# PERCEIVED BARRIERS AND FACILITATORS TO PHYSICAL ACTIVITY AND FUNCTIONAL LIMITATIONS AMONG OLDER ADULTS

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## ABSTRACT

Lower physical function, mobility disability and the possibility of subsequent physical disabilities are major public health issues due to the rapid and continuing growth of the older adult population. In addition, the risk for mobility disability and physical disability increases with age. Longer life expectancy, rapid population growth, and low physical activity participation rates among older adults justify the need for better understanding of perceived barriers to and facilitators of physical activity. However, perceived barriers and facilitators, modifiable intra- and extra-individual mechanisms in the disablement pathway, remain underexplored. This dissertation aimed to provide novel insight into the associations between perceived barriers and facilitators, physical activity and related programs, and functional limitations among older adults. First, there are a range of factors that contribute to engagement in lifestyle programs aimed at mobility disability prevention for sedentary older adults, and these factors may be related to the type of program. Next, barriers may attenuate the effect of a structured physical activity program aimed at reducing major mobility disability. Finally, evidence was provided supporting the importance of considering social support as a specific barrier/facilitator in interventions aimed at improving physical function. Low levels of social support over time may increase the risk for declining physical function and subsequent disability development compared with those reporting moderate or high levels of social support. This

research provides novel evidence that perceived barriers and facilitators are important to consider as they play key roles in the ongoing disablement pathway toward physical disability in older adults. This could inform the development and translation of future intervention efforts aimed at mobility disability reduction and physical disability prevention. Dissemination of feasible, sustainable and low cost programs for older adults is an important public health issue currently gaining more attention. This research took steps toward understanding the complexities of the disablement pathway and where we might be able to intervene to reduce the negative impact of these outcomes on the individual, health care system, and society. Ultimately, generating information to assist public health and health care professionals in addressing functional decline and disability.

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## PREFACE

I would like to take this opportunity to acknowledge and express my gratitude for the people who have made a significantly positive impact on my journey to become a doctor of epidemiology. I could not take credit for my achievements without thanking these people, many of whom have stood by me through years of adversity and challenges that seemed insurmountable at times.

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# 1.0 INTRODUCTION

The aging population, defined as those at least 65 years of age, is growing at a rate that is projected to continue through the year 2050 [1, 2]. Older adults will account for approximately 73 million people in the United States (one in every five people) by 2030 [1]. As the proportion of older adults increases, so will the prevalence of functional limitations and physical disability. In 2013 the overall disability prevalence rates among older adults aged 64-74 years and 75 years and older were estimated to be 25.8% and 59.7%, respectively [3]. Unfortunately these rates are growing and along with them are associated health care costs. Older adults with functional limitations or those who transition to being physically disabled spend at least $10,000 more on health care over 2 years compared with those who are functionally independent [4]. The increasing risk for physical disability that coincides with a high burden of health care costs is one reason why the growing aging population is a major public health concern. It is critical to take advantage of known modifiable risk factors that impact functional decline and physical disability in order to prevent and reduce their onsets.

Physical activity is a modifiable risk factor for mobility disability and physical disability [5, 6]. Although it is known to be effective at reducing risk for these major public health issues, approximately 4%-32% of older adults engage in the current recommendations for physical activity [7]. It is logical to turn attention to physical activity and associated functional limitations among older adults in an effort to address the increasing physical disability rate. This

dissertation will focus on physical activity and related intervention programs aimed at improving physical function and lowering mobility disability in older adults.

Since it is already established that physical activity works but many older adults are not engaging in it, rather than reproducing more evidence to support this, it is important to create a shift in research to explore factors that might reveal barriers and facilitators to engaging in physical activity and related programs. In turn, we can explore how these factors are related to functional limitations among the aging population. Studies have reported on associations of perceived barriers and benefits with physical activity and related programs [8-11]. Knowledge about the role of organized programs for older adults, and their perceptions of them, is lacking. Research emphasizes the need to consider perceived barriers and facilitators, but also what beliefs exist about the benefits to engaging in programs aimed at disability prevention [12].

The research described in this dissertation will provide novel insight into the associations between perceived barriers and facilitators, physical activity and related programs, and functional limitations among older adults. This dissertation will generate information to assist public health and health care professionals in addressing functional decline and disability.

# 2.0 THE OLDER ADULT POPULATION

## 2.1 THE DEMOGRAPHY OF AGING

The size and structure of the older adult population, defined as those 65 years of age and older, continues to change dramatically over time. It is important to understand both of these components as they have important implications for the future of public health and health care. It is known that the older adult population in the United States is experiencing considerable growth. In 2012 it was estimated that 43.1 million people were at least 65 years of age [1]. Current projections estimate that this age group will nearly double to 83.7 million people by 2050 [1, 13]. Older adults will account for about 20% of the total United States population by the year 2030 alone (equating to nearly 73 million people) [1, 2, 13]. Among this older adult population the "oldest old", referring to those at least 85 years of age, is projected to grow from 5.9 million in 2012 to 8.9 million and 18 million in 2030 and 2050, respectively [1, 2]. The aging baby boomer generation and longer life spans are contributing to this reported substantial growth [14]. These trends are not unique to the United States. In fact, the older adult population is projected to continue increasing in all developed nations [1, 14]. It is apparent that there is a demand for public health researchers and health care providers (among virtually every facet of society) to rise to the challenge of meeting the needs of older individuals.

The diversity of the older adult population is changing along with its size. The composition of this age group will likely be around 58% non-Hispanic White, 20% Hispanic, 12% Black and 9% Asian by 2050 [13]. This is compared with 80% non-Hispanic White, 7% Hispanic, 9% Black and 3% Asian in 2010 [13]. The gender structure of the older adult population is expected to change in that the gap between the number of women and men will likely become narrower. By 2050, 55.1% of older adults in the United States are projected to be female compared with 56.4% in 2012 [1]. In addition to the increasing demand to meet the needs of the older population in general, it is important that research is developed to understand the disparities that may be unique to this more diverse structure.

## 2.2 LIFE EXPECTANCY AND MORTALITY

Life expectancy is a representation of the average number of years of life remaining to an individual at a given age under the assumption that the current death rates remain constant. This measure is projected to grow for all racial and ethnic groups of older adults between 2012 and 2050. An older adult surviving to age 65 can expect to live approximately 19.2 more years based on the current mortality conditions [1]. Older adult women have a longer life expectancy compared with men however men are projected to experience a more rapid increase in life expectancy in the coming decades which will contribute to the reduction in the size of the gender gap previously mentioned [13]. It is worth noting that life expectancy in the United States is lower compared with that of many other developed countries [13]. This highlights the possibility that there are disparities unique to the U.S. older adult population and further emphasizes the importance of studying this group.

Chronic diseases are still the leading causes of mortality in the older adult population [13, 14]. These include heart disease, cancer, stroke, diabetes, chronic lower respiratory diseases, and Alzheimer's disease [2]. Unfortunately, chronic diseases and conditions negatively impact one's quality of life and contribute to declines in physical function and independence [13]. In turn, this can lead to disability and ultimately death. Mortality is emerging as the driver of not only the size of the older adult population, but the pace at which they functionally decline. This stresses the significance of understanding factors that drive mortality and mortality prevention in older adults.

## 2.3 BURDEN OF HEALTH CARE COSTS

When considering health care costs as a share of total expenditures, those associated with health care increase dramatically with age. Older adults in the age group 75 years and older spend an estimated 15.1% of total expenditures on health care compared with 11.9% for those between the ages of 65 and 74 years [13]. Health care spending is projected to continue to increase among older adults to around 25% of total expenditures by 2030 [13]. Two out of three older adults in the United States have multiple chronic conditions and their resulting treatment accounts for 66% of the nation's health care budget [2]. Moreover, Medicare spending had already reached $555 billion in 2011 and will sky rocket to around $903 billion by 2020 [2, 4]. These estimates do not take into account inflation and costs of new technologies compared with the current standard of care [2]. The burden of multiple chronic diseases carries over to a broader spectrum of related negative health consequences like diminished quality of life, reflected by a long period of functional decline and mobility disability, which will be the focus

of this dissertation. Restrictions to mobility can result in a cascade effect of continuing deterioration, generating serious consequences for the older adult population, society, and the economy.

# 3.0 THE EPIDEMIOLOGY OF DISABILITY IN OLDER ADULTS

## 3.1 THE DISABLEMENT PROCESS: A CONCEPTUAL FRAMEWORK

It is appropriate to frame the discussion surrounding mobility disability in older adults within the context of the Disablement Process model. This model was originally proposed by the sociologist Saad Nagi and was adopted by the Institute of Medicine in an effort to focus national policy on the prevention of disability [15, 16]. The Disablement Process model is the expression of a physical or mental limitation in a social and medical context. The work presented in this dissertation will focus on physical limitation and disability, specifically physical function and mobility disability. The Disablement Process model does not assume that disability will occur in all older adults. Instead, it stipulates that disability may or may not occur as a result of the interaction among an older adult's physical limitations and the social and physical factors in his/her environment. Verbrugge and Jette expanded the Disablement Process model keeping prevention in mind, by maintaining Nagi's concepts as the main pathway and specifying sociocultural (e.g. physical or social environments) and personal (e.g. attitudes and lifestyle behaviors) factors known to influence the ongoing process of disablement [17, 18]. Figure 1 illustrates the Disablement Process model as the conceptual framework for the work being presented. This dissertation will focus on components of the main pathway, specifically the concepts of functional limitation and disability, and influential components, specifically intra-

individual mechanisms and extra-individual mechanisms. For the purposes of this work it is worthwhile to briefly describe each component of the Disablement Process model followed by a more detailed definition of the concepts that will remain the primary focus moving forward. This discussion will provide a foundation upon which the epidemiology of physical function and mobility disability in older adults can be generated.

The main pathway of the Disablement Process model is made up of four domains: pathology, impairment, functional limitation, and disability (Figure 1). Pathology, the first domain, refers to physiological and biochemical disorders. Examples are infection, injury, or metabolic imbalance. Impairment is the second domain and defined as abnormality at the tissue, organ, or body system level such as a cardiovascular or musculoskeletal dysfunction.

The third and fourth domains, functional limitation and disability, are two main topics of this dissertation. Functional limitations are defined as restrictions in the basic physical or mental performance of an individual, such as climbing stairs or visual acuity. Limitations specific to physical performance in older adults will be discussed in this dissertation and referred to as physical function and mobility disability. These concepts will be defined in more detail in the next section.

The fourth domain of the Disablement Process model is disability. While there are different types of disability this dissertation focuses on physical disability in older adults. Physical disability is defined as impairment in the ability to independently perform instrumental activities of daily living (IADLs) and/or activities of daily living (ADLs). This is distinct from mobility disability.

Verbrugge and Jette's expanded Disablement Process model considers a social epidemiologic perspective by including factors known to influence the process of disability [17-

20]. These factors can be viewed as three categories of variables: risk factors, intra-individual mechanisms, and extra-individual mechanisms (Figure 1). Risk factors are predisposing characteristics that can be biological, social, environmental, psychological, demographic, or behavioral in nature. Risk factors impact the pathology domain of the main pathway. For the purposes of this dissertation, age can be considered a risk factor. Intra-individual mechanisms are related to psychosocial, lifestyle, and behavior attributes. This dissertation will examine perceived social support barriers and facilitators, barriers to active living, and self-efficacy and their association with physical function and mobility disability as specific intra-individual mechanisms influencing the domain of functional limitations. Extra-individual mechanisms are related to the built environment and external supports. Programs designed to promote physical activity and prevent mobility disability fall into this category. This is the specific extra-individual mechanism defined in this dissertation.

In summary, the Disablement Process model illustrates that there are multiple pathways influencing disability. This dissertation focuses on the pathway from functional limitation to disability and how specific intra- and extra- individual mechanisms play a role in this pathway.

The next sections will quantify this public health issue by describing the epidemiology of physical function and mobility disability in older adults.

### 3.1.1 Physical Function in Older Adults

As the number of older adults in the United States and worldwide rises maintaining independent physical function in older adults is a central goal of public health. Physical function rests within the domain of functional limitation in the pathway to physical disability and is known to increase the risk for additional functional decline and physical disability [21-23]. In

epidemiology physical function is defined using measures of physical performance such as the long distance corridor walk, the timed up and go test, the 6 minute walk test, gait speed, and the Short Physical Performance Battery (SPPB) [24-29]. Each of these objective measures represent widely used and validated methods of assessing physical function in older adults and for the purposes of this dissertation the focus will remain on the Short Physical Performance Battery (SPPB).

The SPPB is a valid assessment of physical performance that can characterize a broad spectrum of lower extremity function and accurately predict disability across diverse populations of community dwelling older adults [27, 29, 30]. It is known to be reliable and highly sensitive even to subtle changes in older adults' levels of physical function [31-33]. Estimates for a small meaningful change in SPPB range from 0.27-0.55 with 0.5 representing the most commonly referenced [33]. This is desirable as the SPPB can provide researchers with the ability to evaluate how a small degree of change in physical function might impact an individual older adult's risk of moving further along the Disablement Pathway toward mobility disability, physical disability, and loss of independence. This may be a critical stage within the disablement pathway where prevention efforts could best serve older adults at risk for mobility disability. It also highlights the importance of studying specific intra- and extra-individual mechanisms influencing physical function, which is one of the purposes of this dissertation work.

Studies show that physical function is associated with an increased risk of functional decline, physical disability, nursing home admission, and mortality [5, 29, 34]. Among community dwelling older adults lower physical function is associated with increased incidence of disability in the activities of daily living (ADLs) and mobility disability, the focus of the next section [35, 36]. Physical function is also a long-term predictor of mobility disability and

physical disability [37]. Older adults who have limitations related to physical function (i.e. climbing 10 stairs or walking one quarter of a mile) are at an increased risk for disability compared with normally functioning older adults [21-23]. Decline in the level of physical function is related to increasing age and a higher risk of mobility disability and subsequent functional decline over 10 years of follow-up [38]. Older adults with lower levels of physical function are 4.2-4.9 times as likely to develop disability compared with those with higher levels of physical function [35, 39]. In summary, physical function is a specific functional limitation that plays a significant role in the main pathway to mobility disability and ultimately physical disability and mortality. The magnitude of the risk for mobility disability and more severe outcomes related to physical disability is greater for older adults with lower levels of physical function. The next section will define and describe the epidemiology of physical disability and mobility disability.

### 3.1.2 Mobility Disability in Older Adults

In general this dissertation work focuses on preventing physical disability in older adults by studying physical function and mobility disability as interrelated functional limitations that are known predictors of this enormous public health issue. Researchers define physical disability in older adults as impairment in the ability of an individual to independently perform tasks falling into one of two categories known as instrumental activities of daily living (IADLs) and activities of daily living (ADLs). Within the context of the disablement pathway, IADLs and ADLs rest in the disability domain in the main pathway [17]. IADLs represent activities essential for maintaining independent status in one's own setting whereas ADLs are necessary for survival [17, 18]. One can think of IADLs as activities related to household management

such as preparing meals, managing medications and finances, laundry, using the telephone, using public or personal transportation, shopping, and housekeeping [40]. ADLs are self-care activities such as bathing, feeding, dressing, continence, toileting, and transfer or getting in and out of a chair/bed [41].

The prevalence of physical disability and mobility disability among older adults is high. Data from the 1999-2004 National Health and Nutrition Examination Survey (NHANES) report that among adults aged 60-69, 23% have IADL disability, 20% have ADL disability, 48% have functional limitations, and 30% have mobility disability [42]. These estimates are alarming and unfortunately more recent data shows that the burden of these issues is growing. The 2013 Disability Status Report, based on data from the U.S. Census Bureau's American Community Survey, reports that among adults ages 64-74 the overall prevalence rate is 25.8%. Specifically, the prevalence of disability related to independent living is 7.9%, while the prevalence rates of self-care disability and ambulatory disability are 4.5% and 15.8% respectively [3]. The overall and specific rates increase in adults aged 75 and older. Among this group of older adults, the overall disability prevalence rate is 50.7%. The prevalence of disability related to independent living is 25.6%, and the prevalence rates of self-care disability and ambulatory disability are 13.8% and 33.3% respectively [3]. These reported rates do not differ significantly according to gender. Evidence suggests that non-Hispanic black and Mexican-American men and women report significantly more disability compared with non-Hispanic white men and women, and a large proportion of the difference in disability prevalence between these groups can be explained by disparities related to income and wealth [43, 44].

The high prevalence rates related to disability are not unique to the United States older adult population. Data collected from 59 countries for the World Health Survey and the World

Health Organization's Global Burden of Disease Study estimate that the overall disability prevalence among those aged 60 and over is 38.1% [45]. These rates are concerning due to the projected growth of the aging population compounded with the associated increase in health care costs and utilization of health care services. Once physical disability occurs in an older adult, the likelihood of developing further disability, institutionalization, and death increases greatly [46, 47]. Since physical function and mobility disability are associated with, but do not inevitably lead to physical disability, this dissertation work highlights these functional limitations in the ongoing disablement pathway.

It is now established that mobility disability and physical disability are distinct. Mobility is fundamental to the health and well-being of older adults and is defined as the ability to move around safely and effectively in the environment [2]. Within the functional limitation domain of the disablement pathway, mobility disability can be considered as a distal outcome compared with physical function. In epidemiology mobility disability is defined using measures of self-report and performance testing. When assessed by self-report mobility disability is typically defined as being unable to or having difficulty climbing one flight of stairs and/or walking 400-500 meters (approximately one quarter of a mile) [24, 48, 49]. Mobility disability is measured objectively with performance testing such as fast paced gait speed (defined as < 1.2 m/s), 4 meter or 6 meter usual gait speed (defined as < 1.0 m/s), and the inability to walk 400 meters without sitting down and/or under 15 minutes [50-56]. Recent research recommends defining usual gait speed in older adults as 0.9 m/s therefore some may consider < 0.9 m/s as an indication of mobility disability [57]. This dissertation work will focus on the latter of these performance measures and will also make reference to major mobility disability (MMD), defined as the

inability to complete a 400m-walk test within 15 minutes without sitting and without the help of a walker or other person [53, 58].

Evidence that was previously described shows that physical function is associated with mobility disability and these functional limitations are predictive of physical disability in older adults. Risk factors for mobility disability and physical disability include age, race, sex, hypertension, diabetes, multiple chronic conditions, obesity, arthritis, stroke, smoking, fractures, previous disability, mobility disability, and lower levels of physical activity. Physical activity is a specific extra-individual mechanism within the disablement pathway. The next section will discuss physical activity and its association with functional limitations.

## 3.2 PHYSICAL ACTIVITY AND DISABILITY IN OLDER ADULTS

Physical activity in older adults at least 65 years of age includes transportation (e.g. walking or cycling), leisure time physical activity, occupational activity (for those still working), household chores, recreation, and planned or structured activity [59]. It is currently recommended that older adults engage in at least 150 minutes of moderate-intensity aerobic physical activity (e.g. brisk walking) per week, or at least 75 minutes of vigorous-intensity activity per week, or an equivalent combination of moderate- and vigorous-intensity activity [7, 59]. Unfortunately national survey data estimate the prevalence of older adults meeting these guidelines ranges from less than 4% (based on objective measurement) to less than one third (based on self-report), underscoring the importance of studying physical activity in this population [60, 61].

### 3.2.1 Evidence that Physical Activity Improves Physical Function and Major Mobility Disability in Older Adults

Since physical function and mobility disability represent a critical stage in the disablement pathway during which the risk for physical disability increases greatly, it is essential to study extra- and intra- individual mechanisms that could preserve physical function and mobility and prevent an individual older adult from progressing further into the disablement pathway toward physical disability [27, 35]. It is known that physical activity is associated with a reduced risk for many chronic diseases and conditions that can impact physical function and mobility among older adults including colon and breast cancer, arthritis, type 2 diabetes, cardiovascular disease, and depression [62-67].

In recognition of the importance of studying how modifiable factors like physical activity are directly related to physical disability in older adults, research is beginning to focus on the relationship between physical activity and functional limitations. Evidence suggests that engaging in physical activity is associated with better physical function and longer life expectancy in older adults compared with those who are sedentary [68-70]. Moreover, sedentary older adults who become engaged in physical activity experience a reduction in mortality risk compared with older adults who remain sedentary [62, 71]. This suggests that physical activity is a modifiable extra-individual mechanism that may benefit an individual in the functional limitation domain at any age and baseline level of activity. Data from the Women's Health and Aging Study reports that physical activity is inversely associated with physical disability among older community dwelling disabled women [72]. This evidence is important although limited by its cross-sectional design and focus on only older women who were already disabled.

The InCHIANTI Study conducted, which included a large sample of community dwelling older adults in Italy, examined the association of self-reported past physical activity with physical function and mobility disability, measured by the SPPB and ability to walk 400 meters respectively [51, 73]. Several important results emerged from this study. Physical activity in midlife (ages 20-40 years and 40-60 years) was associated with mobility such that older adults reporting higher levels of midlife physical activity had improved mobility compared with those reporting less midlife physical activity [73]. Cumulative physical activity, or physical activity over the lifecourse, was significantly associated with a smaller decline in physical function, and lower risk of incident mobility disability and premature death compared with older adults who reported less activity during adulthood [51]. This study is limited by the use of self-report physical activity data, however this is a common measurement bias in physical activity epidemiology and does not discredit these findings. The evidence described from these observational studies provided the necessary foundation upon which translational research can evolve, with randomized trials as the next step in translation. The next sections will review the large trials and community based trials examining interventions aimed at improving physical function and mobility disability in older adults.

### 3.2.2 Evidence from Large Trials Examining Interventions Aimed at Improving Physical Function and Major Mobility Disability in Older Adults

As this area of research is evolving there are not many large, multicenter randomized trials examining physical activity interventions specifically aimed at improving physical function and decreasing the risk for mobility disability in older adults. Many of the existing studies evaluate the impact of physical activity interventions on the prevention of falls in older adults

[74, 75]. Falls in older adults is an important outcome related to disability but this component of the disablement pathway is not the focus of this dissertation work. Other studies examining the association between physical activity interventions and physical function or mobility disability focus on specialized populations of older adults, such as those with type 2 diabetes and knee osteoarthritis [76-78]. For example, the Look AHEAD Movement and Memory Study found that after 8 years of follow-up, a lifestyle intervention combining physical activity and caloric restriction improved physical function in overweight and obese middle-aged and older adults with type 2 diabetes compared with diabetes support and education (adjusted mean (SE) difference in SPPB scores: 0.055 (0.022), $p = 0.01$) [76]. This study was limited in that its intervention was specifically designed to achieve weight loss in those with type 2 diabetes, not to improve physical function. Unfortunately the results of these studies cannot be generalized to the entire older adult population at risk for reduced physical function and mobility disability. On the other hand, they may be useful to subsets of the older adult population who may be at high risk for mobility disability and subsequent physical disability.

Randomized controlled trials have overcome the limitations mentioned above and show that structured physical activity interventions are associated with improved physical function [79-82]. Several of these studies report that physical activity is associated with improved physical function, specifically measured by the SPPB score upon which this dissertation work will expand [81, 82]. Nelson et al. found that a 6-month physical activity intervention improved physical function compared with a nutritional education control in functionally impaired older adults [81]. Physical activity in the Increased Velocity Exercise Specific to Task (InVEST) pilot study improved SPPB scores in older women [82]. Although these studies strengthen the developing evidence base in support of studying physical activity and its association with

physical function and mobility disability, they are both limited by very small sample sizes reducing the power of the results and they do not address barriers to achieving desired outcomes.

Investigators of the Lifestyle Interventions and Independence for the Elders (LIFE) Study recognized the need for stronger and more conclusive evidence that physical activity can improve physical function and reduce major mobility disability through a structured intervention. These researchers aimed to fill this knowledge gap by studying sedentary older adults at risk for mobility disability in a large, multicenter randomized controlled trial design. The LIFE pilot (LIFE-P) study, which predates the main LIFE trial, found that a structured physical activity intervention was associated with improved SPPB scores compared with a successful aging intervention in 424 sedentary older adults [83]. The adjusted SPPB scores ($\pm$ standard error) for the physical activity (PA) group versus the successful aging (SA) group at six and twelve months were 8.7 $\pm$ 0.1 versus 8.0 $\pm$ 0.1, and 8.5 $\pm$ 0.1 versus 7.9 $\pm$ 0.2 ($p < 0.001$), respectively [83]. The main LIFE Study expanded upon the findings of the LIFE-P study by including major mobility disability as a more distal functional limitation associated with physical function and the risk for physical disability among sedentary older adults. Major mobility disability (MMD) was measured objectively and defined as loss of the ability to walk 400 meters. This dissertation work makes use of this definition for MMD. The results of the LIFE Study showed that the PA intervention significantly reduced MMD (HR: 0.82; $p = 0.03$) among older adults at risk for disability compared with the SA intervention over 2.6 years of follow-up [53, 58, 84]. Moreover, older adults with lower physical function (SPPB < 8) showed a trend towards reduced MMD compared with higher functioning participants (SPPB $\geq$ 8) [58]. In summary, the evidence from these randomized trials is invaluable and suggests that physical activity interventions can improve physical function and reduce major mobility disability in older adults,

especially those at risk for disability. The next important step in translating this research is studying potential effectiveness through community-based trials.

### 3.2.3 Evidence from Community Based Trials Examining Interventions Aimed at Improving Physical Function and Major Mobility Disability in Older Adults

Given that the evidence base from large, longitudinal and randomized trials is still evolving, this naturally limits the number of existing community based trials examining physical activity interventions aimed at improving physical function and reducing major mobility disability in older adults. More of these trials will be essential over the next several decades as this field of research progresses in its translation.

A recent community based randomized trial conducted over 2 years in Finland reported that a physical activity intervention improved physical function in older women with a history of falls compared with a control group asked to simply maintain their current level of physical activity [85]. The population limits this study since these results are only applicable to older women with a history of falls, and the primary outcome included number of falls. A community based trial conducted by Xu and colleagues found that over 16 weeks a Tai Chi plus behavioral weight loss program improved physical function and coronary heart disease (CHD) risk among obese older women compared with a control group engaging in their usual lifestyles [86].

In summary, the evidence presented highlights that physical activity is a specific extra-individual mechanism that can be successfully modified to impact intermediate and distal functional limitations, specifically physical function and mobility disability. Studying this area of the ongoing disablement pathway could inform the prevention of physical disability through physical activity, one of the aims of this dissertation work. The next chapter will focus on a

specific intra-individual mechanism, perceived social support barriers and facilitators, and their role in the Disablement Pathway.

# 4.0 PERCEIVED BARRIERS AND FACILITATORS

## 4.1 PERCEIVED BARRIERS AND FACILITATORS TO PHYSICAL ACTIVITY

It was mentioned that physical disability and underlying functional limitations are not inevitable consequences of aging yet roughly one-third of older adults have physical function and mobility restrictions. Since engaging in physical activity is an extra-individual mechanism associated with the prevention of functional limitations that can lead to more severe impairments in the disablement pathway like physical disability and subsequent chronic disease, disability, and death, then targeting intra-individual mechanisms that are correlated with physical activity will be instrumental in addressing the disproportionate disability burden the older adult population is facing. Highlighting that less than one-third of older adults meet the recommended physical activity guidelines in the United States further emphasizes the need for a better understanding of influential factors in this pathway [60, 61, 87, 88]. This chapter will discuss perceived barriers to and facilitators of physical activity in older adults, specifically those related to social support, in an effort to target an intra-individual mechanism. The transtheoretical model will provide a framework for this section, which will be prefaced by an overview of existing theoretical models.

