# THE EFFECT OF MODIFIABLE RISK FACTORS ON ACTIVITY LIMITATION AND LIMITATION-FREE LIFE EXPECTANCY AMONG LATE MIDLIFE ADULTS

By

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To my sister

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| | |
|---|---|
| ADL | Activities of Daily Living |
| ALE | Active Life Expectancy |
| BMI | Body Mass Index |
| CDC | Centers for Disease Control and Prevention |
| CHD | Coronary Heart Disease |
| df | Degrees of Freedom |
| HALE | Healthy-Adjusted Life Expectancy |
| HBT | Health Behavior Theory |
| HEP | Health Enhancement Program |
| HRS | Health and Retirement Study |
| IADL | Instrumental Activities of Daily Living |
| ICF | International Classification of Functioning, Disability and Health |
| ICIDH | International Classification of Impairment, Disability, and Handicap |
| IOM | Institute of Medicine |
| LE | Life Expectancy |
| LR | Likelihood Ratio |
| MRF | Modifiable Risk Factor |
| OR | Odds Ratio |
| PRP | Participation Restriction Pathway |
| SA | Successful Aging |
| SES | Socioeconomic Status |
| SRH | Self-Rated Health |
| US | United States of America |
| WHO | World Health Organization |

Abstract of Dissertation Presented to the Graduate School
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THE EFFECT OF MODIFIABLE RISK FACTORS ON ACTIVITY LIMITATION AND LIMITATION-FREE LIFE EXPECTANCY AMONG LATE MIDLIFE ADULTS

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Activity limitation significantly predicts subsequent participation restriction onset, institutionalization, and early mortality. Modifiable risk factors (MRFs) (i.e., physical activity, body mass index, and smoking status) are strong and consistent predictors of activity limitation and participation restriction. This research explores the role of MRFs on activity limitation transitions (onset and recovery) among a late midlife cohort. Additionally, this research examines the influence of MRFs on activity limitation transitions across key social statuses (i.e., gender, race/ethnicity, and educational attainment). Activity limitation is broken into two categories: act limitation and task limitation. This research examines both act limitation and task limitation as separate stages of the Participation Restriction Pathway (PRP). Act limitation is measured using mobility limitation measures such as difficulty walking and climbing stairs, while task limitation is measured using Activities of Daily Living (ADL) measures (e.g., difficulty bathing, getting in and out of bed, or dressing). Additionally, positive changes in MRFs were explored as outcome measures. Utilizing Waves 2-8 (1994-2006) of the Health and Retirement Study (HRS), discrete-time event history models with multiple

competing events was estimated using multinomial logistic regression. The results demonstrate the complex relationship between activity limitation transitions and MRFs as well as complicated links between MRFs and socio-demographic characteristics. In regards to activity limitation onset, the role of MRFs was not consistent for gender, race/ethnicity, and education. Unexpectedly, MRFs had little influence on the relationship between gender, race/ethnicity, and education and activity limitation recovery, which underscores the importance of non-modifiable risk factors. The predictors of a positive change in MRFs varied by outcome and the findings support the need for a greater understanding of factors shaping health promotion. The results highlight the need for further research, and they emphasize the need for functional health promotion within a structural framework.

# CHAPTER 1
# INTRODUCTION

As life expectancy continues to lengthen, a greater emphasis has been placed on quality of life in older ages. Over the past century, life expectancy has nearly doubled, yet as we reach the limits of the life span, the additional years of life expectancy gained are smaller and smaller. To illustrate, from 1980 to 2000 life expectancy increased by approximately 3 years ($LE_{1980}$=73.7; $LE_{2000}$=76.8) (Arias 2010). Although there appears to be a trend of gradual gains in total life expectancy, a fundamental question has arisen: what is the quality of those additional years? Unfortunately, research points toward many of the additional years being typified by chronic conditions and disability (Fries 1980; Fries, Green and Levine 1989). Of the leading causes of death in the United States (US) most are from chronic conditions and the top two, heart disease and cancer, account for approximately half (49.1%) of all mortality in 2006 (Heron et al. 2009). Furthermore, in 2005, approximately 51.8% (18.1 million) US adults 65 years or older had a disability (Brault 2008). As the Baby Boomers, born between 1946 and1964, approach old age, projections of functional health in the US include striking numbers of older adults with activity limitation and disability. For example, it is estimated, by 2030, 22 million and 38 million older adults will be living with activity limitation and disability, respectively (Waidmann and Lui 2000). The world's population is also rapidly aging and the global burden of disability is growing. In 2000, the global disabled population was estimated to be 235 to 549 million individuals; moreover, it was estimated that over a trillion dollars were lost due to disability (Metts 2000). It is evident that as the population grows older ways to improve quality of life, compress morbidity, and reduce disability will continue to take precedence in aging research.

Risk of disability is highest in late life (IOM 2007); therefore, disability research is a popular topic among aging researchers from a variety of disciplines. Additionally, disability has significant individual- and societal-level implications. Because disability represents “the impact that chronic conditions have on people’s ability to act in necessary, expected, and personally desired ways in their society” (Verbrugge 1994: 79), disability is associated with loss of independence, lower quality of life, and increased stress (IOM 2007). On a societal-level, higher rates of disability are linked to an increase need for informal and formal care, which ultimately burdens the healthcare system (Fried et al. 2001; Chan et al. 2002). Lost productivity among workers is another major societal-level concern (IOM 2007). Given the potential consequences of a growing US and world-wide aging population, it is important for aging researchers to identify determinants of disability in hopes of finding ways to reduce disability incidence and prevalence.

Because of the multidisciplinary nature of disability research, several models of disability have been developed to aid researchers in understanding the factors influencing the onset of disability. Traditionally, disability research in the US has drawn from the Nagi (1965) model. Other iterations of Nagi’s original disability model have been developed including a popular socio-medical model, the Disablement Process (see Verbrugge and Jette 1994). Recently the World Health Organization (WHO) updated their International Classification of Functioning, Disability and Health (ICF) model of disability. The most recent ICF has undergone a dramatic transformation in regards to terminology. The ICF emphasizes level of health and functioning and attempts to distance itself from using the term “disability” because of the negative

connotations associated with disability. To illustrate, according to the ICF, “[p]reviously, disability began where health ended; once you were disabled, you were in a separate category” (WHO 2001: 3). To better reflect this shift in thinking, the ICF has adopted different language. Although the concept is very similar to disability, participation restriction is defined as “problems an individual may experience in involvement in life situations” (WHO 2001: 10). Both disability and participation restriction are defined in terms of social expectations, yet participation restriction enables researchers to move away from stigmatizing language. This project attempts to capitalize on the advances of the ICF model and terminology, while utilizing the empirical research from US studies and important conceptual developments from the Nagi and the Disablement Process models. Specifically, a new model of functional health was created for this research called the Participation Restriction Pathway (PRP), which addresses the major criticisms of the current ICF model.

