in promoting physical activity for those who do not have access to/use community-based exercise facilities. Therefore, the built environment is critical in creating physical activity opportunities across all neighborhoods. The purpose of this section is to provide evidence for the environmental factors that influence physical activity in older adults.

Fitness facility and park access.

Implemented within the community, fitness facilities and parks provide people with a plethora of opportunities to accrue physical activity. An estimated 25% of U.S. seniors utilize senior centers (Wallace et al., 1998), providing merit to implement fitness resources within such structures. Fitness facilities can provide exercise equipment that most individuals do not have access to. Fitness facilities can provide cardiovascular and resistance training equipment to improve individual physiological systems, as well as social capital to improve maintenance of physical activity.

The presence of fitness facilities has been positively correlated with physical activity in older adults (Booth et al., 2000; Huston et al., 2003; De Bourdeaudhuji et al., 2003; Addy et al., 2004). This represents the plethora of physical activity promotional opportunities provided via community-based fitness centers, including structured fitness centers, but also group activity classes. Group exercise classes provide supervision and social interaction to promote physical activity that are an effective supplement to a fitness center setting. Fitness centers and activity classes have been shown to be predictive of vigorous intensity physical activity in older adults (Pollock et al., 1991). This garners tremendous public health relevance, due to the host of benefits associated with higher intensity physical activity. However, such efforts require the implementation of resources within the community, which can require high monetary amounts to fund the purchase of equipment, area to implement resources, and employ supervision/educators.

Bedimo-Rung et al., (2005) has shown that accessibility to resources is a key predictor of physical activity levels. Furthermore, Keysor (2005) has shown that the mere implementation of such resources into the community is not a sufficient stimulus to promote physical activity levels in older adults. Thus, additional factors in the environment may serve as promotional stimuli to increase physical activity levels in older adults.

In addition to community-based fitness and recreational facilities, there are other macro level measures of the environment that are related to physical activity levels. Such factors include the presence of sidewalk, proximity to destinations, neighborhood aesthetics, walking trails, and parks/"green spaces" (Shores & West, 2010; Foster & Giles-Corti, 2008). All such factors have been shown to be positively related to heightened levels of ambulatory behavior in older adults. Factors identified that explain such relationships include the enjoyment of nature, social interaction, and escape from normal routine life (McCormack et al., 2010). Accordingly, there are factors within the built environment outside of fitness center facilities that influence physical activity levels. The collective opportunities and characteristics located within the environment are often considered in public health and interventional efforts to increase physical activity, due to the plethora of relevant factors imbedded within the environment.

Summary of Physical Activity Determinants in Older Adults

The majority of older adults are not engaging in sufficient amounts of physical activity to promote health and prevent disease. This is marked by an increase in sedentary behaviors across the older adult years. Strikingly, this disparity in healthy, active behaviors exists despite the known benefits of physical activity. Physical activity is a complex behavior, with many contributing factors, including determinants and barriers. These variables exist across a variety of settings, including individual factors and social and built environments, but collectively influence overall activity levels. Specific to the individual, self efficacy and decisional balance are crucial to develop physical activity habits. Increasing knowledge of the benefits of physical activity and confidence to engage in such behaviors are influenced by education and motivational factors. One of the most influential factors in determining behavior change and maintenance is social support, which defines the aptitude of one's social environment to promote positive lifestyle modifications. In addition to these factors, the physical environment in which one resides has an influence on activity levels, including the presence of fitness centers, recreational areas (parks), and trails, which are associated with higher activity levels. The following section will focus on the current state of the literature as it pertains to physical activity interventions on increasing overall physical activity, in addition to physical activity and the health outcome of functionality.

Physical Activity Interventions

The overall objective of physical activity interventions is to increase engagement in some aspect of physical activity or exercise through behavior modification. Accordingly, there are a plethora of foci regarding physical activity that can be targeted, as defined by the dimensions of physical activity: frequency, intensity, duration, and mode. In addition to examining the specific dimensions of physical activity, one can examine overall volumes of physical activity. Such measures are common in interventional research, for instance those that have focused on the total volume metric of accumulated steps per day. Ambulatory behavior is relatively easy to monitor, and provides a solid description of a person's activity habits. Physical activity interventions employed in the older adult population often investigate health outcomes. Such information provides evidence of the efficacy of a program to increase physical activity levels, but also the associated relationship with a particular health outcome. The older adult population represents a sample population with immense potential to not only investigate efforts to increase physical activity, but also to examine the associated impact on a variety of health outcomes. As discussed previously, decrements in physical functioning, a precursor to physical disablement, is prominent in older adults. Thus, many interventions aimed at increasing physical activity also investigate measures of physical functioning.

Physical activity promotion in older adults is a daunting task, as there are many variables that influence engagement in physical activity. When considering maintaining gains in physical activity, there are additional influential determinants of physical activity that must be considered, in order to determine the efficacy of an intervention. Currently, there have been a plethora of interventional efforts aimed at increasing habitual physical activity levels, targeting various aspects and determinants of physical activity. The ensuing sections will outline the efficacy of such interventions to increase physical activity levels, highlighting key factors that are critical to the success of interventions.

Effectiveness of Physical Activity Interventions to Promote Physical Activity

There have been numerous interventions implemented in older adults to increase activity levels. In the aforementioned sections, a number of important factors have been described, providing evidence to the complexity and variation possible between such approaches. Given the broad scope of measures available to quantify physical activity behavior, the ensuing sections will first focus on measures of physical activity capacity, building towards actual measurements of physical activity behavior. Overall, interventions aimed at increasing total physical activity have reported gains of 2,000 steps/day or higher in older adults (Tudor-Locke et al., 2011). These estimates are similar to the effect of pedometer-based interventions in increasing physical activity levels across broader populations, including young, old, healthy, and diseased individuals (Bravata et al., 2007). Despite such observations, increasing physical activity levels have shown varying levels of benefit pertaining to exercise tolerance and health improvement. For example, increases in physical activity have shown no or minimal benefit pertaining to heart disease (Brubaker et al., 2009), diabetes (Bjorgaas et al., 2010) and cancer (Matthews et al., 2007) , whereas others have shown highly beneficial health outcomes to the same diseases (Kitzman et al., 2010; Diedrich et al., 2010; Pinto et al., 2008). Inconsistent results in intervention outcome can be due to a variety of factors including specific characteristics of the intervention, duration, setting, adherence, and actual baseline or pre-intervention physical activity levels.

Within an individual, physical activity levels can vary greatly from day to day. Furthermore, physical activity accrual is highly variable depending on the population of focus. Such factors influence baseline physical activity levels, which is a potential driving factor for the effectiveness of an intervention. This is due to the general dose-response relationship between physical activity (exposure) and health (outcome) observed from interventions. Therefore, a given physical activity intervention could produce highly beneficial effects for a sedentary person, and little effect for an active individual. Healthy older adults engage in 2,000-9,000 steps/day, and diseased populations engage in 1,200-8,800 steps/day (Tudor-Locke et al., 2011), showing that there is a spectrum of activity engaged in, which is an underlying factor to provide insight to the effectiveness of the intervention.

To date, there have been a plethora of interventions focused on increasing physical activity, both ambulatory behavior and exercise-type behavior (resistance training), in older adults. Overall, the older adult population is largely inactive, and interventions are often not sufficient to improve health. Therefore, there is much effort still required to promote physical activity and the subsequent health benefits to be obtained in this population. By reviewing the current interventional literature, one can glean critical components of success, and build upon such findings in future interventional approaches to further increase physical activity in this population. In an effort to categorize the current available interventional literature, the following review is broken up into the following sections; supervised settings, unsupervised (lifestyle) settings, and comparison of both settings, and underlying variables contributing to the intervention outcome.

Supervised interventions.

There are unique characteristics between supervised and unsupervised physical activity interventions to increase physical activity in older adults. This section will focus on physical activity interventions with a clearly defined supervision component. Supervised physical activity interventions consist of employing a structured exercise program that is monitored and led by a given professional. Usually, this occurs in a community setting, which serves as a common meeting ground for larger samples of individuals to meet at. Commonly, the exercise dose (in some aspect) increases across the length of the intervention, including the duration and intensity of activity. With reference to older adults, common barriers to physical activity include health problems and fear of injury, whereas enablers to physical activity include positive outcome expectations, social support, and program access (Mathews et al., 2010). Supervised interventions aim to increase physical activity engagement during monitored sessions, which in turn, have the potential to induce overall activity levels. Overall, such interventions provide a set of advantages that address the aforementioned barriers and enablers in the older adult population, including education, guidance, and sense of comfort by exercising participants (Conn et al., 2003).

There has been a long established history of the effectiveness of supervised physical activity interventions to promote increases in overall activity levels. Such studies extend nearly 30 years prior, and have established physical activity outcomes that more recent studies have built upon. Gillet, White, and Caserta (1996) provided clear evidence for the effect of a controlled, supervised exercise intervention on improving exercise tolerance in 182 older adults. The exercise group completed three supervised exercise sessions/week for 16 weeks, in addition to receiving an educational seminar once weekly. The education group only received the education component of the intervention. Education meetings consisted of one hour weekly to discuss common health and fitness topics led by geriatric nurse practitioners. The exercise stimulus was three 1-hour session of low impact dance exercise. Post-intervention, the exercise/education group increased their exercise tolerance, expressed as maximal oxygen uptake ($VO_{2\ max}$) by 32% (compared to 8% gain in the education only group), which was achieved through increasing the duration engaged in low-impact aerobic exercises. Similarly, Pollock et al. (1991) examined the efficacy of a supervised walking/jogging program in 57 elderly individuals (70-79 years). Participants engaged in 30-45 minutes/week on three days/week for 26 weeks. Overall, $VO_{2\ max}$ increased 14.6%, from 22.5±5.7 ml/kg/min to 27.1 ±6.5 ml/kg/min ($p<.05$). Extending on the results of Gillet et al. (1996) and Pollock et al. (1991), Hamdorf and colleagues (1992) reported beneficial effects from engaging in supervised exercise interventions. In their study, 80 healthy women (60-70 years) engaged in a 26 week walking program, meeting twice weekly for 45 minutes/session, compared to a matched control group. Overall physical activity capacity was assessed by the Human Activity Profile (HAP), a questionnaire examining physical fitness. One of the HAP outcomes is maximum current activity, a measure similar to $VO_{2\ max}$. Post-intervention, maximum current activity levels increased significantly in the walking group from baseline (76.7±6.9 to 79.9±5.1, $p<.001$), compared to the control group (75.1±6.3 to 74.3±7.5). The aforementioned studies evaluate measures that serve as a proxy for physical activity behavior, including $VO_{2\ max}$ and the HAP. Although beneficial, such outcomes specifically target increasing exercise capacity, and not on actual quantification of physical activity behavior.

In progressing the understanding of physical activity interventions to induce positive physical activity behavior change in older adults, Rubenstein et al. (2000) examined elderly, fall-prone men (74 years) during a 12 week intervention, meeting for three 90 minute sessions/week. The exercise sessions consisted of lower limb resistance training and endurance training via treadmill walking and biking. Physical activity was assessed by the Yale Physical Activity Questionnaire, with the outcome of hours spent in various work, exercise, and recreational activities in a typical week. The exercise group significantly increased the hours spent being physically active from pretest (15.2±8.2 hours/week) to posttest (18.6±10.6 hours/week, $p<.05$), although there were no differences between the exercise and control group (19.4±11.2 hours/week) posttest ($F[1.52]=2.8$, $p=.10$). The lack of difference between the two groups is attributable to the higher baseline activity levels of the control group. However, it should be noted that the physical activity was assessed via subjective methodologies, and are prone to common measurement errors, such as recall bias and error.

In an effort to overcome such limitations associated with subjective physical activity methodologies, Fielding et al. (2007) examined 424 older adults (76.5±4.2 years) participating in a center-based exercise program as part of the Lifestyle Interventions and Independence for Elders Pilot (LIFE-P) study. The exercise group participated in 40-60 minute exercise sessions held three times/week for 12 months, compared to a successful aging group that received health education. Post-intervention, the exercise group engaged in a mean of 135.0 minutes/week of moderate intensity activity, compared to 90.0 minutes/week for the successful aging group. Although not significant, such trends in a large scale study with detailed explanations of the exercise stimulus and physical activity outcome provide merit for future studies to investigate additional methodologies to promote physical activity in older adults in the long term.

The aforementioned studies have shown that older adults respond positively to physical activity interventions. However, it is beneficial to examine how an intervention impacts objectively quantified physical activity behavior that is easily comprehended by a broader audience. Volumetric measures of physical activity, such as steps/day, are relatively easy to measure and provide a physical activity profile that has a high degree of generalizable understanding amongst older adults. Sugiura et al. (2002) examined the difference in self-monitored steps/day in menopausal women (40-60 years) participating in one weekly 90 minute exercise class and matched control participants. Across 24 months, the exercise group averaged between 8,500-11,000 steps/day, whereas the control group averaged 5,700-6,500 steps/day (p<.01). The aforementioned studies provide merit for implementing interventions in older adults to induce the adoption of a more physically active lifestyle. As stated, there is a range of the effect of the results, which is telling of the intervention characteristics that distinguish them from one another. Amongst the variables that influence the effectiveness are the duration and adherence to the exercise prescription and intervention.

Supervised intervention duration.

Amongst the plethora of factors that dictate physical activity interventional efforts are available resources, including funds and research team, for example. Such considerations largely influence the balance between feasibility to effectively deliver an intervention, while achieving meaningful results. In turn, the duration length of the intervention is a key variable to the effectiveness to stimulate changes in behavior. Investigators are continually evaluating the duration that is required to best maintain behavior adoption. Such information provides insight into how intense the intervention stimulus must be in order to achieve meaningful results. Currently there is no consensus on what timeframe distinguishes a short-term intervention from a long-term intervention.

However, common classifications for short-term studies typically consist of less than 6-12 months (van der Bij, Laurant, & Wensing, 2002).

As mentioned previously, exercise tolerance is one outcome assessed in physical activity interventions. Increases in exercise tolerance are the result of numerous physiological adaptations, spanning multiple bodily systems. Depending on the physiological system of interest, adaptation timeframes span from days to weeks (Blomqvist, 1983; Gibala et al., 2006). When evaluating the duration of interventions that yielded gains in exercise tolerance, benefits have been observed from four months (Gillett, White, and Caserta, 1996) to six months (Pollock et al., 1991; Hamdorf et al., 1992; Hamdorf & Penhall, 1999).

With reference to specific measurements of physical activity behavior (as opposed to exercise tolerance/capacity), increases in activity levels from supervised interventions have been observed in shorter periods of time. Rubenstein and colleagues (2000) showed hours spent in physical activity per week increased in as little as three months as the result of an exercise intervention that met three times weekly. Additionally, longer duration, supervised interventions have continued to show increases in physical activity across longer periods of time, suggesting the maintenance of newly adopted behaviors longitudinally. Fielding et al. (2007) reported increases, and maintenance, of physical activity accumulated in amounts ≥150 minutes of moderate intensity activity, across a one year timeframe. Of additional benefit, Kriska et al. (1986) have reported gains in physical activity across a two year time frame, expressed as increases miles of ambulatory activity accrued. These results are attributed, in part, to education provided at the onset of the intervention and the necessity of participants to log their activity through the two year period, highlighting the importance of self-monitoring. Overall, the decline in physical activity is attenuated following long interventions, compared to short term interventions. It is postulated that due to the longer exposure time, long-term interventions are more effective in facilitating behavior adoption, resulting in lower attrition rates following the completion of the intervention.

Supervised intervention adherence.

One of the factors that largely drive the outcomes in physical activity interventions is adherence to the prescribed physical activity stimulus. In order to gauge the effectiveness of an intervention, one must appropriately comply with the exposure dose, in order to make meaningful associations with an outcome variable. One of the benefits of a supervised physical activity intervention is the presence of an instructor who can provide education, guidance, leadership, and encouragement. Such variables can increase one's self efficacy to adopt a more physically active lifestyle, in addition to providing a community approach to exercise which also increases one's social support to continually participate in physical activity. Both self efficacy and social support are key enablers to adhering to physical activity interventions (Mathews et al., 2010).

Generally, adherence to supervised interventions is high. Adherence to prescribed exercise sessions exceeded 80% in numerous studies that reported adherence rates (Pollock et al., 1991; Buchner et al., 1997; Wallace et al., 1998; Hamdorf & Penhall, 1999). It is important to note, however, the number of participants excluded from adherence calculations due to dropping out of the study. For example, Buchner et al. (1997) reported a 95% adherence rate to a thrice weekly exercise session, but 27 of the 105 participants were excluded for various dropout reasons. Similarly, Wallace et al.

(1998) reported a 90% adherence rate (three weekly exercise sessions) when excluding 5 dropouts of the 50 participants in the exercise program, and Hamdorf et al. (1999) reported an 89.7% adherence rate (twice weekly exercise sessions) when excluding 11 dropouts of the total 49 participants. Thus, the true adherence to the physical activity intervention may be lower than the previous results suggest, given that participants who dropped out of the intervention were excluded from analyses. Conversely, Barnett and colleagues (2003) reported that only 1/3 of a total participant group of 163 older adults attended 80% of exercise sessions (twice weekly exercise sessions). With varying levels of adherence evident, especially in light of a spectrum of participants excluded from adherence analysis, other variables may contribute to the interventions' overall effectiveness in increasing physical activity levels, including adherence rates, in older adults.

Drawbacks of supervised interventions.

As previously discussed, there are a variety of advantages to utilizing a supervised intervention to increase physical activity levels in older adults. However, there are drawbacks posed by such approaches that may impact the generalizability of results to the broader older adult population. The necessity of a meeting location to employ the intervention can be considered as one of the biggest potential disadvantages. Depending on where the location is, there are other drawbacks that arise. Specific to older adults, transportation is key barrier to engaging in supervised interventions. As one ages, it can become more difficult to travel by oneself, which is influenced by several factors, including health status and resources. As health declines across the older adult lifespan, autonomy to travel becomes restricted. In turn, there is an increased reliance on others for assistance, including public transportation and private scheduled transportation. Also influencing transportation and participation in supervised interventions is the availability of economic funds. Without available income, one may not be able to afford a car, and may have to hold a job to keep a consistent income.

Additionally, supervised interventions require participation at designated times. If one has to work or has to rely on others for transportation, meeting such scheduling becomes increasingly difficult. Furthermore, it is common for older adults to assist in caring for family and grandchildren, which can further limit their availability. The previously stated disadvantages to supervised interventions assume one's desire to participate. Not all individuals, however, want to participate in community-based, supervisor-led, group exercise classes. Those that do not express affinity may avoid a supervised setting (Van Roie et al., 2010), and favor a more individualized setting to participate in physical activity. Therefore, one must consider the advantages and disadvantages of a supervised setting when employing an intervention.

Summary on supervised interventions.

Supervised interventions provide older adults with great potential to increase physical activity through establishing an exercise locale, guidance, and encouragement to engage in a given activity. Interventional research has shown such approaches to be effective in increasing overall measures of physical activity, which can be in part due to generally high adherence rates to the intervention exposure. Furthermore, the positive benefits of supervised interventions have yielded beneficial results in both short and long term settings. Despite this, there are disadvantages of supervised interventions, such as the resources required to effectively carry out the intervention, as well as the barriers to physical activity pertinent to older adults, including transportation, affinity for group-based exercise sessions, and time constraints. Therefore, the following section will examine the efficacy of unsupervised, oftentimes referred to as lifestyle interventions, in increasing physical activity levels in older adults.

Unsupervised interventions.

In contrast to the previously discussed interventions, unsupervised physical activity interventions represent unique advantages. Given that such interventions are implemented out of a person's home, certain barriers to physical activity are eliminated and/or lessened, such as time or scheduling conflicts, transportation, and lack of affinity with exercising in a center-setting (Mathews et al., 2010). Commonly, unsupervised physical activity interventions are referred to as lifestyle interventions. This is due to the purpose of increasing overall activity levels, which reflect the accumulation of activities chosen by the individual, or their lifestyle. Therefore, the intervention locale consists of in-home and neighborhood settings. Lifestyle interventions hold great merit in the older adult population, as there is a commonly observed inverse relationship between increasing free time and decreasing physical activity levels. Provided the amount of free time available in the older adult population, giving the participant more autonomy on how they accumulate physical activity increases the likelihood of the intervention being effective.

As mentioned previously, one of the underlying advantages of unsupervised interventions is that this approach provided the participant with more independence to engage in physical activity behavior. Currently, there are different physical activity recommendations that are based on different variables, such as the accumulation of steps per day and amount of time spent in various intensities of physical activity. Hultquist, Albright, and Thompson (2005) investigated the effectiveness of providing different physical activity recommendations to adhere to in increasing the number of steps taken per day in an unsupervised setting. Fifty eight previously inactive women (≤7,000 steps/day; 45.0±6.0 years) participated in a four week intervention, consisting of two experimental groups. Both groups were instructed to self-monitor their activity level, where one group was instructed to accumulate 10,000 steps/day, and the other instructed to take a brisk 30 minute walk on most days of the week. Post-intervention the 10,000 steps/day group engaged in significantly more steps/day (10,159±292 steps/day) than the 30 minute walk group (8,270±354 steps/day, $p<.005$). The 10,000 steps/day and 30 minute walk group met their assigned activity goals on 4.2 and 4.4 days per week, respectively. From these results, it is evident that providing specific volumes of ambulatory goals to engage in increases physical activity levels to a higher extent than temporal recommendations. However, the subject pool did not solely consist of older adults, so the generalizability of such results to the broader older adult population is limited.

In an attempt to investigate older adults' perception of their engagement in physical activity, van Stralen et al. (2009) utilized an intervention that involved mailings to participants to monitor their physical activity. One thousand nine hundred and seventy one older adults (64.0±8.6 years) received three mailings across six months, assessing awareness of physical activity engagement, self-reported physical activity, and compliance with physical activity guidelines (30 minutes of moderate intensity activity on most, preferably all, days per week). The intervention was rooted in aspects of the transtheoretical model, self-regulation theory, and self-determination theory. Mailings were sent out at baseline, two weeks, and three months. At six months, the intervention group was 1.64 times more likely to be aware of their physical activity levels (p<.01) and increased their physical activity (β=0.54, p<.001, effect size=0.35), compared to controls. Furthermore, the intervention group was 2.79 times more likely to comply with physical activity guidelines than the control group (p<.001). Compared to Hultquist et al. (2005), such results provide evidence that general awareness of-, and rates of those meeting, physical activity recommendations can improve in an unsupervised, but may necessitate feedback throughout the intervention. Providing additional evidence to the effectiveness of increasing awareness of physical activity through minimal intervention, King and colleagues (2008) utilized personal digital assistants (PDAs) to intermittently prompt physical activity throughout the course of the day in sedentary older adults (>50 years) over an 8 week timeframe. Compared to controls (125.5±267.8 minutes), those in the experimental group with PDA access had significantly higher time spent in moderate-vigorous physical activity (310.6±267.4 minutes; $F[1,36]=4.2$, $p=0.048$).