### 4.1.1 Theoretical Models for Perceived Barriers and Facilitators to Physical Activity

In public health a typical approach to prevention occurs by defining a problem or issue, identifying associated risks, developing and testing strategies, and then disseminating effective interventions. Rather than adhering to this strict approach with rigor, public health researchers and practitioners must apply concepts, theories, methods, and research from social and behavioral sciences to best inform their efforts to improve health outcomes in any population. The disablement pathway provides an example as it acknowledges the importance of traditional medicine and social epidemiology, and illustrates that the pathway to disability in older adults is not linear. It is necessary to describe a theoretical foundation that underlies the specific intra-individual mechanisms: perceived social support barriers to and facilitators of physical activity in older adults. Several theoretical models have been employed in studying physical activity and this dissertation will focus on the transtheoretical model, also commonly known as the stages of change. This section will briefly review these different theoretical models, also shown in Table 1, followed by a detailed discussion of the transtheoretical model.

Social Cognitive Theory (SCT) was developed by Albert Bandura and began as Social Learning Theory. This theory posits that personal factors, the environment, and behavior influence one another in a reciprocal manner [89]. SCT takes into account individuals' past experiences which factor into whether a behavioral action, such as engaging in physical activity, will occur. This has been used in studying physical activity, however for the purposes of this dissertation work the SCT is limited [90, 91]. SCT pays little attention to personal motivation and perceived emotion, and it assumes that environmental changes will lead to individual level changes.

Self-Determination Theory (SDT) indicates that intrinsic and extrinsic motivations regulate behavior [92]. In consideration of physical activity, intrinsic motivation is related to the inherent satisfaction or enjoyment an individual experiences when engaging in physical activity. Extrinsic motivation refers to engaging in physical activity for instrumental reasons or to obtain an outcome separate from the inherent satisfaction received from physical activity. The majority of studies that make use of the SDT and physical activity focus on young populations and do not consider associated health outcomes like improved physical function or reduced risk for mobility disability [90, 93].

The Social Ecological Model (SEM) acknowledges that behaviors both shape and are shaped by the social environment, and there are multiple levels of influence including individual, interpersonal, organizational, community, and policy/societal factors [94]. The SEM has been used to address the social and contextual correlates of physical activity behaviors [8, 94]. Although it may be useful in understanding what influences the adoption of physical activity and related programs, it has mainly been employed in restricted populations and its scope is not an ideal fit for the specific focus of this dissertation.

The Health Belief Model (HBM) was originally developed by social scientists in an effort to understand the failure of people to adopt disease prevention strategies. This model theorizes that an individual's belief in a personal threat of a negative health outcome together with his/her belief in the effectiveness of the recommended health behavior or action will predict the likelihood that individual will adopt the behavior [95, 96]. Applying this to the context of this dissertation, the HBM suggests that an older adult's belief in the personal threat of reduced physical function and mobility disability combined with his/her belief in the effectiveness of physical activity will predict the likelihood of that person engaging in physical activity. While

this model has been applied to physical activity research it is not an ideal fit for this dissertation work [97]. The HBM is more descriptive than explanatory, and although it does take self-efficacy into account it does not consider individual attitudes, beliefs, or other perceived determinants that might influence adoption of a health behavior.

The Theory of Planned Behavior (TPB) developed from the Theory of Reasoned Action and has been used to predict and explain a wide range of health behaviors including physical activity [98, 99]. Behavioral intent is a key component of the TPB which posits that behavioral achievement depends on intent, or motivation, and behavioral control (ability) [100]. In other words, whether an older adult engages in physical activity depends on his/her motivation to be active and his/her perception of the ease or difficulty associated with performing physical activity. The TPB does not consider that behavior changes over time and does not take environmental factors into account, limiting its use for this dissertation. The Transtheoretical Model will be discussed in greater detail in the following section as it is the theoretical foundation that will provide support for the importance of studying perceived social support barriers to and facilitators of physical activity as the specific intra-individual mechanism of interest in the Disablement Pathway throughout the remainder of this dissertation.

### 4.1.2 The Transtheoretical Model: Support for Importance of Perceived Barriers and Facilitators to Physical Activity

Prochaska and DiClemente developed the Transtheoretical model (TTM) in the late 1970s, and it is interchangeably referred to as the Stages of Change model [101-103]. The TTM is a model of intentional change and focuses on the decision making of an individual. It operates on the assumption that people do not change behaviors quickly and decisively. Instead, the

behavior change process is cyclical and occurs continuously over time. This is especially true for habitual behaviors like physical activity [101-103]. The TTM suggests that those adopting physical activity as a behavior progress through five stages of change: precontemplation, contemplation, preparation, action, and maintenance [104]. Each of these stages will be defined in the context of physical activity in older adults, followed by a discussion of the literature supporting application of the TTM to this area of the disablement pathway which will reveal the importance of studying perceived barriers and facilitators related to this extra-individual mechanism.

In the precontemplation stage, older adults do not intend to take action in the foreseeable future, defined as within the next 6 months. People in this phase tend to believe the cons of engaging in physical activity outweigh the pros. These people may be unaware that their current behavior or inactivity in this case, is problematic or has negative consequences.

Older adults in the contemplation phase recognize that their inactivity may be unhealthy and start to place equal and practical emphasis on the pros and cons of engaging in physical activity. People in this stage intend to start engaging in physical activity in the foreseeable future (within the next 6 months). Ambivalence toward behavior change is still common in this phase.

The preparation stage is also considered the determination phase. Older adults in this stage are ready to become physically active within the next 30 days. These people typically believe that being physically active can lead to positive outcomes, such as improved physical function and mobility.

During the action stage older adults recently changed their behavior within the past 6 months and intend to continue being physically active. People within this stage can begin to

acquire new healthy behaviors in addition to engaging in physical activity. Additional modifications of behaviors associated with physical activity continue during the action stage.

The maintenance phase of the TTM occurs when older adults sustained their physical activity for more than 6 months. In this stage people intend on maintaining physical activity and work to prevent relapsing to earlier stages. Entrance into the TTM occurs at the precontemplation stage, and an individual can exit and re-enter at any stage.

The TTM identifies ten processes of change that result in strategies that assist an older adult in progressing through the five stages, engaging in physical activity, and maintaining the change: consciousness raising, dramatic relief, self-reevaluation, environmental reevaluation, social liberation, self liberation, helping relationships, counter-conditioning, reinforcement management, and stimulus control. Some of these processes are associated with barriers to and facilitators of physical activity in older adults, providing theoretical support for the importance of these intra-individual mechanisms and their influence on physical activity and functional limitations in the disablement pathway.

A number of studies employ the TTM to physical activity in older adults and through this application uncover the importance of perceived barriers and facilitators associated with this extra-individual mechanism [105, 106]. Yang and colleagues recognized that forming and maintaining regular physical activity habits is challenging for older adults, especially those that are inactive [107]. These investigators demonstrated that the TTM can be applied to interventions and used to successfully engage older adults in physical activity that they can maintain [107]. This study population consisted of older adults in the contemplation and preparation stages of the TTM and acknowledged that different strategies of facilitating behavior change may be needed for older adults in other stages of change.

Other studies used the TTM to examine factors that may be perceived barriers to or facilitators of the adoption of physical activity by older adults. Cheung and colleagues report that baseline self-efficacy predicts exercise behavior after a 16 week walking program in community-dwelling older adults [108]. Several longitudinal studies used the TTM to show that self-efficacy and perceived barriers to exercise were associated with physical activity participation in older adults [109-111]. Additional research utilizing the TTM discovered that perceived social support directly influenced older adults' motivation and ability to be physically active [112-114].

In summary, the TTM can be used as a guide for understanding behavior change. Research supports the use of the TTM as a theoretical foundation for focusing on perceived barriers to and facilitators of physical activity, and how this impacts physical function and mobility disability in older adults. Discovering the factors, like perceived social support, influencing stages of change for physical activity could have a significant impact on the risk of physical disability in the growing population of older adults.

The disablement pathway does not assume that every older adult with impaired physical function or mobility disability becomes physically disabled, and it acknowledges that psychological and environmental contexts surround biological decline in the form of intra- and extra-individual mechanisms. This underlies the importance of studying the specific intra- and extra-individual mechanisms supported by the TTM, perceived barriers and facilitators and physical activity, and how they may be associated with physical function and mobility disability. The evidence base for perceived barriers to and facilitators of physical activity in older adults can be broken into two categories: quantitative and qualitative studies. The following sections will review the literature within each of these categories.

### 4.1.3 Quantitative Evidence for Perceived Barriers and Facilitators to Physical Activity in Older Adults

Sallis and colleagues examined determinants of vigorous physical activity and reported that self-efficacy, perceived barriers, family support, and friend support were significantly associated with change in physical activity over 2 years among a sample of community-dwelling adults [115]. This study was limited by its focus on healthy adults and vigorous physical activity. This dissertation work will overcome these limitations by examining the same significant determinants reported by Sallis et al among older adults with varying levels of physical function and physical activity. Clark et. al found that lower self-efficacy and greater motivational barriers were associated with less physical activity among adults aged 55 years and older with a high prevalence of physical inactivity, however the study sample consisted of individuals with a low socioeconomic status from one urban primary care center [116]. A study conducted in Texas comparing sedentary older Mexican Americans with European Americans found that self-consciousness and lack of self-discipline, interest, company, and enjoyment were the barriers associated with physical activity in both groups [117]. These investigators also learned that participants in both groups held similar beliefs about the benefits of physical activity (e.g. improved health) [117]. Like the other evidence mentioned these results may not be applicable to the general sedentary older adult population, but they do highlight that it is important not only to consider barriers, but also what beliefs about benefits of physical activity exist, or perceived facilitators. This dissertation work aims to consider both perceived barriers and facilitators.

The remaining quantitative evidence was generated from work outside of the United States. While these studies may not be applicable to the American older adult population, they

do highlight important findings and emphasize the need for additional research within the U.S. A Swedish study examined reasons for adults' non-adherence to physical activity referrals and found that sickness, pain, low motivation, no time, economic factors, and "other" were the main barriers [118]. Sickness and pain barriers to physical activity adherence were more common among older study participants (aged 45-64 years and ≥65 years) while economic factors were more common among younger participants (aged 18-44 years) [118]. This study shows that perceived barriers and facilitators related to physical activity can change with age however it has several significant limitations. In addition to its inclusion of adults ages 18 and over, the study has an inherent selection bias as its population of primary health care patients was chosen by health care center staff who believed a patient would benefit from increased physical activity. The "other" barrier category emerged as significant to physical activity non-adherence across all age groups, but a more precise definition of "other" is not given.

Another international study conducted in Iran reported that higher perceived health benefits and greater self-efficacy were associated with physical activity among the entire sample of older adults [119]. Laziness was the perceived barrier associated with physical inactivity among this study's sedentary participants and friend support was the perceived facilitator related to physical activity among those who were active [119]. A survey of middle aged and older Australian women with type 2 diabetes found that the perceived barriers associated with physical activity were lack of interest, lack of money, tiredness, concern about safety, and feeling what they do does not help [120]. This study was limited by a small ($n = 41$) and restricted sample (women with type 2 diabetes). It only considered perceived barriers to physical activity as a secondary aim, which likely reduced its power further.

In summary, these previous quantitative studies provide evidence for perceived barriers and facilitators associated with physical activity in older adults, the intra- and extra-individual mechanisms within the disablement pathway upon which this dissertation work will focus. These studies are limited by their cross-sectional design and lack of generalizability to the older sedentary adult population in the United States in addition to other study-specific limitations mentioned. Unfortunately most studies do not use a valid tool to measure barriers and facilitators due to lacking standardized assessment methods. Evidence from qualitative studies will be discussed in the next section.

### 4.1.4 Qualitative Evidence for Perceived Barriers and Facilitators to Physical Activity in Older Adults

The qualitative studies examining perceived barriers to and facilitators of physical activity in older adults overcome some of the limitations of the quantitative studies and enhance the existing knowledge in this area. Whereas much of the quantitative work was conducted outside of the U.S. only one of the relevant qualitative studies is not generalizable to older American adults. Sjors et al. explored perceived reasons, incentives, and barriers to physical activity among elderly Swedish men (defined as aged 50-86 years) [121]. Lack of interest/motivation was identified as the primary perceived barrier and enjoyment and health were the facilitators associated with physical activity [121]. Unfortunately perceived barriers were assessed only among the men who self-reported that they never or rarely engage in physical activity and facilitators were assessed among those who reported their physical activity behavior as sometimes or often. This limits these results further as there is no information regarding

perceived facilitators among the sedentary men or potential differences in perceived barriers and facilitators between those who are sedentary and those who are not.

A study conducted in Rhode Island to determine perceived barriers to physical activity among sedentary older adults compared with non-sedentary older adults (aged $\geq$ 65 yrs) and reported some differences between the groups [122]. Inertia, negative affect, and fear of falling were perceived barriers associated with physical activity in sedentary participants and inertia, time constraints, and physical ailments were significant perceived barriers among those who were non-sedentary [122]. This study did not consider perceived facilitators and 86% of the sample were older women, a common bias in physical activity research among older adults.

Rasinaho et al investigated perceived barriers and facilitators related to physical activity among adults with moderate, severe, and no mobility limitation [123]. Participants with severely limited mobility reported lack of company, negative experiences with physical activity, poor health, and an unsuitable environment as perceived barriers to physical activity significantly more compared with those with moderate or no mobility limitation [123]. Perceived facilitators to physical activity were health promotion and disease management for those with no/moderately limited mobility and severely limited mobility, respectively [123]. These findings suggest differences in barriers and facilitators related to physical activity exist among older adults with varying levels of physical function, which this dissertation work will expand upon. Costello et al carried out a study among independent living older adults and compared sedentary with active participants. They found that sedentary older adults experienced more perceived barriers to physical activity compared with those who were active [124].

Another study reporting on factors influencing physical activity among older adults in residential care and assisted living communities revealed staying active, past physical activity

experiences, barriers to physical activity, strategies to facilitate physical activity, and support were important themes influencing physical activity [125]. Furthermore, past physical activity experiences were associated with current physical activity practices, and participants self-reported that physical activity helped maintain physical function [125]. This dissertation work will overcome the limitations of this study by examining perceived barriers and facilitators among a generalizable, non-institutionalized older adult population in the context of a randomized controlled trial and by comparing these to an objective measure of physical function.

Bethancourt and colleagues carried out a qualitative study to assess perceived barriers to and facilitators of physical activity among older adults between the ages of 66 and 78 years [8]. Significant barriers to physical activity were physical limitations, lack of professional/health care provider guidance, and inadequate information on appropriate and available physical activity options and programs [8]. A desire to maintain physical health and access to affordable and convenient programs were facilitators associated with physical activity [8]. This sample of older adults was physically active and healthy. Similar studies in sedentary older adults are needed given that research suggests perceived barriers and facilitators change due to a number of different variables including activity level. While this dissertation will focus on general perceived barriers and facilitators, it will also aim to study social support as a specific barrier/facilitator. The next section will discuss the importance of social support.

## 4.2 PERCEIVED SOCIAL SUPPORT BARRIERS AND FACILITATORS TO ACTIVITY AND/OR PHYSICAL DISABILITY IN OLDER ADULTS

The influence of social factors is widely and formally recognized as an important determinant of health [126]. Physical inactivity and disability among older adults are growing public health problems, and social support is related to each. Data from a large cross-cultural study showed that those who perceived low social support were more than twice as likely to be sedentary compared with those who reported high social support [127]. A review of physical activity interventions reported that studies that considered social support resulted in increased physical activity compared with those that did not incorporate social support [128].

Several studies report a strong association between social engagement and mobility disability and physical disability [129-131]. One cross-sectional study found a relationship between social engagement and disability among community dwelling older adults such that those with more social engagement reported less disability [129]. Less social engagement was associated with low mobility and disability in another community based study of older adults [130]. A cross-sectional design limits these results but they do suggest that social support may be related to functional limitations in the disablement pathway through an intra-individual mechanism. This highlights the importance of studying social support as a specific perceived barrier or facilitator in the prevention of physical disability in older adults, which this dissertation work broadly aims to do. Results from an ongoing longitudinal cohort study of aging, the Rush Memory and Aging Project, reported that social activity was associated with a reduction in risk of incident mobility disability, disability in activities of daily living, and instrumental activities of daily living among older adult participants [131]. Other research acknowledges the importance of studying the social context of the disablement pathway in older

adults [132]. Effective public health approaches to understand physical activity as a modifiable means to impact physical function and mobility disability among older adults should address perceived barriers and facilitators including social support [133].

### 4.2.1 Public Health Significance of the Proposed Research

Longer life expectancy, rapid population growth, and low physical activity participation rates among older adults justify the need for better understanding of perceived barriers to and facilitators of physical activity. However, perceived barriers and facilitators, modifiable intra- and extra-individual mechanisms in the disablement pathway, remain underexplored. Data suggest that perceived barriers and facilitators differ between sedentary and non-sedentary individuals, ages, and level of physical function. Furthermore, some, such as social support, might play roles as protective factors against functional limitations like mobility disability. The existing knowledge in this field provides a groundwork upon which a stronger evidence base can be built. Perceived barriers and facilitators need to be explored in large randomized trials and community based trials aimed at improving physical function and mobility disability in older adults to understand the key role they may play in the disablement pathway. This is critically important as translational research calls for a shift in emphasis from just understanding what works to also understanding how it works in real world settings. As the population ages dramatically, innovative and effective interventions targeted at reducing the risk for physical disability in older adults within this disablement pathway framework will become increasingly important. This dissertation work aims to fill this gap and provide valuable knowledge that will inform how existing and future interventions need to be adapted to account for the influence of perceived social support barriers and facilitators.

In addition, the risk for mobility disability and physical disability increases with age. Lower physical function, mobility disability and the possibility of subsequent physical disabilities are major public health issues due to the rapid and continuing growth of the older adult population previously mentioned. Moreover, the prevalence of older adults engaging in recommended levels of physical activity, a modifiable extra-individual mechanism associated with the functional limitations of interest in this dissertation, is only ~4%-32% [60, 61]. Understanding how perceived social support barriers and facilitators, physical activity and interventions aimed at improving physical function and mobility disability are interrelated may reveal factors that play key roles in the ongoing disablement pathway toward physical disability in older adults. This could inform the development and translation of future intervention efforts aimed at disability prevention.

# 5.0 METHODS

## 5.1 OBJECTIVES AND SPECIFIC AIMS

Although studies have reported on associations of perceived barriers and benefits with physical activity and related programs, little research in this area has focused on the sedentary older adult population at risk for mobility disability [8-11]. Some studies have assessed barriers to engaging in physical activity in limited settings (e.g. outside the U.S., nursing homes, primary care setting) and samples (e.g. young adults, older women, participants with existing chronic diseases and disability) [120, 134-138]. Other studies are limited by a cross-sectional design and a focus on only physical/environmental barriers [117, 139]. Moreover, to the best of our knowledge no studies have examined how perceived barriers, facilitators, or other factors are directly related to changes in physical function and onset of major mobility disability in a population of sedentary older adults at risk for mobility disability followed longitudinally.

The LIFE Study showed that a long term Physical Activity Intervention reduced the risk for major mobility disability (MMD) by 18% in older adults compared with health education [58]. However, participants in the one-year LIFE pilot also improved their physical function [83]. It is still unclear what mechanism(s) underlie why these sedentary older adults were motivated and successful in improving their own physical function and risk for MMD beyond adherence to the intervention programs. As the older adult population continues to grow, so does

the burden of major mobility disability on individuals, society, and the economy. In assessing the effects of barriers and facilitating factors in the LIFE Study population a unique opportunity exists to address this major public health issue in a multicenter randomized trial with a large study population. If these attributes are predictive of those that are more likely to reduce their risk of MMD, this information would be helpful when implementing physical activity programs aimed at lower functioning older adults.

Research emphasizes the need to consider perceived barriers and facilitators, such as social support, but also what beliefs exist about the benefits to engaging in programs aimed at disability prevention [12]. Conducting a qualitative analysis on data collected at the Pittsburgh LIFE Study site and linking it to a quantitative measure (e.g. SPPB) will aim to fill this gap in the current knowledge. Using a mixed-methods approach to the proposed research questions this dissertation will overcome many of the existing limitations and biases in this field of research.

The objectives of this dissertation work are to (1) assess the impact of perceived barriers and facilitators, such as perceived social support, in a multicenter randomized controlled trial and a community based trial: the LIFE Study and the Arthritis Foundation Exercise Program/ 10 Keys to Healthy Aging Study; (2) examine whether these attributes (barriers/facilitators) have ramifications for the impact of a structured physical activity intervention and the outcome mobility disability; and (3) generate hypotheses surrounding the impact of perceived barriers and facilitators on the successful implementation of programs aimed at improved physical function and disability prevention. This work will provide guidance for translation of evidence-based programs to the community.

Specifically, this dissertation work aims to:

**Aim 1:** To identify perceived barriers and facilitators in participant enrollment in two lifestyle intervention programs aimed at mobility disability prevention in the Pittsburgh LIFE Study center population.

**Aim 1a:** To examine whether the perceived barriers and facilitators identified differ by type of intervention.

*Hypothesis:* There is no a priori hypothesis given the exploratory nature of this aim.

**Aim 2:** To assess the impact of baseline barriers/facilitating factors on the effect of a moderate physical activity intervention and its ability to reduce the onset of major mobility disability in sedentary older adults at risk of mobility disability.

*Hypothesis:* A lack of barriers at baseline will be significantly associated with the effect of a structured physical activity intervention compared with a health education intervention on the reduction of major mobility disability in sedentary older adults at high risk of mobility disability in the LIFE Study intervention programs.

**Aim 3:** To evaluate the impact of social support as a specific barrier or facilitating factor to the improvement of physical function in community dwelling older adults.

*Hypothesis:* Better social support (as measured by a higher score on the Perceived Isolation Subscale) will be significantly positively associated with improved physical function in older adults in the AFEP/"10 Keys"™ study compared with those having less social support.

## 5.2 STUDY DESIGN

### 5.2.1 Overview

The LIFE Study is a multicenter, single-blinded, parallel randomized trial conducted at eight field centers: University of Florida, Gainesville, Florida; Northwestern University, Chicago, Illinois; Pennington Biomedical Research Center, Baton Rouge, Louisiana; University of Pittsburgh, Pittsburgh, Pennsylvania; Stanford University, Stanford, California; Tufts University, Boston, Massachusetts; Wake Forest University, Winston-Salem, North Carolina; and Yale University, New Haven, Connecticut.

The Arthritis Foundation Exercise Program (AFEP) and "10 Keys"™ to Healthy Aging Study is a community-based cluster randomized trial conducted at 54 sites, with the community site as the unit of randomization.

### 5.2.2 Population

Eligible older adults in the LIFE Study were (a) sedentary, defined as less than 20 minutes per week of regular physical activity (PA) in the past month and reporting less than or equal to 125 minutes per week of moderate/vigorous PA. This was based on responses to 18 items from the Community Healthy Activities Model Program for Seniors (CHAMPS) physical activity questionnaire; (b) at high risk for mobility disability based on the Short Physical Performance Battery (SPPB), an objective assessment of lower extremity functional limitations. A SPPB score of 9 or less (out of 12) met this criterion; (c) able to walk 400 meters in 15 minutes or less without sitting, leaning against a wall, using a walking aid other than a straight

can or help from another person; (d) aged 70-80 years and (e) willing to be randomized to either a physical activity or health education intervention group. Given that there were a number of exclusion criteria, these are listed in Table 2 [53]. A total of 1635 participants were enrolled in the LIFE Study, with 818 older adults randomized to the physical activity intervention and 817 randomized to the health education intervention [84]. Baseline characteristics were not significantly different in the two intervention groups. In the overall sample the mean age was 78.9 years, 67.2% were women, 17.6% were African American, and the average SPPB score was 7.4 [58].

In the AFEP and "10 Keys"™ to Healthy Aging Study, eligibility criteria included age 50 years or older, no surgery or cardiac event in the past 6 months, and no use of oxygen therapy [140]. Those who were not interested in the study were still invited to participate in the program. Study participants were younger (age 72.7 [SD 7.8] years vs. 75.0 [SD=9.8], p=0.004], more likely to have a college education (63.0% vs. 51.4%, p<0.001), and more likely to report arthritis (83.4% vs. 75.0%, p=0.002) compared with people attending the programs who did not consent to the research assessments. These two groups did not differ in baseline physical activity or the proportion of women or minorities.

Of the 462 total participants enrolled, 416 were evaluated at the 6-month follow-up with 213 older adults in the AFEP (control) program and 203 in the enhanced AFEP and "10 Keys"™ to Healthy Aging intervention program. The baseline characteristics including sociodemographics, prevalence of common chronic health conditions, body mass index, and health behaviors did not differ significantly between the two groups. The study population mean age was 73 years, 88% were women, 80% self-identified as white, 18% African American, and

2% other race groups, 50% had income above $25,000, and two-thirds had education beyond high school.

### 5.2.3 Intervention

The LIFE Study physical activity (PA) intervention involved walking, with a goal of 150 minutes per week, strength flexibility, and balance training [53]. Participants in the PA group attended two LIFE center-based visits per week and engaged in home-based activity 3-4 times per week for the duration of the study (average 2.6 years) [53]. The sessions progressed towards a goal of 30 minutes of walking daily (at moderate intensity), 10 minutes of lower extremity strength training (using ankle weights), 10 minutes of balance training, and large muscle group flexibility exercises [53].

The LIFE Study health education intervention focused on successful aging (HE). Participants attended weekly workshops during the first 26 weeks, followed by monthly sessions for the remainder of the study [53]. The SA intervention workshops covered a variety of topics relevant to older adults other than physical activity, such as nutrition, preventive services and screening recommendations, and how to effectively navigate the health care system [53]. The workshops also included 5 to 10 minutes of instructor led gentle upper extremity stretching or flexibility exercises [53].

Participant assessments were conducted every 6 months at LIFE center clinic visits. Assessment staff was blinded to the intervention group. In addition to SPPB and process measures such as the Barriers to Active Living questionnaire upon which this dissertation work will focus, a number of measures were collected during follow-up at varied intervals [53]. Major mobility disability (MMD), the primary outcome, was assessed at each participant contact.

MMD was defined as the inability to complete a usual-paced 400-meter walk test within 15 minutes without sitting and without the help of another person (using a straight cane was acceptable) [53].

In the AFEP and "10 Keys"™ to Healthy Aging Study the AFEP intervention involved 60 minute long sessions held twice weekly, for 10 weeks [140]. These sessions consisted of exercise and 3-5 minutes of health education about chronic disease risk factors. The exercise included a joint check, warm-up, active range-of-motion, strengthening, joint check, cool down, and relaxation [140].

Sessions for the enhanced AFEP + “10 Keys”™ consisted of the same exercises and 10-20 minutes of health information and health behavior change strategies from the “10 Keys”™ to Healthy Aging program [140]. The "10 Keys"™ is a health promotion behavior change program addressing the major risk factors for disease and disability, including blood pressure control; smoking cessation; immunizations; cancer screening; regulating blood glucose and cholesterol; physical activity; maintaining healthy bones, joints, and muscles; promoting social contact; and combating depression [140]. Sites randomized to the enhanced AFEP and “10 Keys”™ were also offered four monthly maintenance sessions after the 10-week intervention ended [140].