The main focus of this research is activity limitation, which is difficulty executing a task or action (WHO 2001). The choice to explore activity limitation versus primarily focusing on participation restriction developed from a desire to examine the participation restriction process through a life course approach. The majority of functional health research in the US examines disability among older adults (i.e., 65 years or older). This project endeavors to investigate an earlier stage of the participation restriction process among a younger cohort (i.e., late midlife). Examining functional health in late midlife is advantageous when exploring health disparities due to the significance of health trajectories. When discussing cumulative disadvantage in relation to health inequalities, many of the early life disparities manifest in late midlife (Ferraro 2006). In other words,

early life inequalities that lead to differing health trajectories such as higher rates of chronic conditions, disability, and early mortality are visible in late midlife. This research investigates a stage of the participation restriction process where functional health inequalities are unfolding and then follows the same cohort for an additional 12 years. It is important to view functional health through a life course perspective and acknowledge the dynamic nature of functional health because it provides the opportunity to consider interventions.

According to Badley (2008), activity limitations are comprised of two dimensions: acts and tasks. Acts are actions that occur without context such as standing, lifting, or thinking, where tasks occur with a specific context and typically require a range of acts. Examples of tasks include dressing, cooking, or maintaining hygiene. A study conducted by Jette, Haley, and Kooyoomjian (2003), also empirically demonstrated that activity limitations encompass two different domains. Because of this previous literature, the PRP reflects two different stages of activity limitations: act limitations and task limitations. Badley (2008) states that acts are the bridge between bodily impairments and tasks. Previous US studies, using functional limitation (e.g., difficulty walking, climbing stairs, lifting heavy objects) and Activities of Daily Living (ADL)/Instrumental Activities of Daily Living (IADL) measures (e.g., difficulty dressing, bathing, preparing meals), have shown that act limitations (functional limitations) are significant antecedents for task limitations (ADL/IADL impairment) (Kelly-Hayes et al. 1992; Lawrence and Jette 1996; Rantanen et al. 1999).

This research explores both components of activity limitations, act and task limitations, among a late midlife cohort. Act limitations are measured using mobility

limitation measures (i.e., difficulty walking and climbing stairs). Previous research has shown the loss of mobility is a significantly associated with loss of independence, institutionalization, and early mortality (Guralnik et al. 1995; Tinetti et al. 1995; Melzer, Lan, and Guralnik 2003). Task limitations (i.e., ADL impairment) are also investigated. Gaining a more complete understanding of activity limitation may enable researchers to develop interventions to prevent participation restriction onset, which could lead to improved quality of life for individuals and reduced burdens for communities and society.

In addition to activity limitation, this project centers on modifiable risk factors (MRFs) (i.e., physical activity, body mass index, and smoking status). Previous literature has suggested that MRFs are strong and consistent predictors of activity limitation and participation restriction (Vita et al. 1998; Ferrucci et al. 1999; Leveille et al. 1999; Penninx et al. 2001; Hubert et al. 2002; Wang et al. 2002), yet the extant literature often overlooks the importance of viewing MRFs within a structural framework (Berkman et al. 2000). This project strives to view MRFs within a structural context in relation to a number of key social groups. In other words, this research explores to what extent MRFs mediate race and ethnicity, gender, and educational activity limitation disparities. The significance of exploring MRFs and activity limitation disparities is twofold. First, over the past few decades, there has appeared to be a trend of improving functional health; however, previous research has suggested that the gains in functional health may reverse due to participation in negative modifiable risk factors at the population-level (Fogel and Costa 1997; Olshansky, Passaro, and Hershow 2005; Preston 2005). Second, unlike other risk factors, MRFs are viewed as potentially malleable, which

enables researchers to discuss possible interventions. This research contributes to the current literature by exploring race and ethnicity, gender, and educational activity limitation disparities and underscoring the importance of social structure when discussing MRFs.

## Research Questions and Specific Aims

To fully understand the participation restriction process in regards to MRFs, this project focuses on three main research questions: 1) what effect do MRFs have on act limitation? 2) what effect do MRFs have on task limitation? 3) what are the predictors of a positive change in MRFs? Each research question has a series of specific aims. The research questions, in conjunction with the specific aims, explore the participation restriction process with special consideration given to activity limitations. Furthermore, the research questions and specific aims were developed to assess the role of MRFs on the participation restriction process and to investigate disparities throughout the participation restriction process among key social groups. Below the research questions are listed along with their corresponding specific aims:

1. What effect do MRFs have on act limitation?

a) Do MRFs have on act limitation transitions?

b) To what extent do MRFs mediate the effects of race/ethnicity, gender, and educational on act limitations?

2. What effect do MRFs have on task limitations?

a) Do MRFs have an effect on task limitations, net of act limitations?

b) To what extent do MRFs mediate the effect of race/ethnicity, gender, and educational on task limitations net of act limitation?

3. What are the predictors of a positive change in MRFs?

a) Do socio-demographic characteristics predict a positive change in MRFs?

b) To what extent do act limitations mediate the effect of race/ethnicity, gender, and educational on a positive change in MRFs?

Each research question delves into the participation restriction process and explores the effects of MRFs as well as the predictors of positive changes in MRFs. The specific aims intend to discover act limitation and task limitation disparities and the potential of MRFs as mediators. Additionally, the specific aims relating to the third research question highlight the capacity of contextual factors to shape positive changes in MRFs. The research questions and specific aims reflect the desire to have a greater understanding of activity limitation disparities and MRFs.

## Research Contribution

A contribution of this research is the development of a new model of functional health, the Participation Restriction Pathway (PRP). The PRP addresses important criticisms of the ICF and represents multiple advancements on previous models. Additionally, because it investigates activity limitation among a younger cohort, this project will be able to advance our understanding of the participation restriction process. It furthers our knowledge about the role of MRFs for race and ethnicity, gender, and educational activity limitation disparities, which may subsequently reduce health disparities among disadvantaged groups. Furthermore, in addition to examining activity limitation onset, this research examines activity limitation recovery, which allows researchers to consider opportunities for participation restriction prevention. Finally, this research continues to contribute to the extant literature by examining the predictors of a positive change in MRFs. Discussed in the conclusion are policy recommendations including possible interventions within a structural context aimed at improving the quality

of life for older adults. This research has the potential to shape health policy and speak to intervention creation that is impactful, realistic, and manageable.

## Dissertation Overview

This dissertation takes place in multiple steps. Chapter 2 continues with an overview of relevant literature. US functional health trends are highlighted including an in-depth examination of incidence and prevalence rates of activity limitation and participation restriction. Throughout, these trends are explored in relation to aging and gerontology literature; for example, successful aging and quality of life issues are discussed. In addition, MRFs rates and trends are also discussed and some theoretical considerations for health behavior participation are explored. Chapter 3 describes the conceptual framework and details the PRP model. Chapter 4 outlines the methodology and analytic strategy employed. Chapters 5, 6, and 7 are analytical chapters. Each analytical chapter corresponds with one research question and subsequent specific aims. Finally, Chapter 8 discusses the overall results and conclusions.