Previously, it was discussed that providing step goals was more efficacious in promoting gains in physical activity than prescribing physical activity recommendations (Hultquist et al., 2005). Extending on the effective components of an unsupervised intervention, van Stralen et al. (2006) provided evidence that continual feedback is beneficial in promoting physical activity, even when assessing the less effective intervention stimulus as reported by Hultquist et al. (2005), physical activity recommendations. Building upon these studies, Strath et al. (2011) examined the impact of varying levels of intervention stimulus on increasing steps taken per day in older adults. Over a 12 week intervention, 81 older adults (63.8±6.0 years) were randomized to one of four groups: a control group (Group 1), a 10,000 step per day goal pedometer group (Group 2), a 10,000 step per day goal and individualized feedback group (Group 3), and a 10,000 step per day goal and individualized feedback group with biweekly telephone feedback (Group 4). Group 2 received biweekly pedometer logs to record their steps, Group 3 received biweekly pedometer logs, with the goal of increasing their steps each week by 10% of their baseline steps per day, and Group 4 received the same material as Group 3, but with telephone biweekly telephone contact by a trained research assistant. Compared to Group 1, Groups 3 and 4 took an average of 2,159 and 2,488 more steps per day (p<.001). Group 2, however, did not differ in the step per day accumulation than Group 1. Overall, utilizing self-monitoring and increasing the degree of individualized feedback resulted in a linear increase in physical activity, utilizing an easily comprehendible volumetric of physical activity, step accumulation.

Further establishing the success of unsupervised physical activity interventions in older adults, McMurdo et al. (2010) employed a six month intervention with three study groups: a control group, a behavior change intervention (BCI) group, and a BCI with pedometer group. The pedometer utilized, the Omron HJ-113 piezoelectric pedometer, assess activity counts. The BCI was based on self-regulation theory, emphasizing goal setting, planning, and self-monitoring, and involved educated participants how to become more active (focusing on walking), how to overcome barriers, and telephone contact by the researchers. By three months, the BCI and BCI plus pedometer groups were walking significantly more than the control group (p<.05). Although not statistically significant, the BCI group increased their walking activity 10.6%, compared to the BCI plus pedometer group (3.9%). Despite such surprising results, the dropout rate was lower for the BCI plus pedometer group, so it can be inferred that the use of a physical activity monitoring device serves as a tool to increase adherence to a prescribed intervention. Collectively, the previously discussed studies posit that unsupervised physical activity interventions in the older adult population are effective in increasing ambulatory physical activity, with additional gain to be had when implementing variables such as education, feedback, and self-monitoring.

Unsupervised intervention duration.

Similar to other physical activity interventions, unsupervised approaches are largely dictated by available resources. However, unsupervised interventions are unique in that they reduce much of the resources required. In turn, there is more responsibility placed upon the participant to adhere to the exercise stimulus. Given this responsibility, it is beneficial to examine the duration of various interventions to examine the effectiveness of older adults to increase their physical activity without supervision. Such results provide valuable information on the ability of this population to increase their physical activity with less resources and a lower degree of invasiveness, compared to supervised interventions.

Positive increases in physical activity have been observed in as few as four weeks. Hultquist et al. (2005) provided simple walking guidelines to sedentary women to accumulate 10,000 steps/day, showing significant increases from baseline (5,760±1,143 steps/day) to four weeks (11,775±207 steps/day). De Blok and colleagues (2004) employed a more intensive intervention focused on utilizing a counseling program to increase physical activity in those with chronic obstructive pulmonary disorder. By 9 weeks, average steps taken increased 1,430, a 69% increase from baseline. This is significant when compared to a review of pedometer interventions (not specific to older adults) by Bravata et al. (2007) approximated that pedometer users increased their steps/day by an average of 26.9%.

Others have shown increases in physical activity across longer periods of time when using unsupervised interventions. Strath and colleagues (2011) reported gains in physical activity in those reporting ≤7,500 steps/day at baseline across a 12 week period. Similar results were reported by van Stralen et al. (2009), who showed awareness of engagement in physical activity and participation in physical activity increased by three months via mailed questionnaires. Interestingly, they showed that their low-cost intervention showed continual increases in physical activity to six months. The results from McMurdo et al. (2010) mimic these time effects, with six months of self-monitoring increasing ambulatory activity. Collectively, it is of benefit to note that the older adult population is able to increase their activity levels in an unsupervised setting in the short term (four weeks), and is able to continually exhibit increases in activity levels across longer periods of time (six months).

Unsupervised intervention adherence.

The previous section stated that it is possible to observe increases in physical activity in the short term, and that said increases can continue across time. One of the underlying factors associated with the increases in physical activity is the adherence to the intervention. This is of merit to examine, as unsupervised interventions often come at a lower cost than supervised interventions, and provide evidence for older adults to increase their awareness and self-monitor their own behavior. Accordingly, this has immense implications for extending such results to the broader older adult population.

In the face of providing specific physical activity guidelines to adhere to, Hultquist et al. (2005) reported that participants met instructions on just over four days per week over a four week period. Although their intervention provided no additional stimulus, it provides evidence that merely educating one on the current physical activity recommendations is not a sufficient stimulus to result in meeting those requirements (5 days per week). Across six months, van Stralen et al. (2009) showed a 28% dropout rate in participants' response to mailings, from 1,971 participants at baseline, to 1,411 post-intervention. Despite the dropout rate, adherence to fully completing questionnaires increased from 23% at baseline to 72% at six months. Such results provide evidence to make unsupervised physical activity interventions appealing to older adults, as those who stay within the study have higher adherence rates to the intervention. Adherence rates have been shown to remain high across longer periods of time. Rejeski et al. (2011) reported positive response rates of 86.5% in 288 overweight older adults (67.1±4.5 years) enrolled in a weight loss and physical activity intervention. Collectively, adherence rates and participation have proven to remain high across varying timeframes in older adults, providing justification for utilizing unsupervised interventions to increase physical activity in older adults. However, variability in adherence exists, influenced by intervention duration, and the frequency and duration of the intervention stimulus.

Drawbacks of unsupervised interventions.

Despite the beneficial results of unsupervised interventions, one must consider the potential disadvantages of such approaches to increasing physical activity in the older adult population. Primarily, the lack of guidance and expertise are two components that can dilute the benefits of an unsupervised intervention. Given that the participant is on their own, they do not have the monitoring of a professional to help guide and motivate them to adhere to a given activity prescription. The expertise that such individuals have is integral to the success of supervised interventions, and this is removed in an unsupervised setting. To compensate for this, unsupervised interventions often employ education and self-monitoring components to equip the participant with a skill set that otherwise professionals would possess in a supervised exercise intervention. Other drawbacks of unsupervised interventions are the lack of exercise equipment. Not all individuals have the space, interest, or excess capital to equip their homes with exercise equipment. In turn, those developing in-home interventions must acknowledge this and design their approach accordingly, to provide these individuals with comparable opportunities with those interventions occurring in a fitness-center type setting.

Summary on unsupervised interventions.

Unsupervised interventions aimed at increasing physical activity targeting the older adult population have provided positive results through a variety of unique approaches. Importantly, such interventions occur in an in-home setting, eliminating the reliance on expensive exercise equipment in community settings that are led by trained professionals. Unsupervised interventions allow a participant to engage in activities they find appealing on their own time frame. However, it must be acknowledged that social support and self efficacy are two prominent predictors of physical activity engagement in older adults. It is imperative, then, to implement educational and feedback components to maintain adherence to interventions. This has been achieved via feedback, self-monitoring, and counseling aspects, which resulted in high levels of adherence and significant increases in physical activity in both short and longer term durations. Overall, there are two primary settings for physical activity interventions, spanning supervised and unsupervised settings. The following section will review literature that conjointly examines both settings.

Comparison of supervised and unsupervised interventions.

The previous sections describe the unique qualities of supervised and unsupervised interventions, providing evidence for their effectiveness on increasing physical activity in the older adult population. Although similarities and differences regarding the interventions and results can be identified, data examining comparisons between the two settings is sparse. There is evidence, though, that suggests older adults can achieve similar results in both settings. King and colleagues (1991) initiated an exercise intervention with varying degrees of exercise stimuli in a sample of 357 healthy older adults aged 50-65 years. There were three intervention groups: two high intensity exercise groups (one in a community-based setting and one in a home-based setting), and a lower intensity home based group. The high intensity stimulus consisted of three 40 minute sessions/week at 73%-88% of peak treadmill heart rate, whereas the lower intensity stimulus consisted of five 30 minute sessions/week at 60-73% of peak treadmill heart rate. In their 12 month intervention, treadmill exercise tolerance was investigated at six and 12 months, showing that both intensity groups increased their exercise tolerance (0.4-1.5 minutes, $p<.001$) and $VO_{2\ max}$ (0.5-1.5 ml/kg/min, $p<.03$). Noteworthy, the lower intensity group had similar improvements compared with the high intensity group. Furthermore, adherence to the home-based exercise prescriptions was higher for the lower (75.1%±31.8%) and higher intensity groups (78.7%±33.9%) than to the community-based intervention (52.6%±29.8%; F[2,266]=7.76, p<.0005). This study however, assessed exercise capacity ($VO_{2\ max}$) and did not quantify physical activity behavior. Furthermore, this study focused on aerobic-based activities, and did not incorporate resistance training, which is linked to improved muscle characteristics and improved physical activity tolerance.

Much can be learned from the study of Dunn and colleagues (1999) in a sample of sedentary 237 men and women (46.0±6.6 years), although the sample mean age was lower than a common definition of an older adult. They examined changes in physical activity and cardiorespiratory fitness ($VO_{2\ max}$) at 6 and 24 months. Physical activity (energy expenditure) was assessed via the 7 day Physical Activity Recall questionnaire. Those in the structured exercise group were assigned to attend three out of a possible five weekly 20-60 minute supervised exercise sessions, exercising at 50-85% of maximal aerobic power. Group leaders were present to assist with physical activity goal setting and to offer encouragement. The lifestyle intervention group was encouraged to accumulate 30 minutes of moderate intensity activity on most days of the week in any activities of their choosing. Participants in the lifestyle group were encouraged to attend weekly meetings with other participants through week 16, and biweekly until week 24, to learn behavioral and cognitive strategies to physical activity behavior. The lifestyle intervention group increased their energy expenditure by 0.84 kcal/kg/day (p<.01) and 0.77 ml/kg/min (p=.01), and the structured exercise group by 0.69 kcal/kg/day (p=.002) and 1.34 ml/kg/min (p<.001). One important conclusion regarding this study is that similar effects were observed in both supervised and unsupervised intervention groups.

Van Roie and colleagues (2010) implemented lifestyle and structured, center-based physical activity interventions lasting 11 months in 186 older adults (66.9±4.7 years), compared to controls. The lifestyle group received education (including pamphlets) and an orientation on exercises to perform in a meeting with the instructor. Additionally they received biweekly telephone calls to ensure adherence to the activities. King and colleagues (1991) also utilized telephone contact, but they reduced the number of calls from once weekly during the first four weeks, then biweekly for the next four weeks, and then once monthly for 12 months. Given that Dunn et al. (1999) encouraged travel to group meetings, the biweekly telephone contact throughout the duration of the 11 months by Van Roie et al (2010) represents a feedback method that is more frequent that King et al. (1991), but less intensive than Dunn et al. (1999). The structured group was instructed to participate in five supervised exercise sessions over each two week period throughout the intervention. The exercise sessions included aerobic, strength, flexibility, and balance training components, spanning 60-90 minutes/session. Although physical activity was not an outcome variable, $VO_{2\ max}$ significantly increased 3.0 ml/kg/min and 4.5 ml/kg/min in the lifestyle and structured intervention groups, respectively ($p<.05$). Collectively, the aforementioned studies present evidence that older adults are able to achieve similar benefits of physical activity in supervised, center-based settings and unsupervised, in-home settings. Such positive results are influenced by various feedback methodologies, including education and telephone feedback. However, the foci of such studies were on exercise capacity, and not on the assessment of actual physical activity. Future studies are warranted that examine the impact of supervised and unsupervised interventions on measures of physical activity.

Summary on physical activity interventions.

As previously presented, there are a plethora of factors relevant to increasing physical activity behavior in older adults, spanning exercise capacity and the volume of activity engaged in. Supervised and unsupervised interventions have both produced favorable results in increasing physical activity in older adults, but data is lacking in specifically comparing the two settings. Regardless of the setting, interventional factors, including education, self-monitoring, and feedback, have been shown to be effective pieces to include. Such variables provide study participants with more autonomy and knowledge into the benefits of engaging in a more active lifestyle. In terms of the health benefits from physical activity, meaningful increases in physical activity have been shown to occur in as little as 8 weeks. However, such gains have also been shown to be maintained across longer periods of time, with high levels of adherence to interventions. The focus of the aforementioned studies has been on increasing physical activity, though it should be noted the associated capacity to do so in the older adult population is also influenced by physical functioning capacity. In turn, the ensuing sections will the efficacy of physical activity interventions to enhance physical functioning ability, with the goal of further promoting gains in physical activity.

Effectiveness of Physical Activity Interventions to Improve Physical Functioning

As presented in the previous section, there is ample evidence to support the potential of interventions to promote gains in physical activity in older adults. One aspect that may strongly influence one's overall activity levels is their level of physical functioning. High levels of physical functioning are inversely correlated with physical limitations, which have been conceptualized to be the link with physical disabilities.

Physical functioning can be categorized by raw physiological system evaluations, as in quantifying muscular or cardiovascular endurance, or by performance-based assessments. Often, performance-based tests are timed tasks that replicate everyday activities in the form of specific processes (McAuley et al., 2007), such as rising from a chair, climbing stairs, or quantifying gait speed. Collectively, physical activity interventions aimed at improving physical functioning should incorporate aspects of strength and balance training, improving muscular strength and endurance. Additionally, cardiovascular and flexibility training are effective, but not on their own as the intervention stimulus (Kenny et al., 2011). It is beneficial, however, to examine these outcome measures collectively with changes in physical activity levels, allowing one to conclude the associations that increases in physical activity have with improvements in physical functioning. Therefore, the ensuing discussion will focus on the effectiveness of physical activity interventions to increase both habitual physical activity levels and markers of physical functioning within supervised and unsupervised settings.

Supervised settings.

Measures of lower limb strength are of particular importance, as they influence associated measures of balance and fall risk. Fiatarone et al. (1994) had frail older adults residing within a nursing home engage in knee/hip extensor and leg pres training for 45 minutes, three days/week, using resistance training machines for the exercises. Cumulative muscle strength increased 113%, but it should be noted that there was constant supervision provided for the training sessions. Chandler et al. (1998) also showed increases in frail elders' lower limb strength. Physical therapists led in-home exercise sessions, occurring three times per week for 10 weeks. Utilizing therabands for resistance training, exercises consisted of knee flexion/extension, hip extension and abduction, ankle dorsiflexion, toe raises, chair rises, and stair stepping. Overall, strength increased 10%-16% ($p<0.05$) spanning measures of knee flexion/extension and dorsiflexion and plantar flexion. Chiefly, it is beneficial to note that improvements in muscular strength were experienced from an in-home setting, analogous to the unsupervised, lifestyle interventions presented in the previous sections to increase overall physical activity levels. Thus, there is mounting evidence that supports that both physical activity and physical functioning can be increased in older adults in an in-home setting, which is important in reducing the need for expensive exercise equipment. However, there are also additional factors to be examined that influence interventional efficacy, in order to determine what interventions are most effective in improving physical functioning in older adults.

Unsupervised settings.

The results from Fiatrarone et al (1994) and Chandler et al. (1998) reported evidence for improved muscle strength with supervised exercise sessions. Not all researchers have the resources available to provide such services for their interventions, so it is beneficial to examine interventional efforts with less supervision and guidance provided to discern what level of intervention stimulus is required to elicit meaningful changes in physical functioning. Gudlaugsson et al. (2012) examined thigh and hand strength over a six month training period in 117 older adults aged 71-90 years. The delayed intervention group consisted of daily endurance exercise (walking) and twice weekly strength training. The endurance stimulus increased from 20 minutes/session at 50% of heart rate reserve during weeks 1-8, to 35 minutes/session at 70% of heart rate reserve during the final eight weeks. Resistance training consisted of 12 exercises spanning the whole body, including two sets of 12 repetitions at 50% of the one-repetition maximum for the given exercise. Supervision was provided for 50% of endurance training sessions and 100% of strength training sessions. They showed that muscular strength, assessed via knee extension, significantly increased by 28.5% ($p<.001$) in the absence of completely supervised exercise sessions. Although not strictly unsupervised, the study design and results provides evidence for implementing unsupervised interventional aspects in older adults. Campbell et al. (1997), however, showed no improvements in knee extensor strength in a home-based intervention in a sample of 233 women (84.1±3.2 years). Resistance training was performed three times per week for 30 minutes over the course of 12 months. Exercises were prescribed by a physiotherapist and targeted quadriceps, hamstring, and calf muscles via ankle cuff weights, in addition to performing various balance exercises. Also, participants were encouraged to walk outside three days per week. Given that no improvements were observed in strength, evidence does not support the notion that one can simply prescribe an exercise program, even if individualized, to an older adult and anticipate improvements in strength.

Although the results of Campbell et al. (1997) show that no strength gains were evident with an unsupervised intervention, there are additional approaches to implement interaction. Such approaches can be employed through implementing feedback and periodic follow-up sessions with participants in an on-going intervention. Previous approaches have utilized telephone follow up sessions and exercise logs, both stressing the adherence to the prescribed physical activity stimulus. Ettinger et al. (1997)

performed telephone interviews with 365 older adults (69.0±6.0 years) with knee osteoarthritis participating in aerobic and resistance training over 18 months. At the onset of the intervention, those in the aerobic exercise group received guidance on participating in aerobic-based physical activity, where the goal was to accumulate 60 minutes of activity through warm up, stimulus, and cool down phases. The resistance training group was instructed to perform two sets of 12 repetitions on three days per week, spanning leg extension, leg curl, step up, heel raise, chest fly, upright row, military press, bicep curl, and pelvic tilt exercises. Exercise logs were supplied for participants to track their involvement over the study duration. Biweekly telephone calls were made, in addition to bimonthly visits from the exercise leader. Post-intervention, knee flexion strength was significantly greater in the aerobic exercise (50.0±1.1 Newton-meter at 30°, $p<.004$) and resistance training groups (49.5±1.1 Newton-meter at 30°, $p=.01$), compared to a health education subset of participants (45.8±1.0 Newton-meter at 30°). Such results provide evidence for the implementation of various motivational methodologies during physical activity interventions to promote appropriate conclusions for the effectiveness of the prescribed exercise stimulus in improving physical functioning.

Physical activity and skill-tests linked to physical functioning.

In addition to improving muscular strength and endurance, interventions stressing physical activity and exercise have the capacity to improve performance on skill-related tasks that serve as a proxy for physical functioning in older adults. Common performance-related tasks include the ability to rise from a chair, walking velocity (8 feet walk test, 6 minute walk test, 400 meter walk test), balance measures, and the short physical performance battery (SPPB; comprised of balance, walking velocity, and chair rise tasks). There is evidence to support the conclusion that physical activity interventions improve performance on a variety of such tasks, while increasing overall physical activity levels (Gudlaugsson et al., 2012).

Similar to positive results for muscular strength, performance on skill-related tasks can be observed in as little as 10 weeks (Fiatarone et al., 1994; Chandler et al., 1998). Such benefits have been shown to occur with participation in a prescribed physical activity dose ranging from one weekly session (Barnett et al., 2003) to three weekly sessions (Lord et al., 1995; Van Roie et al., 2010; Fiatarone et al. 1994; Campbell et al., 1997). Amongst these studies, those prescribing exercising twice weekly (Lord et al., 1995; Van Roie et al, 2010) have proven efficacious to improve physical functionality, lending credence to the current ACSM and AHA physical activity recommendations.

Balance is a critical component of an older adult's physical functioning profile. Balance influences engagement in physical activity and the associated confidence to engage in such behaviors (Rand, Miller, Yiu, and Eng, 2012). Campbell et al. (1997) showed improvements in balance over a 12 month physical activity and strength training intervention in an in-home setting, in addition to Barnett et al. (2003) in a structured exercise program in a community-based setting. In both studies, overall physical activity levels increased, however balance was measured with a paper and string method to track center of mass movement. There are more robust measures of balance that can be utilized. Lord and colleagues (1995) employed force plates to assess balance in 197 women (71.6±5.4 years), showing that body sway decreased with lower limb exercises over a 12 month period. Future studies should incorporate more precise measurements of balance, such as force plates, while also examining overall physical activity levels and strengthening exercises to gain a more comprehensive understanding of the relationships between physical activity, physical functioning, and balance in older adults.

The ability to rise from a chair is oftentimes the most lacking physical ability of older adults, largely due to extreme degeneration of lower limb muscle tissue. Accordingly, those who cannot easily rise from their resting position are less apt to engage in physical activity. Lower limb strengthening and promotion of ambulatory physical activity have been shown to be effective in improving chair-rise ability. Gudlaugsson and colleagues (2012) examined a six month multimodal training intervention (previously outlined) on SPPB measures and the 8 feet up and go test. Time to complete the chair rise portion of the SPPB and 8 feet up and go test decreased 1.7 seconds ($p<.001$) and 0.6 seconds ($p<.001$), respectively. Both aerobic exercise and resistance training exercises have been shown to be efficacious in improving chair stand ability (number of stands per 30 second period) in 186 sedentary older adults (>60 years), compared to matched controls (Van Roie et al., 2010). The exercise groups improved the number of chair stands by 2.5 successful stands per 30 second period ($p<.001$). Further examining the link between physical activity and chair rise ability, Chandler et al. (1998) showed that improvements in lower limb strength over a 10 week resistance training period in frail elderly (77.6±7.6 years) were more related to improvement in lower limb strength in lower functioning older adults ($\beta=3.8$, $p<.05$), compared to higher functioning older adults ($\beta=-0.26$, $p=.7$). The resistance training component consisted of three sessions per week of an in-home theraband strength training program. Given that chair rise ability is a common lacking ability in older adults, physical activity promotional efforts should incorporate both strength training exercises and physical activity goals to help improve such measures.