Participant assessments were conducted at baseline, post-intervention, 6 months, and one-year. Measurements included height, weight, blood pressure, the SPPB (the primary outcome), and questionnaires including the Perceived Isolation Subscale.

### 5.2.4 Measurements

**Table 1. LIFE Study timeline and measurements relative to aims 1 and 2**

| | Assessment Time point (month) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *Assessment Instruments* | *Baseline* | *6* | *12* | *18* | *24* | *30* | *36* | *42* | *Closeout* | *Data Source* |
| 400 meter walk test | X | X | X | X | X | X | X | X | X | Objective |
| First face to face contact | X | | | | | | | | | Interview |
| Demographic information | X | | | | | | | | | Survey |

**Table 2. AFEP and "10 Keys"™ to Healthy Aging Study timeline and measurements relative to aim 3**

| *Assessment Instruments* | *Baseline* | *Post-Program (10 weeks)* | *6 months* | *Data Source* |
|---|---|---|---|---|
| SPPB | X | X | X | Objective |
| Perceived Isolation Subscale | X | X | X | Survey |
| Demographic information | X | | | Survey |

### 5.2.5 Sample Size

Power calculations for MMD in the LIFE Study were based on a log-rank test with a 2-sided, 0.05 significance level [53]. The effect size targets were based on the LIFE Pilot, clinical relevance (~20% reduction), and consistency with effects from observational studies, and available funding resources [53]. In the LIFE Pilot the annual incidence rate of MMD in the health education intervention was assumed to increase from 18% to 21% after two years [83]. Additional assumptions were uniform recruitment over 21 months, average follow-up of 31

months, and 8% loss to follow-up. Based on the assumptions, randomization of 1600 participants provides 90% power to detect a 24% reduction in risk for MMD in the physical activity intervention participants, and 80% power to detect a 21% reduction in risk [53].

In the AFEP and "10 Keys"$^{TM}$ to Healthy Aging Study, randomization of 360 participants provides 80% power to detect a 7%-14% difference in rates of mobility (SPPB) and social support improvement between the two groups.

## 5.3 STATISTICAL ANALYSIS

Descriptive analyses of participant characteristics and outcomes will be conducted before evaluating the hypotheses. The characteristics of each variable of interest (e.g. distribution, mean, range) will be evaluated to determine the most appropriate statistical test. Central tendency measures such as proportions and standard deviations will be included. Significance will be set at a p-value of 0.05 for two-sided hypothesis testing. Statistical analyses will be performed using SAS 9.3 (SAS Institute, Cary, NC) and Atlas.ti.

*Specific Aim 1*

(1) Identify perceived barriers and facilitators in participant enrollment in two lifestyle intervention programs aimed at mobility disability prevention in the Pittsburgh LIFE Study center population.

(1a) Examine whether the perceived barriers and facilitators identified differ by type of intervention.

Responses to open-ended interview questions from only the LIFE Pittsburgh study participants will be read to identify codes for 1) all options participants provide in answering questions about motivation to join the LIFE Study, desired benefits, and past experience in health education/physical activity programs and 2) key themes. Themes or groupings will be compared and combined or separated by the analyst based on similarities and differences and on frequency analysis. Atlas.ti software will be used to assist with coding and data analysis. Once coding is completed, coding memos will be developed on key areas of interest to summarize findings and provided example quotations. This analysis will allow for the characterization of suggested themes that cannot be captured using the quantitative assessments, examination of potential differences by intervention group, and recommendations for hypotheses that require further exploration.

The baseline characteristics of the Pittsburgh LIFE participants will be described by the categories of themes that are generated during the analysis of the responses to the open-ended questions in the Baseline Face-to-Face Contact interviews. Results will show the themes that emerge by intervention group. Examples of possible "Facilitating Factors" are improved mobility, maintaining function, and lifestyle choice.

*Specific Aim 2*

(1) Assess the impact of baseline barriers/facilitating factors on the effect of a moderate physical activity intervention and its ability to reduce the onset of major mobility disability in sedentary older adults at risk of mobility disability.

Individual baseline barriers from the baseline first face-to-face contact interview will be assessed to examine univariate associations with with reduction in major mobility disability, and

the structured physical activity intervention program. Each individual baseline barrier/facilitator will be dichotomized into a positive and negative score, or trichotomized into "least", "moderate", and "most" scores. The definition of categories for each barrier will be dependent on the scale and frequency distribution associated with each.

The paper will first describe the baseline characteristics of the LIFE participants comparing level/category of each individual barrier/facilitator. Analysis of variance comparing means of continuous characteristics, and chi-square tests comparing categorical characteristics, will be used. Individual barrier/facilitator effects will be examined overall LIFE Study population first. The longitudinal relationship between baseline barriers/facilitators and major mobility disability (MMD) in the overall population will be assessed using cox proportional hazards regression with MMD as a time to event outcome variable, adjusting for sex and site.

The relationship of baseline barriers/facilitators and the impact of the structured physical activity intervention on MMD will be explored among barriers/facilitators that emerge as statistically significant in the overall LIFE population. Cox proportional hazards regression models will be run adjusting for sex and site. Adherence will be included as a covariate in separate models to explore its potential impact on the relationships between barriers/facilitators, the physical activity intervention, and MMD.

*Specific Aim 3*

(3) Evaluate the impact of social support as a specific barrier or facilitating factor to the improvement of physical function in community dwelling older adults.

Summary statistics will be reported as mean and SD for continuous variables and frequency and percentage for categorical variables. The primary outcome is SPPB. Perceived

social support from family, friends, and spouse/current partner will be measured by participant responses to the Perceived Isolation Subscale questions. An approach similar to that of Aim 2 will be used. Individual social support barriers will be assessed to examine univariate associations with improvement in the physical function. Each social support barrier's original categories will be retained for analysis.

The baseline characteristics of the AFEP/"10 Keys" Study participants will be described by level of support for each type of social support. Two-sample t-tests comparing means of continuous characteristics, chi-square tests comparing categorical characteristics, will be used. Individual social support barrier scores will be shown overall, by intervention group, and by baseline level of physical function. Generalized linear mixed models will be used to examine associations between social support and change in SPPB controlling for baseline value of SPPB and the cluster effect of site. Significant covariates that emerge during analyses will be adjusted for to control for possible confounding.

# 6.0 MANUSCRIPT 1: CHARACTERIZATION OF PERCEIVED BARRIERS INFLUENCING MOTIVATION AND SUCCESS IN LIFESTYLE PROGRAMS AIMED AT DISABILITY PREVENTION


## ABSTRACT

**Objective:** To characterize themes related to participant enrollment in the LIFE Study intervention programs aimed at mobility disability reduction in a subset of the LIFE Study population, and to explore whether the themes identified differed by type of intervention. Our purpose was to generate hypotheses surrounding the range of factors that contribute to engagement in and successful implementation of programs aimed at improved physical function and disability reduction among sedentary older adults. There was no a priori hypothesis given the exploratory nature of this study.

**Research Design and Methods:** The present study focused on the University of Pittsburgh Lifestyle Interventions and Independence for Elders (LIFE) Study field center. The qualitative analysis conducted in this study is based on text data extracted from completed baseline interviews with LIFE Study participants from the University of Pittsburgh study site. Responses to open-ended interview questions from study participants were read to identify codes for 1) all options participants provided in answering questions about motivation to join the LIFE Study, desired benefits, and past experience in health education/physical activity programs and

2) key themes. Variations in themes were explored based on the LIFE intervention program in which participants were enrolled.

**Results:** The analysis included 212 of 216 LIFE Study participants. The mean age of this population was 78.5 years and 76.9% were women. Twenty eight percent of participants were minorities and 40.3% had at least a high school education. The mean BMI at baseline was 30.6 and 42.6% of these participants had low physical function at baseline. Participants were motivated by the recruitment letter, and a desire to socialize and improve their own function, mobility, activity level, and knowledge. Participants in the structured physical activity intervention cited themes related to physical function and activity more frequently, while those in the health education intervention cited themes related to knowledge more often.

**Conclusions:** The results of this study indicate that there are a range of factors that contribute to engagement in lifestyle programs aimed at mobility disability prevention for sedentary older adults, and these factors may be related to the type of program. Messages in recruitment material can be tailored to successfully engage a diverse range of sedentary older adults at risk for functional decline in structured programs.

## 6.1 INTRODUCTION

The importance of physical activity for the aging population is well-known, as it is associated with a reduced risk for many chronic diseases and conditions that can impact physical function and mobility among older adults including colon and breast cancer, arthritis, type 2 diabetes, cardiovascular disease, and depression [62-67]. Moreover, evidence suggests that engaging in physical activity is associated with better physical function and longer life expectancy in older adults compared with those who are sedentary [68-70]. Unfortunately, the prevalence of older adults engaging in recommended levels of physical activity is only ~4%-32% [60, 61]. This is alarming given that lower physical function, mobility disability and the possibility of subsequent physical disabilities are major public health issues due to the rapid and continuing growth of the older adult population [1-3]. Developing evidence to understand why older adults are not engaging in physical activity is an area that needs attention given the magnitude of this public health challenge.

Structured lifestyle programs may be successful in engaging older adults in physical activity and reducing risk for disability. Research shows that structured physical activity interventions are associated with improved physical function among older adults [79-82]. The Lifestyle Interventions and Independence for the Elders (LIFE) Study reported physical activity can improve physical function and reduce major mobility disability (MMD) through a structured intervention among sedentary older adults at risk for mobility disability [58, 83]. The results of the LIFE Study showed that a physical activity intervention significantly reduced MMD by 18% among older adults at risk for disability compared with a health education intervention over 2.6 years of follow-up, although older adults in both structured interventions experienced a risk reduction [53, 58, 84]. Beyond adherence to the interventions, it is still unclear what

mechanism(s) (i.e. barriers and facilitators) underlie why these sedentary older adults were motivated and successful in these structured lifestyle intervention programs.

Current research conducted on older adults' engagement in physical activity and related programs focuses primarily on characteristics of regular exercisers compared with non-exercisers, physical activity behavior adoption, and physical activity preferences [108, 111, 122, 141-144]. Although studies have reported on associations of perceived barriers and benefits with physical activity and related programs, little research in this area has focused on the sedentary older adult population at risk for mobility disability [8-11]. Knowledge about the role of organized programs for older adults, and their perceptions of them, is needed and lacking. Research emphasizes the need to consider perceived barriers and facilitators, but also what beliefs exist about the benefits to engaging in programs aimed at disability prevention [12]. The present study aims to fill this gap in the current knowledge.

As the population ages dramatically, innovative and effective interventions targeted at reducing the risk for physical disability in older adults along the disablement pathway will become increasingly important. A better understanding of motivators, benefits, and past experiences with structured interventions or related programs will provide evidence of considerations needed to engage sedentary older adults. The aims of this qualitative study were to characterize themes related to participant enrollment in the LIFE Study intervention programs aimed at mobility disability reduction in a subset of the LIFE Study population, and to explore whether the themes identified differed by type of intervention. Our purpose was to generate hypotheses surrounding the range of factors that contribute to engagement in and successful implementation of programs aimed at improved physical function and disability reduction among

sedentary older adults. There was no a priori hypothesis given the exploratory nature of this study.

## 6.2 METHODS

### 6.2.1 Study Design

The Lifestyle Interventions and Independence for Elders (LIFE) Study is a multicenter, single-blinded, parallel randomized trial conducted at eight field centers: University of Florida, Gainesville, Florida; Northwestern University, Chicago, Illinois; Pennington Biomedical Research Center, Baton Rouge, Louisiana; University of Pittsburgh, Pittsburgh, Pennsylvania; Stanford University, Stanford, California; Tufts University, Boston, Massachusetts; Wake Forest University, Winston-Salem, North Carolina; and Yale University, New Haven, Connecticut [58, 84]. Field centers included urban, suburban, and rural communities. The LIFE Study was originally designed to examine the impact of a long-term structured physical activity program on the risk for major mobility disability compared with a health education program in sedentary older adults at risk for disability [58]. The Institutional Review Board at all participating field centers approved the study protocol. The present study focused on the University of Pittsburgh LIFE Study field center.

### 6.2.2 Participants

Methods of recruitment included mailed brochures and letters to age-eligible residents, community events/outreach, print advertisement (newspaper, magazines), television and radio, flyers, newsletters, Internet, and personal referral. Each LIFE Study field center was encouraged to tailor recruitment plans to best suit the needs of their local communities. Study sites employed a variety of recruitment strategies and the Pittsburgh field center focused primarily on personalized letters compared with other methods. Specific details of the LIFE Study recruitment procedures and methods were previously published [84]. Eligibility criteria to participate in the LIFE Study included men and women aged 70 to 89 years who were sedentary (reported under 20 minutes per week engaged in regular physical activity over the past month and under 125 minutes per week of moderate physical activity); were at high risk for mobility disability (based on Short Physical Performance Battery (SPPB) score of 9 or less out of 12 indicating lower extremity functional limitations); could walk 400 meters in less than 15 minutes without sitting, leaning, or help from another person or walker; had no major cognitive impairment (measured by the Modified Mini Mental State Examination (3MSE)); and could participate safely in the intervention (determined by physical examination, medical history, and resting electrocardiography) [58, 83, 84].

In the parent study 14,812 telephone screens resulted from a 21-month recruitment period. Primary reasons for exclusion among those that telephone screened (37.6%) were regular participation in physical activity, health exclusions, and self-reported mobility disability. A total of 1635 people consented and were enrolled in the LIFE Study, with 818 randomized to the Physical Activity (PA) intervention and 817 randomized to the Successful Aging (HE) intervention [84].

The mean age of the overall LIFE Study population was 78.9 years and 67.2% were women. Twenty-one percent of the participants were minorities (17.6% were African American). The average length of follow-up was 2.6 years [58]. In the present study data were restricted to 216 participants at the University of Pittsburgh field center.

### 6.2.3 Interventions (Physical Activity vs Successful Aging)

The LIFE Study physical activity (PA) intervention involved walking, with a goal of 150 minutes per week, strength flexibility, and balance training [53]. Participants in the PA group attended two LIFE center-based visits per week and engaged in home-based activity 3-4 times per week for the duration of the study (24-42 months, average 2.6 years) [53]. The sessions progressed towards a goal of 30 minutes of walking daily (at moderate intensity), 10 minutes of lower extremity strength training (using ankle weights), 10 minutes of balance training, and large muscle group flexibility exercises [53].

The LIFE Study successful aging (HE) intervention focused on health education surrounding successful aging. Participants attended weekly workshops during the first 26 weeks, followed by monthly sessions for the remainder of the study [53]. The HE intervention workshops covered a variety of topics relevant to older adults other than physical activity, such as nutrition, preventive services and screening recommendations, and how to effectively navigate the health care system [53]. The workshops also included 5 to 10 minutes of instructor led gentle upper extremity stretching or flexibility exercises [53].

#### 6.2.3.1 Assessments

Participant assessments were conducted every 6 months at LIFE center clinic visits, by staff blinded to the intervention group. Baseline assessment and follow-up measures included self-reported demographic and contact information, interviewer administered questionnaires, and physical examination. Major mobility disability (MMD), the primary outcome of the main trial, was assessed at each participant contact. MMD was defined as the inability to complete a usual-paced 400-meter walk test within 15 minutes without sitting and without the help of another person (using a straight cane was acceptable) [53].

#### 6.2.3.2 Variables of Interest

The text data used for this analysis were obtained from a series of questions asked of LIFE Study participants during an initial counseling session known as the "First Individual Face-to-Face Contact". These interviews were conducted with participants by LIFE Study staff at each field center at baseline post-randomization. During this session participants met the interventionist who served as an individual counselor, received an overview of the LIFE Study intervention to which they were randomized, reviewed the goals of the intervention program, discussed personal outcome expectations and concerns, and reviewed results from baseline clinic assessments. The interventionist discussed the participant's past health education and physical activity program experiences, motives and incentives, and factors that may inhibit and facilitate participation.

Participants in both intervention groups were asked, "What led you to join the LIFE Study?" and "What benefits do you hope to achieve?" Those in the PA intervention were asked "What has been your past experience with physical activity/exercise programs?" while participants in the HE intervention were asked "What has been your past experience with health

education programs?" Study participants provided individual responses to these open-ended interview questions, which were administered by three study staff interventionists (2 for PA program, 1 for HE program) at the Pittsburgh field center. Responses were recorded verbatim or interpreted by the interventionist on paper forms and entered into the data entry system as text fields.

The analyses of this study are based on completed baseline interviews with 212 of 216 LIFE Study participants from the University of Pittsburgh study site. Four of 216 did not attend a baseline interview. All 212 participants (n=108 PA, n=104 HE) completed baseline interviews and responded to the three questions described. Interview data were analyzed according to these two categories ("Physical Activity Group" and "Successful Aging Group"). This approach was most grounded in the data and we suspected each category might offer different insights that could inform lifestyle intervention program recruitment and retention.

#### 6.2.3.3 Qualitative Analysis

Atlas.ti software was used to manage data and to facilitate analysis. Two members of the research team worked collaboratively on the analysis. Responses to the open-ended baseline face-to-face interview questions from the LIFE Pittsburgh study participants were read to identify codes for 1) all options participants provided in answering questions about motivation to join the LIFE Study, desired benefits, and past experience in health education/physical activity programs and 2) key themes. One team member read every individual participant response provided and then developed codes that defined themes for each of the research questions evaluated. The two team members working on this analysis met regularly to review and discuss the iterative process. Themes were then compared and combined or separated by the analyst based on similarities and differences and on frequency analysis. Once coding was complete,

coding memos were developed on key areas of interest to summarize findings and provide example quotations.

We explored variations in themes for two categories of program participation to examine if motivators, desired benefits, and past experience were different based on the LIFE intervention program in which participants were enrolled. The first category included only Pittsburgh LIFE Study participants randomized to the Physical Activity (PA) intervention. The second category comprised Pittsburgh LIFE participants randomized to the Successful Aging (HE) intervention. The research team discussed final themes until consensus was achieved. Inter-rater agreement was not calculated because coding was completed by one researcher and finalized by consensus.

## 6.3 RESULTS

### 6.3.1 Study Sample Characteristics

Pittsburgh LIFE Study participant baseline demographics are displayed in Table 3. The mean age of this population was 78.5 years and 76.9% were women. Twenty eight percent of participants were minorities and 40.3% had at least a high school education. The mean BMI at baseline was 30.6 and 42.6% of these participants had low physical function at baseline, defined as a SPPB score of 7 or less out of 12 total points. There were no differences among participants at baseline with respect to sex, age, race, education, body mass index (BMI), and physical function.

### 6.3.2 Themes Related to LIFE Study Participation

***Motivators to joining the LIFE Study***

Top themes related to motivators to joining the LIFE Study are summarized in Table 4. Some participants contributed data to more than one theme, dependent on his/her individual response to the baseline face to face interview question. The most common motivator was the study recruitment letter.

Common personal motivators were the desire to improve physical function and/or mobility ("She wants to improve her ability to walk and also to avoid a decline in physical function"), the desire to increase physical activity, curiosity, and the desire to get out of the house and do something ("…was looking to do something outside of her home, get active in something. Husband in a nursing home long term."). Other personal motivators mentioned less frequently and not included in Table 4 were the desire to help others, maintain independence and quality of life, and the ability to socialize.

Comparing motivators by intervention program, there were some differences in the frequency of themes. Only those in the HE group mentioned the study recruitment letter. Participants in the PA group mentioned motivators related to mobility and physical activity more frequently compared with those in the HE group. However, when these themes were mentioned, the content of the participant responses was similar between the two intervention groups.

***Benefits to participating in the LIFE Study Interventions***

Table 5 summarizes benefits participants hoped to achieve from the Physical Activity (PA) and Successful Aging (HE) LIFE intervention programs. In general, benefits participants cited during the baseline face to face interview were related to personal improvement and maintenance. The most frequently cited theme was improving physical function and mobility

("Improve ability to walk more. Can walk a city block but wants to do more. Increase leg strength"). Increasing energy ("Achieve an increased level of energy"), improving and maintaining one's own health, and improving and maintaining independence and quality of life ("Does not want daughter to have to take care of her") were also mentioned often. Other common themes were the desire to learn and increase knowledge ("Knowledge of aging gracefully") and socialization ("Socialization 'I'm a lonely person'").

There were differences in themes related to benefits by intervention group. Only participants in the HE group cited a desire to learn and increase knowledge. Improving physical function and mobility and increasing energy appeared more often in the PA group responses compared with the HE group responses.

***Past experience with similar physical activity or health education programs***

Themes related to LIFE Study participants' past experience with physical activity or health education programs are summarized in Table 6. Overall, the most common theme was none. In other words, most participants cited no prior experience with some sort of physical activity or health education program. The content of the responses in both intervention program groups was similar with respect to this theme. Among those who cited some prior experience, the most frequently cited themes were community based ("Nutrition classes in the community"), health club or gym based ("Has been a member of a gym in the past"), and physical therapy based ("Participant's only experience with physical activity is the rehab after her knee replacement"). Other themes were home- ("Ppt. has treadmill at home"), neighborhood- ("Has walked for exercise in his neighborhood in the past"), health condition- ("Diabetes class 3 years ago, enjoyed the class"), and profession-based ("Attended health and elder care lectures at the nursing home where she was employed x 12 years").

The main difference in themes between the PA group compared with the HE group was that themes related to activity, specifically health club or gym based, physical therapy based, and neighborhood based, were only cited among participants in the PA group. Health condition based and profession based prior experience were only mentioned among those in the HE group.

## 6.4 DISCUSSION

The results of this study indicate that there are a range of factors that contribute to engagement in lifestyle programs aimed at mobility disability prevention for sedentary older adults, and these factors may be related to the type of program. Participants were motivated by the recruitment letter, and a desire to socialize and improve their own function, mobility, activity level, and knowledge.

A key implication of these findings is that messages in recruitment material can be tailored to successfully engage a diverse range of sedentary older adults at risk for functional decline in structured programs. Our study examined a small sample within a national cohort of sedentary older adult study participants lending support for future exploration of large populations enabling more generalizable suggestions for engaging older adults in physical activity and structured lifestyle programs. This study also provides evidence that it may be helpful to design studies to examine the specific themes that emerged more deeply. Future studies addressing this might seek to utilize the stages of change and the transtheoretical model to focus on issues related to changing perceptions and specific needs of older adults with different profiles. Other studies have demonstrated that the transtheoretical model can be applied to interventions and used to successfully engage older adults in physical activity that they can

maintain [107-111, 124]. Research needs to acknowledge that unique strategies of recruitment and facilitating behavior change may be needed for older adults in different stages of change. Specific processes of the stages of change, such as consciousness raising and helping relationships, could be embedded within recruitment approaches [108, 109, 145]. Applying various modes and mechanisms of communication could result in improved methods of recruitment, and move older adults along the stages of change. This may in turn result in development of more sustainable programs, inclusion of a wider variety of older adults, and ultimately a greater magnitude of improvement in the health of this population. Expansion of this research will be increasingly important as the aging population grows along with the public health burden of disability.

Although other studies have mentioned the importance of studying what motivators, barriers, and beliefs exist about the benefits to engaging in programs aimed at disability prevention, very few have focused on exploring these factors in the sedentary older adult population at risk for mobility disability [8, 10-12]. One study examined motivators and beliefs regarding physical activity behavior in independent-living older adults and reported maintaining health and socialization as shared motivators [124]. We found that these same themes carry over to structured program participation as well. A more recent study sought to understand older adults' motivators and barriers related to participation in structured programs that support physical activity by comparing program joiners with decliners [146]. These investigators found that socialization and marketing materials were among the most frequently cited motivators to program participation [146]. Our study complements these findings in that recruitment material and socialization emerged as commonly cited themes related to structured lifestyle programs in sedentary older adults, lending strength to both studies.

There are several limitations to this study that need to be addressed. We conducted this study in a small sample of the LIFE Study participants, which limits our findings. First, we cannot assume that these results are similar at other LIFE Study field centers or across the entire LIFE Study population. Second, the LIFE Study was a population of sedentary older adults at risk for major mobility disability at study entry. Therefore our results can only be generalized to a similar population of older adults. Third, the data used for the qualitative analysis was only collected at baseline. This permitted a cross-sectional exploration, but it is likely that participant perceptions of their motivators and desired benefits are not static. Future studies should aim to overcome this limitation by making of use longitudinal data or structured interviews to inquire about changing perceptions over time. The nature of the data we used also limited our study. It was not possible to avoid a potential interviewer bias given that study staff recorded the participant responses we evaluated. There were only three staff members (2 PA, 1 HE) involved in administering these interviews reducing any associated bias. Finally, as is illustrated in the results of our study, the responses provided by participants regarding motivators, beliefs, and past experiences were very short in length. Longer structured or semi-structured interviews or focus group data may have provided richer results. This also limited our ability to gain further insight into commonly cited themes such as the recruitment letter. It would be valuable to learn what specific components of the letter motivated study participants.

Strengths of our study include its novelty. To our knowledge, this is the first study to qualitatively explore factors that contribute to engagement in lifestyle programs aimed at mobility disability prevention for sedentary older adults. Since study participants were already randomized at baseline but had not started the intervention, we had the ability to examine whether themes were specific to the type of intervention program assignment. Our findings

emphasize the importance of messages for the recruitment of older adults, and considerations needed if we want to motivate this population to join and engage in structured programs aimed at disability prevention.

In conclusion, this study allowed for the characterization of suggested themes that cannot be captured using quantitative assessments and examination of potential differences by structured intervention group. The results offer insights that can inform lifestyle intervention program recruitment and retention among the sedentary older adult population. This could inform the development of future intervention efforts aimed at disability prevention and provide guidance for the translation of evidence-based programs to the community.