# CHAPTER 2
# LITERATURE REVIEW

## Functional Health Promotion and Successful Aging

Throughout the 20th century, there have been great gains in United States (US) life expectancy. The average life expectancy at birth in 1900 was about 48 years, while in 1950 it was approximately 66 years, and by 2000 it was roughly 75 years (CDC 2008). Much of the dramatic increase in US life expectancies are attributed to declines in mortality among middle-age and older populations (Ory et al. 1994). To illustrate, the fastest growing segment of the US population are the "oldest old" or those 85 years or older; from 1900 to 1994, the oldest old grew 28 times larger (Hobbs 1996). However, researchers have also observed that these higher life expectancies usually mean longer durations with chronic conditions and functional impairment (Fries 1980; 1989). "It has been increasingly recognised that a consequence of [older age] mortality reductions might be that the burden of morbidity in the population expands" (Nusselder 2003). As the Baby Boomers enter late life and the US population continues to age, there is a growing interest in improving the quality of life of the elderly in aging research (Ory et al. 1994). Quality of life is a "multidimensional concept that refers to an individual's overall life satisfaction and total wellbeing" (Ory et al. 1994: 4).

Because health and ability to function are notable factors of quality of life (Ory et al. 1994), aging researchers are interested in discovering ways to increase the length of time that individuals are free of chronic conditions and functional impairment. Consequently, aging literature has developed multiple conceptual models aimed at understanding aging and extending quality of life in later years. Rowe and Kahn's (1997) Successful Aging (SA) model is arguably the most popular. SA addresses

predictors for longer, healthier lives, and promotes lifestyle modifications that can improve the quality of life at later ages, yet the SA model is not without its critiques. The following is a review of the SA model including its development, critiques, and extended models.

The concept of successful aging was not coined by Rowe and Kahn; however, their SA model has come to represent, in contemporary gerontology and aging literature, the foundation for SA. Their original model outlined three components of successful aging: 1) avoidance of disease and disability; 2) high cognitive and physical activity; and 3) active engagement with life (Kahn 1997: 433). An element of avoiding disease and disability includes the presence (or absence) of risk factors for disease, while maintaining high cognitive and physical functioning pertains to potential rather than actualfunctioning (Rowe and Kahn 1997). Engagement with life is broken into two categories: interpersonal relationships and productive activity (Rowe and Kahn 1997). Rowe and Kahn's (1997) three components of SA emphasize the role of lifestyle and risk in aging well. SA focuses on the "adaptive and agentic" aspects of the aging process (Hendricks and Hatch 2006). In other words, it is concerned with the malleable features of aging (i.e., lifestyle). According to Hendricks and Hatch (2006), Rowe and Kahn reduce "successful aging to two factors: how people live and what they eat" (p. 308). Rowe and Kahn (1997) listed several risk factors associated with successful aging including: diet and exercise, mental stimulation, active interpersonal interactions, and productive activities (e.g., working, volunteering, etc.). It was traditionally accepted that declines in health and functioning were inevitable and a normal part of aging; however, Rowe and Kahn (1997) argued that "aging syndrome" could be prevented.

Although the researchers note that there are genetic (heritable) traits that are not modifiable, Rowe and Kahn concentrated on lifestyle and modifiable behaviors.

To understand the development of the SA model, it is important to acknowledge two influential aging theories: disengagement theory and activity theory. Disengagement theory is recognized as the first formal theory of aging (Street 2007). Generally, disengagement theory postulates that aging is the process through which individuals experience decreasing levels of social and institutional interaction; moreover, this limiting of interaction was viewed as a functional and beneficial to both the individual and society (Cummin and Henry 1961; Street 2007). Activity theory was the response to disengagement theory. Activity theory, formalized by Robert Havighurst, challenged the main tenets of disengagement theory (Street 2007). Specifically, activity theory proposed that the individual and social needs of the elderly did not significantly differ from middle-aged adults; it maintained that aging individuals would strive to stay active in social roles as long as possible (Street 2007). Lemon, Bengtson, and Peterson (1972) expanded on activity theory by more precisely defining the mechanisms that related to activity and life satisfaction; the authors demonstrated that "salient role loss is inversely related to life satisfaction" (Lemon et al. 1972: 521). Both disengagement and activity theory endeavored to describe "successful aging" (Havighurst 1961), but the theories had very different notions about expectations and goals for aging. Rowe and Kahn's (1987) original article highlighted modifiable risk factors associated with successful aging; their main goal was to make a distinction between usual and successful aging. Although the term successful aging had been used in gerontological and aging literature for some time, Rowe and Kahn (1987; 1997) drew from previous

theoretical and empirical literature to create a multidimensional model of successful aging.

The first component of the SA model is avoiding disease and disability. Rowe and Kahn (1997) contend that lifestyle factors like diet and exercise are highly correlated with risk factors for many common chronic conditions. There has been a substantial amount of epidemiological research that verifies this position. High blood pressure, coronary heart disease, obesity, diabetes, and some cancers have been shown to be influenced by health risk behaviors (Rowe and Kahn 1987; 1997). The second component of successful aging is maintaining high physical and cognitive function into older ages. Many socio-demographic variables such as socioeconomic status, race/ethnicity, and gender as well as numerous chronic conditions are associated with physical functioning at older ages. High cognitive function is linked to education, strenuous activity, peak pulmonary flow rate, and self-efficacy (Rowe and Kahn 1997). Education is the best predictor of high cognitive function, and Rowe and Kahn (1997) postulate that early education has a life-long benefit and that education is a proxy for life-long intellectual activities (e.g., reading). The third and final component of successful aging (engagement with life) is discussed in two categories: 1) social relationships and 2) productive activities (Rowe and Kahn 1997). Social relationships protect people's health through two mechanisms: expressive needs (e.g., emotional support) and instrumental needs (e.g., giving assistance) (Rowe and Kahn 1997). There is plenty of literature that outlines the benefit of maintaining social networks on health (see Berkman and Glass 2000). Productive activities rely on role theory. Rowe and Kahn (1997) point out the significance of feeling important or useful for upholding

psychological well-being. Each component of the SA model is interrelated. Avoiding disease and disability is linked to continued cognitive and physical function, which is associated with maintaining social engagement. Many of the factors correlated with successful aging (or unsuccessful aging) are interrelated.

There have been numerous empirical studies that have examined the risk and protective factors associated with SA. A study completed by Strawbridge et al. (1996), found that higher income and education, being white, exercising, and having close personal contacts were all positively associated with SA, while depression was found to be negatively associated. Seeman and Chen (2002) used data from the MacArthur Study of Successful Aging, and found that regular exercise and emotional support had protective effects on aging well, and that social conflict was associated with faster declines in physical functioning, net of other socio-demographic variables (i.e., socioeconomic status, race, gender). Hao (2008) investigated the influence of productive activities on psychological well-being. The study indicated that productive activities had a protective effect on mental health; full-time work with low levels of volunteering was found to have the most positive effect on well-being among older adults (Hao 2008). A similar study examined the role of everyday activities on successful aging. Menec (2003) used data from the Aging in Manitoba Study (AIM) to explore the relationship between everyday activities and SA. Menec's (2003) findings suggest that greater participation in everyday activities (e.g., visiting, hobbies, volunteering, housework, etc.) was linked to aging well. Empirically, there is support for Rowe and Kahn's SA model; however, critiques of the model have led to more recent developments in the meaning of SA.