Walking speed has been posited as a predictor of physical functioning, and similar to the aforementioned performance-based skills, has substantial evidence that physical activity can improve such measures. Evaluating walking speed is an easy and inexpensive measure to assess, and is associated with mobility limitations and functional capacity. For example, 3,047 older adults (mean age=74 years) walked a 6 meter course as part of the Health, Aging, and Body Composition Study, categorizing those who completed the course at a rate <1 m/s as high risk, and those >1 m/s as low risk (Cesari et al., 2005). Those in the high risk category had a higher risk of lower extremity limitation (RR=2.20, 95% confidence level [CI]=1.76-2.74) and death (RR=1.64, 95% CI=1.14-2.37), compared to the low risk group. Such associations become increasingly evident across the older adult years. Kim, Yabushita, and Tanaka (2012) examined walking speed and physical functioning in 1,381 older adults (65-84 years). They reported an inverse relationship between decreasing walking speed and increasing age for men ($r=-.35$) and women ($r=-.42$). Furthermore, slower walking speed was shown to be associated with poorer physical functioning, evidenced from performance on the 5 chair sit-to-stand assessment and single leg and tandem leg balance assessments ($p<.001$). Physical activity and exercise have the potential to increase factors related to gait speed, such as muscular strength and balance. There is evidence that a strength training stimulus (8 weeks, 3 sessions per week, 2 sets for 10 repetitions over 6 lower limb exercises) increases lower limb strength, compared to controls ($p<.017$), and is associated with the differences in faster walking speed with the experimental group ($F[1,19]=5.03$, $p<.05$)

(Schlicht, Camaione, & Owen, 2001). Accordingly, there is an inherent link between physical activity and exercise and performance on a variety of skill-related tasks relevant to physical functioning in older adults. However, more research is needed to further explore the relationships amongst performance on such tasks, with physiological measures of physical functioning (muscular profile), and the potential impact of physical activity to improve such measures in older adults.

Physical activity and physical functioning intervention duration.

Improving one's muscular strength and endurance has direct benefits on physical functioning abilities. Coinciding with the widespread low levels of physical activity engaged in by older adults, there is much room for this population to improve their muscular profiles, enabling them to engage in their choice activities through the lifespan. There is evidence to support that muscular improvements can be achieved in a short time frame. Interventions have shown that muscular strength can increase in as little as 10 weeks (Fiatarone et al., 1994; Chandler et al., 1998). Such improvements, however, can be observed in shorter periods of time (i.e. 2-4 weeks) (Christie & Kamen, 2010). Such improvements are the result of improved neuromuscular function, not skeletal muscle morphology adaptations. As presented in the previous section, physical activity levels have been shown to increase in as little as 8 weeks in sedentary older adults. Collectively, interventions are able to induce shifts in sedentary older adults' overall activity profile, as evidenced by ambulatory activity and muscular strength/endurance, in a short period of time.

Overview of Physical Activity and Physical Functioning

Physical activity interventions yield substantial evidence to improve both overall activity levels, but also a plethora of measures of physical functioning. Older adults are largely an inactive population, at risk for multiple physical functioning impairments, which can influence the risk of physical disability. Accordingly, the benefits from interventions can be observed in a relatively short time period (8-10 weeks). Such a time period is sufficient to initiate behavior change that results in favorable outcomes. Physical activity has been shown to increase by both objective and subjective assessment methodologies, highlighting the changes that individuals can make in their lifestyles. Such changes in behavior are likely to be tied to improvements in levels of physical functioning, as evidenced by gains in muscular strength and improvements in performance in skill-based tasks. Collectively, the stimulus of a physical activity intervention, with aspects of feedback and follow-up implemented throughout the course of the intervention, can be employed in community or home-based settings.

Chapter Summary

The growth of the older adult population represents a significant focus for healthcare. As a person ages, there are physiological changes that can leave one more prone to disease and sickness. Chronic diseases remain at extremely high rates in older adults, and absorb healthcare resources, including cost of treatment, rehabilitation, prescription medication, and hospital/doctor visits. The accumulation of such ailments also impacts physical functioning levels, which represents the ability to maintain independence and participate in one's choice activities. In turn, older adults represent a population that is prone to degenerative health, leading to lifestyle modification and medical intervention, providing merit to improve health promotion efforts in this relevant sect of the population.

Physical activity has long been promoted as a means to treat previously stated health ailments. This approach to preventative and physical medicine reduces the reliance on pharmaceutical intervention, not to mention aids in lessening the immense associated economic burden of such treatments. The benefits of physical activity span individual physiological systems, in addition to maintaining whole body functioning, and offsetting the risk of developing a chronic physical disability. Despite the known benefits of physical activity and exercise, the majority of older adults remain inactive. Even worse, time spent being physically active decreases, and engagement in sedentary behaviors increases across the older adult years. Contributors to such trends include a plethora of mediators and determinants to physical activity behavior, spanning the physical self, psychosocial variables, and the social and built environment.

In turn, physical activity interventions have been utilized to promote increases in physical activity, considering mediators and determinants relevant to these behaviors in the older adult population. Additionally, interventions have focused on improving physical functioning, given the associations functional capacity has to physical activity engagement in older adults. The degree of supervision for these interventions is a governing factor with unique implications, addressing variables such as education, monitoring of behavior, adherence, and reducing the impact of barriers to physical activity (transportation, time). Although multiple settings have been shown to be effective in increasing physical activity and physical functioning, there is still a strong scientific need to further investigate the impact of different interventional delivery modalities and their effect of both physical activity and health.

Provided the information reviewed in this chapter, the following studies represent a sequence of efforts to assess mediators to physical activity and health promotion strategies in older adults. Study one examines mediators and barriers to physical activity by assessing awareness and use of community-based fitness resources, based on residence proximity. Given the results of study one, study two examines the efficacy of a home-based intervention to promote increases in physical activity and physical functioning in older adults.

CHAPTER III: PROJECT VOICE

Geospatial Relationships Between Awareness and Utilization of Community Exercise Resources and Physical Activity Levels in Older Adults

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Running Title: Older Adult Community Fitness Resources and Physical Activity

Abstract

Purpose. The purpose of this study was to determine whether awareness and utilization of fitness resources and overall physical activity engagement differed depending on residential distance from community-based fitness resources (CBFR). **Methods.** Four hundred and seventeen older adults (72.9 ± 7.7 years) were randomly recruited from three spatial tiers (≤1, >1 to ≤2, and >2 to 5 miles) surrounding seven senior centers, which housed CBFR. Participants were mailed and returned a health history questionnaire, a CBFR questionnaire and the CHAMPS physical activity questionnaire. Chi square tests were performed to examine if awareness and utilization of CBFR differed across spatial tiers. Kruskal-Wallis tests were performed to examine if engagement in moderate to vigorous physical activity (MVPA) differed across spatial tiers. Multinomial logistic regression analyses were performed to identify predictors to physical activity engagement, and binary logistic regression analyses to identify barriers to CBFR utilization. **Results.** There were no differences in awareness of CBFR across spatial tiers (χ^2=0.90, df=2, *p*=.637), with 48.4% being aware of CBFR in ≤1 mile radius, 50.0% in the >1 to ≤2 mile radius, and 44.4% in the >2 to 5 mile radius. However, only 2.9% of all participants utilized CBFR, with no differences across spatial tiers (χ^2=2.37, df=2, *p*=.306). Across all sites, participants expended 1601±2293 kcals/wk. Engagement in MVPA differed across spatial tiers (χ^2=15.74, df=2, *p*<.001), with the >2 to 5 mile radius having the highest mean energy expenditure. Across all sites, age (β=-.04, *p*<.05) and income level (β=.92, *p*<.05) were significant predictors of low and high amounts of MVPA, respectively, and current health status and lack of interest represented significant barriers to CBFR utilization ($p<.05$). **Conclusion.** Closer proximity to CBFR did not impact awareness or utilization rates of such resources. Physical activity levels marginally increased the further one resided from CBFR. Given the very low utilization rates of CBFR, despite awareness and close proximity to such resources, further work is warranted to investigate complimentary intervention strategies for older adults in an effort to increase physical activity levels.

KEYWORDS: Awareness, utilization, fitness resources, physical activity, older adults

Introduction

Older adults are among the most rapidly growing segment in the United States population, and projections predict this trend to continue into the future (United States Department of Health and Human Services, 2011; Ferrucci et al., 2008). Despite modern advancements in medicine and technology, there are continual health concerns in the older adult population. The prevalence of chronic conditions such as diabetes, osteoporosis, hypertension, hyperlipidemia, obesity, and cancer remain high, having a detrimental effect on an older adult's overall health and quality of life, and placing excessive economic strain on our nation's health care system (Lehnert et al., 2011; Thrall, 2005). Accordingly, there is an increased emphasis on exploring the effectiveness of preventative efforts to ameliorate the burden of such adverse health outcomes in older adults.

Regular physical activity and exercise have long been promoted as a means to treat and prevent a multitude of health conditions (Nelson et al., 2007), yet the number of older adults who are regularly active is staggeringly low. Based on objective physical activity assessments, it is estimated that only 3.5-10% of older adults are meeting physical activity recommendations (Tucker, Welk, and Beyler, 2011; Troiano et al., 2008). Furthermore, the amount of physical activity performed across the older adult years steadily decreases, as sedentary behaviors begin to dominate everyday life (Winett, Williams, and Davy, 2009; Hansen et al., 2012). There is a complex interaction of factors that influence habitual physical activity engagement. Central to the observed sedentary lifestyles and poor health are perceived barriers that make older adults' engagement in regular physical activity increasingly difficult and/or unappealing.

A key barrier to physical activity for the older adult population is access to resources that promote regular physical activity and exercise (Booth et al., 2000; Huston et al., 2003; Addy et al., 2004). Community-based fitness resources (CBFR) can provide older adults a wealth of opportunities to promote increases in physical activity levels, such as removing/minimizing certain barriers to physical activity, including the availability, supervision, and instruction on use of exercise equipment, and availability of social support. Such factors have been shown to be critical in influencing physical activity levels in older adults (Mathews et al., 2010). Proximity to CBFR is likely to be important, as it further reduces a potential transportation barrier (Booth et al., 2000; Huston et al., 2003; Addy et al., 2004; Mathews et al., 2010). Furthermore, closer proximity to CBFR may result in a greater awareness of programming opportunities, and their associated benefits.

Senior Centers offer an excellent conduit in which to promote CBFR, and could serve as an organizational mediator to physical activity behavior in older adults. To date, it remains unclear whether proximity to senior centers with CBFR has an impact on awareness and utilization of resources, and ultimately overall physical activity levels of older adults. Thus, the purpose of the current study was to assess awareness and utilization of CBFR, based on residential spatial tiers of increasing distance from said resources. It was hypothesized that individuals living in closer proximity to CBFR would have greater awareness, utilization rate, and overall higher physical activity levels, compared to those residing further away from CBFR.

Methods

Study Design

This cross-sectional study involved gathering a series of information regarding awareness and utilization of CBFR and current physical activity levels based on proximity to the facilities. Participation consisted of the completion of a series of questionnaires mailed to participants, which included a health history questionnaire, a community-based resources questionnaire, and the CHAMPS physical activity questionnaire. In addition to the questionnaires, a cover letter was enclosed to orient the participant on completing the forms, as well as a preaddressed, stamped envelope for the questionnaires to be returned to the investigative team.

The surrounding areas of seven local senior centers with CBFR throughout a large metropolitan area were included in the current study. Extensive calling lists of those aged ≥60 years were compiled to recruit potential participants. These lists were designated to include all older adults residing within 5 miles of targeted senior centers, obtained through marketing companies. Calling lists were then segmented by geographic information systems (GIS) software into those who resided ≤1, >1 to ≤2, and >2 to 5 miles from targeted senior centers. Within the stratified calling lists, a random sample of potential participants was contacted via telephone to inquire if they would be interested in participating in this study. Upon receiving verbal consent to participate, as approved by the University's Institutional Review Board, all documents were sent out in the mail. All data collection was conducted within a single season, thus reducing the confounding of seasonality on responses.

Participants

Inclusion criteria for participating in the study consisted of being between 60-90 years of age and willingness to complete and return all questionnaires. By nature of the study design, all participants contacted were previously stratified to be residing within 5 miles of a targeted senior center.

Study Measures

Community-Based Fitness Resource Awareness

A questionnaire developed by the investigators was used to gather descriptive data regarding CBFR, consisting of 11 questions. Specific to awareness of CBFR, the following question, "Are you aware of any exercise/fitness programs or classes at your local senior center?" was asked, prompting participants to check a box for "yes" or "no."

Community-Based Fitness Resource Utilization

Quantification of CBFR utilization was gathered from the same aforementioned CBFR questionnaire. To assess utilization of CBFR, participants checked a "yes" or "no" box to the following question, "Do you currently attend or participate in any of the exercise/fitness programs or classes at your local senior center?" If they responded with a "yes," a subsequent question was asked to specify (by checking either a "yes" or "no" box) which exercise/fitness resources they utilized, either structured fitness facilities or activity classes.

Barriers to Community-Based Fitness Resource Utilization

Additionally, participants were asked to document (on the same questionnaire) what barriers pertaining to CBFR use were applicable to them: "What barriers prevent you from attending and participating in any exercise/fitness programs or classes at your local senior center more often/if at all?" A list of common barriers were provided, including knowledge of services, time, transportation, work/other commitments, health, lack of interest, and distance from resources, prompting participants to check "yes" or "no" to which barriers contributed to limiting their engagement. There was no limit to how many barriers could be marked as influencing CBFR utilization.

Physical Activity Assessment

The CHAMPS physical activity questionnaire was used to collect information on the amount of activity participants engaged in. This questionnaire is designed to target the frequency and weekly duration spent in engaging in various exercises, everyday activities, and leisure-time activities commonly engaged in by older adults. For the current study, the outcome measurement from the CHAMPS questionnaire was weekly caloric expenditure in moderate to vigorous activities, using adapted MET values for older adults (Stewart et al., 2001). Calculating energy expenditure from the CHAMPS questionnaire requires calculating weekly duration engaged in each activity, which has been shown to have acceptable measures of reliability, with r values ranging from 0.67 to 0.76 (Harada, Chiu, King, and Stewart, 2001; Stewart et al., 2001). The CHAMPS questionnaire has also been shown to appropriately demarcate varying physical activity levels with a level of precision similar to more intensive measures of physical activity assessment ($F_{2,246}$=20.85, p<.001), providing evidence for the CHAMPS questionnaire to be a valid physical activity assessment tool (Stewart et al., 2001).

Data and Statistical Analysis

Descriptive statistics are expressed as mean ± standard deviation. Chi square tests were performed to examine if awareness and utilization rates of CBFR differed across spatial tiers. Results were calculated as the overall percentage of "yes" respondents of the total sample. Kruskal-Wallis tests were performed to examine if engagement in moderate to vigorous physical activity (MVPA) differed across spatial tiers. Multinomial logistic regression analyses were performed to identify which mediators to physical activity were significant predictors to overall activity levels, represented by caloric expenditure. The dependent physical activity categories included sedentary (0 kcals/wk; referent category), low-active (>0-6710 kcals/wk), and high-active (>6710 kcals/wk). The cut point used to split low-active and high-active categories was based on median energy expenditure values among all non-sedentary participants in the current sample. Independent variables included in the analysis were age, gender, income, car ownership, and CBFR utilization. Binary logistic regression analyses were performed to identify which barriers significantly inhibited CBFR utilization, including knowledge of services, time, transportation, work/other commitments, health, lack of interest, and distance from resources. All statistical analyses were performed utilizing SPSS 19.0 for Windows (Chicago, IL).

Results

Participant Characteristics

A total of 3405 participants were contacted for participation in this study. Figure 1 depicts the recruitment flow, leading to the final sample of 417 older adults. Of the final sample, 161were included in the ≤1 mile radius group, 114 in the >1 to ≤2 mile radius, and 142 in the >2 to 5 mile radius. The successful return rates of complete questionnaires for the aforementioned spatial tiers were 61.5%, 63.0%, and 62.6%, respectively.

Participant demographics are listed in Table 1. Body mass index (BMI) for all participants averaged just below the cut point for classifying obese individuals. There was an even distribution of female (n=208) and male (n=206) respondents, participants were primarily Caucasian, educated, and owned a car. There was no clear trend between education and income levels with car ownership across spatial tiers, although there is little variation among such variables to allow such a distinction to be made.

Community-Based Fitness Resource Awareness and Utilization

The responses for awareness and utilization of CBFR are reported in Figure 2. Among those who responded in the ≤1 mile, >1 to ≤2 mile, and the >2 to 5 mile radii in all targeted neighborhoods, 48.4%, 50.0%, and 44.4% were aware of CBFR, respectively. The utilization rates of CBFR, however, were extremely low. Overall, only 2.9% of the total sample utilized CBFR, with no differences across spatial tiers (χ^2=2.37, df=2, p=.306). Among those residing in the ≤1 mile, >1 to ≤2 mile, and the >2 to 5 mile radii, only 4.3%, 2.6%, and 1.4% of participants responding positively to utilizing CBFR, thus exhibiting a weak trend of decreased utilization with increasing distance from CBFR.

Barriers to Community-Based Fitness Resources

Among the barriers listed that prohibited individuals from utilizing CBFR more often, if at all, lack of interest in CBFR was the most frequently cited barrier (51.6% of participants), followed by time (18.2%), work (16.1%), health (14.1%), transportation (9.1%), and distance (2.9%). Including all participants across all spatial tiers, only health (β=1.408, p=.004) and lack of interest (β=-2.302, p=.002) were significant predictors of individuals not utilizing CBFR. When broken down by spatial tiers, the only significant barriers were transportation (β=5.47, p=.002) in the >1 to ≤2 mile radius, and health (β=2.27, p<.05) in the >2-5 mile radius.

Physical Activity Engagement

The average energy expenditure in MVPA for all participants across all sites was 1601±2293 kcals/wk (n=378), represented in Figure 2. Engagement in MVPA differed across spatial tiers (χ^2=15.74, df=2, p=.000), with mean caloric expenditures rising in conjunction with increasing distance from CBFR: from 1263±2177 kcals/wk (n=146) to 1555±1793 kcals/wk (n=101) to 2013±2680 kcals/wk (n=131), respectively. Overall, 27.8% reported an energy expenditure of 0 kcals/wk (n=105), 29.1% from >0-999 kcals/wk (n=110), 8.7% from 1000-1499 kcals/wk (n=33), 8.5% from 1500-1999 kcals/wk (n=32), 5.8% from 2000-2499 kcals/wk (n=22), and 20.6% >2500 kcals/wk (n=78). Including participants from all spatial tiers, the multinomial regression model accounted for 16.7% of variability in MVPA values, with age being a predictor of low activity (β=-0.04, p<.05) and income of high activity (β=0.92, p<.05). Specific to spatial tiers, age was a significant predictor of low-activity within the ≤1 mile radius (β=-.062, p<.05) and >2-5 mile radius (β=-0.07, p<.05). No other independent variables were significant predictors of low or high-activity levels.

Discussion

National data suggest only a small percentage of older adults are active enough to receive the health benefits of physical activity, increasing the susceptibility to developing chronic disease. One approach to promoting physical activity and exercise in older adults is through local senior centers, providing an environment conducive to support physical activity and exercise by way of exercise equipment/rooms and supervised fitness classes. Such community-based fitness resources aim to reduce the influence of barriers that negatively impact regular physical activity, including lack of access to facilities, guidance, and social support. Still, other factors remain potentially unresolved by CBFR that contribute to their utilization (or lack of use). Mainly, the influence of the availability of transportation and lack of time constraints remain unaffected, and are heavily governed by one's residence distance from such resources. It is unclear how awareness and utilization of CBFR are thus impacted by one's residence distance from centers promoting and providing resources for active lifestyles. The main findings of this study show that among spatial tiers of increasing distance surrounding CBFR, there were no statistical differences in awareness or utilization of CBFR. Moreover, despite approximately one half of participants being currently aware of CBFR, utilization rates were paltry.

An estimated 25% of older adults report utilizing senior centers (Wallace et al., 1998), providing an excellent setting for physical activity promotion, yet the mere implementation of such resources has previously been shown to be ineffective in increasing overall activity levels (Keysor, 2005). Awareness of resources is likely a critical mediating variable to utilizing CBFR, which aim to facilitate regular participation. The current study demonstrated a substantial decline in the number of individuals who used CBFR, relative to those who were aware of the resources (only 3% utilized CBFR, out of approximately 50% whom were aware). Similar awareness-to-active engagement statistics are also available at the national level, were one to consider that an estimated 36% of U.S. adults are aware of physical activity recommendations, with only 10% meeting such benchmarks, implying a higher level of adherence/activity levels in the face of adequate awareness. Provided the disconnect between awareness and utilization of CBFR, other pertinent factors are likely influential.

Among barriers measured in the current study across all spatial tiers, health and interest were the only significant predictors of not utilizing CBFR, although interest was the most commonly reported barrier. Accordingly, efforts are warranted to increase interest in available services, in an attempt to bolster utilization rates. Two groups of individuals should be targeted: those not interested in CBFR and those who are currently interested. Interviews and surveys offer a conduit to listen to what can be implemented to broaden the target audience. For those currently interested, information is necessary to identify pertinent identifying reasons for the lack of utilization, which should include exploration of influential factors for physical activity participation and assurance that the benefits of participating outweigh the personal, financial, time, and other associated costs. (Belza & the PRC-HAN Physical Activity Conference Planning Workgroup, 2007). Collectively, such information can yield a difference in the programming to provide services that the targeted population is interested in and finds merit in participating, as a commonly noted barrier to physical activity in older adults is the lack of a program to help guide and educate (Mathews et al., 2010). Thereafter, implementation of marketing strategies (i.e. face-to-face, newsletters, and word of mouth) is likely to raise awareness among targeted social groups within the community with ties to CBFR locales.

Among other barriers, only transportation and health were significant barriers in the >1 to ≤2 mile and >2 to 5 mile radii, respectively. The term "transportation" is one of the most influential barriers to physical activity in older adults (Patel, Kolt, Keogh, & Schofield, 2012; Wilcox et al., 2005; Lachenmayr & Mackenzie, 2004), and includes multiple contexts, spanning financial, health, distance, time, and built environment factors (Rimmer, Wang & Smith, 2008; Rosenberg, Huang, Simonvich, & Belza, 2013). Accordingly, subsets of questions are likely to more precisely determine what factors are influencing transportation. Among factors related to transportation that require extended time and/or monetary investments, and thus less feasible to modify in the short term, are environment aesthetics, safety, walkability (sidewalks, traffic lights) (Carlson et al., 2012). Conversely, factors more easily modified are often more specific to each individual. Strategies including individual community pick up/drop off, and increasing social support and self efficacy have been linked to increased fitness center utilization (Rosenberg et al., 2013)

Based on current physical activity recommendations, the current sample population was, on average, sufficiently active with an average energy expenditure exceeding 1500 kcals/wk, assuming 100 kcal/s per 10 minutes of moderate intensity activity. Although this is higher compared to other reported activity levels in older adults, there were large variations in energy expenditure, from sedentary to extremely active. Only 132 participants (35.0%) reported actually engaging in over 1500 kcals/wk, providing evidence that bolsters the potential for CBFR to increase physical activity. In particular, such resources have been shown to be linked to increased participation in more intense, exercise-type behaviors (Pollock et al., 1991), which is increasingly important, given the low utilization rate of such resources while approximately two thirds of the sample population were not meeting recommended activity levels. New information from this study revealed that spatial distance from CBFR had no impact on overall physical activity levels, and trends went in the opposite direction of that which was hypothesized, in that activity levels in this random sample marginally increased the further one resided from CBFR. Despite low utilization rates of CBFR, there was a marginal trend of increased utilization of exercise bikes, aerobic machines, and strength training equipment (in general) with increased distance from CBFR. This evidence reinforces the potential of CBFR to increase activity levels via exercise equipment, should utilization rates increase.