## 6.5 TABLES

**Table 3. Baseline Characteristics of Pittsburgh LIFE Study participants overall and by intervention group**

| **Characteristic** | **Overall Population (N=216)** | **Health Education (control) (N=106)** | **Physical Activity (N=110)** | **P-Value** |
|---|---|---|---|---|
| **Sex**, n (%) | | | | |
| Men | 50 (23.1) | 24 (22.6) | 26 (23.6) | 0.86 |
| Women | 166 (76.9) | 82 (77.4) | 84 (76.4) | |
| **Age**, mean (SD), years | 78.5 (5.1) | 78.2 (5.3) | 78.7 (4.9) | 0.50 |
| **Race**, n (%) | | | | |
| Non-Hispanic White | 155 (71.8) | 78 (74.3) | 76 (69.1) | 0.40 |
| Other | 61 (28.2) | 27 (25.7) | 34 (30.9) | |
| **Education**, n (%) | | | | |
| High school | 87 (40.3) | 38 (35.8) | 49 (44.5) | 0.09 |
| College | 82 (38.0) | 48 (45.3) | 34 (31.0) | |
| Graduate School | 41 (19.0) | 19 (17.9) | 22 (20.0) | |
| Other | 6 (2.7) | 1 (1.0) | 5 (4.5) | |
| **SPPB Score**, 0-12 | | | | |
| SPPB < 8 | 92 (42.6) | 51 (48.1) | 41 (37.3) | 0.11 |
| SPPB 8-9 | 124 (57.4) | 55 (51.9) | 69 (62.7) | |
| **BMI,** mean (SD) | 30.6 (5.9) | 30.3 (6.2) | 30.9 (5.6) | 0.47 |

*SPPB: Short Physical Performance Battery, BMI: body mass index

**Table 4. Motivators to joining LIFE Study: major theme among Pittsburgh LIFE participants**

| Theme | Sample Quotations |
|---|---|
| Recruitment Letter | "Received a letter"<br>"Letter, age range was a fit!" |
| Improve Function/Mobility | "She wants to improve her ability to walk and also to avoid a decline in physical function"<br>"I thought I could improve my walking" |
| Increase Physical Activity | "Joined LIFE Study due to being very sedentary and wants to get active."<br>"Desire for exercise" |
| Something To Do | "Because she was looking to do something outside of her home, get active in something. Husband in nursing home long term."<br>"Desire to do something prompted the call." |
| Curiosity/Interest | "Thought it was interesting"<br>"Curious" |
| Improve Health | "Joined LIFE to live a healthier life"<br>"Interest in better health for aging." |
| Need Motivation | "She needs to be motivated in order to exercise and is hoping the LIFE Study can achieve this."<br>"I needed something to motivate me off of the couch" |
| Friend | "Saw a friend's picture on the cover of the LIFE Study flyer and it inspired her to join."<br>"Friend in the study encouraged me to join." |
| Learn | "Joined study to increase knowledge and learn"<br>"Learn more about healthy aging." |
| Improve Independence/Quality of Life | "Joined the LIFE Study as a way to increase independence. Wants to stay out of nursing home."<br>"Interested in learning how to prolong my life, improve my life" |

**Table 5. Desired benefits from LIFE intervention programs: major themes among Pittsburgh LIFE participants**

| Theme | Sample Quotations |
|---|---|
| Improve Function/Mobility | "Improve ability to walk more. Can walk a city block but wants do to more. Increase leg strength"<br>"Move more around the house and neighborhood." |
| Learn/Increase Knowledge | "Knowledge of aging gracefully"<br>"Learn about aging and my health." |
| Improve Health | "Become healthier / feel good"<br>"Improvement in my health" |
| Socialization/Social Support | "Meeting new people"<br>"Socialization 'I am a lonely person'" |
| Increase Energy | "Achieve an increased level of energy"<br>"Increase energy along with increasing stamina in legs" |
| Improve Independence/Quality of Life | "Lose fear of walking and enjoy life"<br>"Any lifestyle adjustments I need to make to enhance my quality of life" |
| Maintain Health | "Maintain health and weight."<br>"Maintain continued good health status" |
| Weight Loss | "Lose some weight"<br>"Education on losing weight" |
| Maintain Independence/Quality of Life | "Does not want daughter to have to take care of her."<br>"Continue to live independently" |
| Increase Physical Activity | "Increase her physical activity level."<br>"Hopes to increase exercise" |

**Table 6. Past experience with physical activity and health education programs: major themes among Pittsburgh LIFE participants**

| Theme | Sample Quotations |
|---|---|
| None | "No past exercise experience"<br>"No previous health education" |
| Community Based | "Silver Sneakers"<br>"Nutrition classes in the community" |
| Health Club/Gym | "10 years at healthclub"<br>"Has been a member of a gym in the past" |
| Physical Therapy | "Participant's only experience with physical activity is the rehab after her knee replacement."<br>"Done physical therapy a few times." |
| Home Based | "Ppt. has treadmill at home."<br>"Self-educates at home" |
| Neighborhood/Park | "Has walked for exercise in his neighborhood in the past"<br>"Used to walk at the Highland Park reservoir." |
| Walker | "She used to walk with her husband while he was alive."<br>"Tries to walk every day, has to have a destination though" |
| Health Condition Based | "Diabetes class 3 years ago, enjoyed the class."<br>"Dietitian-weekly after knee surgery x 6 weeks." |
| Profession Based | "Attended health and elder care lectures at the nursing home where she was employed x 12 years."<br>"Registered nurse, attended presentations for nursing license." |
| Unspecified | "Past exercise experience: inconsistent"<br>"Some programs-'they were interesting, but not complete'" |

# 7.0 MANUSCRIPT 2: EFFECTS OF BASELINE PERCEIVED BARRIERS AND FACILITATING FACTORS ON REDUCTION OF MAJOR MOBILTIY DISABILITY IN A RANDOMIZED TRIAL


## ABSTRACT

**Objective:** To assess the impact of baseline barriers/facilitating factors on the effect of a moderate physical activity intervention and its ability to reduce the onset of major mobility disability in sedentary older adults at risk of mobility disability.

**Hypothesis:** A lack of barriers at baseline will be significantly associated with the effect of a physical activity intervention compared with a health education intervention on the reduction of major mobility disability in sedentary older adults at high risk of mobility disability in the LIFE Study intervention programs.

**Research Design and Methods:** The Lifestyle Interventions and Independence for Elders (LIFE) Study is a multicenter, single-blinded, parallel randomized trial conducted at eight field centers: University of Florida, Gainesville, Florida; Northwestern University, Chicago, Illinois; Pennington Biomedical Research Center, Baton Rouge, Louisiana; University of Pittsburgh, Pittsburgh, Pennsylvania; Stanford University, Stanford, California; Tufts University, Boston, Massachusetts; Wake Forest University, Winston-Salem, North Carolina; and Yale University, New Haven, Connecticut. The primary outcome was major mobility disability (MMD), defined as the inability to complete a usual-paced 400-meter walk test within 15

minutes without sitting and without the help of another person (using a straight cane was acceptable). The longitudinal relationship between baseline barriers/facilitators and major mobility disability (MMD) in the overall population was assessed using cox proportional hazards regression with MMD as a time to event outcome variable, adjusting for sex and site. The relationship of baseline barriers/facilitators and the impact of the structured physical activity intervention on MMD were explored among barriers/facilitators that emerged as statistically significant in the overall LIFE population.

**Results:** The mean age of the overall LIFE Study population was 78.9 years and 67.2% were women. Twenty-one percent of the participants were minorities (17.6% were African American). The average length of follow-up was 2.6 years. Among participants without a personal conflict barrier at baseline, the PA intervention was associated with a significant reduction in MMD compared with the Successful Aging (HE) intervention (HR, 0.81 [95% CI: 0.67-0.98]; p=0.03). These results remained significant after accounting for the impact of adherence to the intervention programs (HR, 0.61 [95% CI: 0.50-0.75]; p<0.0001). There was no significant association between the PA intervention and MMD among those with a personal conflict barrier

**Conclusions:** Our results indicate that in the context of a structured intervention program it is important to take perceived barriers and facilitators into account. The PA intervention was more effective at reducing MMD compared with the HE intervention only among LIFE Study participants who cited they did not have any barriers related to personal conflict. However, PA was not more effective among those citing they did have barriers related to personal conflict. This implies that barriers may attenuate the effect of a structured physical activity program aimed at reducing MMD.

## 7.1 INTRODUCTION

Mobility is fundamental to the health and well-being of older adults and is defined as the ability to move around safely and effectively in the environment [2]. Mobility is directly related to the sustainability of an older adult's independence and quality of life. As the number of older adults in the United States and worldwide rises maintaining independent physical function in older adults is a central goal of public health. Unfortunately the prevalence of mobility disability and subsequent physical disability among older adults is high. Data from the 1999-2004 National Health and Nutrition Examination Survey (NHANES) report that among adults aged 60-69, 23% have IADL disability, 20% have ADL disability, 48% have functional limitations, and 30% have mobility disability [42]. These estimates are alarming and unfortunately more recent data shows that the burden of these issues is growing. The 2013 Disability Status Report, based on data from the U.S. Census Bureau's American Community Survey, reports that among adults ages 64-74 the overall prevalence rate is 25.8%. Specifically, the prevalence of disability related to independent living is 7.9%, while the prevalence rates of self-care disability and ambulatory disability are 4.5% and 15.8% respectively [3]. The overall and specific rates increase in adults aged 75 and older. Among this group of older adults, the overall disability prevalence rate is 50.7% [3].

Since mobility disability represents a critical stage in the disablement pathway during which the risk for physical disability increases greatly, it is essential to study extra- and intra-individual mechanisms, such physical activity and structured intervention programs, that could be modified to preserve physical function and mobility and prevent an individual older adult from progressing further into the disablement pathway toward physical disability [27, 35]. Targeting perceived barriers and facilitators related to success in physical activity and structured

intervention programs could be one way to reveal novel approaches to the improvement of mobility among the aging population.

Investigators of the Lifestyle Interventions and Independence for the Elders (LIFE) Study provided strong and conclusive evidence that physical activity can improve physical function and reduce major mobility disability through a structured intervention. These researchers studied sedentary older adults at risk for mobility disability in a large multicenter randomized controlled trial design. The results of the LIFE Study showed that a structured physical activity intervention significantly reduced major mobility disability (MMD) by 18% among older adults at risk for disability compared with a health education intervention over 2.6 years of follow-up [53, 58, 84]. Moreover, older adults with lower physical function (SPPB < 8) showed a trend towards reduced MMD compared with higher functioning participants (SPPB= 8 or 9) [58]. The evidence from this randomized trial is invaluable and suggests that structured interventions can reduce major mobility disability in older adults, especially those at risk for disability. The next important step in translating this research is studying how perceived barriers and facilitators impact one's success in structured interventions aimed at major mobility disability and the prevention of physical disability.

As the aging population continues to grow, so does the burden of major mobility disability on individuals, society, and the economy. Addressing factors related to major mobility disability in the disablement pathway, such as perceived barriers and facilitators, is pertinent to understanding where prevention efforts for older adults at risk of functional decline need to focus. Although studies have reported on associations of perceived barriers and benefits with physical activity and related programs, little research in this area has focused on the sedentary older adult population at risk for mobility disability [8-11]. Some studies have assessed barriers

to engaging in physical activity in limited settings (e.g. outside the U.S., nursing homes, primary care setting) and samples (e.g. young adults, older women, participants with existing chronic diseases and disability) [120, 134-138]. Other studies are limited by a cross-sectional design and a focus on only physical/environmental barriers [117, 139]. Moreover, to the best of our knowledge no studies have examined how perceived barriers, facilitators, or other factors are directly related to the onset of major mobility disability in a population of sedentary older adults at risk for mobility disability followed longitudinally.

In assessing the effects of barriers and facilitating factors in the LIFE Study population a unique opportunity exists to address this major public health issue in the context of a multicenter randomized trial with a large study population. If these baseline attributes are predictive of those that are more likely to reduce their risk of MMD, this information would be helpful when implementing structured, evidence-based programs aimed at preventing disability among lower functioning older adults. If we know in advance who might not respond to physical activity interventions due to the existence of barriers, then we could adapt programs with the use of booster sessions for example, to facilitate better and sustained engagement for older adults. The objective of this study is to assess the impact of baseline barriers/facilitating factors on the effect of a moderate physical activity intervention and its ability to reduce the onset of major mobility disability in sedentary older adults at risk of mobility disability. We hypothesize that a lack of barriers at baseline will be significantly associated with the effect of a physical activity intervention compared with a health education intervention on the reduction of major mobility disability in sedentary older adults at high risk of mobility disability in the LIFE Study intervention programs.

## 7.2 METHODS

### 7.2.1 Study Design

The Lifestyle Interventions and Independence for Elders (LIFE) Study is a multicenter, single-blinded, parallel randomized trial conducted at eight field centers: University of Florida, Gainesville, Florida; Northwestern University, Chicago, Illinois; Pennington Biomedical Research Center, Baton Rouge, Louisiana; University of Pittsburgh, Pittsburgh, Pennsylvania; Stanford University, Stanford, California; Tufts University, Boston, Massachusetts; Wake Forest University, Winston-Salem, North Carolina; and Yale University, New Haven, Connecticut [58, 84]. The LIFE Study was originally designed to examine the impact of a long-term structured physical activity program on the risk for major mobility disability compared with a health education program in sedentary older adults at risk for disability [58]. The Institutional Review Board at all participating field centers approved the study protocol.

### 7.2.2 Participants

Methods of recruitment included mailed brochures and letters to age-eligible residents, community events/outreach, print advertisement (newspaper, magazines), television and radio, flyers, newsletters, Internet, and personal referral. Each LIFE Study field center was encouraged to tailor recruitment plans to best suit the needs of their local communities. Study sites employed a variety of recruitment strategies and the Pittsburgh field center focused primarily on personalized letters compared with other methods. Specific details of the LIFE Study recruitment procedures and methods were previously published [84]. Eligibility criteria to

participate in the LIFE Study included men and women aged 70 to 89 years who were sedentary (reported under 20 minutes per week engaged in regular physical activity over the past month and under 125 minutes per week of moderate physical activity); were at high risk for mobility disability (based on Short Physical Performance Battery (SPPB) score of 9 or less out of 12 indicating lower extremity functional limitations); could walk 400 meters in less than 15 minutes without sitting, leaning, or help from another person or walker; had no major cognitive impairment (measured by the Modified Mini Mental State Examination (3MSE)); and could participate safely in the intervention (determined by physical examination, medical history, and resting electrocardiography) [58, 83, 84].

In the parent study 14,812 telephone screens resulted from a 21-month recruitment period. Primary reasons for exclusion among those that telephone screened (37.6%) were regular participation in physical activity, health exclusions, and self-reported mobility disability. A total of 1635 people consented and were enrolled in the LIFE Study, with 818 randomized to the Physical Activity (PA) intervention and 817 randomized to the Successful Aging (HE) intervention [84].

The mean age of the overall LIFE Study population was 78.9 years and 67.2% were women. Twenty-one percent of the participants were minorities (17.6% were African American). The average length of follow-up was 2.6 years [58].

### 7.2.3 Interventions (Physical Activity vs Successful Aging)

The LIFE Study physical activity (PA) intervention involved walking, with a goal of 150 minutes per week, strength flexibility, and balance training [53]. Participants in the PA group attended two LIFE center-based visits per week and engaged in home-based activity 3-4 times

per week for the duration of the study (24-42 months, average 2.6 years) [53]. The sessions progressed towards a goal of 30 minutes of walking daily (at moderate intensity), 10 minutes of lower extremity strength training (using ankle weights), 10 minutes of balance training, and large muscle group flexibility exercises [53].

The LIFE Study successful aging health education (HE) intervention focused on successful aging. Participants attended weekly workshops during the first 26 weeks, followed by monthly sessions for the remainder of the study [53]. The HE intervention workshops covered a variety of topics relevant to older adults other than physical activity, such as nutrition, preventive services and screening recommendations, and how to effectively navigate the health care system [53]. The workshops also included 5 to 10 minutes of instructor led gentle upper extremity stretching or flexibility exercises [53].

#### 7.2.3.1 Assessments

Participant assessments were conducted every 6 months at LIFE center clinic visits, by staff blinded to the intervention group. If participants were unable to come to the clinic home, telephone and proxy assessments were attempted. Baseline assessment and follow-up measures included self-reported demographic and contact information, interviewer administered questionnaires, and physical examination including body weight, a usual-paced 400-meter walk test, and Short Physical Performance Battery.

#### 7.2.3.2 Outcome Measure

Major mobility disability (MMD), the primary outcome of interest, was assessed objectively every 6 months for at least 24 months and up to 42 months. MMD was defined as the inability to complete a usual-paced 400-meter walk test within 15 minutes without sitting and

without the help of another person (using a straight cane was acceptable) [53]. Study participants were instructed to walk 400 meters at their usual pace on a 20-meter course for 10 laps (40 meters/lap) without overexertion. A 1-minute pause for fatigue or related symptoms was permitted during the test. If MMD could not be objectively measured at the clinic site or at the participant's home, institution, or hospital as a result of the absence of a suitable walking course then an alternative adjudication of MMD was created. This was based on self-, proxy-, or medical record-reported inability to walk across a room, or on objective inability to walk 4 meters in less than 10 seconds [53, 58]. Meeting these alternative criteria indicated a participant's inability to complete the 400-meter walk within 15 minutes. The time of the last definitive assessment of MMD defined censorship.

#### 7.2.3.3 Predictor Variables

Barrier and facilitator predictor variables were obtained from a series of questions asked of LIFE Study participants post-randomization during an initial counseling session known as the "First Individual Face-to-Face Contact". During this session participants met the interventionist who served as an individual counselor, received an overview of the LIFE Study intervention to which they were randomized, reviewed the goals of the intervention program, discussed personal outcome expectations and concerns, and reviewed results from baseline clinic assessments. These interviews were conducted with participants by LIFE Study staff at each field center. Five questions were used to assess potential barriers and facilitators related to (1) personal conflict, (2) family and friends, (3) doctor, (4) confidence, and (5) valuing goals. 1) Participants were asked "Are there any things that may get in the way of your participating fully in the LIFE Physical Activity/Successful Aging Program such as taking care of a spouse or other family member, volunteer or paid work, health issues, or current physical symptoms?" Response

options were: yes and no. 2) Participants were asked, “Do you think your family and friends will be positive, negative, or really won’t care either way (a rating of 0) about your being physically active at home/participation in the Successful Aging Program?” And 3) “Do you think your family physician is positive, negative, or really doesn’t care either way (a rating of 0) about your being physically active at home/participation in the Successful Aging Program?” Participants were to choose a number on a scale ranging from -3 (extremely negative) to 3 (extremely positive). 4) Participants were asked, “At this point in time, how confident are you that you will be able to do what we are asking you to do?” Participants were to rank their confidence on a scale from 0 (Not at all confident) to 10 (Extremely confident). 5) “Considering everything in your life at this time, how much do you value these goals?” Participants were to choose a number on a scale from 0 (Not at all) to 10 (The most important goal(s) in my life).

#### 7.2.3.4 Other Covariates

Age, sex, race, education, body mass index (BMI), baseline Short Physical Performance Battery (SPPB) score, study intervention arm, site, and adherence were considered as potential covariates. Age, sex, race, and education were ascertained by self-report at baseline. Objective measurements of height and weight collected by blinded study staff were used to calculate BMI. The SPPB consisted of a 3 increasingly challenging balance tests, a 4-meter walk at usual pace, and a timed repeated chair stand. A score from 0 (inability to complete test) to 4 (best performance) was assigned to each measure to obtain a total score ranging from 0 to12. Adherence was calculated as the percentage of intervention sessions attended.

### 7.2.4 Statistical Analysis

Statistical analyses were conducted using SAS version 9.3 (SAS Institute, Cary, NC). Significance was set at 0.05 for two-sided hypothesis testing. Summary statistics were reported as mean and SD for continuous variables and frequency and percentage for categorical variables. Distributions of all variables were examined prior to analysis.

The primary outcome was major mobility disability (MMD), defined as the inability to complete a usual-paced 400-meter walk test within 15 minutes without sitting and without the help of another person (using a straight cane was acceptable) [53]. Individual baseline barriers/facilitators from the baseline first face-to-face contact interview were assessed to examine univariate associations with reduction in major mobility disability, and the structured physical activity intervention program. Each individual baseline barrier/facilitator was dichotomized into a positive and negative score, or trichotomized into “least”, “moderate”, and “most” scores. The definition of the categories for each barrier was dependent on the scale and frequency distribution associated with each.

The baseline characteristics of the LIFE Study participants were described by level of each barrier/facilitator. Analysis of variance and chi-square tests comparing means of continuous characteristics and categorical characteristics were used, respectively. Individual barrier/facilitator effects on MMD were examined in overall LIFE Study population. The longitudinal relationship between baseline barriers/facilitators and major mobility disability (MMD) in the overall population was assessed using cox proportional hazards regression with MMD as a time to event outcome variable (up to 42 months), adjusting for sex and site. These models were also run adjusting for study arm, age, body mass index, baseline Short Physical Performance Battery (SPPB) score, and adherence to explore the impact of these variables.

The relationship of baseline barriers/facilitators and the impact of the structured physical activity intervention on MMD were explored. Cox proportional hazards regression models were run adjusting for sex and site. Adherence was included as a covariate in separate models to explore its potential impact on the relationships between baseline barriers/facilitators, the physical activity intervention, and MMD.

## 7.3 RESULTS

The demographic characteristics of the LIFE Study population are described by baseline barrier/facilitator status in Tables 7 and 8. There were no significant differences in level of family/friend, doctor, and personal conflict status by sex, race, education, and body mass index (BMI) (Table 7). There was a statistically significant difference in the frequency of baseline friend and family barrier status by study intervention arm, with a greater percentage of those in the HE arm reporting that friends and family care the least compared with those in the PA arm (14.6% vs 10.2%), p=0.01 (Table7). There was a difference in personal conflict by study arm and baseline SPPB score. A larger percentage of those in the PA arm reported having some other personal conflict that may interfere with intervention program participation compared with the HE arm (22.0% vs 10.4%), $p<0.0001$. Also, a greater percentage of LIFE Study participants with a better SPPB score at baseline (8 or 9) reported having some other personal conflict that may interfere with intervention program participation compared with those with a lower SPPB score at baseline (18.1% vs 14.1%), p=0.03. There was a statistically significant difference in age across categories of doctor barrier/facilitator status such that those reporting their doctor

cared moderately had a higher mean age (80.4 $\pm$ 5.1yrs) compared with those reporting their doctor cared the least (78.9 $\pm$ 5.4yrs) and the most (78.7 $\pm$ 5.3yrs), p=0.02 (Table 7).

Demographic characteristics did not differ in level of confidence or valuing goals by age and BMI (Table 8). A higher percentage of participants in the HE arm (56.5%) compared with those in the PA arm (39.5%) were most confident in their ability to do what was asked of them in the intervention programs, p<0.0001. Several significant differences were found by level of valuing goals (Table 8). Women reported valuing goals the most compared with men (52.3% vs 40.6%), p=0.0001. Compared with those who were non-Hispanic white, a greater percentage of participants of other races reported valuing goals the most (60.1% vs 44.9%), p<0.0001. One hundred percent of LIFE Study participants with no formal education (100%) valued goals the most compared with participants with other levels of education, p=0.01. A higher percentage of participants with low SPPB scores (7 or less) valued goals the most compared with those who had better SPPB scores at baseline (52.9% vs 44.9%), p=0.002. More participants in the HE arm reported valuing goals the least compared with those in the PA arm (9.1% vs 4.6%), p=0.001.

Table 9 shows the results of the associations between each barrier predictor and major mobility disability (MMD) in the overall LIFE Study population. Participants who identified that some personal conflict may interfere with their ability to take part in the intervention programs compared with those that did not had significantly less risk of major mobility disability (HR, 0.71 [95% CI, 0.56-0.90]; p=0.005) after adjusting for sex and site. These results were consistent but attenuated after adjusting for age, body mass index, adherence, and baseline Short Physical Performance Battery score (HR, 0.66 [95% CI, 0.52-0.84]; p=0.0006). No other barrier predictors were associated with MMD (Table 9).

Figures 1 and 2 illustrate the effects of the PA intervention program compared with the HE intervention program on MMD among those without a personal conflict barrier and those with a personal conflict barrier. Among participants without a personal conflict barrier at baseline, the PA intervention was associated with a significant reduction in MMD compared with the HE intervention after adjustment for sex and site (HR, 0.81 [95% CI: 0.67-0.98]; p=0.03) (Figure 1). These results remained significant after accounting for the impact of adherence to the intervention programs (HR, 0.61 [95% CI: 0.50-0.75]; p<0.0001). There was no difference between the PA and HE interventions on MMD among those with a personal conflict barrier (Figure 2).

## 7.4 DISCUSSION

The results of this study showed that self-reported identification of a personal conflict at baseline in the LIFE Study intervention was associated with a significant reduction in major mobility disability (MMD) among sedentary older adults at risk for mobility disability over an average of 2.6 years. No other barriers/facilitators had a significant impact on MMD. When examining the impact of the intervention programs on MMD while taking personal conflict barrier status into account, the significant effect of the PA intervention program on MMD compared with the HE intervention program remained only among LIFE Study participants who perceived that they did not have any personal conflict barriers. The PA intervention still significantly reduced MMD compared with the HE intervention among those without personal conflict barriers after accounting for the influence of adherence. Importantly, the PA intervention had no effect on MMD among those with a personal conflict barrier.

Our results indicate that in the context of a structured intervention program it is important to take perceived barriers and facilitators into account. The PA intervention was more effective at reducing MMD compared with the HE intervention only among LIFE Study participants who cited they did not have any barriers related to personal conflict. However, PA was not more effective among those citing they did have barriers related to personal conflict. This implies that barriers may attenuate the effect of a structured physical activity program aimed at reducing MMD. It may be critical to identify those with barriers during the recruitment process, as these participants may need additional remediation in order to be successful in reaching study goals. Booster sessions or supportive counseling targeted at addressing individual's specific barriers and changes over time may be beneficial throughout intervention programs.

The findings of this study support the existing literature that has acknowledged the importance of perceived barriers and benefits of physical activity and related programs in limited settings and samples [10-12, 121-123, 137-139, 147]. Our study extends this knowledge by its focus on the sedentary older adult population at risk for mobility disability in a multicenter randomized clinical trial setting. The LIFE Study was the largest and longest randomized trial of physical activity in sedentary older adults including a reliable, well-validated, and objectively measured assessment of major mobility disability [58]. The results of this landmark trial provided a strong foundation upon which our study was generated. Our findings expand the knowledge gained from the main LIFE Study by showing that a structured PA intervention program can reduce MMD compared with a HE intervention program when barriers related to personal conflict are not a factor. The hazard ratio for those without personal conflict barriers was similar to that which resulted from the main LIFE Study. Moreover, the hazard ratio of 0.61 after adjusting for adherence is actually lower than the reported hazard ratio of the main LIFE

Study. Given that this association is not seen when personal conflict barriers are a factor, we highlight the importance of studying how barriers and facilitators are involved in the disablement pathway. To the best of our knowledge this study is the first to examine how perceived barriers and facilitators are directly related to the impact of a moderate physical activity intervention and its effects on major mobility disability in a large population of sedentary older adults at risk for mobility disability followed longitudinally.

There were several limitations to the present study. First, the baseline predictor barrier and facilitator variables were not extracted from a standardized survey. As a result, cut points were not previously developed for the survey and the categorization used in this study was driven by the frequency distribution of each question used for analysis. Frequencies were heavily weighted toward the positive end of each scale so categories were created accordingly. A greater variance in scores resulting in alternative definitions for the categories may have provided different results. Also, the question regarding barriers and facilitators related to personal conflict was extremely broad. We have no way of knowing the specific factors that participants perceived as personal conflict barriers and how these individually might have influenced MMD. Second, the baseline face-to-face questionnaires were not originally designed to be used in analysis of the main LIFE Study, which reduced our power to detect significant findings. Also, these data were only available at baseline. We recognize that barriers and facilitators change over time and future studies should aim to repeat these measurements over the course of research studies. Third, the LIFE Study was designed to examine a population of sedentary older adults at risk for mobility disability. Since this only represents a subset of the growing older adult population, our results are only generalizable to sedentary older adults of a similar profile. Finally, the additive effect of the barriers and facilitators by intervention arm on

MMD was not explored. This a future direction for this work since it is plausible that a combination of barriers and facilitators may impact the structured interventions and MMD.