Rowe and Kahn's SA model is popular because it portrays achievable goals in improving the quality of life among the elderly and older adults. It suggests that with changes in behavior people can age successfully. The SA model centers on micro-level processes that can be addressed on an individual and community scale. However, critics of the model point out that successful aging is dependent on social structural factors. By focusing on agency, Rowe and Kahn ignore the significance of larger forces. Many disparities in heath and aging stem from systematic structural inequalities. To demonstrate, Hendricks and Hatch (2006) argue that Rowe and Kahn's model does not take social structure into account; they highlight that the risk factors for SA are situated in "socially prescribed parameters" (p. 308). Individuals' lifestyle choices occur within a context of other social factors. Another popular criticism of SA is that it does not include a subjective perception component. George (2006) asserts that Rowe and Kahn's model does not take into account individual's perceptions of well-being or quality of life; in other words, the model insists that those with functional disability or disease cannot age successfully. Moreover, those who meet the criteria of aging successfully are successful even if they rate their quality of life low. A study completed by Strawbridge et al. (2002) compared Rowe and Kahn's criteria of successful aging versus self-rated successful aging; the authors found that 50.3% of their sample rated themselves as aging successfully, while only 18.8% of the sample was aging successfully according to Rowe and Kahn's classification. This study supports the need for inclusion of a subjective measure in the successful aging model. Other critics have even criticized the use of "successful aging" stating that it connotes that there are winners and losers to the aging process, which stigmatizes a portion of the older

population (George 2006). Although there are several critiques of the Rowe and Kahn's SA model, it has maintained popularity in the aging literature.

Relating to SA, there are clear functional health promotion implications. Although Rowe and Kahn's model specifies a narrow category of SA, it pushed the concept to the forefront. This has led to numerous empirical studies linking different SA indicators to outcomes. A more recent study examined perceptions of SA and compared it to researchers' definitions; the main findings reiterated some of the key attributes (i.e., freedom from disease, independent functioning, and active engagement in life) of SA in published literature (Phelan et al. 2004). The findings also highlighted that perceptions of SA were multidimensional, yet the importance of functional health persists. Then again, Minkler and Fadem (2002) stress the potential of SA to lead to further stigmatization and marginalization among those with severe functional impairment. The authors argue that "an overemphasis on the role of individual choices and behaviors in determining the probability of disease and disease-related disability is problematic" (Minkler and Fadem 2002: 230). Generally, Minkler and Fadem (2002) discuss the need to move away from dichotomous concepts of aging as well as highlighting the significance of social and physical environments. Overall, many of the critiques of SA are similar; however, SA is also lauded by many critics for emphasizing health promotion. It continues to be a prominent model in contemporary literature, and its influence is often seen in the extant functional health research.

## Models of Functional Health

Over the past few decades, several functional health models have been developed. From these models, different definitions of functional impairment have arisen. For example, disability, handicap, and participation restriction have all

represented functional impairment within a social context. This section will briefly describe the evolution of functional health models and subsequent research implications. The Nagi (1965) model of disability is the first functional impairment model. Nagi's model is comprised of four components: 1) pathology; 2) impairment; 3) functional limitations; and 4) disability. According to the Nagi (1965) model of disability, pathology is the underlying condition that leads to interruption of normal body processes. Impairment refers to the anatomical or physiological abnormalities, while function limitations represent restrictions in ability to perform tasks. Disability is socially situated and arises from functional limitations. In other words, in Nagi's model, disability represents an interruption in social roles. Since Nagi originally created his model, several other models have expanded on his ideas.

To illustrate, the first Institute of Medicine (IOM) model of disability drew heavily from the Nagi's model of disability (Altman 2001). According to the IOM model, disability is defined as limitation or inability to perform socially defined roles or activities as well as the gap between an individual's capabilities and demands of the social and physical environment (IOM 2007; IOM 1991). The first part of the definition is very similar to the Nagi's model, but the second part of the definition adds another component to the definition of disability. The IOM model highlights the role of environment in relation to disability. Additionally, Verbrugge and Jette's (1994)Disablement Process model uses the same terminology and pathway as the Nagi model; however, Verbrugge and Jette attempt to highlight the role of social factors. The Disablement Process takes into account "behaviors and attributes that increase risks of or that provide buffers to functional limitations and disability" (Whiteneck 2006: 52). It is important to note that

besides the emphasis on social factors there are some differences in definitions of concepts. Most notably is the usage of pathology; in Verbrugge and Jette's model, pathology "refers very specifically to biochemical and physiological abnormalities that are detected *and* medically labeled as disease, injury, or congenital or developmental conditions" [sic] (Altman 2001). Similar to the IOM model, the Disablement Process also discusses the gap between capabilities and demands as a facet of disability (Verbrugge and Jette 1994). Both the Disablement Process model and the IOM model of disability are derivations of the Nagi model. The models use the same terminology, although in some cases to some extent different definitions, and comparable pathways from pathology to disability.

Similar to the Nagi model and its extensions, the WHO's original functional impairment model, the International Classification of Impairment Disability and Handicap (ICIDH), is also comprised of four components: 1) disease and disorders; 2) impairment; 3) disability; and 4) handicap (WHO 1980). The ICIDH model defined disability as a restriction of ability to perform an activity, which is parallel to the Nagi model's functional limitations (Altman 2001). The ICIDH model used the concept of handicap to define impairment within a social context. The most recent version of the WHO's functional impairment model, the International Classification of Functioning, Disability, and Health (ICF), underwent a dramatic transformation in terms of language. The new components of the WHO's ICF model are: 1) health conditions; 2) impairments; 3) activity limitation; and 4) participation restriction. The purpose of the shift in language stems from the desire to move away from marginalizing language. "ICF is named as it is because of its stress is on health and functioning, rather than on disability" (WHO 2001).

According to the ICF model, participation restrictions “are problems an individual may experience in involvement in life situations” (WHO 2001: 10). Participation restriction refers to the socially defined limitations.

Traditionally, in the US, functional health researchers have utilized the Nagi model or one of its extensions; therefore, the majority of research uses the concept of disability. However, there has been a push for US researchers to adopt the ICF language. Dr. Alan Jette, a leading US disability researcher, has argued that US disability researchers need to adopt the ICF language (Jette 2006; IOM 2007; Jette 2009a). The most recent IOM’s Committee on Disability in America discussed the opportunity for US researchers to “achieve agreement on an international taxonomy” (IOM 2007: 42). Furthermore, the committee agreed that the ICF model had important contributions such language associated with positive health outcomes instead of negative and the inclusions of contextual factors, yet the committee also agreed that there also key limitations in the ICF model that needed to be addressed. For example, the committee noted that the distinction between activities and participations was not clear and that there was a need to further develop the classification of personal and environmental factors influencing functional health (IOM 2007).