Overall, closer proximity to CBFR did not impact awareness or utilization rates of such resources, while physical activity levels marginally increased the further one resided from CBFR. This study benefited from having a large, random sample of older adults from different spatial tiers, reporting on the activity levels, and means in which that energy expenditure is accrued. A limitation of this study is obtaining physical activity data via subjective methodologies, specifically pertaining to the risk of participant bias based on expectant outcomes and memory error. Collectively, the data collected represents an important first step in increasing accessibility and marketing, and improving on-site programming to enhance services available to the broader population. Future work in objectively assessing physical activity while utilizing CBFR is warranted to explore the utility of such resources to promote meaningful increases in energy expenditure in older adults, while investigating other complimentary intervention strategies to increase physical activity levels.

Figure 1. Participant Flow Diagram.

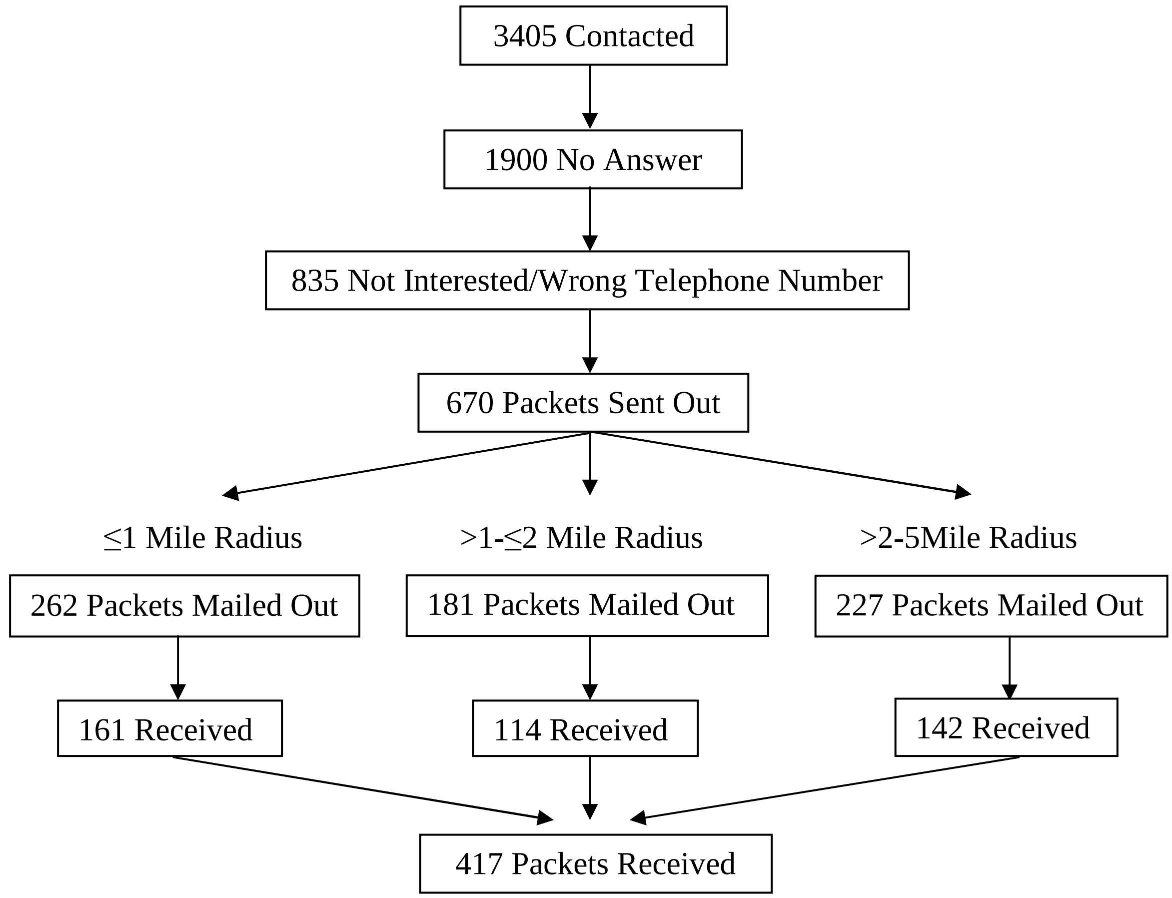
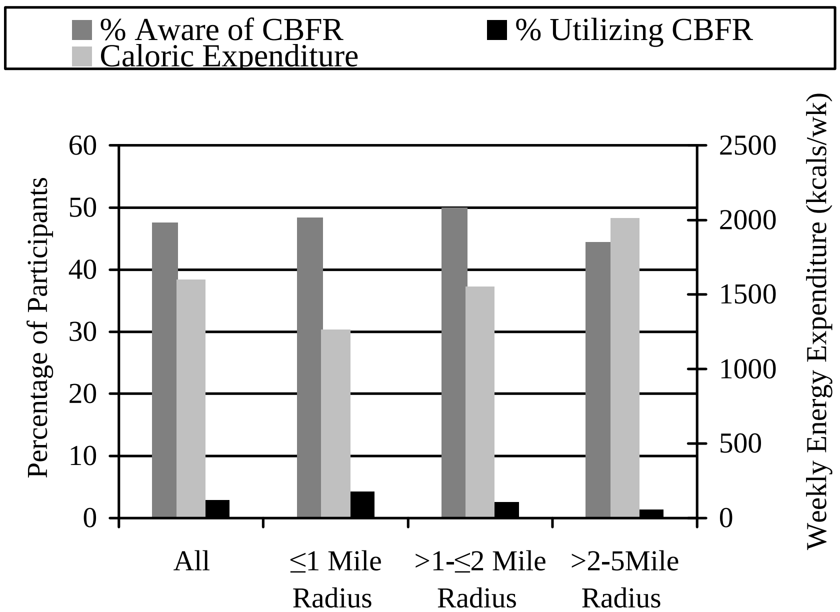


Table 1: Participant Demographics (mean ± SD).

	All (N=417)	≤1 Mile Radius (n=161)	>1-≤2 Mile Radius (n=114)	>2-5Mile Radius (n=142)
Age (yrs, n=414)	72.9 ± 7.7	73.4 ± 7.9	72.5 ± 7.7	72.6 ± 7.6
Height (cm, n=381)	168.7 ± 11.7	168.6 ± 11.3	167.8 ± 10.1	169.3 ± 13.3
Weight (kg, n=385)	82.9 ± 20.0	83.9 ± 21.3	81.9 ± 19.5	82.6 ± 19.0
Body Mass Index (kg/m^2, n=373)	29.3 ± 6.6	29.7 ± 6.6	29.2 ± 6.0	29.0 ± 7.1
Gender (%, n=414)	50.2	50.9	56.8	44.4
Ethnicity (%, n=412)	82.3	81.3	80.2	87.9
Education (%, n=409)	96.3	96.2	98.2	94.9
Income (%, n=376)				
<$5,000	1.7	1.9	2.6	0.7
$5,000-$14,999	11.3	13.7	10.5	9.2
$15,000-$24,999	18.9	19.9	17.5	19.0
$25,000-$34,999	19.2	18.0	20.2	19.7
$35,000-$49,999	15.1	16.1	14.0	14.8
>$50,000	24.0	19.9	24.6	28.2
Car (n=417)	85.0	84.5	86.8	83.8

Note. Gender: percentage of female participants. Ethnicity: percentage of Caucasian participants. Education: percentage of those with at least a high school education. Car ownership reflects the percentage of participants that own a car.

Figure 2. Awareness and Utilization of Community-Based Fitness Resources (CBFR) Compared to Weekly Energy Expenditure (Mean±SE).



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CHAPTER IV: PROJECT PACE

The Efficacy of an In-Home Walking and Resistance Training Program to Increase Physical Activity and Physical Function in Low-Active Older Adults

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Running Title: Walking and Resistance Training in Older Adults

Abstract

Purpose. The purpose of this study was to examine whether an in-home, individually tailored intervention is efficacious in promoting increases in physical activity (PA) and improvements in physical functioning (PF) in low-active older adults. **Method.** This randomized controlled trial consisted of an 8 week in-home PA intervention. Individuals were randomized to either an enhanced physical activity (EPA) group, which received daily step goals increasing 10% each week, a resistance band and training program, and educational pamphlets in the mail, or a standard of care (SoC) group was given the goal to reach 10,000 steps/day by the final intervention week. Pre- and post-intervention measures were assessed in community senior centers, including choice step reaction time (CSRT), knee extension/flexion strength, hand grip strength, and 8ft up and go test completion time. Independent t-tests were performed to detect the presence of any baseline differences in physical activity and physical functioning between groups. Mixed between-within ANOVAs were performed to assess changes in PA and PF between the EPA and SoC groups. **Results.** Forty participants completed in this study (74.7±6.4 years). Significant increases in steps/day were observed for both the EPA (1598) and SoC (502) groups (p<.05). However, when including only those who adhered to weekly step goals, the level of improvement was significantly higher in the EPA group (2943 steps/day) than the SoC (599 steps/day) group (p<.05). Both groups experienced significant gains in the physical functioning variables, with the EPA group exhibiting significantly greater improvements for the 8ft up and go test (p=.000) and knee extension strength (p<.05), compared to the SoC group. **Discussion.** The results from the current study indicate significant increases in physical activity and improvements in physical

functioning via a cost effective intervention that is easily translatable to the broader older adult population. Future research is warranted in efforts to improve adherence to physical activity programs to achieve the highest degree of favorable outcomes.

KEYWORDS: Steps, resistance bands, physical functioning, older adults

Introduction

The number of people living well into their elder years is steadily increasing, with older adults anticipated to comprise 20% of the total U.S. population by 2050. Of particular concern to older adults is the heightened prevalence of chronic diseases, frailty, and disability. Such adverse outcomes are highlighted by the (in)ability to perform activities of daily living, such as walking, climbing stairs, and lifting objects – correlates of physical functioning (PF) – which becomes diminished with increasing age (Crane, MacNeil, & Tarnopolsky, 2013; Morie et al., 2010). Over 70 million adults have difficulty in performing basic life activities, with an estimated 4% of those aged 65+ years having PF levels that necessitate assistance in personal care, increasing to 11% to those aged 85+ (Federal Interagency Forum on Aging-Related Statistics, 2008). Poor physical functioning in the older adult years has been linked to quality of life (Wilson & Cleary, 1995), disability (Guralnik et al., 1995), fall risk (Tinetti, Speechley & Ginter, 1988), and mortality (Newman et al., 2006). It is well established that maintaining a physically active lifestyle and engaging in exercise is beneficial for preserving and improving PF (Crane et al., 2013; Brown et al., 2005; Rantanen et al., 1999; LaCroix et al., 1993). Despite this, the majority of older adults are not sufficiently active, and even fewer report regularly engaging in exercise-type behaviors, rendering older adults a prime candidate population for physical activity interventions to improve PF levels.

Numerous interventions have demonstrated benefits pertaining to PF associated with increasing physical activity (PA) in older adults, including studies focused on increasing walking activity (Dunn et al., 1999), strength training (Chandler et al., 1998; Beyer et al., 2007), and combinations of both aerobic and strength training (King et al., 2000; Nelson et al., 2004; The LIFE Study Investigators, 2006). Through varying study designs, an underlying focus has been to reduce the influence of barriers that deter individuals from initiating, and maintaining, a physically active lifestyle. However, long-term adherence to increases in physical activity from interventions remains difficult for an older adult, thus limiting the practicality of the programs (Ashworth, Chad, Harrison, Reeder, & Marshall, 2005). Critical factors regarding the efficacy of interventions to increase physical activity and improve PF within the older adult population pertains to the ease of implementation into daily lives, offering flexibility and choice to the individual (Clemson et al., 2010; Litt, Kleppinger & Judge, 2002).

One promising and translatable interventional structure that can be easily incorporated into an older adult's day is the use of in-home physical activity interventions. Integrating exercise into daily routines, particularly within one's own residence, aims to overcome numerous barriers associated with physical activity and exercise, such as transportation, time, health, and reliance on external resources (Moschny et al., 2011; Fiatarone Singh, 2000). Despite this, there is a lack of information on increasing physical activity and strength, and thereby improving PF in older adults. Therefore, the purpose of the current study is to examine whether an in-home, individually tailored intervention is efficacious in promoting meaningful increases in PA and improvements in PF in low-active older adults.

Methods

Study Design

Participation in this randomized controlled trial consisted of an in-home PA program, with pre- and post-intervention assessments. Recruitment took place in 7 local community senior centers, where baseline, and post-intervention, measures were taken. Upon their interest in the current study, all participants signed an informed consent document to participate in the study, as approved by the University's Institutional Review Board. As part of the recruitment process, participants were provided a pedometer and log to record their steps for 4 consecutive days. Those who were low-active based on baseline pedometer steps/day were contacted via telephone and invited to participate in the 8 week intervention. Upon meeting in the senior center, participants were randomly were assigned to an enhanced physical activity (EPA) group or standard of care (SoC) group. Concluding the intervention, post-intervention measurements were taken in the same senior centers.

Enhanced Physical Activity Group

Those in the EPA group received two orientation sessions within their local senior center in the first week to provide a pedometer and individualized daily step goals. The step goals included increasing daily step goals each week by 10% of the average baseline steps. A resistance band and program, consisting of eight exercises (all seated: knee extension, knee flexion, hip lift, toe raise, chest press, seated row, arm curl, and arm extension) was provided for each participant, to be completed twice per week. The individual workouts were designed to progress in the following manner: weeks 1 and 2: 1 set of each exercise for 10 repetitions; weeks 3, 4, and 5: 1 set for 15 repetitions, and weeks 6, 7, and 8: 2 sets for 15 repetitions. The goal of each set was to reach the prescribed repetitions and/or elicit volitional fatigue in the targeted muscle group. In order to provide instruction and ensure proper form of the exercises, the first two resistance training sessions (week 1) were supervised at the senior center (as part of the orientation), in addition to each participant receiving a printed sheet graphically and verbally depicting the exercise. Weekly logs were provided to each participant to record daily pedometer steps and the number of sets/repetitions for each exercise, in addition to pre-stamped envelopes to mail the logs back to the investigative team.

Each week an education pamphlet discussing a different topic relating to PA was mailed to the participant. The topics were informed by the social cognitive theory, focusing on increasing one's self efficacy, knowledge of expected benefits and outcomes, overcoming barriers, and maintaining PA behavior adoption across time. Telephone calls were made to each participant at the end of weeks 2, 3, 5, and 7 to briefly review each education pamphlet, inquire on the progress in reaching step goals and completing resistance training sessions, and to provide a reminder to continue mailing pedometer/resistance training logs.

<u>Standard of Care Group</u>

Those in the SoC group were met at their local senior center and were provided a pedometer, along with instructions to increase their daily step accumulation to reach 10,000 steps/day by the final (8^{th}) week of the intervention. They were called during week 7 to provide a reminder to record their daily steps for the final week of the intervention.

Participants

Fifty participants were screened to participate in the current study. Recruitment efforts were made through newsletters, recruitment flyers, and postings within senior centers and word of mouth. Inclusion criteria consisted of being between the ages of 65 and 85 years, being low-active (≤6,500 steps/day during pedometer monitoring period), and having no limitations to exercise. Exclusion criteria consisted of using a walking aid (cane, walker, etc.) and participation in exercise-type activities twice a week for the previous three months.

Study Measures

General Demographics

Participants completed an abbreviated health history form, inquiring on their age, ethnicity. Body height (to the nearest 0.1 cm) and body mass (to the nearest 0.01 kg) were measured with no shoes and minimal clothing via a calibrated physician's scale and stadiometer (Detecto, Kansas City, MO). Body mass index (BMI; kg/m^2) was calculated.

Physical Activity

Physical activity during the baseline period, as well as during the intervention, was assessed via the Digi-Walker SW-200 pedometer (Lifestyles, Inc., Kansas City, MO), worn during all waking hours. Such pedometers have been shown to be cost-effective, while providing valid and reliable data on steps taken per day (Crouter et al., 2003; Schneider et al., 2003).

Physical Functioning

A variety of measures were assessed to quantify PF. *Choice step reaction time* (CSRT) was assessed as a proxy for fall risk (Lord & Fitzpatrick, 2001), consisting of standing on two force plates and stepping, as quickly and safely as possible, into a randomly chosen corner when visually prompted from a computer screen directly in front of the participant. Participants were fitted in a protective harness (to ensure balance throughout the stepping trials). Ten practice trials, providing feedback to ensure proper stepping placement, preceded 20 test trials.

Maximal knee extension and flexion force were calculated via isometric contractions. Participants sat on a padded table, pressing against a manual muscle testing system (Lafayette Industries, Lafayette, IN), quickly increasing force production from minimal effort to maximal exertion by the conclusion of a three second trial. The muscle testing system was affixed to a seat belt and anchored around a stable structure. Two trials, with verbal encouragement, were performed for knee extension and flexion assessments, alternating trials between legs.

Maximal hand grip strength was assessed to incorporate an upper body PF measurement (Rantanen et al., 1999; Sydall et al., 2003). Participants performed two maximal contractions in each hand with the LA-78010 dynamometer (Lafayette Industries, Lafayette, IN). Standing, participants held the dynamometer in their hand with their freely arm hanging. Two maximal contractions, spanning 2-3 seconds with verbal encouragement, were performed in each hand, alternating between hands after each trial.

The *8 feet up and go test*, similar to CSRT, was incorporated as a skill-based assessment of PF *(*Podsiadlo & Richardson, 1991) and predictor of falls *(*American Geriatrics Society, British Geriatrics Society, & American Academy of Orthopaedic Surgeons Panel on Falls Prevention, 2001; Shumway-Cook, Brauer, & Woollacott, 2001). Participants were seated in a standard foldable chair against a wall, with a tape marking on the floor 8 feet directly in front of them. They were instructed to rise from the chair, walk to and around the tape marking, and return to the chair and sit as quickly and safely as possible. Time was recorded from a stopwatch that manually began timing as soon as the upward transition from the chair began, and was stopped when sitting contact was made with the chair. Three trials, with a rest period in between, were performed.

Data and Statistical Analyses

Descriptive statistics are expressed as mean ± standard deviation (SD). The minimal requirement for pedometer wear reported on returned logs was three days, which has been shown to have high between day reliability, with older and diseased populations requiring less time (two days) to gauge habitual activity levels (Hart, Swartz, Cashin, & Strath, 2009; Tudor-Locke, Hart, & Washington, 2009). The minimal amount of steps/day acceptable in order to be included in data analysis was 500 steps/day. The maximal force productions for leg extension/flexion and hand grip strength were utilized for data analysis, in addition to the fastest trial time for the 8ft up and go test. The average reaction time over the 20 test trials during the CSRT assessment was averaged (milliseconds).

Three categories were utilized for analyses: all participants who were enrolled in the study, those who completed the intervention through post-intervention testing, and those who adhered to the prescribed intervention. Intent to treat analysis via last observation carried forward analyses was used to account for missing data. Adherence was defined by completing and meeting 80% of eight possible pedometer logs and 80% of16 possible resistance band exercise sessions. Previous research has demonstrated an 80% intervention compliance rate as a level to be indicative of attaining health benefits, compared to those adhering to less than 80% of the intervention (Asikainen et al., 2002; Murtagh, Boreham, Nevill, Hare, & Murphy, 2005; Quinn, Klooster, & Kenefick, 2006).

To test for differences in demographics, physical activity, and physical functioning between the EPA and SoC group at baseline, independent t-tests were performed. Mixed between-within ANOVAs were performed to assess changes in steps/day and physical functioning, as assessed by CSRT, leg extension/flexion and hand grip strength, and 8ft up and go test completion time between the EPA and SoC groups. The EPA group was demarcated into three groups: Those with last observation carried forward analysis applied, those who completed the intervention, and those who adhered to the intervention. Analyses were performed utilizing SPSS 19.0 for Windows (Chicago, IL), and the level for achieving statistical significance was set at $p<.05$.

Results

Participant Characteristics

A total of 39 participants completed the current study, with Figure 1 illustrating the attrition of participants from screening to study completion. Of those screened for activity levels prior to beginning the intervention, four participants exceeded 6,500 steps/day, rendering them ineligible for the study. An additional four participants qualified to participate based on their activity levels, but did not return telephone calls to schedule an orientation. Two potential participants failed to return their pedometer and log, as part of the screening process. Among those enrolled in the study, one participant in the EPA group dropped out of the study (during week 2) due to a lack of time, resulting in 20 and 19 participants in the EPA and SoC group, respectively, completing the study. Participant characteristics are reported in Table 1, with no statistical differences between the EPA and SoC groups, even when considering intervention completers and adherers.

Physical Activity

All Participants

There were no significant differences in baseline steps/day between the EPA (2692±1678) and SoC (2676±1287) group ($t(37)=-.03$, $p=.602$). The mean weekly steps/day at the end of week 8 for the EPA and SoC groups are presented in Table 2. Of all participants within the EPA group, four participants met every weekly step goal, one met seven, one met six, four met five, one met four, four met three, three met two, and two met only 1. There was a statistically significant interaction effect for steps/day [$F(1, 37)=4.4$, $p<.05$] between the EPA and SoC groups, with the mean increase in steps/day for the EPA group being more than 1,000 steps/day higher than the SoC group (partial eta squared=.107).

Intervention Completers

All participants completed the study through post-intervention testing, with the exception of two participants in the EPA group and two in the SoC group. There was a statistically significant effect of time for the EPA and SoC groups [$F(1, 34)=14.4$, $p=.001$] for steps/day, despite the EPA group eclipsing a higher increase in mean steps/day of 1,000 steps/day (partial eta squared=.298).

Intervention Adherers

Twenty five percent of those in the EPA group successfully completed the intervention and adhered to weekly step goal prescriptions. There was a statistically significant interaction effect for steps/day [$F(1, 21)=6.4$, $p<.05$] between the EPA and SoC groups. The mean increase in steps/day for the EPA group was approximately 3,000 steps/day, compared to an increase of 600 steps/day for the SoC group (partial eta squared=.242).

Adherence to exercise sessions utilizing resistance bands, compared to meeting step goals, was much higher. Seventy percent of the EPA group successfully completed 80% of the prescribed exercise sessions, with nine participants completing all 16 training sessions, three completing 14, one completing 13, 12, and 10, two completing 8, and one completing 7, 3, and 2 sessions. Those who adhered to resistance band exercise sessions (n=14) were no more likely to reach weekly step goals, compared to non-adherers (n=6, data not shown).

Physical Functioning

All Participants

Baseline and post-intervention physical functioning values for all participants, additionally segmented by EPA and SoC groups, are presented in Table 3. At baseline, the EPA group had significantly lower peak knee extension forces for both the right ($t(35)=2.242$, $p<.05$) and left ($t(35)=2.147$, $p<.05$) legs, compared to the SoC group.