Strengths of this study are related to its novelty. As mentioned, we are the first to examine the impact of barriers and facilitators on a moderate physical activity intervention and major mobility disability in a large national sample of sedentary older adults at risk for mobility disability. This strength overcomes some of limitations of prior work making use of observational and limited study samples. We showed that some barriers and facilitators assessed at baseline are important, lending support for future studies to examine these factors and how a change over time might be associated with major mobility disability and related outcomes. It was also found that personal conflict issues could act as barriers related to structured physical activity programs and major mobility disability. This suggests that development of a more in depth and structured assessment of barriers and facilitators may be worthwhile. This information would allow researchers to develop more feasible and sustainable evidence-based programs for older adults.

In conclusion, our study provides support that studying extra- and intra-individual mechanisms related to functional limitations in the disablement pathway, like mobility disability, is important. We highlighted that barriers and facilitators related to physical activity and structured intervention programs for the older adult population warrant further exploration, especially since the pathway to functional decline and physical disability is not linear. Our results also emphasize the need for a better understanding of barriers and facilitators given that they may have the ability to significantly impact major mobility disability through a structured physical activity program depending on one's perception of his/her own unique barriers. In the future, development of a more comprehensive and standardized approach to measuring barriers

and facilitators is needed. The provision of a reliable and valid assessment of these factors could allow us to better quantify the impact of different types of barriers and facilitators on physical activity and related programs, and the role they play on outcomes like major mobility disability in the disablement pathway. As the older adult population continues to grow so will the burden of major mobility disability and subsequent physical disability if we do not continue to take steps toward understanding the complexities of the disablement pathway and where we might be able to intervene to reduce the negative impact of these outcomes on the individual, health care system, and society.

## 7.5 TABLES

**Table 7. LIFE Study Participant Demographic Characteristics by Barrier/Facilitator Status***

| | Friends and Family | | | | | Doctor | | | | | Personal Conflict | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **N** | **-3 to 0 Least** | **1 and 2 Moderate** | **3 Most** | **P-value** | **N** | **-3 to 0 Least** | **1 and 2 Moderate** | **3 Most** | **P-Value** | **N** | **No** | **Yes** | **P-Value** |
| | | | | | | | | | | | | | | |
| **Sex**, n (%) | | | | | 0.10 | | | | | 0.49 | | | | 0.97 |
| Men | 5507 | 69 (13.7) | 30 (5.9) | 405 (80.4) | | 465 | 42 (9.0) | 30 (6.5) | 393 (84.5) | | 505 | 423 (83.8) | 82 (16.2) | |
| Women | 1033 | 121 (11.7) | 41 (4.0) | 871 (84.3) | | 937 | 93 (9.9) | 47 (5.0) | 797 (85.1) | | 1036 | 867 (83.7) | 169 (16.3) | |
| **Age**, mean (SD), years | 1537 | 79.3(5.0) | 78.3(5.0) | 78.8 (5.3) | 0.38 | 1402 | 78.9(5.4) | 80.4(5.1) | 78.7(5.3) | 0.02 | 1541 | 78.9 (5.3) | 78.8(5.3) | 0.81 |
| **Race**, n (%) | | | | | 0.16 | | | | | 0.12 | | | | 0.10 |
| Non-Hispanic White | 1167 | 143 (12.3) | 60 (5.1) | 964 (82.6) | | 1053 | 95 (9.0) | 64 (6.1) | 894 (84.9) | | 1172 | 971 (82.8) | 201 (17.2) | |
| Other | 365 | 47 (12.9) | 10 (2.7) | 308 (84.4) | | 346 | 40 (11.6) | 13 (3.8) | 293 (84.7) | | 364 | 315 (86.5) | 49 (13.5) | |
| **Education**, n (%) | | | | | 0.9 | | | | | 0.17 | | | | 0.39 |
| No formal | 9 | 0 (0.0) | 0 (0.0) | 9 (100.0) | | 9 | 3 (33.3) | 0 (0.0) | 6 (66.7) | | 9 | 9 (100.0) | 0 (0.0) | |
| Grade 0-8 | 26 | 3 (11.5) | 1 (3.9) | 22 (84.6) | | 25 | 1 (4.0) | 2 (8.0) | 22 (88.0) | | 27 | 22 (81.5) | 5 (18.5) | |
| High school | 458 | 51 (11.1) | 21 (4.6) | 386 (84.3) | | 421 | 47 (11.2) | 17 (4.0) | 357 (84.8) | | 459 | 373 (81.3) | 86 (18.7) | |
| College | 604 | 79 (13.1) | 31 (5.1) | 494 (81.8) | | 542 | 51 (9.4) | 35 (6.5) | 456 (84.1) | | 607 | 513 (84.5) | 94 (15.5) | |
| Graduate School | 380 | 48 (12.6) | 17 (4.5) | 315 (82.0) | | 351 | 26 (7.4) | 21 (6.0) | 304 (86.6) | | 380 | 325 (85.5) | 55 (14.5) | |
| Other | 57 | 9 (15.8) | 1 (1.8) | 47 (82.4) | | 51 | 7 (13.7) | 2 (3.9) | 42 (82.4) | | 56 | 48 (85.7) | 8 (14.3) | |
| **SPPB Score**, 0-12 | | | | | 0.52 | | | | | 0.58 | | | | 0.03 |
| SPPB < 8 | 690 | 78 (11.3) | 32 (4.6) | 580 (84.1) | | 628 | 56 (8.9) | 32 (5.1) | 540 (86.0) | | 690 | 593 (85.9) | 97 (14.1) | |
| SPPB >= 8 | 847 | 112(13.2) | 39 (4.6) | 696 (82.2) | | 774 | 79 (10.2) | 45 (5.8) | 650 (86.0) | | 851 | 697 (81.9) | 154 (18.1) | |
| **BMI**, mean (SD) | 1537 | 29.5(5.8) | 30.1(5.9) | 30.3 (6.0) | 0.23 | 1402 | 29.9(6.3) | 29.6(6.3) | 30.5 (6.0) | 0.30 | 1541 | 30.2(6.0) | 30.3(5.8) | 0.95 |

**Table 7 Continued**

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Overall Population** | 1537 | 190 (12.4) | 71 (4.6) | 1276(83.0) | 0.01 | 1402 | 135 (9.6) | 77 (5.5) | 1190(84.9) | 0.07 | 1541 | 1290(83.7) | 251 (16.3) | <0.0001 |
| Successful Aging (control) | 759 | 111 (14.6) | 39 (5.1) | 609 (80.2) | | 753 | 81 (10.7) | 48 (6.4) | 624 (82.9) | | 761 | 682 (89.6) | 79 (10.4) | |
| Physical Activity | 778 | 79 (10.2) | 32 (4.1) | 667 (85.7) | | 649 | 54 (8.3) | 29 (4.5) | 566 (87.2) | | 780 | 608 (78.0) | 172 (22.0) | |

*** SPPB: Short Physical Performance Battery; BMI: body mass index**

**Table 8. LIFE Study Participant Demographic Characteristics by Barrier/Facilitator Status***

| | Confidence | | | | | Valuing Goals | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **N** | **0 to 6 Least** | **7-9 Moderate** | **10 Most** | **P-value** | **N** | **0-6 Least** | **7-9 Moderate** | **10 Most** | **P-Value** |
| | | | | | | | | | | |
| **Sex**, n (%) | | | | | 0.06 | | | | | 0.0001 |
| Men | 506 | 24 (4.7) | 245 (48.4) | 237 (46.9) | | 483 | 39 (8.1) | 248 (51.3) | 196 (40.6) | |
| Women | 1033 | 78 (7.5) | 455 (44.1) | 500 (48.4) | | 1000 | 63 (6.3) | 414 (41.4) | 523 (52.3) | |
| **Age**, mean (SD), years | 1539 | 79.1(5.2) | 78.8 (5.3) | 78.9 (5.2) | 0.86 | 1483 | 79.6(5.1) | 78.7 (5.1) | 78.9 (5.3) | 0.23 |
| **Race**, n (%) | | | | | 0.10 | | | | | <0.0001 |
| Non-Hispanic White | 1173 | 84 (7.2) | 541 (46.1) | 548 (46.7) | | 1127 | 85 (7.5) | 536 (47.6) | 506 (44.9) | |
| Other | 361 | 17 (4.7) | 156 (43.2) | 188 (52.1) | | 351 | 14 (4.0) | 126 (35.9) | 211 (60.1) | |
| **Education**, n (%) | | | | | 0.06 | | | | | 0.01 |
| No formal | 9 | 0 (0.0) | 3 (33.3) | 6 (66.7) | | 9 | 0 (0.0) | 0 (0.0) | 9 (100.0) | |
| Grade 0-8 | 27 | 0 (0.0) | 10 (37.0) | 17 (49.0) | | 26 | 3 (11.5) | 10 (38.5) | 13 (50.0) | |
| High school | 458 | 41 (9.0) | 193 (42.1) | 224 (48.9) | | 436 | 37 (8.5) | 180 (41.3) | 219 (50.2) | |
| College | 607 | 40 (6.6) | 291 (47.9) | 276 (45.5) | | 588 | 37 (6.3) | 275 (46.8) | 276 (46.9) | |
| Graduate School | 378 | 15 (4.0) | 177 (46.8) | 186 (49.2) | | 366 | 22 (6.0) | 178 (48.6) | 166 (45.4) | |
| Other | 57 | 6 (10.5) | 23 (40.4) | 28 (49.1) | | 55 | 2 (3.7) | 18 (32.7) | 35 (63.6) | |
| **SPPB Score**, 0-12 | | | | | 0.66 | | | | | 0.002 |
| SPPB < 8 | 688 | 50 (7.3) | 311 (45.2) | 327 (47.5) | | 664 | 50 (7.5) | 263 (39.6) | 351 (52.9) | |
| SPPB >= 8 | 851 | 52 (6.1) | 389 (45.7) | 410 (48.2) | | 819 | 52 (6.4) | 399 (48.7) | 368 (44.9) | |
| **BMI**, mean (SD) | 1539 | 29.7(6.6) | 30.1(6.0) | 30.5(5.9) | 0.27 | 1483 | 29.7(5.7) | 30.1 (6.2) | 30.4 (6.0) | 0.51 |
| **Overall Population** | 1539 | 102 (6.6) | 700 (45.5) | 737 (47.9) | <0.0001 | 1483 | 102 (6.9) | 662 (44.6) | 719 (48.5) | 0.001 |
| Successful Aging (control) | 760 | 29 (3.8) | 302 (39.7) | 429 (56.5) | | 749 | 68 (9.1) | 312 (41.7) | 369 (49.3) | |
| Physical Activity | 779 | 73 (9.4) | 398 (51.1) | 308 (39.5) | | 734 | 34 (4.6) | 350 (47.7) | 350 (47.7) | |

*** SPPB: Short Physical Performance Battery; BMI: body mass index**

**Table 9. Hazard Ratio of Major Mobility Disability for Overall LIFE Study Population According to Baseline Barrier/Facilitator**

| | Adjusted HR** | 95% CI | | P-Value |
|---|---|---|---|---|
| Personal Conflict | | | | |
| Yes (vs no) | 0.71 | 0.56 | 0.90 | 0.005 |
| | | | | |
| Family and Friends | | | | |
| moderate (vs least) | 1.00 | 0.62 | 1.60 | 0.99 |
| most (vs least) | 1.00 | 0.77 | 1.33 | 0.95 |
| | | | | |
| Your Doctor | | | | |
| moderate (vs least) | 0.88 | 0.53 | 1.45 | 0.60 |
| most (vs least) | 0.96 | 0.70 | 1.31 | 0.78 |
| | | | | |
| Confidence | | | | |
| moderate (vs least) | 0.78 | 0.55 | 1.09 | 0.15 |
| most (vs least) | 0.76 | 0.54 | 1.07 | 0.12 |
| | | | | |
| Valuing Goals | | | | |
| moderate (vs least) | 1.05 | 0.72 | 1.52 | 0.82 |
| most (vs least) | 1.08 | 0.75 | 1.56 | 0.68 |

**Adjusted for sex and site

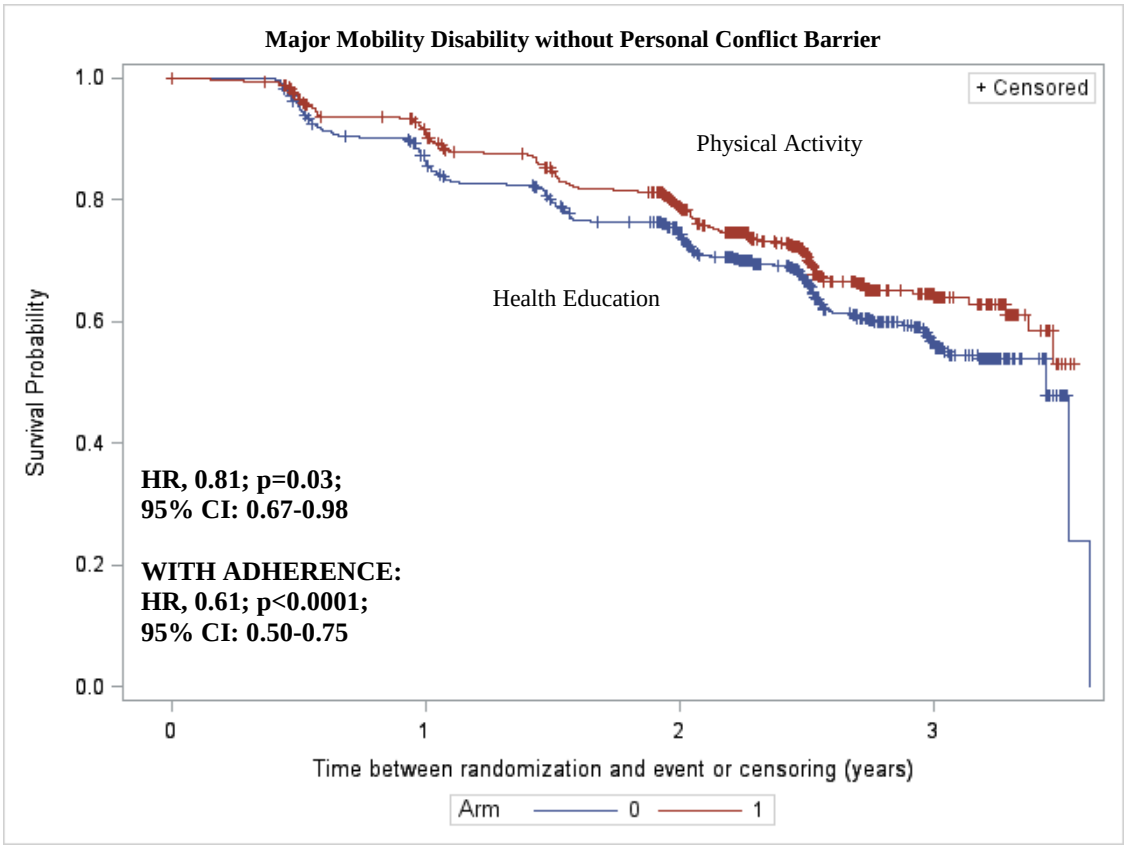


**Figure 1. Effect of a moderate physical activity intervention on the onset of major mobility disability among those without personal conflict barriers**

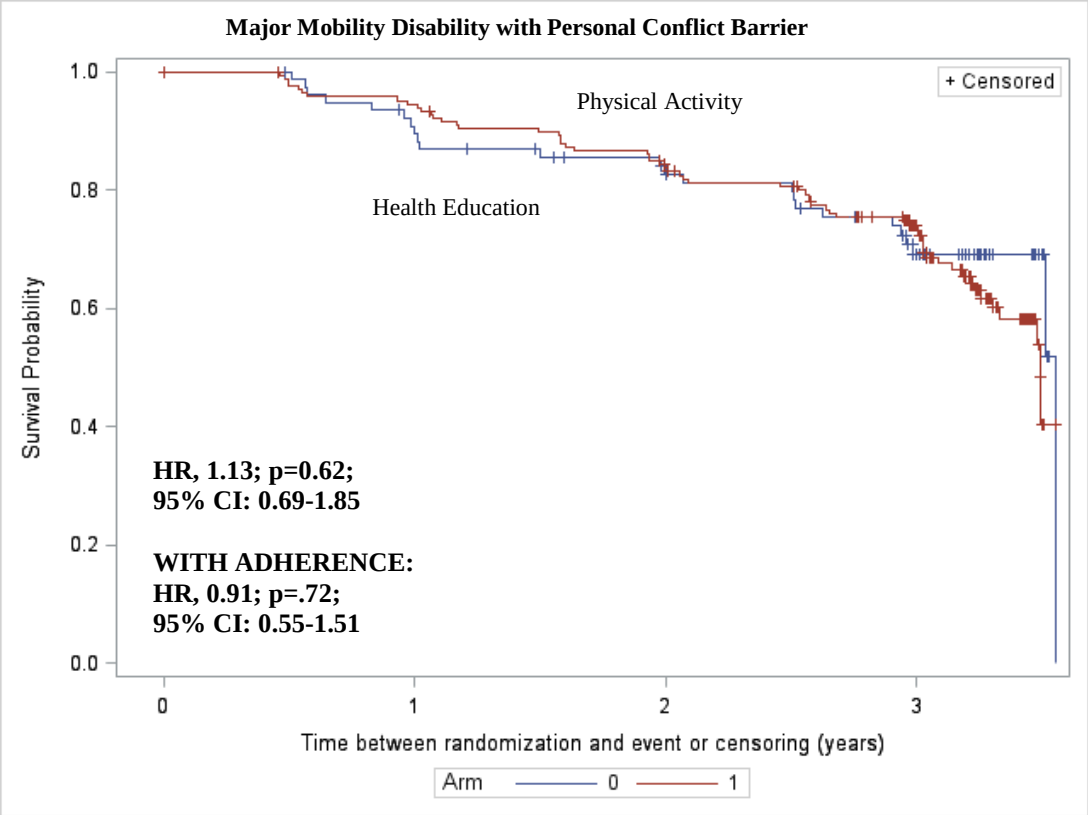


**Figure 2. Effect of a moderate physical activity intervention on the onset of major mobility disability among those with personal conflict barriers**

# 8.0 MANUSCRIPT 3: IMPACT OF PERCEIVED SOCIAL SUPPORT AS A SPECIFIC BARRIER OR FACILITATING FACTOR TO IMPROVED PHYSICAL FUNCTION IN A COMMUNITY BASED TRIAL


## ABSTRACT

**Objective:** To evaluate the impact of perceived social support as a specific barrier or facilitating factor to the improvement of physical function in community dwelling older adults participating in a community based intervention trial: the Arthritis Foundation Exercise Program (AFEP) and "10 Keys"™ to Healthy Aging Study.

**Hypothesis:** Better social support will be significantly positively associated with improved physical function in older adults in the AFEP/"10 Keys"™ study compared with those having less social support.

**Research Design and Methods:** The Arthritis Foundation Exercise Program (AFEP) and "10 Keys"™ to Healthy Aging Study is a community-based, non-blinded cluster randomized trial conducted at 54 sites, with the community site as the unit of randomization. The primary outcome was change in Short Physical Performance Battery (SPPB) score, defined as SPPB at 6 months minus SPPB at baseline. Social support was measured using variables from the Perceived Isolation Subscale. Generalized linear mixed models were used to examine associations between social support and change in SPPB controlling for baseline value of SPPB, the cluster effect of site, sex, age, and income. The analytical sample in this study included

participants with a baseline and 6-month follow-up (n=316), as this subset had a Short Physical Performance Battery score available from both assessment time points allowing generation of the outcome variable.

**Results:** Study participants were predominantly female (86.1%), Caucasian (81.9%), and had a mean age of 72.6 years. There were no significant associations; however the adjusted beta coefficients suggest a dose-response trend such that there was a stepwise improvement or decline in physical function with increasing levels of social support. Participants that reported having moderate friend support ("some of the time") had a .28 unit increase in SPPB score over 6 months and those that reported the most friend support ("often") had a .65 unit increase in SPPB compared with those that reported the least friend support. A similar trend was seen in spouse/partner support, those that reported moderate support and the most support had a .41 and .95 unit increase in SPPB, respectively, compared with those that had the least spouse/partner support. The reverse trend was seen with respect to spouse/partner reliance. Moderate spouse/partner reliance was associated with a .58 unit decrease in SPPB while the most spouse/partner reliance was associated with a 1.28 unit decrease in SPPB over 6 months compared with the least reliance.

**Conclusions:** This study provides evidence supporting the importance of considering social support in interventions aimed at improving physical function, as low levels of social support over time may increase the risk for declining physical function and subsequent disability development compared with those reporting moderate or high levels of social support.

## 8.1 INTRODUCTION

In 2012 it was estimated that 43.1 million people were at least 65 years of age [1]. Older adults, defined as those 65 years of age or older, will account for about 20% of the total United States population by the year 2030 alone (equating to nearly 73 million people) [1, 2, 13]. Current projections estimate that this age group will nearly double in size to 83.7 million people by 2050 [1, 13]. The 2013 Disability Status Report, based on data from the U.S. Census Bureau's American Community Survey, reports that among adults ages 64-74 the overall prevalence rate of disability is 25.8% [3]. Among those aged 75 and older, the overall disability prevalence rate is 50.7% [3]. These rates are concerning due to the projected growth of the aging population compounded with the associated increase in health care costs and utilization of health care services. Once physical disability occurs in an older adult, the likelihood of developing further disability, institutionalization, and death increases greatly [46, 47].

The burden of physical disability is compounded by the severity of health outcomes and conditions associated with high cost and increased risk for loss of independence and death, and by the current and projected growth of the older adult population [1, 4, 13, 46, 47]. As this highlights physical disability as a major public health concern, research focusing on functional limitations within the disablement process is becoming increasingly important given that this pathway is not linear and can be intervened upon to prevent progression to physical disability [15-18, 148]. Ultimately this means placing attention on specific modifiable intra- and extra-individual mechanisms, such as social support, that influence functional limitations in older adults.

Although the importance of studying the social context of the disablement pathway in older adults has been acknowledged, it remains underexplored [132]. Evidence suggests that social support may benefit those aging with and at risk for physical disabilities. Social support is recognized as an important determinant of health and aging [126, 149]. Moreover, it is associated with outcomes within the functional limitation and disability domains of the disablement pathway in older adults [129-131, 150-155]. Studies of populations of older adults with existing chronic diseases and functional impairments report that lack of or no access to and availability of social support is associated with physical disability [150-153]. Among samples of community dwelling older adults, social support may provide protection against disability such that being embedded in a strong social network is associated with a reduction in the risk of developing physical disability including disability in activities of daily living, and instrumental activities of daily living [129, 131, 155, 156].

Perceived, or self-assessed, social support is predictive of functional limitations like mobility disability and subsequent physical disability in population-based epidemiologic studies of older adults conducted in the United States and internationally [154, 157]. Greater frequency of social contact is associated with better physical performance and an increased risk of functional status decline over time in a cohort of community dwelling older adults [158]. It remains unclear how perceived social support may be related to outcomes like physical function that precede mobility disability in the functional limitation domain of the ongoing disablement pathway in intervention studies. Current research acknowledges the importance of social contact frequency and highlights a cross-sectional relationship with physical function in older adults. It is unknown how varying levels of perceived, or self-assessed, social support impact success in

lifestyle interventions aimed at improving physical function in community dwelling older adults, a gap which this study will address.

Expansion of the existing evidence base in this area can provide the field of public health with a better understanding of the complex trajectories of the pathway to disablement that is further complicated by the process of aging. The specific details revealed by this study will provide important evidence that could inform the next steps that need to be taken to consider perceived social support in interventions, programs and service delivery aimed at improving physical function and physical disability risk reduction in community dwelling older adults.

The objective of this study is to evaluate the impact of perceived social support as a specific barrier or facilitating factor to the improvement of physical function in community dwelling older adults participating in a community based intervention trial: the Arthritis Foundation Exercise Program (AFEP) and "10 Keys"™ to Healthy Aging Study. The AFEP is an evidence-based exercise program for older adults that is shown to improve arthritis symptoms, upper and lower extremity function, self-management behaviors, and self-efficacy without adverse events [159]. The 10 Keys to Healthy Aging Program ("10 Keys"™) was developed by the University of Pittsburgh's Center for Aging and Population Health Prevention Research Center (CAPH-PRC) [160, 161]. The "10 Keys"™ bundles the most common chronic disease risk factors and applies evidence-based behavior change strategies to prevent disease and disability in older adults. The "10 Keys"™ include control of blood pressure, glucose and LDL cholesterol, smoking cessation, cancer screenings, immunizations, physical activity, musculoskeletal health, social contact, and combating depression. The AFEP program was enhanced by adding the "10 Keys"™. In the parent study, the resulting enhanced program was a 10-week, 20-session program called the AFEP + "10 Keys"™. The specific details of the parent

study's methods and main results were previously published [140, 162]. To evaluate the objective of this study, it is hypothesized that better social support will be significantly positively associated with improved physical function in older adults in the AFEP/"10 Keys"™ study compared with those having less social support.

## 8.2 METHODS

### 8.2.1 Study Design

The Arthritis Foundation Exercise Program (AFEP) and "10 Keys"™ to Healthy Aging Study is a community-based, non-blinded cluster randomized trial conducted at 54 sites, with the community site as the unit of randomization. This study was originally designed to test the effectiveness of the AFEP enhanced with the "10 Keys"™ to Healthy Aging compared with the AFEP alone in improving arthritis symptoms and physical function in community dwelling older adults and has been previously described [140]. Of the 54 sites randomized, 15 (27.8%) were residential facilities, 13 (24.1%) senior centers, 9 (16.7%) churches, 5 (9.3%) community centers, 4 (7.4%) YMCAs, 4 (7.4%) fitness centers/clubs, and 4 (7.4%) were libraries [140, 162]. The protocol was approved by the University of Pittsburgh Institutional Review Board.

### 8.2.2 Participants

Methods of recruitment included mailed brochures to age-eligible people within nearby zip codes and ads in newspapers, church bulletins, local newspapers, and websites. Interested members of the community contacted the study staff directly, or sites provided a list of interested participants who were subsequently called by the research staff [140]. During this call, potential participants were given information about the program and were screened for eligibility. Eligibility criteria to participate in the AFEP and "10 Keys"™ to Healthy Aging Study included age 50 years or older, no surgery or cardiac event in the past 6 months, and no use of oxygen therapy [140]. Older adults who were not interested in the study (n=152) were still invited to participate in the program (Figure 1). Study participants (n=462) were younger (age 72.7 [SD 7.8] years vs. 75.0 [SD=9.8], p=0.004], more likely to have a college education (63.0% vs. 51.4%, p<0.001), and more likely to report arthritis (83.4% vs. 75.0%, p=0.002) compared with people attending the programs who did not consent to the research assessments [140]. These two groups did not differ in baseline physical activity or the proportion of women or minorities.

In the parent study, 670 program participants expressed initial interest in the research study, and 462 consented to participate. Of 670 screened, 56 did not meet eligibility criteria and 152 declined to participate. Of the 462 total participants enrolled, 416 were evaluated at the 6-month follow-up with 213 older adults in the AFEP (control) program and 203 in the enhanced AFEP and "10 Keys"™ to Healthy Aging intervention program [140, 162] (Figure 1).

The mean age of the overall study population was 73 years and 88% were women. Eighty percent of the participants self-identified as white, 18% African American, and the remainder other race groups. Approximately half of the population had an income above $25,000 and two-thirds of the participants had education beyond high school [162].