More recent research examining and further developing the concepts put forth by the ICF has made several advances. For example, a study conducted by Jette, Haley, and Kooyoomjian (2003), used factor analysis to investigate the domains of activity and participation. The authors found that there are two dimensions of activity and one dimension of participation. Activity encompassed both mobility activities and daily activities, while participation included social participation measures (Jette et al. 2003).

Interestingly, the mobility activity measures use by the authors echoed traditional functional limitation measures used in the US and daily activity measures paralleled traditional Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) measures. Social participation measures relied heavily on social roles and reflected the social context of participation restriction.Another recent study explored the conceptual clarity of activity and participation and also supported the need for two separate dimensions of activity. Badley (2008) describes two components of activity: acts and tasks. Both Jette et al. (2003) and Badley (2008) promote two dimensions of activity and one dimension of participation.

No model of functional health is without criticisms; it is clear that the ICF model needs further development before it is embraced by all US aging researchers. This project uses a model that draws from both the Nagi/The Disablement Process and ICF models. The model developed for this research is called the Participation Restriction Pathway (PRP). It pulls from previous models conceptual advancements as well as empirical data including US functional health trends. Understanding prior health trends and measurements allows researchers to continue to improve conceptual models of functional health.

## US Functional Health Trends

In the US, the majority of functional health research has concentrated on disability and to a lesser extent functional limitations. Disability has traditionally been measured using ADLs and IADLs. ADLs are measures of difficulty or impairment for basic daily tasks. For example, common ADLs include difficulty with: bathing/showering, dressing, eating, getting in/out of bed, and using the toilet. The original ADL scale was created by Katz and colleagues and stemmed from clinical

rehabilitation work among the chronically ill and elderly (Kovar and Lawton 1994). Conceptually, the onset of ADL disability signifies the loss of independence by an individual. IADLs are similar to ADLs; however, they integrate components of the social context and cognitive functioning—examples include difficulty with: shopping, using the phone/calculator/microwave, doing housework, and preparing meals. Originally, the IADL scale was created to assess complex functioning among community dwelling elderly (Kovar and Lawton 1994). In some cases, a combination of ADL and IADL measures are used to define disability. There are critiques for both ADL/IADL as measures of disability such as ADLs only capture severe impairment, while IADLs are culturally biased (Kovar and Lawton 1994); in spite of this, ADLs and IADLs are common measures of disability and demonstrate the likely loss of independence and a reduction in quality of life. In many cases, functional limitations and disability are treated interchangeably in the literature (Kelly-Hayes et al. 1993); however, according to the Nagi model and the Disablement Process model, they are two distinct concepts. Previous research has operationalized functional limitations as difficulty walking, climbing stairs, or pushing/pulling large objects. Empirically, these measures have been verified as distinct concepts; moreover, previous literature has also demonstrated the predictive ability of functional limitations on subsequent disability (Guralnik et al. 1994; Lawrenceand Jette 1996; Guralnik et al. 2000).

There appears to be a general trend of improving functional health in the US. Previous research examining disability and functional limitation trends has suggested that overall both have declined in recent years; however, some researchers have argued that this trend is not fully understood and may fluctuate based on medical

technology, changes in disease-profiles, and/or population-level lifestyle patterns (Freedman and Martin 1998; Costa 2002; Freedman, Martin, and Schoeni 2002). A systematic literature review examining studies that looked at disability demonstrated a trend of improving functional health (Freedman, Martin, and Schoeni 2002). Similarly, a study that focused on long-term disability trends found that active life expectancy (ALE), a measure of the average numbers of years a person can expect to live disability free, has lengthened and the proportion of total life expectancy that is spent disability free has increased over the last century (Manton, Gu, and Lamb 2006). Yet, other research has suggested that trends in disability and ALE are more dynamic. For example, a study examining ALE trends from 1970 to 1990 observed a compression of morbidity and an increase in ALE from 1980 to 1990, and from 1970 to 1980, observed an increased in life expectancy without an increase in ALE; in other words, all of the additional years of life added in that period of time from 1970 to 1980 were disabled years (Crimmins, Saito, and Ingegneri1997). Moreover, a very recent study found evidence of *increasing* disability, for all measures of disability, among US adults aged 60-69 years (Seeman et al. 2010). This research demonstrates the potential fluctuations in disability and functional limitations trends, and underscores the fact that functional health may not inevitably continue to improve in the US.

## Predictors of Functional Health Decline

Predictors of functional health decline are important to discuss because they may highlight potential health disparities. Non-modifiable risk factors are often defined as ascribed statuses such as gender and age. For this research, non-modifiable will refer to predictors that are not related to lifestyle. It is possible to argue that socioeconomic status (SES) or environmental factors are not ascribed; however, these factors often

reflect large, structural processes and systematic dis/advantage. For further illustration, marital status is discussed as a non-modifiable risk factor because it is not a health behavior and because it also is shaped by greater structural processes. Important socio-demographic characteristics predict marital status, and marital status is also indicative of social support. Therefore, even though an individual may change his or her marital status, at a population-level marital status is more akin to a non-modifiable risk factor than a modifiable risk factor.

**Non-modifiable Risk Factors**

Non-modifiable risk factors include socio-demographic characteristics, health status, and environmental factors. Age is one of the strongest and most consistent predictors of functional health decline (IOM 2007; Lightfoot 2007). The risk of functional health decline increases over time (Land and Yang 2006). Unlike age, the influence of gender on functional health decline is somewhat controversial. Part of the confusion surrounding gender as a risk factor of functional health decline is due to women's longer life expectancies, but higher rates of morbidity (Verbrugge 1985). Men, on the other hand, have shorter life expectancies, but they experience lower rates of chronic illness and functional decline. This very distinct pattern is referred to as the "iceberg of morbidity" (Verbrugge and Wingard 1987; Rieker and Bird 2000); "[M]ale mortality makes up the smaller visible part of the iceberg and women's substantially higher rates of chronic nonfatal disease comprise the larger, less visible part" (Bird and Rieker 2000: 99). Using ALE to examine gender differences in functional health, previous studies have suggested that women have longer ALE (Guralnik et al. 1993; Land, Guralnik, and Blazer 1994; Crimmins, Hayward, and Saito 1996); however, this may be from women's longer life expectancies and likelihood of accumulating more non-disabled and disabled

years (Crimmins, Hayward, and Saito 1996). Perhaps a more meaningful measure is the proportion of years men and women spend inactive; accordingly, Crimmins, Hayward, and Saito (1996), found that women (aged 70, 80, and 90 years) spent, on average, a greater percentages of their lives disabled than men. A more recent study also found that women had lower percentage of lives lived free of disability; Jagger et al. (2007), found that women aged 65 years could expect to spend 57% of their lives free of disability, while men aged 65 years could expect to spend 79% of their lives free of disability. Generally, it appears that women have higher prevalence rates of functional health decline, but it is still unclear whether higher incidence rates or longer total life expectancy contribute to this finding (Land and Yang 2006).