Intervention Completers

Physical functioning values for those who completed the intervention within the EPA and SoC groups are presented in Table 4. For those who completed the intervention, there were significant time by group interactions for the 8ft up and go test [$F(1, 33)=7.6$, $p<.05$; partial eta squared=.187], and the right [$F(1, 32)=7.5$, $p<.05$; partial eta squared=.190] and left knee extension force [$F(1, 32)=13.4$, $p<.05$; partial eta squared=.296]. Additionally, there was a significant time effect for CSRT [$F(32, 1)=17.3$, $p=.000$; partial eta squared=.352], right maximal knee flexion [$F(32, 1)=31.8$, $p=.000$; partial eta squared=.498], left maximal knee flexion [$F(32, 1)=40.8$, $p<.05$; partial eta squared=.560], right maximal hand grip strength [$F(34, 1)=13.5$, $p<.05$; partial eta squared=.284], and left maximal hand grip strength [$F(34, 1)=10.0$, $p<.05$; partial eta squared=.228].

Intervention adherers

Physical functioning values for those who adhered to the intervention are presented in Table 4. Only left maximal knee extension force exhibited a significant time by group interaction [$F(1, 20)=5.4$, $p<.05$; partial eta squared=.211]. Among the remaining variables, all but one (right maximal knee extension force), exhibited a significant time effect (CSRT [$F(1, 19)=20.2$, $p=.000$; partial eta squared=.516], 8ft up and go test [$F(1, 20)=17.2$, $p=.000$; partial eta squared=.463], right maximal knee flexion [$F(1, 20)=17.4$, $p<.05$; partial eta squared=.465], left maximal knee flexion [$F(1, 20)=16.3$, $p<.05$; partial eta squared=.449], right maximal hand grip strength [$F(1, 20)=6.3$, $p<.05$; partial eta squared=.241], and left maximal hand grip strength [$F(1, 20)=5.3$, $p<.05$; partial eta squared=.211].

The results for the physical functioning variables, based on level of resistance training adherence, are reported in Table 5. There were no differences in any of the variables between adherers and non-adherers at baseline. There was a significant time by group interaction for the 8ft up and go test [$F(1, 16)=6.9$, $p<.05$; partial eta squared=.301]. All other variables, with the exception of left maximal hand grip strength, showed a significant time effect (CSRT [$F(1, 16)=4.7$, $p<.05$; partial eta squared=.226], right maximal knee extension [$F(1, 15)=10.4$, $p<.05$; partial eta squared=.410], left maximal knee extension [$F(1, 15)=24.6$, $p=.000$; partial eta squared=.622], right maximal knee flexion [$F(1, 15)=21.5$, $p=.000$; partial eta squared=.589], left maximal knee flexion [$F(1, 15)=23.0$, $p=.000$; partial eta squared=.605], and right maximal hand grip strength [$F(1, 17)=5.5$, $p<.05$; partial eta squared=.246].

Discussion

Within the older adult population, declines in physical functioning levels can be indicative of deteriorating health and quality of life. Previous research has demonstrated the vast benefits of increasing both ambulatory activity and resistance training exercises, yet the number of older adults who are regularly physically active remains low, with an even staggeringly lower amount of those engaging in regular exercise. Interventional efforts have targeted many contributing factors related to participation in physical activity, with success in showing significant increases in physical activity that are associated with meaningful improvements in a variety of physical functioning variables. In an effort to make such lifestyle modifications more long term and more generalizable to the broader population, there is a great need to ensure the benefits of such interventional efforts are easily translatable into everyday lives. The main findings of the current study showed that a group receiving an enhanced physical activity (EPA) prescription significantly increased physical activity and improved a variety of physical functioning variables to a greater extent than a standard of care (SoC) group that received general physical activity guidelines. Of noteworthy importance, higher rates of adherence to prescribed activity programs resulted in greater improvements in both physical activity and physical functioning.

The majority of older adults do not meet physical activity recommendations, and spend an increasingly larger amount of time in sedentary activities across the lifespan. On average, healthy older adults take 2,000-9,000 steps/day (Tudor-Locke et al., 2011). In the current study, baseline steps/day were toward the bottom of such published ranges, being at 2,700 steps/day on average. Accordingly, the weekly 10% increase in prescribed step goals would not equate to an unattainable stepping volume by the end of the intervention, and current study results demonstrate participants were able to reach such goals. Previous meta-analyses have suggested an increase of 2,000 steps/day to be clinically relevant for increasing ambulatory behavior (Bravata et al., 2007), a mark eclipsed by the EPA group in the current study, accruing nearly 3,000 steps/day. Conversely, the prescription of the SoC group to reach 10,000 steps/day may have been unrealistic in the designated time frame, considering the low baseline values and lack of additional interventional stimuli that the EPA group received. Still, the SoC group increased their activity levels to a degree in concert with other studies prescribing a 10,000 steps/day goal (Bravata et al., 2007).

Despite those in the EPA intervention study arm significantly increasing their activity levels, overall physical activity increases were substantially higher for those who adhered to physical activity prescriptions in this study group. Collectively in the EPA study group, only one quarter of the participants sufficiently adhered to the weekly step goal targets. Even though the relative adherence of all participants in the EPA group was high, based on current literature (Simek, McPhate, and Haines, 2012), efforts to increase and maintain adherence rates remain of the utmost importance to future interventional efforts. An effective tool in bolstering adherence rates to physical activity interventions has been implementing educational components, covering information regarding enablers, barriers, motivators, and outcome expectations (King, Rejeski, and Buchner, 1998). Frequent consultation with experts has been shown to be linked to increased adherence, albeit at the added cost to employ such individuals (Freidrich, Cermak, and Maderbacher, 1996). In an effort to maintain adherence in physical activity interventions, while avoiding exorbitant expenses, consultation via telephone contact has been documented to be successful in enhancing the efficacy of such programs (Simek, McPhate, and Haines, 2012). The current study incorporated evidence-based practices, such as education and bi-weekly telephone contact, to enhance the efficacy of the intervention as much as possible, yet three quarters of participants failed to adhere to the EPA prescription. Although higher adherence rates are desirable, the results of the current study are beneficial in demonstrating the combined effect of the currently employed methodologies. In an effort to further increase physical activity adherence, additional supplemental strategies that improve the perceived benefit to cost ratio and impact other relevant factors to older adults and physical activity (Belza et al., 2007), may bring such goals in this intervention setting to fruition.

There were significant interaction effects observed for the 8ft up and go test and maximal knee extension forces. Compared to normative data, participants in the current study performed considerably better on the 8ft up and go test at baseline by two seconds, and three seconds by post-intervention (Bohannon, 2006). Consistent with the results of the current study, improvements of 0.5-1 seconds on the 8ft up and go test have been demonstrated with physical activity (Gudlaugsson et al, 2013; Snyder, Colvin, and Gammack, 2011; Hallage et al., 2010) and resistance training (Straight et al., 2012; Sousa et al., 2013) interventions in older adults. However, such results were observed from greater interventional stimuli, such as exercise training three times per week for 60 minutes (Hallage et al., 2010), use of expensive exercise equipment and free weights (Sousa et al., 2013), and dietary intervention (Straight et al., 2012). Participants in the current study had faster times at baseline, implying less room for improvement, and improved their times more than other studies post-intervention. Performance on the 8ft up and go test is influenced by the ability to rise from a chair and gait speed, which are highly correlated to knee extension strength. Although the EPA group had lower knee extension forces at baseline, the effect size observed for increases in knee extension strength are consistent with other interventions (Silva et al., 2013). While increasing the training volume per week and intensity of other interventional stimuli have been shown to increase such effects in healthy older adults (Silva et al., 2013), the underlying purpose of this intervention showed similar outcomes are attainable in a less costly, easily translatable intervention into older adults' lives without supervision.

Both study groups demonstrated improvements in the other measures of physical functioning. The measures that exhibited main effects for time were consistent with previous published literature. Compared to the improvements in knee extension strength, increases in knee flexion strength were of a lesser extent (Kalapothrakos, Smilios, Parlavatzas, and Tokmakidis, 2007). As exercises were prescribed for knee extension and flexion movements, the greater improvement of the knee extension is likely attributable to increasing walking activity. There is limited evidence on the associated relationship between increasing physical activity and performance on the CSRT test, which is related to neuromuscular, sensiormotor, and balance variables (Lord & Fitzpatrick, 2001). Voukelatos et al. (2007) reported significant improvements in CSRT of 10ms through a Tai Chi intervention, although their sample size was substantially larger than in the current study. Improved performance on the CSRT has been shown to be positively related to gains in quadriceps strength (Pijnappels, Delbaere, Sturnieks, and Lord, 2010), so one can speculate that the observed improvements can be, in part, attributed to increased knee extension strength. Multimodal exercise training programs have shown significant improvements in maximal hand grip strength (Seco et al., 2013), and results from the LIFE-P trial have shown decreased levels of physical activity to be related with lower hand grip strength (Ip et al., 2013). Improvements in hand grip strength were more noticeable between study groups, rather than intra-group among adherers and non-adherers performing resistance training in the EPA group. Accordingly, hand strength improvements may be more related to the sample population and their daily activities outside of the prescribed intervention (as resistance training is linked to improvements in hand strength), and not which study group they were randomized to.

The results from this study have many implications for future research. Primarily, a low-cost intervention easily integrated into everyday life is capable of promoting increases in physical activity and improvement in a variety of clinically relevant physical functioning measures. It is likely that higher rates of adherence would elicit higher degrees of benefit. However, low adherence in the current study, also echoed in other meta analyses in older adults (Bravata et al., 2007; Simek et al., 2012), highlights the difficulties of implementing interventions within this population. Future studies are warranted to investigate the relative influence of physical activity mediators on program adherence, in addition to strategies to incorporate feasible and cost effective interventions in older adults' lives that translate to long term participation.

Figure 1. Participant Recruitment Flow.

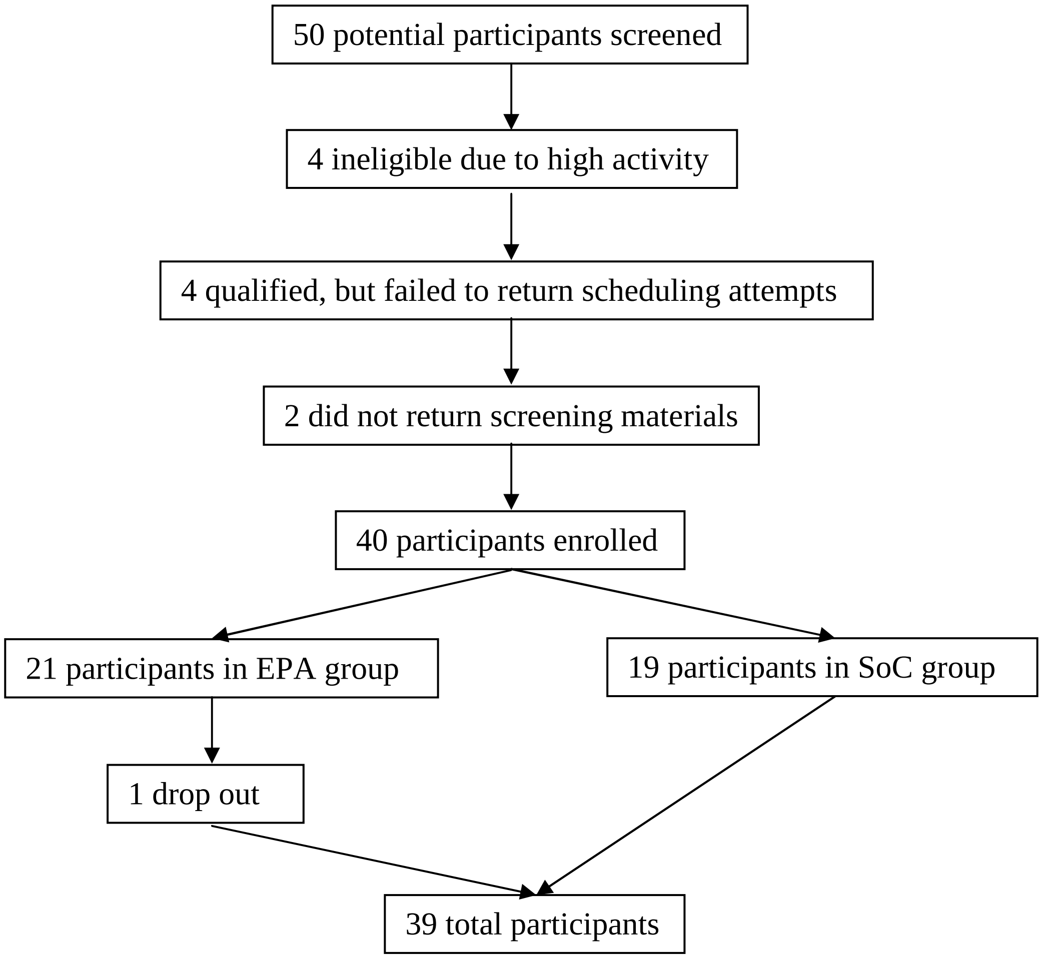

Table 1. Baseline Participant Characteristics (Mean±SD).

	ALL (N=40)	EPA Group Completers (n=19)	EPA Group Adherers (n=5)	SoC Group Completers (n=19)	SoC Group Adherers (n=17)
Age (yrs)	74.7 ± 6.4	73.5 ± 5.6	69.8 ± 4.7	75.4 ± 6.8	75.3 ± 6.5
Height (cm)	163.4 ± 10.7	161.2 ± 12.0	157.1 ± 13.3	165.4 ± 9.2	165.0 ± 9.3
Weight (kg)	80.7 ± 17.0	81.7 ± 16.8	79.4 ± 22.2	79.6 ± 18.1	79.5 ± 19.1
Body Mass Index (kg/m^2)	30.4 ± 5.7	31.6 ± 5.9	31.6 ± 3.7	29.1 ± 5.5	29.1 ± 5.7
Gender (%)	70.0	80.0	83.3	63.2	64.7
Ethnicity (%)	85.0	80.0	100.0	89.5	88.2

Note. EPA: enhanced physical activity. SoC: standard of care. Gender: percentage of female participants. Ethnicity: percentage of Caucasian participants. Completers: participants that completed post-intervention testing. Adherers: participants that adhered to physical activity prescriptions by reaching 80% of weekly step goals.

Table 2. Participant Steps Per Day at Baseline and Post-Intervention Based on Adherence (Mean±SD).

	ALL		Intervention Completers		Intervention Adherers	
	Pre-Intervention	Post-Intervention	Pre-Intervention	Post-Intervention	Pre-Intervention	Post-Intervention
EPA Group	2712 ± 1638 (n=21)	4309 ± 2689‡* (n=20)	2662 ± 1717 (n=19)	4222 ± 2734†* (n=19)	2856 ± 1980 (n=5)	5799 ± 2932‡* (n=5)
SoC Group	2676 ± 1287 (n=19)	3178 ± 1816* (n=19)	2609 ± 1270 (n=17)	3208 ± 1893†* (n=17)	2609 ± 1270 (n=17)	3208 ± 1893* (n=17)

Note. EPA: enhanced physical activity. SoC: standard of care. Completers: participants that completed post-intervention testing. Adherers: participants that met 80% of weekly step goals. †Significant pre-post intervention effect. ‡ Significantly greater than the SoC group. *p<.05.

Table 3. Baseline and Post-Intervention Physical Functioning Among Participants (Mean±SD).

	ALL		EPA Group		SoC Group	
	Pre-Intervention	Post-Intervention	Pre-Intervention	Post-Intervention	Pre-Intervention	Post-Intervention
Choice Step Reaction Time (ms)	1388.4±253.3 (n=40)	1251.6±279.5 (n=34)	1423.1±207.1 (n=21)	1268.9±321.4 (n=18)	1350.1±297.3 (n=19)	1232.1±232.4 (n=16)
8ft up and go (sec)	7.1±1.8 (n=39)	6.2±1.6 (n=36)	7.1±1.1 (n=20)	5.7±1.0 (n=19)	7.0±2.3 (n=19)	6.7±1.9 (n=17)
Right Knee Extension Force (kg)	17.7±5.8 (n=38)	20.9±5.9 (n=35)	15.8±5.3* (n=19)	21.8±6.0 (n=18)	19.6±5.7 (n=19)	19.9±5.8 (n=17)
Left Knee Extension Force (kg)	16.6±5.3 (n=38)	20.0±4.9 (n=35)	15.0±4.2* (n=19)	20.7±5.3 (n=18)	18.2±5.9 (n=19)	18.8±4.6 (n=17)
Right Knee Flexion Force (kg)	12.8±4.9 (n=38)	17.8±6.0 (n=35)	11.6±4.8 (n=19)	18.3±5.9 (n=18)	14.1±5.1 (n=19)	17.3±6.3 (n=17)
Left Knee Flexion Force (kg)	12.8±5.0 (n=38)	18.9±6.1 (n=35)	11.5±4.8 (n=19)	19.1±5.9 (n=18)	14.0±5.0 (n=19)	18.4±6.6 (n=17)
Right Hand Grip Strength (lbs.)	62.0±23.5 (n=40)	68.1±21.7 (n=36)	59.0±26.0 (n=21)	64.2±23.4 (n=19)	65.3±20.5 (n=19)	72.5±19.4 (n=17)
Left Hand Grip Strength (lbs.)	57.7±22.3 (n=40)	63.3±21.6 (n=36)	56.1±23.9 (n=21)	61.7±23.1 (n=19)	59.4±20.9 (n=19)	65.2±20.2 (n=17)

Note. EPA: enhanced physical activity. SoC: standard of care. *Significantly lower than SoC baseline knee extension force, $p<.05$.

Table 4. Baseline and Post-Intervention Physical Functioning Among Participants Based on Adherence to Physical Activity Prescriptions (Mean±SD).

	EPA Group				SoC Group	
	Intervention Completers		Intervention Adherers		Intervention Completers	
	Pre-Intervention	Post-Intervention	Pre-Intervention	Post-Intervention	Pre-Intervention	Post-Intervention
Choice Step Reaction Time (ms)	1406.7±210.4 (n=18)	1268.9±321.4†* (n=18)	1373.3±165.8 (n=5)	1105.6±133.7†* (n=5)	1395.4±279.6 (n=16)	1232.1±232.4 (n=16)
8ft up and go (sec)	7.2±1.1 (n=18)	5.7±1.0‡* (n=18)	7.2±0.9 (n=5)	5.3±0.7†* (n=5)	7.2±2.4 (n=17)	6.7±1.9 (n=17)
Right Knee Extension Force (kg)	15.4±5.4 (n=17)	21.8±6.0‡* (n=17)	15.6±6.1 (n=5)	21.5±7.7 (n=5)	19.3±5.9 (n=17)	19.9±5.8 (n=17)
Left Knee Extension Force (kg)	14.6±4.1 (n=17)	20.7±5.3‡* (n=17)	14.0±14.5 (n=5)	19.6±6.3‡* (n=5)	18.0±6.1 (n=17)	18.8±4.6 (n=17)
Right Knee Flexion Force (kg)	11.6±4.7 (n=17)	18.3±5.9†* (n=17)	11.8±6.0 (n=5)	20.8±8.1†* (n=5)	13.5±4.8 (n=17)	17.3±6.3 (n=17)
Left Knee Flexion Force (kg)	11.6±4.9 (n=17)	19.1±5.9†* (n=17)	11.1±5.8 (n=5)	19.6±6.7†* (n=5)	13.7±5.1 (n=17)	18.4±6.6 (n=17)
Right Hand Grip Strength (lbs.)	57.3±25.5 (n=19)	64.2±23.4†* (n=19)	57.0±36.0 (n=5)	67.6±34.2 †* (n=5)	64.1±20.8 (n=17)	72.5±19.4 (n=17)
Left Hand Grip Strength (lbs.)	55.2±24.3 (n=19)	61.7±23.1†* (n=19)	52.0±34.2 (n=5)	61.2±31.2†* (n=5)	58.2±21.7 (n=17)	65.2±20.2 (n=17)

Note. EPA: enhanced physical activity. SoC: standard of care. Completers: participants that completed post-intervention testing. Adherers: participants that met 80% of weekly step goals. SoC intervention adherers' physical functioning values (not shown) are identical to SoC intervention completers.
†Significant pre-post intervention effect. ‡ Significantly improved compared to the SoC group. **p*<.05.

Table 5. Physical Functioning Among the Enhanced Physical Activity Group Based on Adherence to Resistance Training Prescription.

	Intervention Non-Adherers		Intervention Adherers	
	Pre-Intervention	Post-Intervention	Pre-Intervention	Post-Intervention
Choice Step Reaction Time (ms)	1348.8±122.6 (n=6)	1216.5±119.5†* (n=6)	1433.4±240.2 (n=12)	1295.2±388.5†* (n=12)
8ft up and go (sec)	7.2±1.5 (n=5)	6.1±1.2 (n=5)	7.1±1.0 (n=13)	5.5±0.9‡* (n=13)
Right Knee Extension Force (kg)	15.0±2.8 (n=4)	19.8±6.3†* (n=4)	15.6±6.1 (n=13)	22.6±6.0 †* (n=13)
Left Knee Extension Force (kg)	14.6±2.9 (n=4)	19.1±3.4†* (n=4)	14.6±4.4 (n=13)	21.3±5.9 †* (n=13)
Right Knee Flexion Force (kg)	11.3±0.6 (n=4)	18.5±5.9†* (n=4)	11.7±5.4 (n=13)	18.2±6.1 †* (n=13)
Left Knee Flexion Force (kg)	10.8±1.9 (n=4)	19.1±7.5†* (n=4)	11.9±5.6 (n=13)	19.2±5.5 †* (n=13)
Right Hand Grip Strength (lbs.)	59.8±26.0 (n=6)	65.0±20.2†* (n=6)	56.2±26.2 (n=13)	63.9±25.5†* (n=13)
Left Hand Grip Strength (lbs.)	58.0±24.3 (n=6)	62.3±20.0 (n=6)	53.9±25.2 (n=13)	61.4±25.1 (n=13)

Note. Completers: participants that completed post-intervention testing. Adherers: participants that completed 80% of resistance training sessions. †Significant pre-post intervention effect. ‡ Significantly improved compared to Non-Adherers. **p*<.05.

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CHAPTER V: DISCUSSION

As an increasingly prominent population in the United States, and worldwide, older adults are garnering a heightened emphasis on healthcare-related issues. Of prominent chronic conditions facing the aging population, declines in physical functioning level have a massive influence on everyday life. Physical activity and exercise have long been shown to have the ability to positively impact numerous health conditions across all ages. Given the noted high prevalence of chronic conditions and physical functioning impairments in older adults, there lies immense potential for the treatment and preventative capabilities of physical activity to be applied in this population.

Despite the known health benefits demonstrated by physical activity and exercise, the number of older adults who are sufficiently active is paltry. Accordingly, there has been much research examining factors critical to physical activity engagement in order to better develop strategies to promote such increases in activity. Factors driving such behaviors relevant to older adults span biological, psychosocial, and environmental determinants. Thus, such variables contribute to the overall complexity of promoting increases in physical activity in older adults. In turn, a plethora of interventions have been successful in accomplishing such endeavors. However, there remains a need to ensure such interventions are translatable to the broader older adult population. Provided such background on the older adult population, health disparities, and physical inactivity, the purpose of this dissertation was to link information on community-based fitness resources (CBFR) that promote physical activity and exercise (Project VOICE) to an intervention that can be seamlessly incorporated into everyday life, in order to improve a variety of physical functioning measures (Project PACE).