### 8.2.3 Interventions (AFEP vs AFEP/10 Keys)

All study participants received 10 weeks of the AFEP and those in the intervention group received the AFEP enhanced with the "10 Keys"™ to Healthy Aging Program. The AFEP intervention (control) included 60 minute long sessions held twice weekly, for 10 weeks [140]. These sessions consisted of 50-55 minutes of exercise and 3-5 minutes of health education about chronic disease risk factors. The exercise included a joint check, warm-up, active range-of-motion, strengthening, joint check, cool down, and relaxation [140].

Sessions for the enhanced AFEP + "10 Keys"™ (intervention) consisted of the same exercises and 10-20 minutes of health information and health behavior change strategies from the "10 Keys"™ to Healthy Aging program [140]. Sites randomized to the enhanced AFEP and "10 Keys"™ were also offered four monthly maintenance sessions after the 10-week intervention ended [140]. These sessions were added to enhance awareness and reinforce behavior change strategies.

### 8.2.4 Assessments

Participant assessments were conducted on site by non-blinded research assessors at baseline, 10 weeks, 6 months, and one-year post-intervention. Measurements included height, weight, blood pressure, a measure of physical function known as the Short Physical Performance Battery (SPPB), and questionnaires including the Perceived Isolation Subscale [163].

#### 8.2.4.1 Outcome Measure

The outcome measure of interest was the Short Physical Performance Battery (SPPB), a valid and objective assessment of physical function that can characterize a broad spectrum of lower extremity function and accurately predict disability across diverse populations of community dwelling older adults [27, 29, 30]. The SPPB is a brief performance battery based on three timed tests: a short distance walk (4 meters), repeated chair stands, and a set of three balance tests [27, 29, 35]. During the short distance walk participants are instructed to walk 4 meters at their usual walking pace while being timed as a measurement of gait speed. The repeated chair stand test assesses lower extremity strength and participants are instructed to stand up from a chair 5 times without using the support of their arms. Participants are directed to try and hold three different positions for 10 second each during the balance test: feet side-by-side, semi tandem, and tandem. Each component of the SPPB is scored on a scale from 0 to 4 to provide an overall SPPB score between 0 and 12. A higher score indicates better physical function. For the purposes of this study participants are defined as low versus high functioning. Low physical function is defined as a SPPB score $< 8$ and high physical function is defined as a SPPB score $\geq 8$ [58, 83]. This assessment was administered by study staff and took approximately 10-15 minutes to complete.

#### 8.2.4.2 Predictor Variables

Social support was measured using variables from the Perceived Isolation Subscale [163]. The Perceived Isolation Subscale is a scale combining nine-items and has been validated for use in studies of older adults [164, 165]. Six of the nine items in the scale are indicators of perceived social support, specifically family, friend, and spouse/partner support. Participants were asked "How often can you open up to members of your family if you need to talk about your worries?"

and “How often can you rely on them for help if you have a problem?” The same two questions were asked about friends and current spouse or partner. The remaining three items are indicators of perceived loneliness. Participants were asked: “How often do you feel that you lack companionship?” “How often do you feel left out?” and “How often do you feel isolated from others?” Response options for all questions in the subscale indicated perceived level of social support: Hardly ever/Never, Some of the time, and Often. The Perceived Isolation Subscale was self-administered by the study participants.

#### 8.2.4.3 Other Covariates

Age, sex, race, income, education, body mass index (BMI), intervention group, and exercise routine were considered as potential covariates. Age, sex, race, income, education and exercise routine were ascertained by self-report at baseline assessments. Objective measurements of height and weight collected by trained study staff were used to calculate BMI [162].

### 8.2.5 Statistical Analyses

Statistical analyses were conducted using SAS version 9.3 (SAS Institute, Cary, NC). Significance was set at 0.05 for two-sided hypothesis testing. Summary statistics were reported as mean and SD for continuous variables and frequency and percentage for categorical variables. Distributions of all variables were examined prior to analysis. Variables that were not normally distributed were transformed or categorized prior to analysis.

The primary outcome was change in SPPB (physical function), defined as SPPB at 6 months minus SPPB at baseline. Individual social support barriers were assessed to examine

univariate associations with change in physical function (SPPB). Each social support barrier consisted of three categories indicating level of perceived social support: “hardly ever/never”, “some of the time”, “often”. Social support variables were trichotomized and the same three categories referenced above were retained to evaluate varying levels of social support. “hardly ever/never” indicates the least social support, “some of the time” indicates moderate social support, and “often” indicates the most social support.

The baseline characteristics of the AFEP/"10 Keys"™ Study participants were described by level of support for each type of social support. Two-sample t-tests and chi-square tests comparing means of continuous characteristics and categorical characteristics were used, respectively. Individual social support barrier scores were examined overall, by intervention group, and by baseline level of physical function (low function: SPPB $< 8$ versus high function: SPPB $\geq 8$). Generalized linear mixed models were used to examine associations between social support and change in SPPB controlling for baseline value of SPPB and the cluster effect of site. Age, sex, race, income, education, BMI, intervention group, and exercise routine were explored as potential covariates in the linear mixed models. Based upon a significance level of 0.05, none of these variables emerged as significant covariates during analyses. Age, sex, and income were forced into the models and adjusted for to control for possible confounding. The analytical sample in this study included participants with a baseline and 6-month follow-up (n=316), as this subset had a Short Physical Performance Battery score available from both assessment time points allowing generation of the outcome variable described (change in SPPB).

## 8.3 RESULTS

Table 10 shows the baseline characteristics of the AFEP/"10 Keys"™ Study participants analyzed in this study overall and by intervention group. Participants were predominantly female (86.1%), Caucasian (81.9%), and had a mean age of 72.6 years. There were no significant differences among participants at baseline with respect to sex, age, race, income, education, physical function, and BMI. There was a significant difference in baseline exercise routine such that a higher frequency of those in the control group (AFEP) reported never exercising (15.5%) compared with those in the intervention (AFEP + "10 Keys"™) group (6.8%, p=0.01) (Table 10).

The demographic characteristics of the population are described by baseline social support status in Tables 11-13. There were no significant differences in level of family, friend, and spouse/partner support by race, education, baseline physical function (SPPB), BMI, exercise routine, and intervention group (Tables 11-13). There was a statistically significant difference in the frequency of baseline family and spouse/partner support by income status, with a greater percentage of those with an income <$25,000 report having less family and spouse/partner support compared with those with an income $\geq$$25,000 (22.2% vs 12.5%, p=0.04 and 31.1% vs 8.1%, p=0.0002 for family and spouse/partner support, respectively) (Table 11). There was a difference in age across levels of friend support such that those reporting the least support ("hardly ever/never") had a higher mean age (75.4 $\pm$ 6.9yrs) compared with those reporting friend support "some of the time" (72.9 $\pm$ 7.9yrs) and "often" (71.5 $\pm$ 7.7yrs), p=0.002 (Table 2). A larger percentage of women (49.1%) reported having friend support "often" compared with men (27.4%, p=0.015) (Table 11).

Demographic characteristics did not differ by baseline family and friend reliance (Table 12). A higher percentage of men (83.3%) compared with women (56.0%) reported the most spouse/partner reliance, p=0.005. With respect to income status, a higher percentage of those with an income <$25,000 (31.8%) reported the least spouse/partner reliance compared with those with an income ≥$25,000 (5.2%), p<0.0001.

Several significant differences in demographic characteristics were found by frequency of social isolation status (Table 13). Those with an income <$25,000 reported lacking companionship and social isolation "often" compared with those with an income ≥$25,000 (16.8% vs 9.4%, p=0.003 and 8.2% vs 2.9%, p=0.006 for lacking companionship and social isolation, respectively). A higher percentage of men reported "hardly ever/never" lacking companionship (77.4% vs 48.0%) whereas a higher percentage of women reported lacking companionship "some of the time" (38.5% vs 17.0%) and "often" (13.5% vs 5.6%), p=0.0003. Compared with those who were white, a greater percentage of non-white participants reported lacking companionship "often" (20.5% vs 10.8%, p=0.003).

Tables 14 and 15 show the results of the covariate-adjusted associations between each individual social support predictor and change in SPPB score. There were no significant associations between any of the nine social support predictors and change in SPPB after adjusting for baseline physical function, age, sex, and income. In the partial adjusted model (Table 16), there was a statistically significant association between the most support and reliance ("often") and change in SPPB score after accounting for baseline SPPB. The most friend support was associated with a 1.08 unit increase in SPPB score over 6 months compared with the least friend support (95% CI: 0.29-1.86; p=0.008) while the most spouse/partner support was associated with a 1.88 unit increase in SPPB score compared with the least spouse/partner

support (95% CI: 0.19-3.57; p=0.03) (Table 16). Spouse/partner reliance was associated with a decline in SPPB score. The most spouse/partner reliance was statistically significantly associated with a 2.64 unit decrease in SPPB over 6 months compared with the least spouse/partner reliance (95% CI: -4.48- -0.80; p=0.005) (Table 16).

The results seen in the partial adjusted model were attenuated after accounting for potential confounding in the fully adjusted model. There were no significant associations; however the adjusted beta coefficients suggest a dose-response trend such that there was a stepwise improvement or decline in physical function with increasing levels of social support. Participants that reported having moderate friend support ("some of the time") had a .28 unit increase in SPPB score over 6 months and those that reported the most friend support ("often") had a .65 unit increase in SPPB compared with those that reported the least friend support (Table 16). A similar trend was seen in spouse/partner support, those that reported moderate support and the most support had a .41 and .95 unit increase in SPPB, respectively, compared with those that had the least spouse/partner support. The reverse trend was seen with respect to spouse/partner reliance. Moderate spouse/partner reliance was associated with a .58 unit decrease in SPPB while the most spouse/partner reliance was associated with a 1.28 unit decrease in SPPB over 6 months compared with the least reliance.

## 8.5 DISCUSSION

The results of this study showed a trend that better friend and spouse/partner support were associated with improved physical function over 6 months in community dwelling older

adults participating in this intervention study. Moreover, the magnitude of improvement in physical function increased by level of support compared with the least support.

Importantly, there was a similar, but inverse, trend for spouse/partner reliance. Increasing level of spouse/partner reliance was associated with decreasing physical function among the AFEP/"10 Keys"™ study participants such that there was a larger decline in physical function with each increase in level of reliance compared with the least spouse/partner reliance. Overall there may be a dose-response relationship between increasing levels of social support and physical function. The most friend and spouse/partner support may be associated with clinically meaningful changes in physical function compared with the least support [166]. This is also the case for moderate and the most spouse/partner reliance compared with the least reliance. Estimates for a small meaningful change in SPPB range from 0.27-0.55 with 0.5 representing the most commonly referenced [33]. Our results are comparable with those of Seeman et al. who reported the importance of the frequency of support from social networks in changing physical performance in a similar cohort of high-functioning older adults aged 70-79 years [158].

The findings of this study support the existing literature that social support is an important determinant to consider with respect to health and aging, specifically with respect to outcomes related to functional limitations and disability in the Disablement Pathway [126, 149] [129-131, 150-155]. Other studies have reported associations between social support and physical disability in limited populations of older adults with chronic diseases and functional impairments [150-153]. Social support was associated with a reduction in the risk of developing physical disability in other samples of community dwelling older adults [129, 131, 155, 156]. These studies were limited by cross-sectional and cohort designs. They also used broad

assessments of social support that were not based on participants' perceptions. The present study showed that social support may be associated with clinically meaningful changes in functional limitations that are precursors to physical disability even in healthy and high-functioning older adults in a community based lifestyle intervention trial. This fills a gap in the existing research by showing that social support may be important to consider for older adults at different levels of physical function and health status. Social support and its role as an intra-individual mechanism in the disablement pathway warrants further investigation.

Several limitations to the present study need to be acknowledged. The ability to detect statistically significant results was impacted by a large amount of missing data. Although the initial sample size provided sufficient power to pursue the analysis for this study, the associations presented may have been attenuated by this limitation. Given that there is a ceiling effect bias associated with the outcome measure used to assess physical function (SPPB) and this study population was high-functioning at baseline, the power to detect a statistically significant result was greatly reduced. There is also a well-known volunteer bias associated with research studies. It is apparent that this study population was relatively healthy, high functioning, highly educated, and lacked diversity with respect to sex, race, and income. Therefore the results of this study can only be generalized to community dwelling older adults of a similar profile.

This study has several strengths. We used a measure of physical function (SPPB) that is known to be reliable and highly sensitive even to subtle changes in older adults' levels of physical function [31-33]. Until now, research has often assessed social support broadly. The evidence presented in this study suggests that different types and components of social support may impact physical function among older adults in unique ways. A more comprehensive assessment of social support may need to be developed to allow researchers to begin to better

understand how social support is related to functional limitations in older adults, and ultimately, the prevention of progression toward physical disability in the disablement pathway. The possibility of a dose-response relationship between varying types of social support and physical function indicates that interventions aimed at improving function and mobility may be more effective when incorporating special considerations for those with different levels and types of social support. Addressing these considerations in future studies may result in clinically meaningful changes in older adults' physical function.

Additional research is needed to evaluate these claims in similar and more generalizable populations of community dwelling older adults. Although the trends and associations reported in this study were ultimately not statistically significant after accounting for the potential confounding of baseline level of function, sex, age, and income, the results highlight population level factors upon which researchers and public health may need to focus when tailoring future interventions aimed at physical function in older adults to make them more effective. In conclusion, this study provides evidence supporting the importance of considering social support in interventions aimed at improving physical function, as low levels of social support over time may increase the risk for declining physical function and subsequent disability development compared with those reporting moderate or high levels of social support.

## 8.5 TABLES

**Table 10. Baseline Characteristics of AFET + "10 Keys" study participants overall and by intervention group**

| **Characteristic** | **Overall Population (N=316)** | **AFEP+ "10 Keys" (N=153)** | **AFEP (control) (N=163)** | **P-Value** |
|---|---|---|---|---|
| **Sex**, n (%) | | | | |
| Women | 272 | 132 (86.3) | 140 (85.9) | 0.92 |
| Men | 44 | 21 (13.7) | 23 (14.1) | |
| **Age**, mean (SD), years | 72.6 (8.0) | 72.7 (8.1) | 72.5 (8.0) | 0.84 |
| **Race**, n (%) | | | | |
| White | 258 | 120 (78.9) | 138 (84.7) | 0.19 |
| Non-White | 57 | 32 (21.1) | 25 (15.3) | |
| **Education**, n (%) | | | | |
| High school or less | 108 | 50 (32.9) | 58 (35.6) | 0.62 |
| Some college or higher | 207 | 102 (67.1) | 105 (64.4) | |
| **Income**, n (%) | | | | |
| <$25,000 | 132 | 59 (43.4) | 73 (48.7) | 0.37 |
| >=$25,000 | 154 | 77 (56.6) | 77 (51.3) | |
| **SPPB Score**, 0-12 | | | | |
| SPPB < 8 | 64 | 28 (18.3) | 36 (22.1) | 0.40 |
| SPPB >=8 | 252 | 125 (81.7) | 127 (77.9) | |
| **BMI,** mean (SD) | 31.2 (7.1) | 31.0 (7.2) | 31.3 (7.0) | 0.77 |
| **Exercise Routine** | | | | |
| Never | 35 | 10 (6.8) | 25 (15.5) | 0.01* |
| Sometimes | 169 | 78 (52.7) | 91 (56.5) | |
| Regular | 105 | 60 (40.5) | 45 (28.0) | |

* SPPB: Short Physical Performance Battery; BMI: body mass index

****** Analytical sample in this study included participants with a baseline and 6-month follow-up (n=316), as this subset had a Short Physical Performance Battery score available from both assessment time points allowing generation of the outcome variable described (change in SPPB).

**Table 11. AFEP + "10 Keys" Demographic Characteristics by Baseline Social Support Status: "How often can you open up to your ___ if you need to talk about your worries?"**

| | Family Support | | | | | Friend Support | | | | | Spouse/Partner Support | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **N** | **Hardly Ever/Never** | **Some of the time** | **Often** | **P-value** | **N** | **Hardly Ever/Never** | **Some of the time** | **Often** | **P-Value** | **N** | **Hardly Ever/Never** | **Some of the time** | **Often** | **P-Value** |
| | | | | | | | | | | | | | | | |
| **Sex**, n (%) | | | | | 0.23 | | | | | 0.015 | | | | | 0.087 |
| Women | 378 | 57 (15.1) | 129 (34.1) | 192 (50.8) | | 375 | 50 (13.3) | 141 (37.6) | 184 (49.1) | | 160 | 26 (16.3) | 54 (33.7) | 80 (50.0) | |
| Men | 52 | 12 (23.1) | 19 (36.5) | 21 (40.4) | | 51 | 10 (19.6) | 27 (52.9) | 14 (27.4) | | 43 | 2 (4.7) | 13 (30.2) | 28 (65.1) | |
| **Age**, mean (SD), years | 430 | 72.7 (8.1) | 72.8 (7.9) | 72.4 (7.7) | 0.84 | 426 | 75.4 (6.9) | 72.9 (7.9) | 71.5 (7.7) | 0.002 | 203 | 73.6 (8.9) | 71.5 (7.6) | 70.8 (7.2) | 0.22 |
| **Race**, n (%) | | | | | 0.72 | | | | | 0.16 | | | | | 0.46 |
| White | 351 | 53 (15.1) | 125 (35.6) | 173 (49.3) | | 348 | 52 (14.9) | 137 (39.4) | 159 (45.7) | | 177 | 23 (13.0) | 57 (32.2) | 97 (54.8) | |
| Non-White | 74 | 13 (17.6) | 23 (31.1) | 38 (51.3) | | 73 | 5 (6.9) | 29 (39.7) | 39 (53.4) | | 26 | 5 (19.2) | 10 (38.5) | 11 (42.3) | |
| **Education**, n (%) | | | | | 0.24 | | | | | 0.56 | | | | | 0.85 |
| High school or less | 156 | 25 (16.0) | 46 (29.5) | 85 (54.5) | | 152 | 24 (15.8) | 61 (40.1) | 67 (44.1) | | 63 | 10 (15.9) | 21 (33.3) | 32 (50.8) | |
| Some college or higher | 224 | 43 (16.1) | 99 (37.1) | 125 (46.2) | | 267 | 33 (12.4) | 106 (39.7) | 128 (47.9) | | 138 | 18 (13.1) | 46 (33.3) | 74 (53.6) | |
| **Income**, n (%) | | | | | 0.04 | | | | | 0.51 | | | | | 0.0002 |
| <$25,000 | 194 | 43 (22.2) | 63 (32.5) | 88 (45.3) | | 190 | 29 (15.3) | 77 (40.5) | 84 (44.2) | | 45 | 14 (31.1) | 15 (33.3) | 16 (35.6) | |
| >=$25,000 | 200 | 25 (12.5) | 72 (36.0) | 103 (51.5) | | 199 | 24 (12.1) | 77 (38.7) | 98 (49.2) | | 136 | 11 (8.1) | 44 (32.4) | 81 (59.6) | |
| **SPPB Score**, 0-12 | | | | | 0.49 | | | | | 0.83 | | | | | 0.10 |
| SPPB < 8 | 83 | 10 (12.1) | 32 (38.5) | 41 (49.4) | | 83 | 12 (14.5) | 30 (36.1) | 41 (49.4) | | 31 | 8 (25.8) | 9 (29.0) | 14 (45.2) | |
| SPPB >=8 | 334 | 56 (16.8) | 112 (33.5) | 166 (49.7) | | 329 | 48 (14.6) | 130 (39.5) | 151 (45.9) | | 168 | 19 (11.3) | 58 (34.5) | 91 (54.2) | |
| **BMI,** mean (SD) | 416 | 30.9 (7.4) | 31.4 (7.4) | 30.9 (7.3) | 0.77 | 411 | 30.3 (6.4) | 31.2 (7.3) | 31.5 (7.6) | 0.57 | 198 | 31.3 (9.8) | 30.0 (6.5) | 31.1 (7.3) | 0.59 |
| **Exercise Routine** | | | | | 0.44 | | | | | 0.26 | | | | | 0.50 |
| Never | 48 | 8 (16.7) | 16 (33.3) | 24 (50.0) | | 43 | 7 (16.3) | 14 (32.5) | 22 (51.2) | | 23 | 3 (13.0) | 8 (34.8) | 12 (52.2) | |
| Sometimes | 227 | 41 (18.1) | 83 (36.5) | 103 (45.4) | | 229 | 36 (15.7) | 97 (42.4) | 96 (41.9) | | 107 | 19 (17.8) | 36 (33.6) | 52 (48.6) | |
| Regular | 139 | 17 (12.2) | 46 (33.1) | 76 (54.7) | | 139 | 15 (10.8) | 51 (36.7) | 73 (52.5) | | 67 | 6 (9.0) | 21 (31.3) | 40 (59.7) | |
| **Overall Population** | 430 | 69 (16.0) | 148 (34.4) | 213 (49.6) | 0.18 | 426 | 60 (14.1) | 168 (39.4) | 198 (46.5) | 0.46 | 203 | 28 (13.8) | 67 (33.0) | 108(53.2) | 0.63 |
| AFEP + "10 Keys" | 213 | 40 (18.8) | 66 (31.0) | 107 (50.2) | | 216 | 32 (14.8) | 90 (41.7) | 94 (43.5) | | 102 | 12 (11.8) | 36 (35.3) | 54 (52.9) | |
| AFEP (control) | 217 | 29 (13.4) | 82 (37.8) | 106 (48.8) | | 210 | 28 (13.3) | 78 (37.1) | 104 (49.6) | | 101 | 16 (15.8) | 31 (30.7) | 54 (53.5) | |

* SPPB: Short Physical Performance Battery; BMI: body mass index

**Table 12. AFEP + "10 Keys" Demographic Characteristics by Baseline Social Reliance Status "How often can you rely on your ___ if you have a problem?"**

| | Family Reliance | | | | | Friend Reliance | | | | | Spouse/Partner Reliance | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **N** | **Hardly ever** | **Some of e** | **Often** | **P-** | **N** | **Hardly ever** | **Some of e** | **Often** | **P-** | **N** | **Hardly ever** | **Some of e** | **Often** | **P-** |
| | | | | | | | | | | | | | | | |
| **Sex**, n (%) | | | | | 0.76 | | | | | 0.12 | | | | | 0.005 |
| Women | 378 | 32 (8.5) | 103 (27.2) | 243 (64.3) | | 369 | 43 (11.6) | 139 (37.7) | 187 (50.7) | | 159 | 23 (14.5) | 47 (29.5) | 89 (56.0) | |
| Men | 53 | 4 (7.5) | 17 (32.1) | 32 (60.4) | | 51 | 8 (15.7) | 25 (49.0) | 18 (35.3) | | 42 | 2 (4.8) | 5 (11.9) | 35 (83.3) | |
| **Age**, mean ears | 431 | 71.0 (8.0) | 72.2 (8.4) | 73.0 (7.5) | 0.25 | 420 | 74.7 (7.9) | 72.6 (7.8) | 71.8 (7.7) | 0.06 | 201 | 74.1 (8.0) | 71.0 (7.4) | 70.9 (7.5) | 0.15 |
| **Race**, n (%) | | | | | 0.56 | | | | | 0.86 | | | | | 0.84 |
| White | 351 | 26 (7.4) | 96 (27.4) | 229 (65.2) | | 346 | 42 (12.1) | 135 (39.0) | 169 (48.9) | | 176 | 21 (11.9) | 46 (26.1) | 109 (62.0) | |
| Non-White | 75 | 8 (10.7) | 22 (29.3) | 45 (60.0) | | 70 | 7 (10.0) | 27 (38.6) | 36 (51.4) | | 25 | 4 (16.0) | 6 (24.0) | 15 (60.0) | |
| **Education**, n | | | | | 0.20 | | | | | 0.40 | | | | | 0.51 |
| High school or | 156 | 8 (5.1) | 45 (28.9) | 103 (66.0) | | 150 | 22 (14.7) | 56 (37.3) | 72 (48.0) | | 62 | 10 (16.1) | 14 (22.6) | 38 (61.3) | |
| Some college or | 268 | 27 (10.1) | 74 (27.6) | 167 (62.3) | | 264 | 27 (10.2) | 106 (40.2) | 131 (49.6) | | 137 | 15 (11.0) | 38 (27.7) | 84 (61.3) | |
| **Income**, n (%) | | | | | 0.07 | | | | | 0.21 | | | | | <.0001 |
| <$25,000 | 193 | 24 (12.4) | 54 (28.0) | 115 (59.6) | | 184 | 27 (14.7) | 75 (40.8) | 82 (44.5) | | 44 | 14 (31.8) | 9 (20.5) | 21 (47.7) | |
| >=$25,000 | 202 | 12 (6.0) | 57 (28.2) | 133 (65.8) | | 199 | 22 (11.0) | 71 (35.7) | 106 (53.3) | | 136 | 7 (5.2) | 40 (29.4) | 89 (65.4) | |
| **SPPB Score**, 0-12 | | | | | 0.66 | | | | | 0.38 | | | | | 0.12 |
| SPPB < 8 | 83 | 5 (6.0) | 22 (26.5) | 56 (67.5) | | 83 | 7 (8.4) | 31 (37.4) | 45 (54.2) | | 30 | 7 (23.3) | 6 (20.0) | 17 (56.7) | |
| SPPB >= 8 | 334 | 29 (8.7) | 94 (28.1) | 211 (63.2) | | 325 | 43 (13.2) | 128 (39.4) | 154 (47.4) | | 167 | 17 (10.2) | 46 (27.5) | 104 (62.3) | |
| **BMI**, mean (SD) | 416 | 33.4 (7.3) | 31.3 (7.8) | 30.7 (7.1) | 0.12 | 406 | 30.8 (6.5) | 30.8 (7.0) | 31.7 (7.8) | 0.47 | 196 | 32.5 (7.7) | 29.0 (7.4) | 31.2 (7.3) | 0.09 |
| **Exercise e** | | | | | 0.24 | | | | | 0.20 | | | | | 0.37 |
| Never | 47 | 4 (8.5) | 12 (25.5) | 31 (66.0) | | 42 | 8 (19.0) | 12 (28.6) | 22 (52.4) | | 22 | 3 (13.6) | 6 (27.3) | 13 (59.1) | |
| Sometimes | 226 | 20 (8.8) | 72 (31.9) | 134 (59.3) | | 229 | 27 (11.8) | 99 (43.2) | 103 (45.0) | | 107 | 18 (16.8) | 26 (24.3) | 63 (58.9) | |
| Regular | 142 | 9 (6.3) | 32 (22.5) | 101 (71.2) | | 136 | 14 (10.3) | 49 (36.0) | 73 (53.7) | | 66 | 4 (6.0) | 18 (27.3) | 44 (66.7) | |
| **Overall tion** | 431 | 36 (8.4) | 120 (27.9) | 275 (63.7) | 0.27 | 420 | 51 (12.1) | 164 (39.1) | 205 (48.8) | 0.98 | 201 | 25 (12.5) | 52 (25.8) | 124 (61.7) | 0.74 |
| AFEP + "10 | 216 | 21 (9.7) | 65 (30.1) | 130 (60.2) | | 211 | 26 (12.3) | 83 (39.3) | 102 (48.4) | | 102 | 11 (10.8) | 26 (25.5) | 65 (63.7) | |
| AFEP (control) | 215 | 15 (7.0) | 55 (25.6) | 145 (67.4) | | 209 | 25 (12.0) | 81 (38.8) | 103 (49.2) | | 99 | 14 (14.1) | 26 (26.3) | 59 (59.6) | |