Race and ethnicity are also important predictors of functional health decline, but their effects are somewhat inconsistent. The majority of researchers agree that there is "evidence of racial differences in disability levels" (Land and Yang 2006: 50), but the trends in race/ethnic functional health decline are somewhat contentious. Previously, studies had found that disability disparities among Whites and Blacks grew over time (Liao et al. 1999), while other studies found evidence that the disparity converged over time (Johnson 2000). A more recent study, suggested that racial disparities in the US persist over time (Kelley-Moore and Ferraro 2004). In the ALE literature, White/Black disability disparities have been well documented. Compared to Whites, Blacks tend to have lower active life expectancies and total life expectancies (Guralnik et al. 1993; Crimmins, Hayward, and Saito 1996; Hayward and Heron 1999; Crimmins and Satio 2001; Geronimus et al. 2001). Previous researchers have postulated that much of the Black/White difference in ALE is attributed to socioeconomic disparities (Guralnik et al.

1993; Crimmins and Satio 2001; Geronimus et al. 2001); however, there is evidence that the Black/White ALE gap varies by socioeconomic levels (i.e., educational attainment). Crimmins and Saito (2001) study found that the Black/White ALE disparity was greater for lower levels of educational attainment. Unfortunately, the amount of research that focuses on ethnicity and functional health is more limited in the literature; however, there are a few notable studies. For example, from 2001 to 2005, for US adults 18 and older, there is some evidence that those with Hispanic/Latino or Asian origins have lower rates of disability and activity limitations, though this finding in respect to Hispanic/Latino adults is thought to reflect a younger age distribution (Altman and Bernstein 2008). A study, specifically examining US adults 60 years old or older found that Black and Puerto Rican adults were at a greater risk for disability and functional limitations (Jette, Crawford, Tennstedt 1996), while a similar study found Black and Mexican American adults to be at greater risk of disability and functional limitations compared to Whites (Ostchega et al. 2000). It is also important to note that minority women represent a particularly vulnerable population (Ostchega et al. 2000; Andresen and Brownson 2000). In regards to Asian American functional health, there is considerable variation among Asian and Pacific Islander groups. According to Cho and Hummer (2001), Southeast Asians, Vietnamese, and Pacific Islander adults have worse functional health profiles, while Japanese, Chinese, Filipino, and Asian Indian adults have better functional health outcomes. Again, in contrast to research investigating Black/White differences in ALE, research is more limited for ethnicity. One exceptional study, Hayward and Heron (1999), examined White, Black, Asian American, Native American, and Hispanic differences in ALE; the researchers discovered that Asian

Americans had the longest ALE, while Blacks had the lowest ALE. Compared to Whites, both Hispanics and Native Americans were at a disadvantage with lower ALEs (Hayward and Heron 1999). Generally, minorities, with the exception of Asian Americans, are at a greater risk of functional health decline; although, among Asian American groups there are distinct populations at risk of functional health decline.

Socioeconomic status (SES) as a predictor of functional health decline is well established. Whether using measures of education, income, poverty line percentage, wealth, or occupational status, previous studies have identified a gradient of functional health decline (Land and Yang 2006; Minkler, Fuller-Thomson, Guralnik 2006). Individuals with lower socioeconomic status are at a greater risk of functional health decline. The gradient of functional health decline is also reflected in ALE. Lower SES is linked with lower ALEs both in the US and internationally (Rogers, Rogers, and Belanger 1992; Guralink et al. 1993; Land, Guralnik, and Blazer 1994; Kaprio et al. 1996; Kington and Smith 1997; Liao et al. 1999; Crimmins and Saito 2001; Kaneda, Zimmer, and Tang 2005; Jagger et al. 2007). For example, Crimmins, Hayward, and Saito (1996) found that those with lower educational attainment (0-11 years of education vs. 12+ years of education) were more likely to spend more years and a greater proportion of their life disabled, controlling for gender and race. Crimmins and Saito (2001) had parallel results with a trichotomous measure of educational attainment (0-8, 9-12, 13+); ALE was greater for each subsequently higher bracket of educational attainment. It is apparent that SES is a strong and consistent predictor of functional health decline.

Other non-modifiable risk factors that appear in the functional health literature include health status (e.g., morbidity status, self-rated health (SRH)) and environmental factors (social or physical). Among health status measures, morbidity status, usually measured as number of chronic conditions, is highly predictive of subsequent functional health decline (Stuck et al. 1999). There are similar results for SRH; individuals with lower SRH are more likely to experience functional decline (Idler and Benyamini 1997, Idler, Russell, and Davis 2000; Lee 2000). Mental health is also a significant predictor; cognitive impairment and depression are strong predictors of functional health decline (Stuck et al. 1999).

Finally, environmental factors, both physical and social environment, are important predictors of functional health decline. Physical environment factors are related to place and include physical features of an individual's community or home as well as the availability of healthy environments (Macintyre and Ellaway 2000). The association between the physical environment and health disparities is well documented. Disadvantage communities based on race and class are more likely to be at risk for pollution due to toxic and hazardous material (Williams and Collins 2002). Moreover, disadvantage communities are more likely to have lower quality housing (Williams and Collins 2002). These hazardous environments lead to higher rates or morbidity, functional impairment, and mortality (Williams and Collins 2002; Conrad 2005). Researchers have also suggested that unsafe neighborhoods influence health behaviors (Williams and Collins 2002; Macintyre and Ellaway 2000. Social environmental factors are related to social relationships to individuals and organizations such as social networks (Macintyre and Ellaway 2000; Conrad 2005). Berkman and

Glass (2000) describe social support and networks as being embedded in the community. Research has shown that social support and networks impact mental and physical health (Berkman and Glass 2000; House et al. 2005). The social environment can influence one's availability of material needs and emotional support.

Some researchers have proposed that studying environmental factors is especially important for older adults. As people age, place and support become more essential. According to Glass and Balfour (2003), there are four possible reasons why aging increases the importance of environmental factors: 1) older adults may be subjected to longer durations of environmental hazards; 2) poor environments may affect older adults more because of increased biological susceptibility due to aging; 3) older adults have diminishing spatial resources; and 4) older adults often experience shrinking social networks and support. A recent study examining neighborhood characteristics and disability among older adults found that crime levels, resident instability, and street characteristics were associated with higher levels of disability (Beard et al. 2009). Furthermore, another recent study focusing on the social environment found that physical disability was linked with greater loneliness (Russell 2009). Both physical and social environments are important in older ages—particularly with respect to functional health.