Project VOICE

The purpose of Project VOICE was to determine whether awareness and utilization of fitness resources and overall physical activity engagement differed depending on residential distance from CBFR. There were three specific aims to this study: 1) To examine awareness of CBFR among those residing within ≤1, >1 to ≤2, and >2 to 5 miles around senior centers housing CBFR, 2) to examine utilization of CBFR among the same individuals, and 3) to examine if overall physical activity levels increased the closer one's proximity to CBFR.

The results of this study showed no differences in the awareness or utilization of CBFR across spatial tiers. More specifically, approximately 50% of participants were aware of CBFR, yet utilization rates were extremely low. Additionally, overall physical activity levels increased the further one's residence from CBFR, adding to the evidence that targeted CBFR may not be as effective in increasing physical activity in older adults as they are equipped to be. The data suggests that increasing interest and improving transportation to available resources may be a driving factor in increasing utilization rates. Additionally, development of exercise programming within CBFR is likely to increase individuals' overall activity levels by instilling knowledge that can be applied to increasing activity both within and outside of community exercise locales.

Project PACE

The purpose of Project PACE was to examine whether an in-home, individually tailored intervention is efficacious in promoting meaningful increases in physical activity and improvements in physical functioning in low-active older adults. There were two specific aims: To examine if an enhanced physical activity (EPA) intervention of individually tailored step goals and resistance training with bi-weekly telephone follow-up in low-active older adults 1) significantly increases physical activity (as assessed by steps/day), and 2) improves measures of physical functioning, as measured by choice step reaction time, balance, knee flexion/extension strength, maximal handgrip strength, and 8ft up-and-go test completion time significantly more than a standard of care (SoC) group.

Both EPA and SoC groups significantly increased their walking activity over the intervention. However, those who adhered to the walking prescriptions within the EPA group increased steps/day significantly more than the SoC group. Both groups experienced significant gains in the physical functioning variables, with interaction effects shown for the 8ft up and go test and knee extension strength. The results from the current study indicate significant increases in physical activity and improvements in physical functioning via a cost effective intervention that is easily translatable to the broader older adult population. Future research is warranted in efforts to improve adherence to physical activity programs to achieve the highest degree of favorable outcomes.

Conclusions

Scholars in the realm of physical activity and health must continually evaluate the direction of research in order to advance knowledge. The results from Project VOICE represent an overview of a random sample of individuals who have access to resources that aim to promote physical activity. Given that individuals were largely aware, but not utilizing CBFR, an examination of such results is an important first step in evaluating future directions. Primarily, there is a strong need to improve the programming within the current CBFR. A logical first step is to provide open access regarding recommended volumes of exercise to engage in, how to properly progress exercise equipment utilization, and strategies to assist maintenance of these activities in the long term. Also, strategies are warranted to help increase awareness in utilizing current CBFR. Potential strategies to explore could incorporate health screenings, competitions, and seminars that offer a variety of aspects that individuals find appealing.

The results from Project VOICE represent a definitive linkage to Project PACE. Although there are definite long-term strategies to improve upon within CBFR (as evidenced by Project VOICE), there are avenues to explore that are informed from the apparent short comings of CBFR. In particular, home-based physical activity interventions have the potential to provide the same benefits of CBFR in promoting exercise resources, but also are not defined by similar disadvantages. Like any physical activity intervention, the overall purpose is to improve health. Project PACE incorporates a battery of clinically relevant measures that define physical functioning in older adults. Although demonstrating significant increases in physical activity and physical functioning, such results hint at future work that is still needed. Specific areas to elaborate on from Project PACE include examining methodologies to promote higher rates of intervention adherence, frequent outcome measurements and follow up assessments. Also, variations in intervention stimulus and study designs that allow for the exploration of independent and combined effects of physical and resistance training on outcomes are warranted. Collectively, these research tracts provide the opportunity to deduce potential protective thresholds for physical activity and exercise for improving/maintaining physical functioning outcomes in a population at risk for functional impairments and disabilities.

Chapter Summary

Overall, this sequence of studies highlights many different interesting facets pertaining to increasing physical activity to improve health in the older adult population. Although each respective study presents results that have implications for follow up investigations, they also present a broad overview of the apparent challenges that persist in physical activity research, spanning mediating variables, community programming, and feasibility and practicality of interventions.

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Appendices

Appendix A
Project VOICE Screening Form

Physical Activity & Health Research Lab

UWM UNIVERSITY of WISCONSIN MILWAUKEE

Department of Human Movement Sciences

Enderis Hall, Rm. 434 • (414) 229-4392

Screening Form for Project VOICE

Call log: Date/ Time Comment

____

____

Hello, my name is _____________ and I am a________________ working with the Physical Activity & Health Research Laboratory at the University of Wisconsin- Milwaukee. You have been randomly selected to participate in a study to provide valuable information about your neighborhood. If you have a moment, please let me tell you about a study that we are currently working on. It is a study designed to examine the awareness and utilization of community resources, specifically fitness/exercise programs or classes in your neighborhood. It involves completing a few brief surveys about community resources, physical activity, and your health. If you would be willing to participate, do you mind if I ask your age to determine if you qualify for the study?

1. What is your current age?_______________ Date of birth: ________________

They qualify if between 60 and 90 years old

IF THEY QUALIFY…

You are one of 1,025 individuals who are being asked to participate in this study at the Physical Activity and Health Research Laboratory of the University of Wisconsin-Milwaukee. The study involves the completion of a few surveys that will be mailed to your residence, along with pre-paid postage for you to mail the completed documents back to our Laboratory. The questionnaires inquire on health history, your awareness and utilization of community resources, and current physical activity levels. By completing and returning the documents to UWM, you will be providing your implied consent to participate in this study. However, if you would like a written consent form, we can provide you with that, as well.

Would you like a written informed consent form? ☐ Yes ☐ No

Is there any reason why you cannot complete the study? ☐ Yes ☐ **No**

<u>IF NO, MAIL THEM STUDY PACKET</u>

May I ask for your mailing address? (Cross check with calling list) ☐ **Yes** ☐ No

____

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____

Once we mail you the packet, we will give you a call in about 7 days, just to make sure you received the mailing and to answer any questions you may have. **Thank you greatly for your time!**

Confirm telephone number: ____

Initials and date of person who filled out this form_________________________

Appendix B
Project VOICE Cover Letter

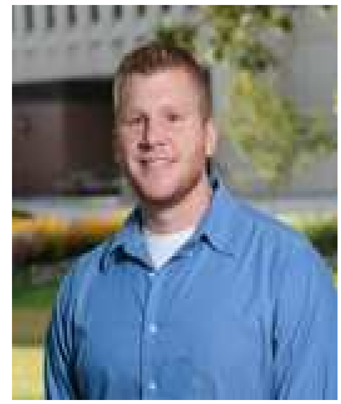
Physical Activity and Health Research Lab

UWM UNIVERSITY of WISCONSIN MILWAUKEE

Department of Human Movement Sciences

Enderis Hall, Rm. 434 · (414) 229-4392

Hello!



Thank you for expressing interest in participating in Project VOICE! The surveys enclosed are part of my doctoral dissertation project examining peoples' awareness and utilization of resources in community senior centers, specifically any exercise/fitness programs or classes. The information collected through this study will help us in making county resources more accessible to all. The following documents are enclosed:

- Health history questionnaire (pages 1 and 2)
- Community resource questionnaire (pages 3 and 4), which is designed to examine the awareness and utilization of community resources
- CHAMPS physical activity survey (pages 5-13)

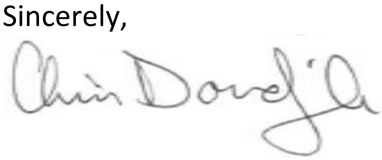
By completing these surveys, you are implying your consent to participate in the study, allowing the information provided to be used in the study. At no point will you be asked to provide your name or any other personal identifying information. All information is kept strictly confidential. There is a stamped and self-addressed envelope provided to return the documents to me.

We need your help and a brief amount of time to make our study a success. Your answers to the items in these surveys are very important to us. This will not take long to complete.

We want to know what you think, so please complete the three questionnaires to the best of your ability, not skipping any questions, keeping in mind there are no right or wrong answers. We may be following up with you soon (seven days after mailing the documents to you) if we have not received them back to make sure you got them safely or to check if you have any questions or concerns.

We **greatly thank you** for your participation and look forward to receiving your responses back in the mail!

Sincerely,



Christopher Dondzila, M.S.
Doctoral Student
Physical Activity and Health Research Laboratory
University of Wisconsin-Milwaukee

Appendix C
Project VOICE Health History Questionnaire

Physical Activity and Health Research Lab

UWM UNIVERSITY of WISCONSIN MILWAUKEE

Department of Human Movement Sciences

Enderis Hall, Rm. 434 · (414) 229-4392

PROJECT ID
- -

HEALTH HISTORY AND

DEMOGRAPHIC QUESTIONNAIRE

Date of Birth: ____________________ **Current Age:** ________

Gender (circle one): M F

Occupation: ____ **Full Time? (circle one):** Yes No

Marital Status (circle one): Single Married Divorced Widowed

Education (circle highest level completed): Elementary High School College Graduate School

Race (circle ethnicity): White American Indian Asian Hispanic

Black / African American Native Hawaiian / Pacific Islander

Household Income Level per year (circle one):

< $5,000 per year $5,000 - $14,999 $15,000 - $24,999

$25,000 - $34,999 $35,000 - $49,999 > $50,000

Do you have a valid driver's license? (circle one): Yes No

Do you own a car? (circle one): Yes No

Are you taking any prescription or over-the counter medication? (circle one) YES NO

If YES, please indicate the names, reasons, and how long you have been taking the medication below.

Name of Medication	Reason for Taking	For How Long?

PLEASE TURN OVER

YOUR PAST HEALTH HISTORY

Circle any of the following medical conditions you have either been diagnosed with or have experienced and indicate how long you have experienced the condition in the lines provided.

Stroke ________________ Recurring leg pain (not related to arthritis) ____________

Blood Clots ________________ Ankle swelling (not related to twisting) ____________

Cancer ________________ Any heart problems ____________

Liver or Kidney Disease ________ High blood pressure ____________

Diabetes ________________ Low back or joint problems ____________

Arthritis ________________ Any breathing or lung problems ____________

YOUR PRESENT HEALTH (SIGNS & SYMPTOMS)

Circle any of the following signs and symptoms you are currently experiencing (within the last year).

Chest pain / discomfort	Cough on exertion	Shortness of breath
Coughing of blood	Heart palpitations	Dizzy spells
Skipped heart beats	Frequent headaches	Heart Attack
Orthopedic / joint problems	Diabetes	Back Pain

Any other chronic conditions/diseases:____

Have you been hospitalized in the last year? (circle one) Yes No

If YES, how many days were you in hospital? ________

Do you have any limitations to physical activity or any other functional limitations? (circle one) Yes No

If YES, what limitations are these?____

____

Appendix D
Project VOICE Community Resource Questionnaire

Physical Activity and Health Research Lab

UNIVERSITY of WISCONSIN MILWAUKEE

Department of Human Movement Sciences

Enderis Hall, Rm. 434 · (414) 229-4392

PROJECT ID

\- -

Community Resource Questionnaire

1. Are you aware of any community-based senior centers within 5 miles of your current residence? (Check yes or no)

☐ Yes ☐ No

1.a. Do you currently attend this senior center? (Check yes or no)

☐ Yes ☐ No

1.a.i. If yes - in a typical week (throughout the course of the year) - how many times do you attend the senior center?

(Circle one number)

0 1 2 3 4 5

1.a.ii. If you attend the senior center, how do you get there?

(Check all that apply)

☐ Drive yourself ☐ Walk ☐ Bike

☐ Get picked up ☐ Other ....

2. Are you aware of any exercise/fitness programs or classes at the senior center? (Check yes or no)

☐ Yes ☐ No

2.a. Do you currently attend or participate in any exercise/fitness programs or classes at the senior center? (Check yes or no)

☐ Yes ☐ No

2.b. If yes, which do you attend or participate in at the senior center? (Check all that apply)

☐ Activity class ☐ Fitness center ☐ Physical Therapy

2.c. If you attend or participate in any exercise/fitness programs or Classes at the senior center - in a typical week (throughout the course of the year) - how many times do you participate in these programs? (Circle one number)

0 1 2 3 4 5

3. Do you attend or participate in any exercise/fitness programs or classes in your neighborhood outside of the senior center? (Check yes or no)

☐ Yes ☐ No

4. What are some of the barriers that prevent you from attending the **senior center** more often/if at all? (Check all that apply)

☐ Knowledge of activities/services ☐ Lack of time

☐ Transportation ☐ Work/other commitments

☐ Health ☐ Lack of interest

☐ Distance

☐ Other:..

....

....

5. What are some of the barriers that prevent you from attending and participating in any **exercise/fitness programs or classes** in the senior center more often/if at all? (Check all that apply)

☐ Knowledge of activities/services ☐ Lack of time

☐ Transportation ☐ Work/other commitments

- ☐ Health
- ☐ Lack of interest
- ☐ Distance
- ☐ Other: ....

....

Appendix E
CHAMPS Physical Activity Questionnaire

This questionnaire is about activities that you may have done in the past 4 weeks. The questions on the following pages are similar to the example shown below.

INSTRUCTIONS

If you DID the activity in the past 4 weeks:

Step #1 Check the YES box.

Step #2 Think about how many TIMES a week you usually did it, and write your response in the space provided.

Step #3 Circle how many TOTAL HOURS in a typical week you did the activity.

Here is an example of how Mrs. Jones would answer question #1: Mrs. Jones usually visits her friends Maria and Olga twice a week. She usually spends one hour on Monday with Maria and two hours on Wednesday with Olga. Therefore, the total hours a week that she visits with friends is 3 hours a week.

In a typical week during the past 4 weeks, did you…							
1. Visit with friends or family (other than those you live with)? ☒ **YES** How many TIMES a week? 2 ➔ ☐ **NO**	How many TOTAL hours a week did you usually do it? ➔	Less than 1 hour	1-2½ hours	(3-4½ hours)	5-6½ hours	7-8½ hours	9 or more hours

If you DID NOT do the activity:

- **Check the NO box and move to the next question**

In a typical week during the past 4 weeks, did you …							
1. Visit with friends or family (other than those you live with)? ☐ **YES** How many TIMES a week?______ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
2. Go to the senior center? ☐ **YES** How many TIMES a week?______ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
3. Do volunteer work? ☐ **YES** How many TIMES a week?______ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
4. Attend church or take part in church activities? ☐ **YES** How many TIMES a week?______ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
5. Attend other club or group meetings? ☐ **YES** How many TIMES a week?______ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
6. Use a computer? ☐ **YES** How many TIMES a week?______ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours

In a typical week during the past 4 weeks, did you …							
7. Dance (such as square, folk, line, ballroom) (do <u>not</u> count aerobic dance here)? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
8. Do woodworking, needlework, drawing, or other arts or crafts? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
9. Play golf, carrying or pulling your equipment (count <u>walking time</u> only)? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
10. Play golf, riding a cart (count <u>walking time</u> only)? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
11. Attend a concert, movie, lecture, or sport event? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours

In a typical week during the past 4 weeks, did you …							
12. Play cards, bingo, or board games with other people? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
13. Shoot pool or billiards? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
14. Play singles tennis (do <u>not</u> count doubles)? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
15. Play doubles tennis (do <u>not</u> count singles)? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
16. Skate (ice, roller, in-line)? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
17. Play a musical instrument? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours

In a typical week during the past 4 weeks, did you …							
18. Read? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
19. Do heavy work around the house (such as washing windows, cleaning gutters)? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
20. Do light work around the house (such as sweeping or vacuuming)? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
21. Do heavy gardening (such as spading, raking)? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
22. Do light gardening (such as watering plants)? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours

In a typical week during the past 4 weeks, did you …							
23. Work on your car, truck, lawn mower, or other machinery? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL hours a week did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
****Please note: For the following questions about running and walking, include use of a treadmill.**							
24. Jog or run? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL hours a week did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
25. Walk uphill or hike uphill (count only uphill part)? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL hours a week did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
26. Walk fast or briskly for exercise (do not count walking leisurely or uphill)? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL hours a week did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
27. Walk to do errands (such as to/from a store or to take children to school (count walk time only)? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL hours a week did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours

In a typical week during the past 4 weeks, did you …							
28. Walk <u>leisurely</u> for exercise or pleasure? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
29. Ride a bicycle or stationary cycle? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
30. Do other aerobic machines such as rowing, or step machines (do <u>not</u> count treadmill or stationary cycle)? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
31. Do water exercises (do <u>not</u> count other swimming)? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
32. Swim moderately or fast? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
33. Swim gently? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL <u>hours a week</u> did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours

In a typical week during the past 4 weeks, did you ...							
34. Do stretching or flexibility exercises (do not count yoga or Tai-chi)? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL hours a week did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
35. Do yoga or Tai-chi? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL hours a week did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
36. Do aerobics or aerobic dancing? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL hours a week did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
37. Do moderate to heavy strength training (such as hand-held weights of more than 5 lbs., weight machines, or push-ups)? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL hours a week did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
38. Do light strength training (such as hand-held weights of 5 lbs. or less or elastic bands)? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL hours a week did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours

In a typical week during the past 4 weeks, did you …							
39. Do general conditioning exercises, such as light calisthenics or chair exercises (do not count strength training)? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL hours a week did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
40. Play basketball, soccer, or racquetball (do not count time on sidelines)? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL hours a week did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours
41. Do other types of physical activity not previously mentioned (please specify)? ☐ **YES** How many TIMES a week?_____ ➔ ☐ **NO**	How many TOTAL hours a week did you usually do it? ➔	Less than 1 hour	1-2½ hours	3-4½ hours	5-6½ hours	7-8½ hours	9 or more hours

Thank You

Appendix E
Project VOICE Informed Consent

NIVERSITY OF WISCONSIN – MILWAUKEE
CONSENT TO PARTICIPATE IN RESEARCH

1. GENERAL INFORMATION

Study title: Assessing Awareness and Utilization of Fitness Centers in Community-Dwelling Older Adults (Project VOICE).

Persons in Charge of Study:

Scott J. Strath, Ph.D.
Associate Professor
Department of Human Movement Sciences
University of Wisconsin – Milwaukee

Christopher J. Dondzila, M.S.
Doctoral Student
Department of Human Movement Sciences
University of Wisconsin – Milwaukee

2. STUDY DESCRIPTION

Study description:
The purpose of this research study is to examine the amount of older adults who are aware of, and additionally utilize exercise/fitness programs or classes at local senior centers located in the community. You will be one of 1025 individuals participating in a research study. Our research team at the Physical Activity and Health Research Laboratory will mail to you three questionnaires to complete. We request you to then mail the completed questionnaires back to us in a provided self-addressed stamped envelope. Participation in the research study is completely voluntary and you do not have to participate if you do not want to.

3. STUDY PROCEDURES

What will I be asked to do if I participate in the study?
This research study will consist of three questionnaires mailed to your household. Each of these documents are to be mailed back to the Physical Activity and Health Research Laboratory at the University of Wisconsin-Milwaukee via provided envelopes with pre-paid mail postage.

<u>Questionnaires and Surveys</u>
You will be mailed three documents to complete and return to the Physical Activity and Health Research Laboratory.

Health History Questionnaire
This questionnaire will inquire on basic demographic information, personal and family health history, and medications being taken.

Community Resource Questionnaire
This survey will inquire on your awareness and utilization of community resources available in local senior centers, in addition to any barriers preventing you from engaging in any of the designated activities.

CHAMPS Physical Activity Questionnaire
This questionnaire will inquire on the duration of a variety of activity and social behaviors from the previous four weeks.

4. RISKS & MINIMIZING RISKS

What risks will I face by participating in this study?
You will face very minimal risks by participating in this research study.

The information collected in this study is kept strictly confidential. Only the people directly involved in this study will have access to the information. Your name will be associated with an identification number that will not allow your information to be traced back to this research study. We may decide to present what we find to others, or publish our results in scientific journals or at scientific conferences. If this happens, your name will never be associated with any of the data collected, and your identity will always remain strictly confidential. All research data is stored electronically on a password-protected computer as well as in hard copy in a locked cabinet.

As with any research study, there may be additional risks of participating that are unforeseeable or hard to predict.

5. BENEFITS

Will I receive any benefit from my participation in this study?
There are no direct benefits associated with participation, other than providing input in order to make community resources more accessible to all.

Are subjects paid or given anything for being in the study?
No, there is no compensation for participating in this study.

6. STUDY COSTS

Will I be charged anything for participating in this study?

You will not be responsible for any of the cost associated with participating in this research study.

7. CONFIDENTIALITY

What happens to the information collected?
All information collected about you during the course of this study will be kept confidential to the extent permitted by law. We may decide to present what we find to others, or publish our results in scientific journals or at scientific conferences. Information that identifies you personally will not be released without your written permission. Only people directly involved in this research study will have access to the information. However, the Institutional Review Board at UW-Milwaukee or appropriate federal agencies like the Office for Human Research Protections may review your records.

8. ALTERNATIVES

Are there alternatives to participating in the study?
There are no known alternatives available to you other than not taking part in this study.

9. VOLUNTARY PARTICIPATION & WITHDRAWAL

What happens if I decide not to be in this study?
Your participation in this study is entirely voluntary. You may choose not to take part in this study, or if you decide to take part, you can change your mind later and withdraw from the study. You are free to not answer any questions or withdraw at any time. Your decision will not change any present or future relationships with the University of Wisconsin Milwaukee. The investigator may stop your participation in this study if he/she feels it is necessary to do so.

10. QUESTIONS

Who do I contact for questions about this study?
For more information about the study or the study procedures or treatments, or to withdraw from the study, contact:

Scott J. Strath, Ph.D.
Associate Professor
Department of Human Movement Sciences
University of Wisconsin – Milwaukee
P.O. Box 413, Milwaukee, WI 53201
Telephone Number: (414) 229-3666

Who do I contact for questions about my rights or complaints towards my treatment as a research subject?

The Institutional Review Board may ask your name, but all complaints are kept in confidence.

Institutional Review Board
Human Research Protection Program
Department of University Safety and Assurances
University of Wisconsin – Milwaukee
P.O. Box 413
Milwaukee, WI 53201
(414) 229-3173

11. CONSENT TO PARTICIPATE

Research Subject's Consent to Participate in Research:
By completing and submitting the attached surveys, you are voluntarily agreeing to take part in this study. Completion and submission of the surveys indicates that you have read this entire consent form and have had all of your questions answered, and that you are 18 years of age or older.