*SPPB: Short Physical Performance Battery; BMI: body mass index

**Table 13. AFEPP + "10 Keys" Demographic Characteristics by Baseline Social Isolation Status: "How often do you feel _____?"**

| | | Lacking Companionship | | | | | Feeling Left Out | | | | | Social Isolation | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **N** | **Hardly Ever/Never** | **Some of the time** | **Often** | **P-value** | **N** | **Hardly Ever/Never** | **Some of the time** | **Often** | **P-Value** | **N** | **Hardly Ever/Never** | **Some of the time** | **Often** | **P-Value** |
| | | | | | | | | | | | | | | | |
| **Sex,** n (%) | | | | | 0.0003 | | | | | 0.09 | | | | | 0.063 |
| Women | 377 | 181 (48.0) | 145 (38.5) | 51 (13.5) | | 378 | 225 (59.5) | 132 (34.9) | 21 (5.6) | | 382 | 259 (67.8) | 102 (26.7) | 21 (5.5) | |
| Men | 53 | 41 (77.4) | 9 (17.0) | 3 (5.6) | | 52 | 39 (75.0) | 12 (23.1) | 1 (1.9) | | 54 | 45 (83.3) | 8 (14.8) | 1 (1.9) | |
| **Age**, mean (SD), years | 430 | 73.2 (7.2) | 72.5 (8.3) | 70.4 (8.9) | 0.07 | 430 | 73.1 (7.3) | 72.2 (8.6) | 69.5 (8.9) | 0.09 | 436 | 73.1 (7.1) | 71.6 (9.3) | 70.3 (8.9) | 0.09 |
| **Race**, n (%) | | | | | 0.05 | | | | | 0.70 | | | | | 0.64 |
| White | 352 | 189 (53.7) | 125 (35.5) | 38 (10.8) | | 350 | 218 (62.3) | 116 (33.1) | 16 (4.6) | | 354 | 251 (70.9) | 87 (24.6) | 16 (4.5) | |
| Non-White | 73 | 31 (42.5) | 27 (37.0) | 15 (20.5) | | 75 | 44 (58.7) | 26 (34.7) | 5 (6.6) | | 77 | 51 (66.2) | 21 (27.3) | 5 (6.5) | |
| **Education**, n (%) | | | | | 0.11 | | | | | 0.54 | | | | | 0.55 |
| High school or less | 154 | 77 (50.0) | 63 (40.9) | 14 (9.1) | | 155 | 99 (63.9) | 50 (32.3) | 6 (3.8) | | 158 | 114 (72.2) | 38 (24.0) | 6 (3.8) | |
| Some college or higher | 270 | 141 (52.2) | 89 (33.0) | 40 (14.8) | | 268 | 160 (59.7) | 92 (34.3) | 16 (6.0) | | 271 | 185 (68.3) | 70 (25.8) | 16 (5.9) | |
| **Income**, n (%) | | | | | 0.003 | | | | | 0.09 | | | | | 0.006 |
| <$25,000 | 190 | 81 (42.6) | 78 (41.1) | 31 (16.3) | | 194 | 110 (56.7) | 69 (35.6) | 15 (7.7) | | 197 | 123 (62.4) | 58 (29.4) | 16 (8.2) | |
| >=$25,000 | 203 | 120 (59.1) | 64 (31.5) | 19 (9.4) | | 202 | 131 (64.8) | 64 (31.7) | 7 (3.5) | | 203 | 154 (75.9) | 43 (21.2) | 6 (2.9) | |
| **SPPB Score**, 0-12 | | | | | 0.33 | | | | | 0.39 | | | | | 0.54 |
| SPPB < 8 | 83 | 38 (45.8) | 31 (37.3) | 14 (16.9) | | 84 | 46 (54.8) | 33 (39.3) | 5 (5.9) | | 85 | 56 (65.9) | 23 (27.1) | 6 (7.0) | |
| SPPB >= 8 | 335 | 178 (53.1) | 118 (35.2) | 39 (11.7) | | 332 | 209 (63.0) | 106 (31.9) | 17 (5.1) | | 337 | 240 (71.2) | 81 (24.0) | 16 (4.8) | |
| **BMI**, mean (SD) | 416 | 31.2 (7.6) | 31.2 (7.5) | 31.5 (6.7) | 0.96 | 415 | 30.5 (7.4) | 32.4 (7.6) | 32.1 (5.8) | 0.05 | 421 | 30.7 (7.4) | 32.6 (7.4) | 31.8 (5.4) | 0.08 |
| **Exercise Routine** | | | | | 0.78 | | | | | 0.12 | | | | | 0.06 |

**Table 13 Continued**

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Never | 48 | 27 (56.2) | 14 (29.2) | 7 (14.6) | | 49 | 31 (63.3) | 16 (32.6) | 2 (4.1) | | 49 | 31 (63.3) | 18 (36.7) | 0 (0.0) | |
| Sometimes | 229 | 113 (49.3) | 85 (37.1) | 31 (13.6) | | 228 | 134 (58.8) | 76 (33.3) | 18 (7.9) | | 232 | 159 (68.5) | 56 (24.2) | 17 (7.3) | |
| Regular | 138 | 72 (52.2) | 51 (37.0) | 15 (10.8) | | 137 | 88 (64.2) | 47 (34.3) | 2 (1.5) | | 139 | 103 (74.1) | 31 (22.3) | 5 (3.6) | |
| **Overall Population** | 430 | 222 (51.6) | 154 (35.8) | 54 (12.6) | 0.66 | 430 | 264 (61.4) | 144 (33.5) | 22 (5.1) | 0.24 | 436 | 304 (69.7) | 110 (25.2) | 22 (5.1) | 0.19 |
| AFEP + "10 Keys" | 215 | 114 (53.0) | 77 (35.8) | 24 (11.2) | | 215 | 139 (64.7) | 68 (31.6) | 8 (3.7) | | 219 | 154 (70.3) | 58 (26.5) | 7 (3.2) | |
| AFEP (control) | 215 | 108 (50.2) | 77 (35.8) | 30 (14.0) | | 215 | 125 (58.1) | 76 (35.4) | 14 (6.5) | | 217 | 150 (69.1) | 52 (24.0) | 15 (6.9) | |

**Table 14. Covariate Adjusted Associations between each Social Support Predictor at Baseline and Change in Physical Function (SPPB) Score (Individual model for each predictor)**

| | Adjusted β** | 95% CI | | P-Value |
|---|---|---|---|---|
| **Family Support** | | | | |
| Some of the time (vs Hardly Ever/Never) | -0.451 | -1.013 | .111 | 0.11 |
| Often (vs Hardly Ever/Never) | -0.196 | -0.730 | 0.337 | 0.47 |
| | | | | |
| **Friend Support** | | | | |
| Some of the time (vs Hardly Ever/Never) | -0.189 | -0.792 | 0.415 | 0.54 |
| Often (vs Hardly Ever/Never) | 0.231 | -0.364 | 0.826 | 0.44 |
| | | | | |
| **Spouse/Partner Support** | | | | |
| Some of the time (vs Hardly Ever/Never) | -0.439 | -1.354 | 0.475 | 0.34 |
| Often (vs Hardly Ever/Never) | 0.052 | -0.833 | 0.937 | 0.91 |
| | | | | |
| **Family Reliance** | | | | |
| Some of the time (vs Hardly Ever/Never) | -0.314 | -1.044 | 0.415 | 0.40 |
| Often (vs Hardly Ever/Never) | -0.145 | -0.823 | 0.533 | 0.67 |
| | | | | |
| **Friend Reliance** | | | | |
| Some of the time (vs Hardly Ever/Never) | 0.270 | -0.364 | 0.905 | 0.40 |
| Often (vs Hardly Ever/Never) | 0.344 | -0.273 | 0.962 | 0.27 |
| | | | | |
| **Spouse/Partner Reliance** | | | | |
| Some of the time (vs Hardly Ever/Never) | -0.721 | -1.783 | 0.342 | 0.18 |
| Often (vs Hardly Ever/Never) | -0.476 | -1.470 | 0.518 | 0.34 |
| | | | | |
| **Social Isolation** | | | | |
| Hardly Ever/Never (vs Often) | -0.440 | -1.305 | 0.424 | 0.32 |
| Some of the time (vs Often) | -0.791 | -1.692 | 0.110 | 0.09 |
| | | | | |
| **Feeling Leftout** | | | | |
| Hardly Ever/Never (vs Often) | -0.107 | -0.987 | 0.774 | 0.81 |
| Some of the time (vs Often) | -0.246 | -1.144 | 0.651 | 0.59 |
| | | | | |
| **Lacking Companionship** | | | | |
| Hardly Ever/Never (vs Often) | 0.214 | -0.403 | 0.832 | 0.50 |
| Some of the time (vs Often) | -0.176 | -0.810 | 0.458 | 0.58 |

**Adjusted for cluster effect of site, baseline level of physical function, age, gender, and income

**Table 15. Covariate Adjusted Associations between each Social Support Predictor at 6 months and Change in Physical Function (SPPB) Score (Individual model for each predictor)**

| | Adjusted β** | 95% CI | | P-Value |
|---|---|---|---|---|
| **Family Support** | | | | |
| Some of the time (vs Hardly Ever/Never) | -0.301 | -0.948 | 0.346 | 0.36 |
| Often (vs Hardly Ever/Never) | -0.257 | -0.874 | 0.360 | 0.41 |
| | | | | |
| **Friend Support** | | | | |
| Some of the time (vs Hardly Ever/Never) | -0.048 | -0.696 | 0.600 | 0.88 |
| Often (vs Hardly Ever/Never) | -0.037 | -0.634 | 0.561 | 0.90 |
| | | | | |
| **Spouse/Partner Support** | | | | |
| Some of the time (vs Hardly Ever/Never) | 0.213 | -0.802 | 1.229 | 0.68 |
| Often (vs Hardly Ever/Never) | 0.332 | -0.598 | 1.261 | 0.48 |
| | | | | |
| **Family Reliance** | | | | |
| Some of the time (vs Hardly Ever/Never) | -0.530 | -1.425 | 0.366 | 0.24 |
| Often (vs Hardly Ever/Never) | -0.314 | -1.154 | 0.526 | 0.46 |
| | | | | |
| **Friend Reliance** | | | | |
| Some of the time (vs Hardly Ever/Never) | 0.351 | -0.330 | 1.033 | 0.31 |
| Often (vs Hardly Ever/Never) | 0.045 | -0.603 | 0.693 | 0.89 |
| | | | | |
| **Spouse/Partner Reliance** | | | | |
| Some of the time (vs Hardly Ever/Never) | 0.219 | -0.777 | 1.571 | 0.50 |
| Often (vs Hardly Ever/Never) | 0.397 | -0.863 | 1.301 | 0.69 |
| | | | | |
| **Social Isolation** | | | | |
| Hardly Ever/Never (vs Often) | -0.053 | -1.009 | 0.902 | 0.91 |
| Some of the time (vs Often) | -0.269 | -1.264 | 0.725 | 0.59 |
| | | | | |
| **Feeling Leftout** | | | | |
| Hardly Ever/Never (vs Often) | 0.831 | -0.123 | 1.785 | 0.09 |
| Some of the time (vs Often) | 0.791 | -0.183 | 1.766 | 0.11 |
| | | | | |
| **Lacking Companionship** | | | | |
| Hardly Ever/Never (vs Often) | 0.627 | -0.040 | 1.293 | 0.07 |
| Some of the time (vs Often) | 0.366 | -0.321 | 1.052 | 0.29 |

**Adjusted for cluster effect of site, baseline level of physical function, age, sex, and income

**Table 16. Final Adjusted Model Associations between BL Friend and 6m Spouse/Partner Support Reliance and Change in Physical Function (SPPB) Score**

| | Adjusted β** | 95% CI | | P-Value |
|---|---|---|---|---|
| | | | | |
| **Friend Support** | | | | |
| Some of the time (vs Hardly Ever/Never) | 0.577 | -0.204 | 1.358 | 0.15 |
| Often (vs Hardly Ever/Never) | 1.075 | 0.291 | 1.859 | 0.008* |
| | | | | |
| **Spouse/Partner Support** | | | | |
| Some of the time (vs Hardly Ever/Never) | 1.275 | -0.270 | 2.819 | 0.10 |
| Often (vs Hardly Ever/Never) | 1.879 | 0.191 | 3.567 | 0.03* |
| | | | | |
| **Spouse/Partner Reliance** | | | | |
| Some of the time (vs Hardly Ever/Never) | -1.472 | -3.151 | 0.207 | 0.09 |
| Often (vs Hardly Ever/Never) | -2.637 | -4.476 | -0.799 | 0.005* |
| **Baseline Physical Function** | -0.344 | -0.455 | -0.233 | <0.0001 |

**Adjusted for cluster effect of site and baseline physical function (SPPB) score

| | Adjusted β** | 95% CI | | P-Value |
|---|---|---|---|---|
| | | | | |
| **Friend Support** | | | | |
| Some of the time (vs Hardly Ever/Never) | 0.284 | -0.531 | 1.099 | 0.49 |
| Often (vs Hardly Ever/Never) | 0.651 | -0.211 | 1.512 | 0.14 |
| | | | | |
| **Spouse/Partner Support** | | | | |
| Some of the time (vs Hardly Ever/Never) | 0.414 | -1.330 | 2.157 | 0.64 |
| Often (vs Hardly Ever/Never) | 0.951 | -0.913 | 2.815 | 0.31 |
| | | | | |
| **Spouse/Partner Reliance** | | | | |
| Some of the time (vs Hardly Ever/Never) | -0.582 | -2.612 | 1.448 | 0.57 |
| Often (vs Hardly Ever/Never) | -1.280 | -3.496 | 0.937 | 0.25 |
| **Baseline Physical Function** | -0.357 | -0.473 | -0.241 | <0.0001 |
| **Age** | -0.033 | -0.068 | 0.0017 | 0.06 |
| **Sex (women)** | 0.255 | -0.374 | 0.885 | 0.42 |
| **Income (<$25,000)** | -0.386 | -1.007 | 0.234 | 0.22 |

**Adjusted for cluster effect of site, baseline level of physical function, age, sex, and income

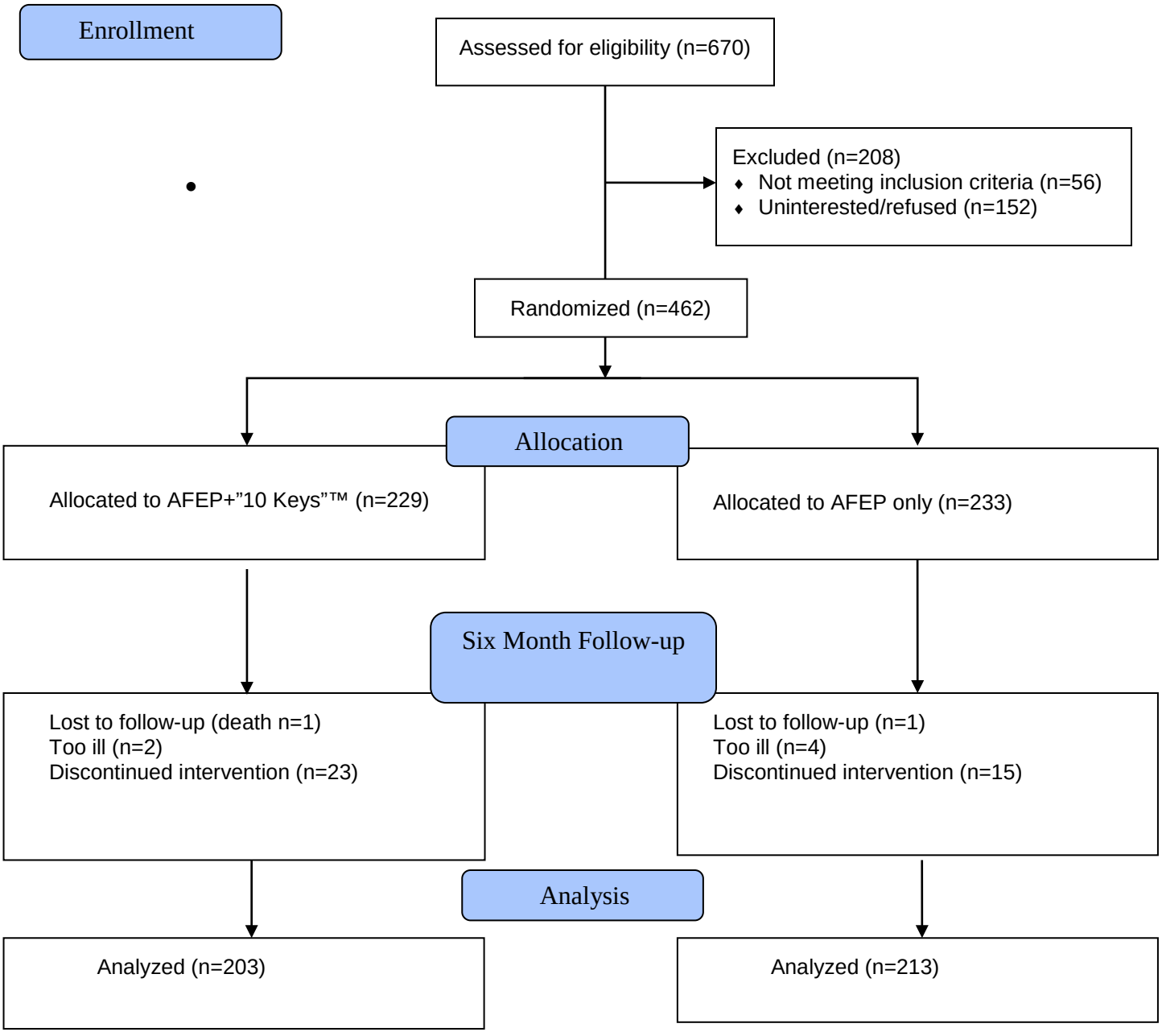


**Figure 3. CONSORT Flow Diagram**

# 9.0 CONCLUSIONS

The aging baby boomer generation and longer life spans are contributing to the substantial growth of the older adult population, defined as those at least 65 years of age [14]. Older adults will account for about 20% of the total United States population by the year 2030 alone (equating to nearly 73 million people) [1, 2, 13]. These trends are not unique to the United States. In fact, the older adult population is projected to continue increasing in all developed nations [1, 14]. It is apparent that there is a demand for public health researchers and health care providers (among virtually every facet of society) to rise to the challenge of meeting the needs of older individuals.

As the number of older adults in the United States and worldwide rises maintaining independent physical function in older adults is a central goal of public health. Physical function is associated with an increased risk of functional decline, physical disability, nursing home admission, and mortality [5, 29, 34]. Among community dwelling older adults lower physical function is associated with increased incidence of disability in the activities of daily living (ADLs) and mobility disability [35, 36]. Physical function is also a long-term predictor of mobility disability and physical disability [37]. Older adults with lower levels of physical function are 4.2-4.9 times as likely to develop disability compared with those with higher levels of physical function [35, 39]. Especially given that the magnitude of the risk for mobility disability and more severe outcomes related to physical disability is greater for older adults with

lower levels of physical function, it is critical to focus on preventing physical disability in older adults by studying physical function and mobility disability as interrelated functional limitations that are known predictors of this enormous public health issue.

The prevalence of physical disability and mobility disability among older adults is high. Data from the 1999-2004 National Health and Nutrition Examination Survey (NHANES) report that among adults aged 60-69, 23% have IADL disability, 20% have ADL disability, 48% have functional limitations, and 30% have mobility disability [42]. These rates are concerning due to the projected growth of the aging population compounded with the associated increase in health care costs and utilization of health care services. Once physical disability occurs in an older adult, the likelihood of developing further disability, institutionalization, and death increases greatly [46, 47].

The Disablement Process model supports the relationships between physical function, mobility disability, and subsequent physical disability [15, 16]. This model was adopted by the Institute of Medicine in an effort to focus national policy on the prevention of disability, highlighting the importance of these public health challenges. The Disablement Process model does not assume that disability will occur in all older adults and illustrates a pathway of domains that are involved in the complex process: pathology, impairment, functional limitation, and disability; where physical function and mobility disability rest within the functional limitation domain emphasizing that they precede physical disability. This model stipulates that disability may or may not occur as a result of the interaction among an older adult's physical limitations and the social and physical factors in his/her environment. Specifically, the disablement pathway considers a social epidemiologic perspective by including factors known to influence the process of disability [17-20]. These factors can be viewed as three categories of variables:

risk factors, intra-individual mechanisms, and extra-individual mechanisms. Since physical function and mobility disability represent a critical stage in the disablement pathway during which the risk for physical disability increases greatly, it is essential to study extra- and intra-individual mechanisms that could preserve physical function and mobility and prevent an individual older adult from progressing further into the disablement pathway toward physical disability [27, 35].

Risk factors for mobility disability and physical disability include age, race, sex, hypertension, diabetes, multiple chronic conditions, obesity, arthritis, stroke, smoking, fractures, previous disability, mobility disability, and lower levels of physical activity. Fortunately, some of these risk factors are modifiable including physical activity. Moreover, physical activity is a specific extra-individual mechanism within the Disablement Pathway. Physical activity in older adults at least 65 years of age includes transportation (e.g. walking or cycling), leisure time physical activity, occupational activity (for those still working), household chores, recreation, and planned or structured activity [59]. It is currently recommended that older adults engage in at least 150 minutes of moderate-intensity aerobic physical activity (e.g. brisk walking) per week, or at least 75 minutes of vigorous-intensity activity per week, or an equivalent combination of moderate- and vigorous-intensity activity [7, 59]. Unfortunately national survey data estimate the prevalence of older adults meeting these guidelines ranges from less than 4% (based on objective measurement) to less than one third (based on self-report), underscoring the importance of studying physical activity in this population [60, 61].

Physical disability and underlying functional limitations are not inevitable consequences of aging yet roughly one-third of older adults have physical function and mobility restrictions. Since engaging in physical activity is an extra-individual mechanism associated with the

prevention of functional limitations that can lead to more severe impairments in the disablement pathway like physical disability and subsequent chronic disease, disability, and death, then targeting intra-individual mechanisms that are correlated with physical activity will be instrumental in addressing the disproportionate disability burden the older adult population is facing. Highlighting that less than one-third of older adults meet the recommended physical activity guidelines in the United States further emphasizes the need for a better understanding of influential factors in this pathway [60, 61, 87, 88]. In an effort to target an intra-individual mechanism also related to physical function and mobility disability, research has started to turn its attention to perceived barriers and facilitators associated with physical activity and related programs in older adults. This could be one way to reveal underlying factors associated with the low prevalence of older adults engaging in physical activity and related programs, in turn uncovering novel insights to the improvement of physical function and reduction of mobility disability among the aging population.

## 9.2 SUMMARY OF FINDINGS

This dissertation examined perceived barriers and facilitators, physical activity and structure lifestyle intervention programs, and functional limitations among older adults in a randomized clinical trial and a community based trial setting. The aims were to: 1) identify perceived barriers and facilitators in participant enrollment in two lifestyle intervention programs aimed at mobility disability prevention in a subset of sedentary older adults at risk of mobility disability, and to examine whether the perceived barriers and facilitators identified differ by type of intervention; 2) assess the impact of baseline barriers/facilitating factors on the effect of a

moderate physical activity intervention compared with a health education intervention and its ability to reduce the onset of major mobility disability in sedentary older adults at risk of mobility disability; and 3) evaluate the impact of social support as a specific barrier or facilitating factor to the improvement of physical function in community dwelling older adults.

In the first aim, we sought to characterize themes related to participant enrollment in the Lifestyle Interventions and Independence for Elders (LIFE) study intervention programs aimed at mobility disability reduction in a subset of the study population, and to explore whether the themes identified differed by type of intervention. We found that the most common motivator to joining the study was the study recruitment letter. In general, benefits participants hoped to achieve by participating in the study were related to personal improvement and maintenance. Specifically, the most frequently cited themes were the desire to improving physical function and mobility, learn/increase knowledge, increase energy, and socialize. Most participants cited no prior experience with some sort of physical activity or health education program. There were differences in themes related to benefits by intervention group. Only participants in the health education intervention group cited a desire to learn and increase knowledge. Improving physical function and mobility and increasing energy appeared more often in the physical activity intervention group responses compared with the health education intervention group responses. The results of this study indicate that there are a range of factors that contribute to engagement in lifestyle programs aimed at mobility disability prevention for sedentary older adults, and these factors may be related to the type of program. Another key implication of these findings is that messages in recruitment material can be tailored to successfully engage a diverse range of sedentary older adults at risk for functional decline in structured programs.

In specific aim two, the impact of baseline barriers/facilitating factors on the effect of a moderate physical activity intervention's ability to reduce major mobility disability in sedentary older adults at risk of mobility disability was explored. We found that participants who identified some personal conflict may interfere with their ability to take part in the intervention programs compared with those that did not significantly reduced major mobility disability (MMD) by 29%. Furthermore, we revealed significant findings that supported our hypothesis. Among those without a personal conflict barrier, the physical activity intervention program significantly reduced major mobility disability by 19% compared with the health education intervention program over an average of 2.6 years of follow-up. Importantly, the physical activity intervention was not successful in reducing MMD among those with a personal conflict barrier.

Our results indicate that in the context of a structured intervention program it is important to take perceived barriers and facilitators into account from the outset. The physical activity intervention was more effective at lowering MMD compared with the HE intervention among LIFE Study participants who cited they did not have any barriers related to personal conflict. However, it was not effective among those citing they did have barriers related to personal conflict. This implies that barriers may attenuate the effect of a structured physical activity program by removing its ability to significantly reduce MMD. It may be critical to identify those with barriers during the recruitment process, as these participants may need additional remediation targeted at specific barriers during intervention programs in order to be successful in reaching study goals. For example, booster sessions or supportive counseling targeted at addressing individual's specific barriers and changes over time may be beneficial throughout intervention programs. The results related to the second aim suggest that barriers associated with

personal conflict are important factors associated with MMD. We highlighted that barriers and facilitators related to physical activity and structured intervention programs aimed at MMD reduction for the older adult population warrant further exploration, especially since the pathway to functional decline and physical disability is not linear. Our results also emphasize the need for a better understanding of barriers and facilitators given that they may have the ability to significantly impact major mobility disability through a structured physical activity program depending on one's perception of his/her own unique barriers.

In specific aim three, we sought to evaluate the impact of perceived social support as a specific barrier or facilitating factor to the improvement of physical function in community dwelling older adults participating in a community based intervention trial. Although our results were not statistically significant, they suggest a dose-response trend such that there was a stepwise improvement or decline in physical function with increasing levels of social support. Participants that reported having moderate friend support ("some of the time") had a .28 unit increase in Short Physical Performance Battery (SPPB) score over 6 months and those that reported the most friend support ("often") had a .65 unit increase in SPPB compared with those that reported the least friend support. A similar trend was seen in spouse/partner support, those that reported moderate support and the most support had a .41 and .95 unit increase in SPPB, respectively, compared with those that had the least spouse/partner support. The reverse trend was seen with respect to spouse/partner reliance. Moderate spouse/partner reliance was associated with a .58 unit decrease in SPPB while the most spouse/partner reliance was associated with a 1.28 unit decrease in SPPB over 6 months compared with the least reliance.