**Modifiable Risk Factors**

Functional health decline is thought to be due to a complex interplay of biological, psychological, and social forces that influence health outcomes. A large body of empirical contemporary functional health research has concentrated on MRFs because these risk factors are viewed as the best opportunity for improving individual- and population-level health. MRFs are associated with lifestyle choices such as physical

activity, smoking, and diet. This is especially significant in relation to functional health because there is some evidence that current lifestyle patterns are influencing and reducing functional health trends (Reynolds, Saito, and Crimmins 2005). Moreover, if gains in functional health were to be lost because of lifestyle patterns, the burdens to the healthcare system and loss of worker productivity would be substantial.

The strongest and most consistent finding regarding health risk behaviors and functional health is physical activity. Low physical activity is associated with earlier onset of disability, functional limitations, and lower ALEs (Ferrucci et al. 1999; Leveille et al. 1999; Vita et al. 1998; Hubert et al. 2002; Wang et al. 2002; Penninx et al. 2001). Furthermore, Leveille et al. (1999) found that the likelihood of dying without disability was two times higher for those who participated in vigorous activity than those who were not physically active. Previous research suggests that moderate to vigorous physical activity delays the onset of disability, which is of particular importance when patterns of physical activity over the life course are taken into account. Participation in physical activity reduces as individuals age (Dipietro 2001; Bijnen et al. 1998; Verbrugge et al. 1996). The most common types of physical activity in older ages are lower intensity (e.g., walking, gardening, golf, and bicycling), while higher intensity activities (e.g., running and team sports) decrease as individuals age (Dipietro 2001). A study conducted by Brown et al. (2005) found that of the population of adults 50 years and older, 23% were inactive, 38% were active, but at insufficient levels, and 39% were active at the recommended levels (3 days a week, 20 + minutes, of moderate to vigorous activity). There are many determinants of physical activity including physiological factors, psychosocial factors, and environmental factors; however, among

the older population, a central predictor of physical activity participation is the role of chronic disease and functional health. Older adults are at increased risk for chronic diseases, which, in turn, increases their risk of disability. The relationship with physical activity and disability is bidirectional. Being physically active has potential protective effects from chronic disease and disability onset, while chronic disease(s) and disability onset can interfere with physical activity participation (Dipietro 2001). According to Dipietro (2001), there is some evidence that current physical activity is more protective than past activity, but cumulative, lifetime activity patterns should be considered especially for diseases with long developmental periods.

Another health risk behavior that is associated with functional health decline is tobacco smoking. Current smokers and former smokers are more likely to have functional limitations, disability, and lower ALEs than nonsmokers (Ferrucci et al. 1999; Leveille et al. 1999; Vita et al. 1998; Brønnum-Hansen and Juel 2001; Hubert et al. 2002). Smoking rates can vary dramatically from cohort to cohort, which may noticeably influence functional health for different cohorts. Contemporary smoking rates reflect continued disparities; although tobacco smoking has been declining over the past few decades, the rates are not declining at the same rate for all groups. Smoking rates among less-educated, lower-income, or African American adults remain much higher (Kent 2011).

Unlike physical activity and smoking, the relationship between alcohol consumption and functional health has yet to be established. Previous research in the area has had inconsistent results. For example, Leveille et al. (1999) did not find statistically significant evidence that alcohol consumption (at four different levels)

influenced disability rates. Yet, LaCroix et al. (1993) found that alcohol abstainers were more likely to lose mobility earlier than those who consumed low to moderate amounts of alcohol. Another study observed a protective effect for light drinking in relation to physical disability (Ying, McCrone, and Lai 2008). The contradictory findings may be due to alcohol's potential beneficial and detrimental effects. Moderate consumption of alcohol has been shown to have health benefits, while binge drinking or alcoholism has been shown to have negative health consequences (Gaziano et al. 2000). Abstainers may have pre-existing conditions such as medications or prior alcoholism that lead to worse health outcomes.

Obesity has also garnered much attention with respect to functional health. Where physical activity and smoking are health risk behaviors, obesity is a health risk that is often a product of lifestyle choices, but many of the studies that examine health risk behaviors and functional health also investigate obesity. As obesity rates continue to climb, obesity has become a mounting concern in the United States. Researchers are worried about the possible implications of obesity on younger cohorts' longevity. A study conducted by Reynolds, Saito, and Crimmins (2005) revealed that obesity had little effect on total life expectancy, but it did have a significant influence on active life expectancy; they found, on average, males at age 70 years who were obese could expect to live a third (33%) of their total life expectancy with disability and obese females at age 70 years could expect to live three-quarters (75%) of their total life expectancy with disability. Sturm, Ringel, and Andreyeva (2004) traced disability trends among US adults ages 50 to 69 years and demonstrated that the current obesity trend could lead to a one percent per year increase in disability rates. Alley and Chang

(2007) note that obesity-related mortality is decreasing, while obesity-related disability is increasing. This research suggests that over time the US may experience increased disability burden as obese populations continue to live longer, but develop functional impairment.

It is evident that modifiable risk factors have a substantial impact on functional health. Because of these empirical findings, researchers have tried to further understand individuals' lifestyle choices. There has been multiple models developed pertaining to health behavior theory (HBT). Among the most well-known models are: Health Belief Model, Theory of Reasoned Action, Social Cognitive Theory, and Transtheoretical Model (Noar and Zimmerman 2005). In general, HBT is splintered among the various models; however, some key tenets have arisen. For example, many of the current HBT models discuss evaluation of positive and negative aspects and outcomes of behavior; additionally, normative beliefs and self-efficacy are seen in many HBT models (Noar and Zimmerman 2005). Even though there is some overlap in HBT models, there is still an ongoing debate about what are the most important factors influencing lifestyle behavior. In regard to health behavior change, more specifically, a popular approach is the Transtheorectical Model because it views positive behavioral change as a process (Bond et al. 2004; Prochaska, Johnson, and Lee 2009). Other previous literature notes the importance of socio-cultural factors on maintaining positive health behavioral change (Mulvaney-Day and Womack 2009), and more recently there has been a push for multilevel theoretical models so that meso- and macro-level factors are not neglected (Schneider and Stokols 2009). There is still much that is unknown about health behavior and lifestyle choices; however, it is evident that health behavior is

not only an individual-level phenomenon. Gaining a greater understanding of HBT and MRFs is an important area to continue exploring to aid future health promotion.

## Summary

This project sets out to examine activity limitation within the participation restriction pathway. Exploring functional health is imperative because of the individual and societal implications associated with functional health decline. Multiple models of functional health decline have been developed over the past few decades. This project will attempt to unify the multiple models and utilize the ICF language which emphasizes health rather than disability. Additionally, this research is interested in MRFs as they relate to activity limitation. MRFs are a valuable avenue for researchers to explore because they hold the potential for functional health promotion; however, modifiable risk factors are not fully understood, and unfortunately, much of the functional health and modifiable risk factor literature overlooks the importance of structural factors. The following chapter, Chapter 3, will discuss the conceptual framework and model of functional health, the Participation Restriction Pathway (PRP), for this study.