Appendix F
Project PACE Data Collection Form

physical activity and health research lab
UWM
Department of Kinesiology
Enderis Hall, Rm. 434 • (414)229-4392

Milwaukee County Fall Risk Assessment

Name____
Address____
____
Telephone #________________________
Age_____________ Gender: M F Ethnicity________

Previous year's falls_______________________
Height (cm)___________________________________
Weight (lbs)__________________________________
CSRT (ms)____________________________________
BIA (%)___________________________________
Waist (cm) 1._______ 2. ________ 3. (if necessary) _______ =_______
Hip(cm) 1. _______ 2. ________ 3. (if necessary) _______ =________
W:H_____________________________________
RAPA: Meet PA recommendations? ☐Yes ☐No
Meet flexibility recommendations? ☐Yes ☐No
Meet strength training recommendations? ☐Yes ☐No

Will you allow the above information to be used for research purposes?
☐Yes ☐No

ID#____________ Pedometer # issued_________________________
Knee extension strength (kg) R:_________ _____ _____________
L:_____________ _____________
Knee flexion strength(kg) R:_________ _____ _____________
L:_____________ _____________
Hand grip strength (lbs) R:_________ _____ _____________
L:_____________ _____________
8 ft up and go test (sec) ________ _________ _________

Are you interested in learning more about available programs in Milwaukee County Senior Centers?
☐Yes ☐No

Appendix G
Project PACE Results Form

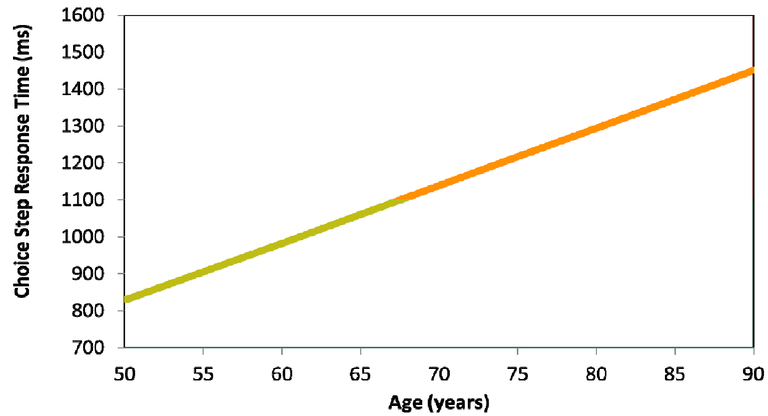
Screening Information

- ID: ______________
- Age: ____________yrs
- Height: __________cm
- Weight: __________lbs

Fall Risk Assessment

Choice Step Response Time: ___________________

How many times did you fall last year?__________



Prior Exercise

Do You Get Enough Physical Activity ?

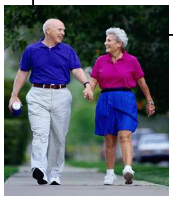
Yes □ Congratulations! You are living a healthy lifestyle!

No □ Continue working on increasing your Physical Activity, as it is shown to have significant health benefits.

Do You Engage in Strengthening / Flexibility Exercises ?

Yes □ Congratulations! You are living a healthy lifestyle!

No □ Continue working on increasing your strength and flexibility, as it is shown to have significant health benefits.



Thank You for Taking Park in this Screening.
Be sure to learn more about programs free to you to help.

No information given to you today represents any form of a medical diagnosis.

Appendix H
Project PACE Recruitment Flyer

Free Fall Risk Screening!

UWM

Individuals are invited to participate in fall risk screenings.

- Learn if you are at risk for experiencing a fall in the future.
- Receive information about **available programs** to **improve your health** and **decrease fall risk** as part of a research study!
- Additional health measures will be available to help you learn how to be healthy and happy!

For more information, please call the Physical Activity and Health Research Lab (PHARL) at (414-229-5121) and ask for Chris or Kim

This study has been approved by the Institutional Review Board for the Protection of Human Subjects for the period of xx/xx/xx-x/xx/xx. (Protocol # xx.xx.xxx)

UWM PHARL Laboratory
Call CHRIS or KIM
414-229-5121

UWM PHARL Laboratory
Call CHRIS or KIM
414-229-5121

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Call CHRIS or KIM
414-229-5121

UWM PHARL Laboratory
Call CHRIS or KIM
414-229-5121

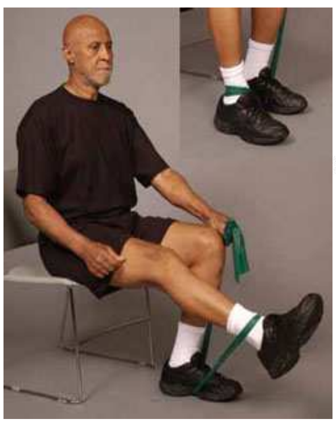
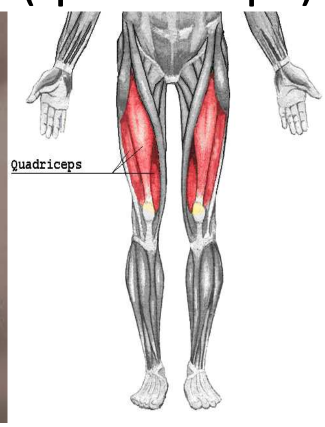
Appendix I
Project PACE Resistance Training Program

Resistance Training with Therabands

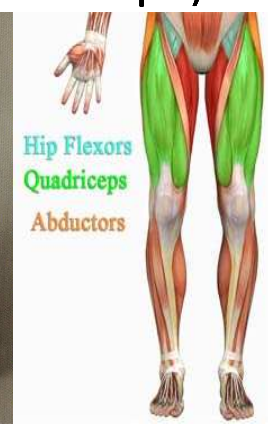
- Perform the following exercises two days/week, but not on consecutive days.
- The final repetition should result in fatigue.
- Remember, record your exercises in the logs, along with your steps.

Sessions during weeks 1 and 2: 1 set, 10 repetitions (______-______)
Sessions during weeks 3, 4, and 5: 1 set, 15 repetitions (______-______)
Sessions during weeks 6, 7, and 8: 2 sets, 15 repetitions (______-______)

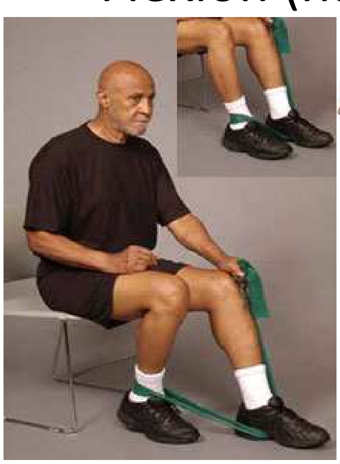
- Seated Knee Extension (quadriceps)

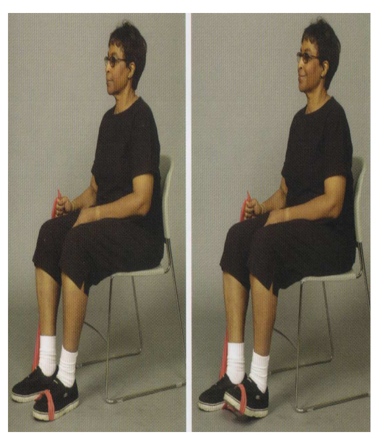
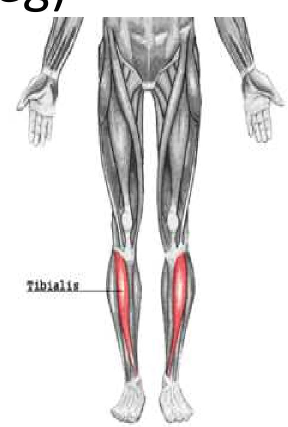
- Seated Hip Lift (Hip muscles, quadriceps)

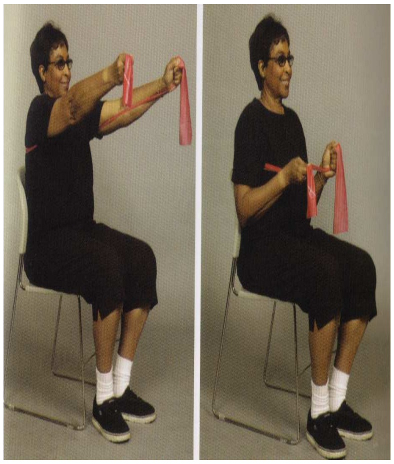
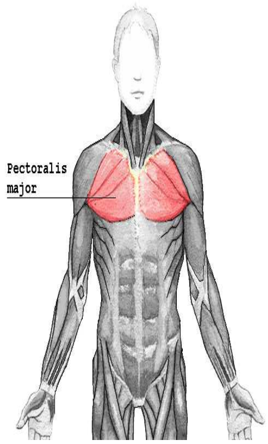
- Seated Knee Flexion (hamstrings)



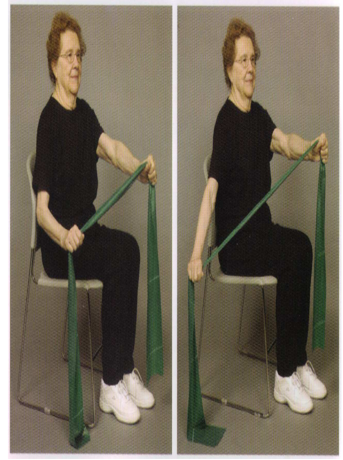
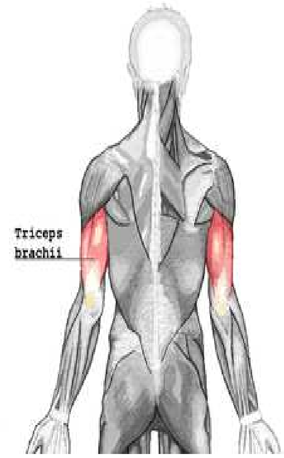

- Seated Foot Raise (Foot and lower leg)

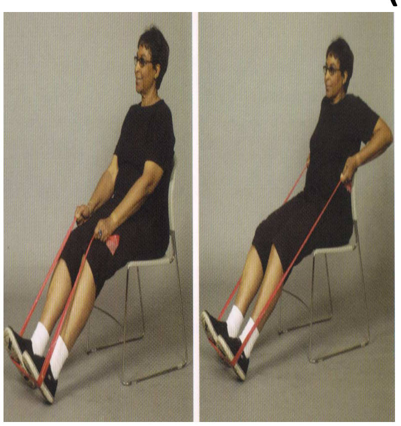
- Chest press (chest, shoulder, triceps)

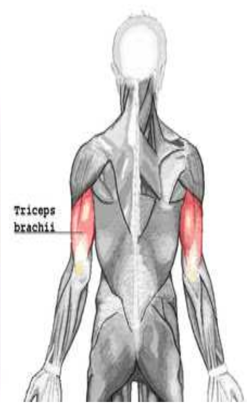
- Elbow extension (triceps)

- Seated row (back, biceps)




- Arm curl (biceps)

Appendix J
Project PACE Mailed Education Brochures

Physical Activity and Health Research Laboratory
Department of Kinesiology

UNIVERSITY of WISCONSIN MILWAUKEE

INCREASING AWARENESS AND CONFIDENCE TO BECOME MORE PHYSICALLY ACTIVE

The purpose of this guide is to help you make activity a more regular part of your life. This guide will help you find the most fun and healthy ways to be more regularly active and assist you in increasing your confidence to be regularly physically active.

Recommendations for Physical Activity

To increase the health benefits gained from physical activity, health organization's recommend that adults accumulate **a minimum of 30 minutes of <u>moderate-intensity physical activity</u> on most, preferably all, days of the week.**

How do you fit into this recommendation?

- Thirty minutes may seem like a lot of time, but remember that you can add up little bouts of activity throughout the day (i.e. 3 x 10 minute bouts = 30 minutes).
- What does "moderate-intensity physical activity" mean?
  - Requires some effort. You will feel your heart beat a little faster and might sweat a little toward the end of the activity, but you can still carry on a conversation while doing the activity. .
  - Examples include:

Bicycling	Hiking
Brisk Walking	Playing actively with children
Dancing	Raking leaves
Gardening and yard work	Vacuuming a carpet
Golf (without a cart)	Washing and waxing a car

    - You are already doing some activity each week. How can you add to what you are already doing to reach the recommended guidelines?
  - Turn LIGHT activities into MODERATE whenever possible:
    - Try to get a little faster when taking your daily walk(s).
    - Be more animated when doing housework such as vacuuming…try playing fast music!
    - When shopping, take one "lap" around the mall quickly, looking in the windows of stores to see where you want to go.
  - Choose some days where you complete your activity all at once (30 minute exercise class or walk, for example). Choose other days where you add up several 10 minute bouts of activity throughout the day.

- Try to identify some times during the week where you feel confident you could increase your activity level, even if by a little bit.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Here are some thoughts to help you think about how you might be able to be more active…

- You are already doing some activity each week. How can you add to what you are already doing to reach the recommended guidelines?
    - Turn LIGHT activities into MODERATE whenever possible:
        - Try to get a little faster when taking your daily walk(s).
        - Be more animated when doing housework such as vacuuming…try playing fast music!
        - When shopping, take one "lap" around the mall quickly, looking in the windows of stores to see where you want to go.
    - Choose some days where you complete your activity all at once (30 minute exercise class or walk, for example). Choose other days where you add up several 10 minute bouts of activity throughout the day.

SETTING GOALS

The purpose of this guide is to help you think about why you want to become more active. Every person is unique and has different things that motivate them. Below are some examples of goals that are common to other people.

- An important step to becoming more active is setting goals.
  - Some goals relate to something you want to achieve, such as…
    - Losing weight
    - Gaining muscle
    - Improve balance
    - Improving health and decreasing disease risk
  - Other goals can relate to what activities you want to continue to do, or improve your ability to perform, such as…
    - Not feeling tired when playing with grandchildren or when walking the dog.
    - Maintain independence and being able to walk to the grocery story by yourself.
    - Do activities you once did in the years past.

Try to identify what your goals are, both in the short term and long term, are write them down. This will help you stay motivated and remind you of your efforts to physically active.

Short Term Goals
• • •

Long Term Goals
• • •
•

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Physical Activity and Health Research Laboratory
Department of Kinesiology

Benefits of Becoming More Physically Active

The previous guides helped you improve your confidence to become more active, and how setting goals can help you accomplish those goals. The purpose of this sheet is to help you become familiar with the beneficial outcomes of engaging in physical activity. If you need a reminder of what exactly is physical activity, refer back to the first

It's GREAT for your body

- Assists in maintaining a healthy weight
- Helps raise "good" cholesterol
- Can help control blood pressure
- Helps prevent osteoporosis
- Helps treat and prevent type 2 diabetes
- Helps prevent heart disease

It's good for your MIND!

- can help increase your confidence and self esteem
- can help to decrease or manage stress
- has been shown to decrease sadness

Physical activity has a lot of other benefits outside of improving your body and mind.

- Being active is an opportunity to gather and do activities while socializing and reminiscing with friends and family
- Gives you a chance to do some activities that you once did during your younger years

Take a few moments to write down what benefits you are most interested in. Writing these anticipated outcomes can be an effective way to help you stay motivated and active!

-
-
-
-

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Department of Kinesiology

Benefits of Resistance and Weight Training

The previous guide presented benefits and outcomes that can be achieved through becoming more physically active. The purpose of this guide is to explain what resistance training is and what the benefits of such activities are

Resistance training, also called weight training, is when you use weights, bands, or body weight to perform exercises that improve the strength and endurance of your muscles.

Recommendations for Resistance Training

It is recommended that we perform resistance training exercises on two days per week, not on two days in a row, though. The exercises should include working muscles in both the lower and upper body, and

Benefits of Resistance Training

- Improve muscle strength and endurance
- Improve balance
- Reduce the reliance on devices that assist in walking
- Improve your overall physical functioning. This means that you have more ability to do the activities that you like to do for fun, but also care for yourself and perform chores around the house
- Reduce the risk of falling
- Help to control body weight

Tips

- You do not need to be young and strong to receive benefits from resistance training.
- When exercises are performed with proper form, the risk of injury is very minimal.
- After you become comfortable with some exercise, you can slowly increase the amount of exercises you do to receive more benefit.

Overcoming Barriers to Physical Activity

You may have noticed times when it seemed impossible to meet your daily goals. Perhaps last week was easy, but you doubt your ability to maintain that same level of physical activity every week. The purpose of this form is to help you identify and plan to overcome obstacles on your way to being physically active!

Below is a list of common obstacles other people list for why they aren't regularly active, followed by suggestions for how to overcome each obstacle.

OBSTACLES:	STRATEGIES:
It's hard to remember to exercise or do physical activity	Write yourself notes and place them around your home or car. Leave your sneakers or exercise equipment in an obvious place to remind you to use them!
I am very tired	Remember that physical activity often makes you feel energized…most people feel a "second wind" after exercise or activity!
The weather is bad	Always have a back-up plan. If you like to walk, join a mall walking club in the winter. If you like to bicycle, ride an exercise bike when it is cold, rainy, or windy. Have a list of indoor activities you can do when the weather is bad.
I hurt myself last time I was active	Start slowly and listen to your body. Stretch before and after activity.
I am in a bad mood	Physical activity can improve your mood. It helps relieve stress and sadness. If you're not up to doing your usual activities, try to do something instead of nothing!
I am on vacation	There are still many ways to be active while on vacation. Use hotel pools and fitness facilities. Walking in a new city or park is a perfect way to see the sites and get your day's activity!

Take some time to think about the obstacles that are most likely to get in your way. Then try to find a way to deal with them, while still remaining active. It may help to review the strategies listed on the other side of this page (positive programming, enlist social support, reward yourself, and commit yourself).

OBSTACLE:

Solution:

OBSTACLE:

Solution:

OBSTACLE:

Solution:

If you had trouble thinking of obstacles that could arise, keep a journal over the next two weeks. Record a daily goal for physical activity and whether or not you achieved that goal. If you did, what worked? If you did not, what seemed to get in your way. Follow up each entry with a summary of how you will repeat or change your physical activity thoughts and behavior for next time.

Role Models:

Another useful tactic for staying motivated is to pick a role model. Maybe there is a friend or family member who is regularly physically active. Talk to that person and ask them what works…and doesn't work…for them.

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Physical Activity and Health Research Laboratory

Department of Kinesiology

Ways to Become More Active

The previous guide helped you identify various barriers that can arise that make sticking to your activity goals harder. On the other hand, the purpose of this guide is to help you identify ways that make being active more feasible and more FUN!

Being active and exercising doesn't have to be a chore. Try to mix some things that you like doing with your activity goals…If you enjoy socializing with friends, get involved in group activities

Now that you have hopefully found a few activities that you enjoy doing, we would like to point out some tips to help you begin to increase your activity level in the most healthy and maintainable way.

Stretch before and after activity.

Gentle stretching will help you limber up before activities, and prevent soreness or injuries.

- Hold each stretch for 15-20 seconds
- Do not bounce while stretching
- Slowly apply pressure until you feel a gentle stretch
- Exhale as you apply pressure, then breath in and out deeply (don't hold your breath!)
- Focus on the muscles that you will be using, such as
    - Back of your legs (hamstrings)
    - Front of your legs (quadriceps)
    - Calves
    - Shoulders
    - Neck and upper back
    - Lower back

Begin your activity session slowly.

Allow your body to warm-up during the first 2-5 minutes of your activity. After you feel warm and loose, go ahead and pick up the pace for a while (Only if you want to, you don't have to). You should always gradually slow down your pace as you finish your activity session. This will allow your body to gently return to normal.

If you decide to take a 10 minute walk before work, another one around lunch time, and one more at the end of the day, you won't need to "warm up" or "cool down". You can easily fit these walks into your day!

Making Physical Activity an Experience that is as Unique as You are!

As you get ready to be more active, it will be easy to plan for your activity using the "four W's". To complete your plan, write in a response to each "W" for the physical activity plans below. Put them together and use them as your blueprint for activity.

What activity would you be most willing to try?

When could you find 10 minutes for this activity?

Where do you plan to do the activity?

Who do you want to share the activity with?

What activity would you be most willing to try?

When could you find 10 minutes for this activity?

Where do you plan to do the activity?

Who do you want to share the activity with?

What activity would you be most willing to try?

When could you find 10 minutes for this activity?

Where do you plan to do the activity?

Who do you want to share the activity with?

What activity would you be most willing to try?

When could you find 10 minutes for this activity?

Where do you plan to do the activity?

Who do you want to share the activity with?

Now you have 4 sets of instructions for activities. Try to use them in different combinations each day to add up to 30 minutes total. So, if you decide to walk for 10 minutes and garden for 15, then take another 5-10 minute walk, that would equal one days "activity plan". Good luck and remember to HAVE FUN!

Physical Activity and Health Research Laboratory
Department of Kinesiology

Staying Active Across Time

You are meeting the physical activity guidelines of 30 minutes of moderate intensity physical activity for at least 5 days a week. Once you have been doing that for 6 months or more, you have really started to make physical activity a life long habit. Congratulations!

This last page is designed to help you keep physical activity a permanent part of your life.

Stay Healthy!

- Wear proper clothing for the weather. Avoid extreme hot or cold, and exercise indoors when the weather is bad.
- Keep your equipment in working condition. When used frequently, sneakers need to be replaced once they start to wear out. If your joints are aching all of a sudden when you walk, see a doctor, but you might want to try a new pair of shoes!
- Drink plenty of fluids when you are active.
- Stretch before and after activity.

Stay on Track

- Vary your activity to keep things fun and exciting.
- Set goals and follow your progress.
- Reward yourself…Exercise can become its own reward too!
- Keep friends and family involved, maybe mentor someone and become their physical activity role model.
- Keep an activity log. Record your progress and how you feel about activities. Seeing your progress and accomplishment can feel great!.

Think positively and problem solve when..

- The weather is bad.
- You hurt yourself or get sick.
- You're in a bad mood or stressed.
- It's a holiday or you're on vacation.

It can help to…

- Choose a role model…and become one for someone else too!
- Not get discouraged. You may occasionally miss a planned activity, just try to get back to your plan as soon as possible!
- Plan ahead to stay active. Try to keep at least a week ahead of your schedule, and plan when, where, what, and how you will do your activities!

Avoiding Pitfalls

Often, the potholes on the way to success are easy to anticipate. As long as you prepare for these situations, you can have a plan to avoid or work through them. Below is an activity to help you identify situations that may throw you off course. Identify specific times where these things could occur and how you will adapt to prevent a lapse in your regular physical activity, or how you will get back on track should you be prevented from activity for a bit.

Emotional Upsets: A bad mood can hinder your motivation for activity.

When might this occur:

Can you avoid it, if so, how?

What will you do to work through it?

Good Samaritan: Helping a friend in need can take time away from activity

When might this occur:

Can you avoid it, if so, how?

What will you do to work through it?

On the Mend: Getting sick or injured requires rest. Once well, how will you get back on track?

When might this occur:

Can you avoid it, if so, how?

What will you do to work through it?

Holiday Madness: There is a lot going on and it is a special time. What will happen to your activity plan?

When might this occur:

Can you avoid it, if so, how?

What will you do to work through it?