The results of aim three showed a trend that better friend and spouse/partner support were associated with improved physical function over 6 months in community dwelling older adults

participating in the intervention study. Moreover, the magnitude of improvement in physical function increased by level of support compared with the least support. Importantly, there was a similar but inverse trend for spouse/partner reliance. Increasing level of spouse/partner reliance was associated with decreasing physical function among study participants such that there was a larger decline in physical function with each increase in level of reliance compared with the least spouse/partner reliance. Overall there may be a dose-response relationship between increasing levels of social support and physical function. The most friend and spouse/partner support, and both moderate and the most spouse/partner reliance may be associated with clinically meaningful changes in physical function compared with the least support [166]

## 9. 3 CONTRIBUTION TO THE LITERATURE

The findings of this dissertation are significant and help to fill a gap in the literature by examining how perceived barriers and facilitators, physical activity, and interventions aimed at improving physical function and mobility disability are interrelated in a randomized clinical trial and community based setting. Exploration of this area may reveal factors that play key roles in the ongoing disablement pathway toward physical disability in older adults. This could inform the development and translation of future intervention efforts aimed at mobility disability reduction and physical disability prevention.

The first manuscript incorporated into this report provides evidence of considerations needed to engage sedentary older adults in structured lifestyle intervention programs aimed at mobility disability reduction. Current research conducted on older adults' engagement in physical activity and related programs focuses primarily on characteristics of regular exercisers

compared with non-exercisers, physical activity behavior adoption, and physical activity preferences [108, 111, 122, 141-144]. One study examined motivators and beliefs regarding physical activity behavior in independent-living older adults and reported maintaining health and socialization as shared motivators [124]. We found that these same themes carry over to structured program participation as well. A more recent study sought to understand older adults' motivators and barriers related to participation in structured programs that support physical activity by comparing program joiners with decliners [146]. These investigators found that socialization and marketing materials were among the most frequently cited motivators to program participation [146]. Our study complements and extends these findings in that recruitment material and socialization emerged as commonly cited themes related to structured lifestyle programs in sedentary older adults, lending strength to both studies.

Knowledge about the role of organized programs for sedentary older adults, and their perceptions of them, is lacking. Research emphasizes the need to consider perceived barriers and facilitators, but also what beliefs exist about the benefits to engaging in programs aimed at disability prevention [12]. The first manuscript adds to the existing literature by beginning to fill this gap. To our knowledge, this is the first study to qualitatively explore factors that contribute to engagement in lifestyle programs aimed at physical activity and mobility disability prevention for sedentary older adults. Since study participants were already randomized at baseline but had not started the intervention, we had the ability to examine whether themes were specific to the type of intervention program assignment. Our findings emphasize the importance of messages for the recruitment of older adults, and considerations needed if we want to motivate this population to join and engage in structured programs aimed at disability prevention.

The second manuscript that is incorporated into this dissertation adds significantly to the literature. The findings of this study support the existing literature that has acknowledged the importance of perceived barriers and benefits of physical activity and related programs in limited settings (e.g. outside the U.S., nursing homes, primary care setting) and samples (e.g. young adults, older women, participants with existing chronic diseases and disability) [10-12, 121-123, 137-139, 147]. Other studies have been limited by a cross-sectional design and a focus on only physical and environmental barriers [117, 139]. Our study develops this literature base further by extending it to focus on a large population of sedentary older adults at risk for mobility disability in a multicenter randomized clinical trial setting.

The Lifestyle Independence and Interventions for Elders (LIFE) study was the largest and longest randomized trial of physical activity in sedentary older adults including a reliable, well-validated, and objectively measured assessment of major mobility disability [58]. The LIFE Study showed that a structured physical activity intervention significantly reduced major mobility disability (MMD) by 18% among older adults at risk for disability compared with a health education intervention over 2.6 years of follow-up, although participants in both interventions experienced a reduction in MMD [53, 58, 84]. The evidence from this study is invaluable and suggests that structured interventions can reduce major mobility disability in sedentary older adults, especially those at risk for disability. The results of this landmark trial provided a strong foundation upon which our study was generated. In order to move this field of research forward toward translation, we made an effort to create a shift in emphasis from understanding what works to also understanding how it works. We took this step by studying how perceived barriers and facilitators related to the LIFE Study structured interventions impact major mobility disability and the prevention of physical disability. Our study demonstrated that

some barriers, specifically those related to personal conflict, are significantly associated with MMD after controlling for sex and study site. In fact, it was found that personal conflict issues could act as a barrier to success in structured physical activity programs aimed at reducing major mobility disability. Our findings extend the knowledge gained from the main LIFE Study by showing that a structured PA intervention program can reduce MMD compared with a HE intervention program when barriers related to personal conflict are not a factor. Given that the PA compared with the HE intervention was not effective in reducing MMD for those with a personal conflict barrier, this highlights the importance of studying how barriers and facilitators are involved in the disablement pathway. To the best of our knowledge, this study is the first to examine how perceived barriers and facilitators are directly related to major mobility disability in a large population of sedentary older adults at risk for mobility disability followed longitudinally, providing a unique opportunity to address this major public health issue.

The third manuscript supports the existing literature that suggests social support may benefit those aging with and at risk for physical disabilities. Studies of populations of older adults with existing chronic diseases and functional impairments report that lack of or no access to and availability of social support is associated with physical disability [150-153]. Among samples of community dwelling older adults, social support may provide protection against disability such that being embedded in a strong social network is associated with a reduction in the risk of developing physical disability including disability in activities of daily living, and instrumental activities of daily living [129, 131, 155, 156]. Perceived, or self-assessed, social support is predictive of functional limitations like mobility disability and subsequent physical disability in population-based epidemiologic studies of older adults conducted in the United States and internationally [154, 157]. Finally, greater frequency of social contact is associated

with better physical performance and an increased risk of functional status decline over time in a cohort of community dwelling older adults [158]. Our study filled a gap in this literature as it remains unclear how perceived social support may be related to outcomes like physical function that precede mobility disability in the functional limitation domain of the ongoing disablement pathway in intervention studies. Moreover, it is unknown how varying levels of perceived, or self-assessed, social support impact success in lifestyle interventions aimed at improving physical function in community dwelling older adults, a gap which our study also addresses.

We found that social support may be associated with clinically meaningful changes in functional limitations that are precursors to physical disability even in healthy and high-functioning older adults in a community based lifestyle intervention trial. This fills a gap in the existing research by showing that social support may be important to consider for older adults at different levels of physical function and health status. Our study provided evidence that social support and its role as an intra-individual mechanism in the Disablement Pathway warrants further investigation and may have an important public health impact.

## 9.4 STUDY LIMITATIONS

Research is not without limitations and it is important to acknowledge those that existed in this dissertation. In the first manuscript, we conducted the study in a small sample of the LIFE Study participants and cannot assume that these results are similar at other LIFE Study field centers or across the entire LIFE Study population. The nature of the data we used also limited this study. It was not possible to avoid a potential interviewer bias given that study staff recorded the participant responses we evaluated. There were only three staff members (2 PA, 1

HE) involved in administering these interviews reducing any associated bias. Finally, as is illustrated in the results of our study, the responses provided by participants regarding motivators, beliefs, and past experiences were very short in length. Longer structured or semi-structured interviews or focus group data may have provided richer results. This also limited our ability to gain further insight into commonly cited themes such as the recruitment letter. It would be valuable to learn what specific components of the letter motivated study participants.

Some limitations also apply to the first and second manuscripts. The data used for the analyses were only available at baseline. We recognize that barriers and facilitators change over time, and we may have seen different results if these data were available at other time points. The LIFE Study was designed to examine a population of sedentary older adults at risk for mobility disability. Since this represents a subset of the growing older adult population, our results are only generalizable to sedentary older adults of a similar profile.

There were several limitations unique to the second manuscript. First, the predictor barrier and facilitator variables were not extracted from a standardized survey. As a result, cut points were not previously developed for the survey and the categorization used in this study was driven by the frequency distribution of each question used for analysis. Frequencies were heavily weighted toward the positive end of each scale so categories were created accordingly. A greater variance in scores resulting in alternative definitions for the categories may have provided different results. Also, the question regarding barriers and facilitators related to personal conflict was extremely broad. We have no way of knowing the specific factors that participants perceived as personal conflict barriers and how these individually might have influenced MMD. Second, the questionnaires from which we obtained predictor variables were not originally designed to be used in analysis of the main LIFE Study, which reduced our power

to detect significant findings. Finally, the additive effect of the barriers and facilitators by intervention arm on MMD was not explored. This a future direction for this work since it is plausible that a combination of barriers and facilitators may impact the structured interventions and MMD.

In the third manuscript, the ability to detect statistically significant results was impacted by a large amount of missing data. Although the initial sample size provided sufficient power to pursue the analysis for this study the associations presented may have been attenuated by this limitation. Given that there is a ceiling effect bias associated with the outcome measure used to assess physical function (SPPB) compounded with a study population that was high-functioning at baseline the power to detect a statistically significant result was greatly reduced. There is a well-known volunteer bias associated with research studies. It is also apparent that this study population was relatively healthy, high-functioning, highly educated, and lacked diversity with respect to sex, race, and income. Therefore the results of this study can only be generalized to community dwelling older adults of a similar profile.

## 9.5 PUBLIC HEALTH SIGNIFICANCE

The risk for mobility disability and physical disability increases with age. Lower physical function, mobility disability and the possibility of subsequent physical disabilities are major public health issues due to the rapid and continuing growth of the older adult population. Moreover, the prevalence of older adults engaging in recommended levels of physical activity, a modifiable extra-individual mechanism associated with the functional limitations of interest in this dissertation, is only ~4%-32% [60, 61]. Understanding how perceived barriers and

facilitators, physical activity, and interventions aimed at improving physical function and mobility disability are interrelated may reveal factors that play key roles in the ongoing disablement pathway toward physical disability in older adults. This could inform the development and translation of future intervention efforts aimed at disability prevention. Beyond this point, public health could begin to inform better provision of health care for older adults by incorporating this powerful evidence into traditional medicine.

Longer life expectancy, rapid population growth, and low physical activity participation rates among older adults justify the need for better understanding of perceived barriers to and facilitators of physical activity and how these are related to functional limitations. However, perceived barriers and facilitators, modifiable intra- and extra-individual mechanisms in the disablement pathway, remain underexplored. The existing knowledge in this field provides a groundwork upon which a stronger evidence base can be built. We explored perceived barriers and facilitators in a large randomized trial and community based trial aimed at improving physical function and mobility disability in older adults to understand the key role they may play in the disablement pathway. This is critically important as translational research calls for a shift in emphasis from just understanding what works to also understanding how it works in real world settings. As our population ages dramatically, innovative and effective interventions targeted at reducing the risk for physical disability in older adults within this disablement pathway framework will become increasingly important. In this dissertation work we hoped to fill this gap and provide valuable knowledge that will inform how existing and future interventions need to be adapted to account for the influence of perceived barriers and facilitators.

We have done sound and strong work so far in public health to account for the efficacy of physical activity and structured interventions, and the impact these have on functional limitations, physical disability, and many other chronic diseases and conditions that contribute to functional decline, loss of independence, diminished quality of life, and ultimately death in older adults. Restrictions to mobility can result in a cascade effect of continuing deterioration, generating serious consequences for the older adult population, society, and the economy. If we do not have a clear understanding of older adults' perceptions of the barriers and facilitators that contribute to their ability to engage in a modifiable factor that can improve or even prevent their progression toward these serious and costly health outcomes, the public health burden of all of these issues may very well continue to grow.

The results from the three manuscripts of this dissertation complement one another and have potential public health impact. The first manuscript allowed for characterization of suggested themes that cannot be captured using quantitative assessments and examination of potential differences by structured intervention group. This offers insights that can inform lifestyle intervention program recruitment and retention among the growing sedentary older adult population. This could inform the development of future intervention efforts aimed at disability prevention and provide guidance for the translation of evidence-based programs to the community. The second manuscript provides support that studying extra- and intra-individual mechanisms related to functional limitations in the disablement pathway is important. We highlighted that barriers and facilitators related to physical activity and structured intervention programs for the older adult population warrant further exploration, especially since the pathway to functional decline and physical disability is not linear. In the third manuscript, although the trends and associations reported were ultimately not statistically significant after accounting for

the potential confounding of baseline level of function, sex, age, and income, the results highlight population level factors upon which researchers and public health may need to focus when tailoring future interventions aimed at physical function in older adults to make them more effective. This study provides evidence supporting the importance of considering social support in interventions aimed at improving physical function, as low levels of social support over time may increase the risk for declining physical function and subsequent disability development compared with those reporting moderate or high levels of social support.

As the older adult population continues to grow so will the burden of major mobility disability and subsequent physical disability if we do not continue to take steps toward understanding the complexities of the disablement pathway and where we might be able to intervene to reduce the negative impact of these outcomes on the individual, health care system, and society. Dissemination of feasible, sustainable and low cost programs for older adults is an important public health issue currently gaining more attention. A better understanding of barriers and facilitators underlying sedentary older adults' motivation, and how this is connected to outcomes related to functional limitations and physical disability (which place a high cost burden on society), can lead to improvements of sustainable lifestyle programs. Success in programs could be improved by assessing barriers and addressing them up front. In this dissertation we started to lay groundwork for a richer understanding of barriers and facilitators related to physical activity and structured programs designed to engage older adults. Ultimately, in order to provide sound evidence that moving forward is translatable into something tangible for the growing population of older adults at risk for functional decline and disability.

## 9.5 FUTURE RESEARCH

In this research, the associations between perceived barriers and facilitators, physical activity and structure lifestyle intervention programs, and functional limitations among older adults were investigated. Future studies addressing this might seek to utilize the stages of change and the transtheoretical model to focus on issues related to changing perceptions about barriers and facilitators, and specific needs of older adults with different profiles. Other studies have demonstrated that the transtheoretical model can be applied to interventions and used to successfully engage older adults in physical activity that they can maintain [107-111, 124]. Research needs to acknowledge that unique strategies of recruitment and facilitating behavior change may be needed for older adults in different stages of change reflecting different kinds of barriers and facilitators. As mentioned previously, specific processes of the stages of change, such as consciousness raising and helping relationships, could be embedded within recruitment approaches [108, 109, 145]. Applying various modes and mechanisms of communication could result in improved methods of recruitment, and move older adults along the stages of change. This may in turn result in development of more sustainable programs, inclusion of a wider variety of older adults, and ultimately a greater magnitude of improvement in the health of this population. Expansion of this research will be increasingly important as the aging population grows along with the public health burden of disability.

Our results also emphasize the need for a better understanding of barriers and facilitators, especially given that they may have the ability to significantly reduce major mobility disability depending on one's perception of his/her own unique barriers and the type of program in which one is engaged. In the future, development of more comprehensive and standardized approaches to measuring barriers and facilitators is needed. The provision of a reliable and valid assessment

of these factors could allow us to better quantify the impact of different types of barriers and facilitators on functional limitations, consider changes over time, and the role this plays in the disablement pathway. Eventually this could lead to the development of a tool assessing one's overall barrier index that is directly applicable to lifestyle program use and improvements in functional limitations. This may mean that epidemiologists and public health professionals make movement toward use of mixed-method approaches. The use of a mixed-method approach in this dissertation was informative and shows that it can provide additional insight into important and complex public health issues.

## 9.6 RECOMMENDATIONS

As the aging population and the burdens associated with increasing prevalence of functional limitations rises, novel approaches to address disability reduction and prevention are needed if we are to make advances at the individual, provider, community, and health care system levels. Functional limitations and physical disability are major public health concerns, which are influenced by barriers and facilitators experienced by older adults. Decisions about how to best approach these issues need to be made with the influence and inclusion of public health experts. As we move toward continued translation and sustainability of feasible programming for older adults, the use of interdisciplinary collaborative approaches are highly recommended. Experts in social epidemiological perspectives, behavioral and community health, bioengineering, social work, physical therapy, geriatric medicine, alternative medicine, and palliative/supportive care could begin to form a coalition of experts generating better results and best practices for the older adult population and the needs unique to them.

## APPENDIX: SUPPLEMENTAL TABLES AND FIGURES

### Table 17. Overview of Theoretical Models

| Theoretical Model | Description | Limitation |
|---|---|---|
| Social Cognitive Theory [89] | Reciprocal interaction between person, environment, and behavior | Assumes environmental changes automatically lead to individual changes |
| Self-Determination Theory [92, 93] | Intrinsic and extrinsic motivations regulate behavior | Studies focus on young populations and do not include disability related outcomes |
| Social Ecological Model [94] | Multiple levels of the social environment shape and are shaped by behavior (individual, interpersonal, organizational, community, policy/society) | Employed in restricted populations and does not fit scope of this dissertation work |
| Health Belief Model [95, 96] | Belief in personal threat of a negative health outcome combined with belief in effectiveness of recommended health behavior predicts likelihood of health behavior adoption | Does not account for individual attitudes or other perceived beliefs and determinants; descriptive not explanatory |
| Theory of Planned Behavior [100] | Behavioral achievement depends on behavioral intent (motivation) and behavioral control (ability) | Does not account for environmental factors; Does not consider that behavior can change over time |

**Table 18. LIFE Study Population Exclusion Criteria**

| |
|---|
| Unable or unwilling to give informed consent or accept randomization in either study group |
| Current diagnosis of schizophrenia, other psychotic disorders, or bipolar disorder |
| Consumption of more than 14 alcoholic drinks per week |
| Plans to relocate out of the study area within the next 2 years or plans to be out of the study area for more than six consecutive weeks in the next year |
| Self-reported inability to walk across a room |
| Another member of the household is a participant in the LIFE Study |
| Nursing home residence |
| Difficulty communicating with study personnel due to speech or language or hearing problems |
| Modified Mini-Mental State Examination (3MSE) below 2 *SD*s of education- and race-specific norms |
| Participation in LIFE Pilot study |
| Severe arthritis, such as awaiting joint replacement, that would interfere with the ability to participate fully in either study arm |
| Cancer requiring treatment in the past 3 years, except for nonmelanoma skin cancers or cancers that have an excellent prognosis (eg, early-stage breast or prostate cancer) |
| Lung disease requiring regular use of corticosteroids or of supplemental oxygen |
| Cardiovascular disease (including NYHA Class III or IV congestive heart failure, clinically significant valvular disease, history of cardiac arrest, presence of an implantable cardiac defibrillator, or uncontrolled angina) |
| Parkinson's disease or other progressive neurological disorder |
| Renal disease requiring dialysis |
| Chest pain, severe shortness of breath, or occurrence of other safety concerns during the baseline 400-m walk test |
| Other medical, psychiatric, or behavioral factors that in the judgment of the principal investigator may interfere with study participation or the ability to follow either the intervention or the successful aging protocol |
| Other illness of such severity that life expectancy is less than 12 months |
| Clinical judgment concerning safety or noncompliance |
| **Temporary exclusion criteria** |
| Uncontrolled hypertension (systolic blood pressure > 200 mmHg diastolic blood pressure > 110 mmHg) |
| Uncontrolled diabetes with recent weight loss, diabetic coma, or frequent hypoglycemia |
| Stroke, hip fracture, hip or knee replacement, or spinal surgery in the past 6 months |
| Serious conduction disorder (eg, third-degree heart block), uncontrolled arrhythmia, new Q waves within the past 6 months or ST-segment depressions (>3 mm) on the ECG |
| Myocardial infarction, major heart surgery (ie, valve replacement or bypass surgery), stroke, deep vein thrombosis, or pulmonary embolus in the past 6 months |
| Current participation in physical therapy or cardiopulmonary rehabilitation |
| Current enrollment in another randomized trial involving lifestyle or pharmaceutical interventions |

*Adapted from the LIFE Study [53]

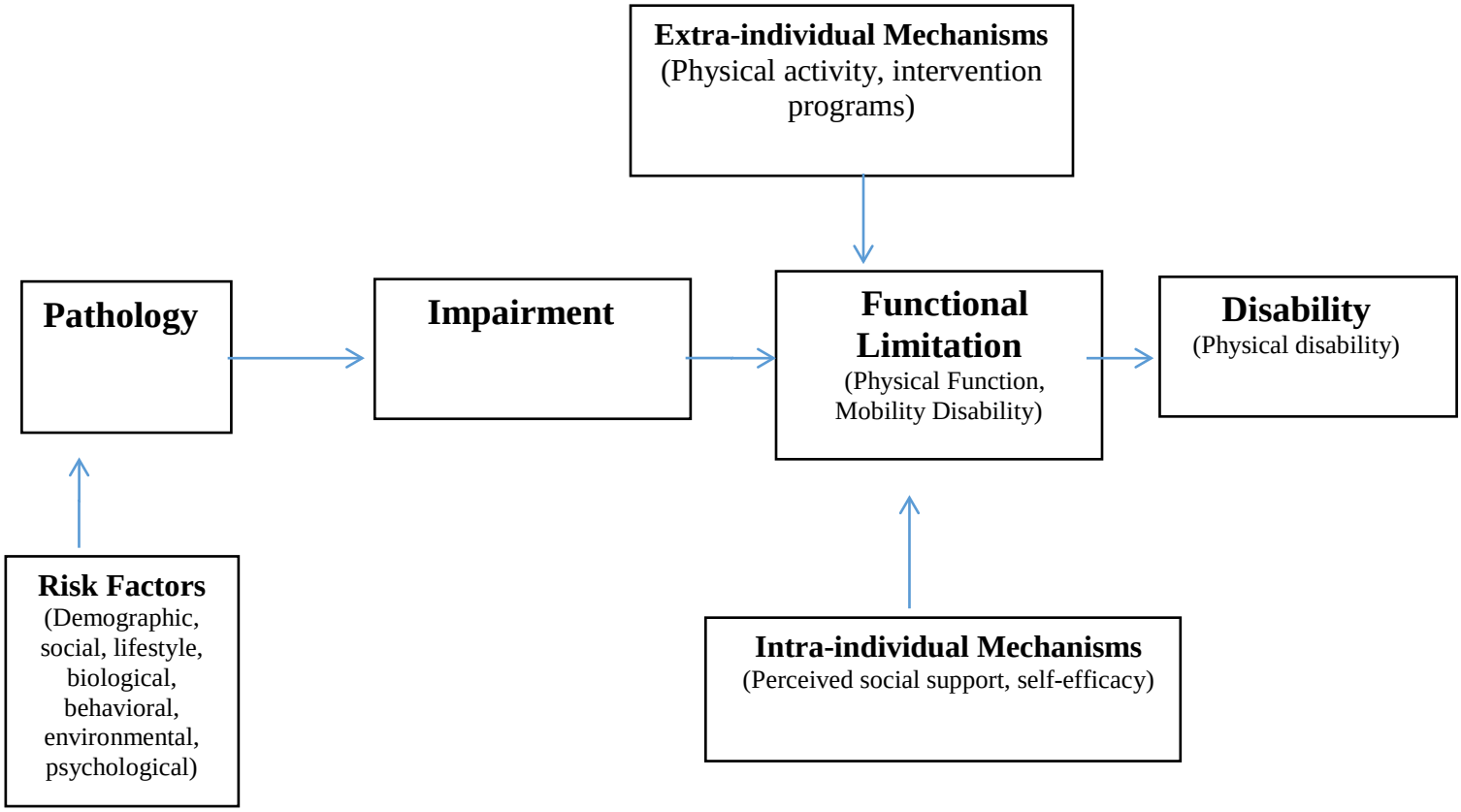


**Figure 4. The role of perceived social support barriers and facilitators in the Disablement Pathway**

(Adapted from Verbrugge and Jette, 1994 (8))

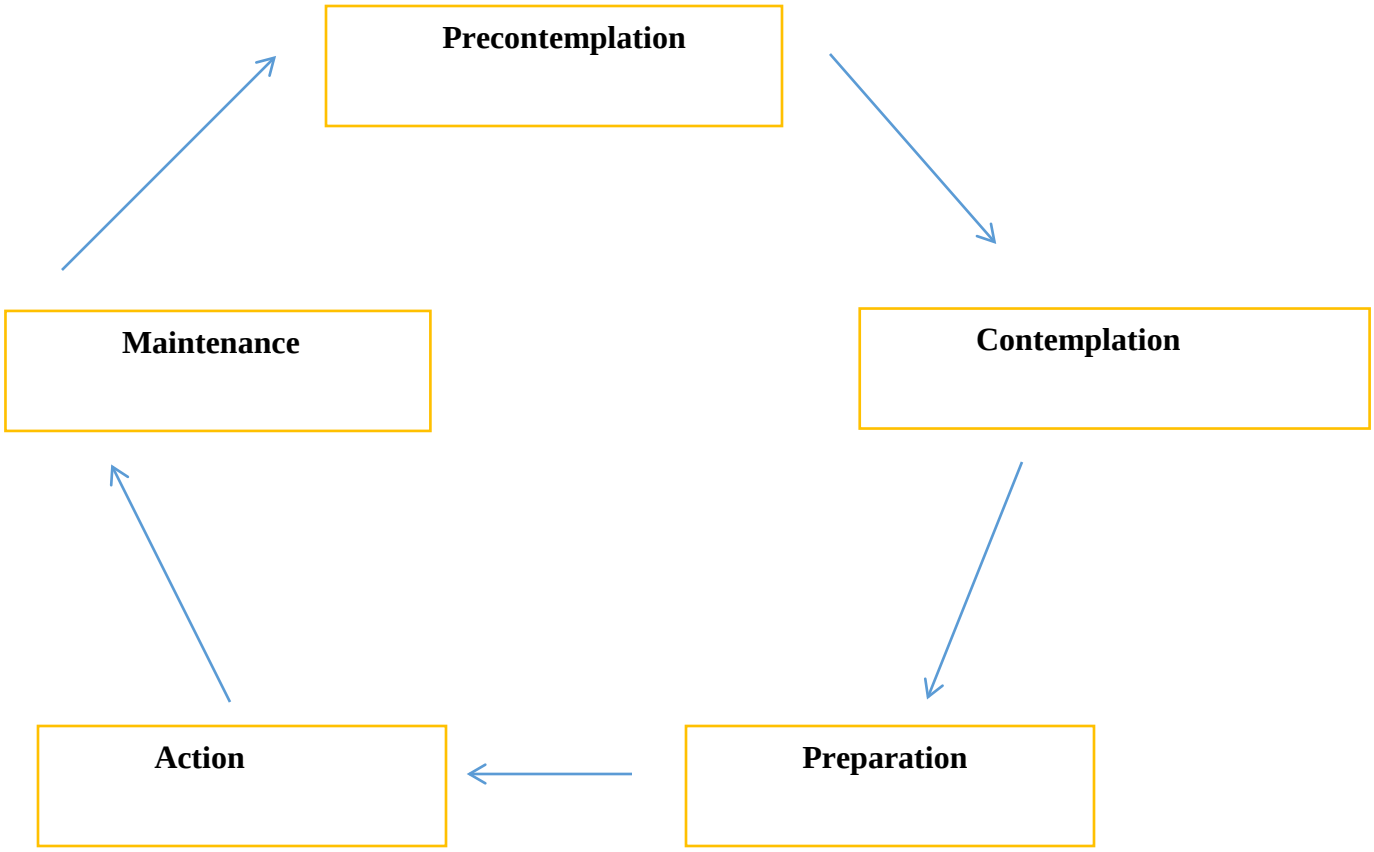


**Figure 5. The Transtheoretical model and its stages of change**

(Adapted from Prochaska and DiClemente [103])

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