Appendix K
Project PACE Informed Consent

UNIVERSITY OF WISCONSIN – MILWAUKEE
CONSENT TO PARTICIPATE IN RESEARCH

1. GENERAL INFORMATION

Study title: Promoting Activity in Community Elderly (Project PACE).

Persons in Charge of Study:

Scott J. Strath, Ph.D.
Associate Professor
Department of Kinesiology
University of Wisconsin – Milwaukee

Christopher J. Dondzila, M.S.
Doctoral Student
Department of Kinesiology
University of Wisconsin – Milwaukee

2. STUDY DESCRIPTION

Study description:
The purpose of this study is to examine whether an in-home, individually tailored intervention is efficacious in promoting meaningful increases in physical activity and improvements in physical functioning in low-active older adults. You will be one of 200 individuals participating in a research study. Those who qualify for the study will be randomized to one of two study groups for an 8 week home-based intervention. Participation in the research study is completely voluntary and you do not have to participate if you do not want to.

3. STUDY PROCEDURES

What will I be asked to do if I participate in the study?
This research study will consist of collecting baseline measures of body measurements and others that describe physical abilities, a 4 day pedometer monitoring period, randomization into one of two study arms (an enhanced physical activity group or a standard of care group) , and participation in an 8 week unsupervised intervention.

<u>**Baseline Data Collection**</u>
Demographic Questionnaire
Participants will be asked to complete a questionnaire, inquiring on name, age, mailing address, telephone number, gender, ethnicity, and the number of falls experienced in the past year.

Rapid Assessment of Physical Activity (RAPA) Questionnaire
This questionnaire involves answering "yes" or "no" to nine questions inquiring on a person's current physical activity level, assessing one's activity level and adherence to physical activity guidelines.

Do you consent to allow screening information collected minutes prior in the senior center to be utilized in the current study?

□ Yes □ No

Body Measurements

Height and weight measurements will be assessed via a calibrated balance beam scale and stadiometer. Shoes will be removed for both measurements. Waist and hip circumference will be measured using a flexible, tension gauge measuring tape, with the waist circumference being taken at the narrowest portion of the waist (above the navel) and the hip circumference being taken at the widest portion of the hips (above the gluteal fold). Both measurements will be taken twice, and a waist/hip ratio will be calculated. Additionally, body fat percentage will be calculated via bioelectrical impedence analysis. This process involves gripping a small handheld device in front of the body at shoulder height, resulting in the estimation of current body fat percentage.

Do you consent to allow height and weight information collected minutes prior in the senior center to be utilized in the current study?

□ Yes □ No

Choice Step Reaction Time

The test involves standing on two stationary force plates positioned on the ground, mounted in an overhead bracing system. A harness is suspended from the bracing system, attached to a harness that is outfitted around the participants' waist to keep the participant elevated (should they lose their footing). In front of the participant, a computer screen will illuminate one of the four corners of the force plates, prompting the right or left leg to touch the respective corner. Ten practice trials with feedback will be conducted to ensure proper execution of the tasks, followed by 20 test trials.

Do you consent to allow screening information collected minutes prior in the senior center to be utilized in the current study?

□ Yes □ No

Knee Flexion/Extension Strength

Participants will sit on a table with a seat belt attached to a hand held dynamometer to assess muscle strength on the front of the lower shin. They will be asked to extend the lower leg with maximal force for two-2 second trials, separated by 15 seconds. The participant will then have the dynamometer place on the back of the lower leg, just above the heel. They will be asked to flex the lower leg with maximal force for two-2 second trials, separated by 15 seconds.

Hand Grip Strength

This test involves griping a hand held dynamometer with one hand while standing at the waist level. Two trials of maximal grip strength will be performed for 2 seconds each trial, separated by a 15 second rest period. This will be done with both hands.

8 Feet-Up-and-Go Test

This test begins with the participant seated in a chair that is stable on the floor, against a wall. Upon the beginning of the test, the participant will be asked to rise out of the chair, walk to a cone 8 feet away from the chair, and return to the chair and seat themselves in as fast and safely as possible.

Pedometer Monitoring Period

A pedometer will be issued to quantify daily steps, in addition a log to record the amount of wear time and steps taken each day. Participants will be asked to wear and record pedometer steps for 4 consecutive days following baseline data collection. There will be a marked box to place pedometers and logs in the front lobby areas of senior centers. The logs will be collected to determine who qualifies for the study (≤6,000 steps/day), and eligible participants will be contacted via telephone to return to a senior center for orientation and randomization to a study group. Based on their activity level, not all participants will be eligible to participate in this study.

Study Groups

Enhanced Physical Activity Group

The enhanced physical activity group will receive individualized step goals, with the intent to increase the amount of steps taken per day to increase 10% per week from the baseline amount. Additionally, this group will receive a resistance band and training program to be completed twice weekly during the intervention period. Participants will attend two orientation sessions to become acclimated to the training program, led by graduate students from the Physical Activity and Health Research Laboratory. The first session will occur on a separtate day from the the baseline measures, after the pedometer screening logs have been collected. Logs will be provided to participants to track their daily steps and resistance band sessions, which will be mailed back to the Physical Activity and Health Research Laboratory at the University of Wisconsin-Milwaukee via provided envelopes with pre-paid mail postage. Participants will be contacted during the 2nd, 3rd, 5th, and 7th weeks via telephone to review educational pamphlets administered at randomization, to inquire if the participant has any questions pertaining to the intervention, and to remind them to mail their pedometer logs back. During the 7th week telephone call, participants will be given days to return to a senior center for post-intervention testing, which consists of the same measures taken at baseline.

Standard of Care Group

The standard of care group will receive a folder with a pedometer and log to record daily steps taken during the 8th week of the intervention. Participants will be given a general goal to accumulate 10,000 steps per day by the end of the 8 week intervention. They will be contacted via telephone during the 7th week of the intervention, instructing them to wear and record their steps during the final (8th) week of the intervention, and will be given days to return to a senior center for post-intervention testing, which consists of the same measures taken at baseline.

4. RISKS & MINIMIZING RISKS

What risks will I face by participating in this study?

You will face very minimal risks by participating in this research study. It is common for individuals who are in the process of increasing their physical activity to experience mild muscle soreness. Such soreness typically subsides within one or two days and should have a detrimental impact on usual activities. During the assessment of choice step reaction time, there is an extremely minimal risk of losing balance when performing the prompted foot placement trials. To protect all participants from falling or stumbling, a protective harness will be outfitted around the waist (attached to the overhead bracing system) to ensure participants maintain their balance and standing, upright position.

The information collected in this study is kept strictly confidential. Only the people directly involved in this study will have access to the information. Your name will be associated with an identification number that will not allow your information to be traced back to this research study. We may decide to present what we find to others, or publish our results in scientific journals or at scientific conferences. If this happens, your name will never be associated with any of the data collected, and your identity will always remain strictly confidential. All research data is stored electronically on a password-protected computer as well as in hard copy in a locked cabinet.

As with any research study, there may be additional risks of participating that are unforeseeable or hard to predict.

5. BENEFITS

Will I receive any benefit from my participation in this study?
Participants will receive information regarding their fall risk (from choice step reaction time results), an estimation of the current physical activity levels, in addition to height, weight, waist-hip ratio, and body composition information. It is plausible that participants in this study will receive benefits regarding their aerobic functioning and muscular strength and endurance.

Are subjects paid or given anything for being in the study?
Participants in this study will be able to keep the pedometer used for the intervention. Additionally, those in the enhanced physical activity group will be able to keep the resistance band used for the home-based exercises.

6. STUDY COSTS

Will I be charged anything for participating in this study?
You will not be responsible for any of the cost associated with participating in this research study.

7. CONFIDENTIALITY

What happens to the information collected?
All information collected about you during the course of this study will be kept confidential to the extent permitted by law. We may decide to present what we find to others, or publish our results in scientific journals or at scientific conferences. Information that identifies you personally will not be released without your written permission. Only people directly involved in this research study will have access to the information. However, the Institutional Review Board at UW-Milwaukee or appropriate federal agencies like the Office for Human Research Protections may review your records.

8. ALTERNATIVES

Are there alternatives to participating in the study?
There are no known alternatives available to you other than not taking part in this study.

9. VOLUNTARY PARTICIPATION & WITHDRAWAL

What happens if I decide not to be in this study?
Your participation in this study is entirely voluntary. You may choose not to take part in this study, or if you decide to take part, you can change your mind later and withdraw from the study. You are free to not answer any questions or withdraw at any time. Your decision will not change any present or future relationships with the University of Wisconsin Milwaukee. The investigator may stop your participation in this study if he feels it is necessary to do so.

10. QUESTIONS

Who do I contact for questions about this study?

For more information about the study or the study procedures or treatments, or to withdraw from the study, contact:

Scott J. Strath, Ph.D.
Associate Professor
Department of Kinesiology
University of Wisconsin – Milwaukee
P.O. Box 413, Milwaukee, WI 53201
Telephone Number: (414) 229-3666

Who do I contact for questions about my rights or complaints towards my treatment as a research subject?

The Institutional Review Board may ask your name, but all complaints are kept in confidence.

Institutional Review Board
Human Research Protection Program
Department of University Safety and Assurances
University of Wisconsin – Milwaukee
P.O. Box 413
Milwaukee, WI 53201
(414) 229-3173

11. SIGNATURES

Research Subject's Consent to Participate in Research:

To voluntarily agree to take part in this study, you must sign on the line below. If you choose to take part in this study, you may withdraw at any time. You are not giving up any of your legal rights by signing this form. Your signature below indicates that you have read or had read to you this entire consent form, including the risks and benefits, and have had all of your questions answered.

____

Printed Name of Subject/ Legally Authorized Representative

____ ___________________

Signature of Subject/Legally Authorized Representative Date

Principal Investigator (or Designee)

I have given this research subject information on the study that is accurate and sufficient for the subject to fully understand the nature, risks and benefits of the study.

____ __________________

Printed Name of Person Obtaining Consent Role on Study

____ __________________

Signature of Person Obtaining Consent Date

Christopher J. Dondzila, Ph.D.

I. CONTACT INFORMATION

II. EDUCATION

Ph.D., University of Wisconsin-Milwaukee
Department of Kinesiology
Primary Area of Emphasis: Exercise Physiology
Advisor: Scott J. Strath, Ph.D.
Anticipated Graduation Date: Summer 2013

M.S., University of Wisconsin-Milwaukee
Department of Kinesiology
Primary Area of Emphasis: Exercise Physiology
Advisor: Scott J. Strath, Ph.D.
2008-2010

B.S., Grand Valley State University
Department of Human Movement Sciences
Primary Area of Emphasis: Clinical Exercise Science
2003-2008

III. HONORS AND AWARDS

- **Helen Bader Applied Gerontology Scholarship Recipient**
  University of Wisconsin-Milwaukee, 2011

- **Chancellor's Award Recipient**
  University of Wisconsin-Milwaukee, 2010

- **Helen Bader Applied Gerontology Scholarship Recipient**
  University of Wisconsin-Milwaukee, 2010

- **State Competitive Scholarship**
  Grand Valley State University, 2007

- **Award of Excellence**
  Grand Valley State University, 2003

IV. CERTIFICATIONS HELD

● American Red Cross CPR certified (2008-Present)

● American Red Cross First Aid certified (2008-Present)

V. PROFESSIONAL AFFILIATIONS

● Midwest American College of Sports Medicine (2012-Present)

● Gerontological Society of America (2012-Present)

● National American College of Sports Medicine (2009-Present)

VI. SERVICE

● Graduate student representative on UWM College of Health Sciences Search and Screen Committee for 2013 faculty hire (exercise physiology)
University of Wisconsin-Milwaukee (2012)

● Graduate student mentor to incoming graduate students
University of Wisconsin-Milwaukee (2010-Present)

● Human Movement Sciences Graduate Student Association, *Vice President*
University of Wisconsin-Milwaukee (2010-2011)

VII. TEACHING EXPERIENCE

INSTRUCTOR

● *KIN 200*: Introduction to Kinesiology
University of Wisconsin-Milwaukee (Fall 2012)

● *KIN 430*: Exercise Testing and Prescription
University of Wisconsin-Milwaukee (Spring 2012, Spring 2013)

INVITED GUEST LECTURES

● *University of Wisconsin-Milwaukee, KIN 799 Physiological Assessment Techniques*, November 7, 2012, “A Comprehensive Analysis of the Physiology and Assessment of Lactate Threshold.”

● *University of Wisconsin-Milwaukee, KIN 351 Sociological Aspects of Health and Human Movement*, October 30, 2012, “Social and Cultural Aspects of Age and Aging in Relationship to Health and Physical Activity.”

● *University of Wisconsin-Milwaukee, Physical Activity and Health Research Laboratory*, March 16, 2011, "Total Body, Lumbar Spine, and Femoral Neck Bone Mineral Density Assessment via Dual Energy X-Ray Absorptiometry."

● *University of Wisconsin-Milwaukee, KIN 430 Exercise Testing and Prescription*, March 3, 2010, "Exercise Prescription and Metabolic Calculations."

● *University of Wisconsin-Milwaukee, KIN 430 Exercise Testing and Prescription*, February 22, 2010,
"Physical Activity Assessment and Exercise Leadership."

● *University of Wisconsin-Milwaukee, KIN 430 Exercise Testing and Prescription*, April 27, 2009,
"Pediatric Exercise Testing and Prescription."

● *University of Wisconsin-Milwaukee, KIN 330 Exercise Physiology*, December 2, 2008, "Limitations to $VO_{2\ max}$."

● *University of Wisconsin-Milwaukee, KIN 200 Introduction to Kinesiology*, November 12, 2008,
"Student Academic Transitions from the Undergraduate to Graduate Level."

GRADUATE TEACHING ASSISTANT

● *KIN 330*: Exercise Physiology Laboratory Sections
University of Wisconsin-Milwaukee (Fall 2008, Fall 2009, Summer 2010)

● *KIN 430*: Exercise Testing and Prescription Laboratory Sections
University of Wisconsin-Milwaukee (Spring 2009, Spring 2010)

UNDERGRADUATE TEACHING ASSISTANT

● *PED 420*: Laboratory Practicum in Exercise Science
Grand Valley State University (Spring 2008)

VIII. <u>RESEARCH EXPERIENCE</u>

RESEARCH ASSISTANT
University of Wisconsin-Milwaukee, (2010-Present)

● Wellness Works Older Adult Fitness Program Manager

○ The Wellness Works Older Adult Fitness Program is aimed at increasing physical activity levels in older adults by implementing a structured exercise environment complete with exercise equipment within 5 local senior centers. Tasks included:

- Establish and maintain contact between physicians to obtain exercise participants' consent to exercise via phone and fax.
- Schedule participants for intake health assessments within fitness centers.
- Tally monthly attendance, including demographics and discerning new versus returning participants, and relay information to the local governing agency, the Milwaukee County Department on Aging.
- Scan health history questionnaires and intake health assessment forms into the program's website via Teleform Scan Programs and enter individual participant's medications.
- Recruit undergraduate students to be employed in the fitness centers and train them on performing health assessments, including heart rate, blood pressure, height, weight, the six minute walk test, and the Short Physical Performance Battery, in addition to equipment maintenance.
- Orientate participants to exercise programs, including proper use of exercise equipment and tracking progress/goal setting.
- Oversee the performance of 20 undergraduate students, 2 undergraduate interns, and 2 Master's students in work-related tasks.
- Investigate longitudinal changes in fitness program use with relation to anthropometric measurements and physical functioning.

● Physical Activity and Health Research Laboratory

○ Subject recruitment and scheduling

○ Data collection, reduction and entry

○ Brief statistical reports for ongoing laboratory funded projects

○ Assist in study protocols for participant laboratory visits

AFFILIATED RESEARCH PROJECTS

University of Wisconsin-Milwaukee (2008-Present)

● Dissertation

○ Home-based intervention to promote physical activity and physical function in low functioning older adults, compared to an education-only control group.

- Recruitment and assess baseline physical activity (via pedometers) and functional screening performed at local senior centers.
- Pre- and post-intervention measurements of physical function, including balance, postural sway, and choice step reaction time from a portable force plate system.
- Provide physical activity goals with logs and bi-weekly telephone contact.
- Provide resistance training band for in-home strength training, with a one week, two session, orientation to the exercises prior to the intervention.

● Project VOICE (Voicing Opportunities in Community Elderly)

○ Lead investigator on a large scale cross sectional analysis of the awareness and utilization of community exercise and fitness resources in older adults, as it relates to physical activity engagement.

● Project PAAS (Physical Activity Assessment Study)

○ A NIH funded study designed to evaluate new computational approaches to morph physiological signals and movement sensors to improve the field monitoring of physical activity behavior.

● Master's Thesis: *The Association Between Physical Activity and Bone Mineral Density in Post-Menopausal Women*.

○ A cross sectional analysis of total body, lumbar spine, and femoral neck bone mineral density via dual-energy x-ray absorptiometry, in relation to the volume and intensity of physical activity engaged in. Physical activity was obtained via a 7-day observation period where participants wore an Actigraph GT3X accelerometer.

● Project NEIGHBORHOOD

○ A cross sectional analysis of the relationships between objective and self-perceived measures of the environment and objective assessments of physical activity in older adults residing in both low- and high-walkability environments.

● Stepcount

○ A 12 week randomized control trial examining the efficacy of a web-mediated physical activity program versus a mail-delivered log for increasing steps taken each progressive week in older adults.

● Treadtrack

○ A cross sectional study examining the accuracy of two uploadable pedometers in quantifying steps taken in treadmill, overground, and free-living conditions.

Grand Valley State University (2007-2008)

● Elementary School Academic Achievement Study

○ A cross sectional study examining the relationships between elementary students' anthropometric values and fitness levels (assessed via FITNESSGRAM test) with their level of academic achievement.

● Step it up! Study

○ Collect pedometer data from elementary school students, leading them in weekly exercise activities.

LABORATORY AND ASSOCIATED SKILLS

● Body composition assessment methodologies, including skin folds, DEXA, BodPod, Bioelectrical Impedance Analysis, and Hydrostatic Weighing
● Physical activity assessment methodologies, including accelerometers and pedometers
● Indirect Calorimetry Measurement utilizing the ParvoMedics Metabolic Measurement System and Cosmed $K4b^2$ Portable Metabolic Measurement System
● Lactate threshold testing
● Training in Phlebotomy

IX. GRANTS AWARDED

● **College of Health Sciences Doctoral Student Research Grant** ($2,000)
University of Wisconsin-Milwaukee, 2012

● **College of Health Sciences Master's Student Research Grant** ($500)
University of Wisconsin-Milwaukee, 2010

X. PUBLICATIONS

PUBLISHED MANUSCRIPTS

Dondzila, C.J., Swartz, A.M., Miller, N.E., Lenz, E.K., and Strath, S.J. (2012). Validity of Uploadable Pedometers in Laboratory, Overground, and Free-Living Conditions in Young and Older Adults. *International Journal of Behavioral Nutrition and Physical Activity*. (Accepted for publication as of September 25, 2012).

Strath, S.J., Greenwald, M.J., Isaacs, R., Hart, T.L., Lenz, E.K., **Dondzila, C.J.** and Swartz, A.M. (2012). Measured and perceived environmental characteristics are related to accelerometer defined physical activity in older adults. *International Journal of Behavioral Nutrition and Physical Activity*, 9,40.

PUBLICATIONS IN REVIEW

Dondzila, C.J., Gennuso, K.P, Swartz, A.M., Tarima, S.S., Gennuso, K.P., Lenz, E.K., Stein, S.S., Kohl, R.J., & Strath, S.J. (2013). Dose-Response Walking Activity and Physical Function in Older Adults. *Journal of Aging and Physical Activity.*

Dondzila, C.J., Swartz, A.M., Azen, R., and Strath, S.J. (2013). Geospatial Relationships between Awareness and Utilization of Community Exercise Resources and Physical Activity Levels in Older Adults. *BMC Public Health.*

PUBLICATIONS IN PREPARATION

Dondzila, C.J., Swartz, A.M., Keenan, K.G., Harley, A.E, Azen, R., & Strath, S.J. (2013). The Efficacy of an In-Home Walking and Resistance Training Program to Increase Physical Activity and Physical Function in Low-Active Older Adults

Dondzila, C.J., Keenan, K.G., Swartz, A.M., Miller, N.E., and Strath, S.J. (2013) Lower Physical Function is Related to Sedentary Behavior in Older Adults.

XI. PRESENTATIONS

INVITED PRESENTATION

Dondzila, C.J., Swartz, A.M., Miller, N.E., Keenan, K.G., Finco, K.L., Hawkins, J.M. Jr & Strath, S.J. Markers of Sedentary Behavior and Physical Function in Older Adults. Thematic Poster Presentation, National Conference for the American College of Sports Medicine, San Francisco, CA, May 2012.

POSTER PRESENTATIONS

Miller, N.E., Swartz, A.M., Cashin, S.E., **Dondzila, C.J.**, & Strath, S.J. Can Lifetime Leisure Physical Activity Recall Predict Current Activity Levels in Older Adults? International Society for Behavioral Nutrition and Physical Activity, May 2013.

Strath, S.J., Lenz, E.K., Miller, N.E., **Dondzila, C.J.**, Rote, A.E., Tarmia, S.S., & Swartz, A.M. Efficacy of an Individually-Tailored, Internet-Mediated Physical Activity Intervention in Older Adults: A Randomized Controlled Trial. National Conference for the American College of Sports Medicine, May 2013.

Dondzila, C.J., Swartz, A.M., & Strath, S.J. Physical Activity Differences Among Older AdultsUtilizing Community Versus In-Home Resources. Midwest Chapter Conference for the American College of Sports Medicine, November 2012.

Dondzila, C.J., Swartz, A.M., Azen, R., Finco, K.L., & Strath, S.J. Is Awareness and Proximity to Community-Based Fitness Resources Predictive of Physical Activity in Older Adults? Gerontological Society of America. November 2012.

Dondzila, C.J., Swartz, A.M., Keenan, K.G., Grimm, E.K., Gennuso, K.P., & Strath, S.J. Lower Function is Related to Sedentary Behavior in Older Adults. International Conference on Ambulatory Monitoring of Physical Activity and Movement. May 2011.

Grimm, E.K., Swartz, A.M., Rote, A.E., Miller, N.E, **Dondzila, C.J.,** & Strath, S.J. Accelerometry Wear Time Effects on Sedentary Behavior and Physical Activity Intensity. International Conference on Ambulatory Monitoring of Physical Activity and Movement. May 2011.

Grimm, E.K., S.J. Strath, A.M. Swartz, N.E. Miller, K.P. Gennuso, A.E. Rote, **C.J. Dondzila**, & K.M. Sweere. Objective Measurement of Sedentary and Active Behavior in Older Adults. Medicine and Science in Sports and Exercise. 41:S476, 2009.

Rote, A.E., A.M. Swartz, S.E. Cashin, S.J. Strath, N.E. Miller, E.K. Grimm, K.P. Gennuso, **C.J. Dondzila**, & K.M. Sweere. Psychosocial Factors Influencing Physical Activity in Older Adults. Medicine and Science in Sports and Exercise. 41:S290, 2009.