# CHAPTER 3
# THE PARTICIPATION RESTRICTION PATHWAY

The relationship between chronic diseases and subsequent functional impairment has been a central focus of gerontologists for numerous decades. As the aging population continues to grow, the process by which an individual becomes functionally impaired will also continue to increase in consequence. The population health of the US has undergone a dramatic shift in disease burden known as the epidemiological transition; since the early 20$^{th}$ century, acute causes of death have been replaced by chronic diseases and longer life expectancies (Omran 1977). For example, the top three leading causes of death in the US are from chronic diseases (i.e., coronary heart disease (CHD), cancer, and stroke); however, the most common chronic diseases are nonfatal (i.e., arthritis and high blood pressure) (CDC 2010). Chronic disease, both fatal and nonfatal, symptoms lead to functional impairment. As the life expectancy extends and begins to reach the limits of the life span, examining health in later life including senescence, the aging process, is essential. For many aging researchers, the goal of research is the compression of morbidity. The compression of morbidity refers to the intricate relationship between chronic disease, functional impairment, and mortality.

According to Fries (1983), there is potential to extend the life expectancy, while reducing the amount of time a population spends suffering from chronic disease and functional impairment. Alternatively, some researchers note the potential for the expansion of morbidity stating that “declining mortality from fatal diseases produces a population with high risks of chronic morbidity and related disability” (Nusselder 2003). Active life expectancy (ALE), the average number of years an individual can expect to

live free of functional impairment, can be used as a proxy measure of compression of morbidity. Examining the proportion of ALE to total life expectancy for the entire population demonstrates the average number of years the population can expect to live with and without functional impairment. Given that a main goal of aging research is the compression of morbidity, exploring the pathways and potential mechanisms by which a chronic disease(s) leads to functional impairment is necessary to help gain a more complete understanding of health and aging.

Previous models of functional health have attempted to extricate the relationship between condition and subsequent functional impairment onset. Within the US, the majority of functional health research has drawn from the Nagi model of disability or extended versions of the Nagi model (e.g., The Disablement Process). This is reflected in definitions and operationalizations of functional impairment in US functional health literature. The World Health Organization (WHO) recently updated their model of functional health, the International Classification of Functioning, Disability, and Health (ICF), and contemporary research exploring functional health around the world has begun to draw from the ICF. The WHO's updated model has undergone a radical change in language and attempts to emphasize personal and contextual factors influencing functional health. There is an ongoing debate in the US among many leading health and aging scholars as to whether researchers should adopt the ICF model. Dr. Alan Jette, a leading US disability researcher, has been a vocal advocate for the adoption of the ICF language by US disability and aging researchers (Jette 2006; IOM 2007; Jette 2009a). The most recent meeting of the IOM's Committee on Disability in America discussed the opportunity for US researchers to "achieve agreement on an

international taxonomy" (IOM 2007: 42). Furthermore, the committee agreed that the ICF model had important contributions such non-stigmatizing language and the inclusions of contextual factors, yet the committee also agreed that there are also key limitations in the ICF model that needed to be addressed. For example, the committee noted that the distinction between activities and participations was not clear and that there was a need to further develop the classification of personal and environmental factors influencing functional health (IOM 2007). Before adoption of the ICF language by US researchers occurs, these limitations need to be addressed. Chapter 3 outlines a new, proposed model of functional health, called the Participation Restriction Pathway (PRP), that is informed by previous US models of disability, the ICF model and language, and empirical data from previous functional health research.

## The Nagi Model of Disability and the Disablement Process

The majority of US functional health research draws from the Nagi (1965) model of disability and accordingly much of the empirical work completed in the US utilizes Nagi's concepts and definitions. Additionally, various extensions of the Nagi model have been developed. For example, there is a popular socio-medical model, the Disablement Process (Verbrugge and Jette 1994), that is heavily informed by the Nagi model. Some of the resistance to adopting the ICF language stems from the reluctance to abandon concepts and measures that have been developed and use for many years. However, advocates of the ICF language highlight the similarities between the Nagi and ICF concepts.

Figure 3-1 illustrates the original model of disability as put forth by Nagi (1965). The Nagi model of disability defines a major pathway from active pathology to disability. According to Nagi (1976), an active pathology refers to the mobilization of the body's

defenses against a disease or injury, while impairment refers to “an anatomical, physiological, intellectual, or emotional abnormality or loss” (p. 445). Functional limitation as defined by Nagi includes restrictions in completing activities or obligations at the whole organism or person level, whereas disability is a “pattern of behavior that evolves in situations of long-term or continued impairment that are associated with functional limitations” (Nagi 1965; Altman 2001). In other words, functional limitations are difficulty executing a task and disability is “limitation in performance of socially defined roles” that may stem from functional limitations (Verbrugge and Jette 1994: 2).

Figure 3-2 represents the Disablement Process model. One clear similarity that the Disablement Process has to the original Nagi model is the main pathway. The Disablement Process delineates the main pathway from pathology to disability. According to Verbrugge and Jette (1994) pathology refers to “biochemical and physiological abnormalities,” impairments are “dysfunctions and structural abnormalities in specific body systems,” functional limitations refer to the “restrictions in performing fundamental physical and mental actions,” and disability is the “experienced difficulty doing activities in any domain of life due to health or physical problems” (p. 3-4). Table 3-1 presents a side-by-side comparison of the definitions used in the Nagi model and the Disablement Process model.

The Disablement Process expands on the Nagi model by adding the concepts of risk factors, extra-individual factors, and intra-individual factors. Risk factors are predisposing socio-demographic, environmental, biological, behavioral, or psychological characteristics that may influence an individual’s presence/severity of functional limitation and disability (Verbrugge and Jette 1994). Intra- and extra-individual factors

differ from risk factors because intra- and extra-individual factors are “overt actions taken in response to disease/dysfunction.” Risk factors influence the initial stage of the disabling process (i.e., risk of pathology), while intra- and extra individual factors influence subsequent stages.

Intra-individual factors include lifestyle and behavior changes, psychosocial attributes, and activity accommodations, and extra-individual factors include medical care and rehabilitation, medications, external supports, and built, physical, and social environments (Verbrugge and Jette 1994). The Disablement Process also introduces the concepts of interventions and exacerbators, which may either speed up or slow down the development of disability from pathology (Verbrugge and Jette 1994). Interventions and exacerbators either reduce or escalate, respectively, the impairment an individual may experience; interventions and exacerbators are part of the disablement process (Verbrugge and Jette 1994), are facets of extra-individual or intra-individual factors. Interventions include medical care and rehabilitation, medications and other therapeutic regimens, external supports (personal assistance, special equipment and devices), modifications of built/physical/social environment, lifestyle and behavior changes, psychosocial attributes and coping, and activity accommodations (Verbrugge and Jette 1994: 8). Examples of exacerbators include “interventions that have gone awry,” adoption of behaviors or attitudes that are harmful to health, and societal impediments such as “inflexible work hours, architectural barriers, social prejudice” (Verbrugge and Jette 1994: 8).

Consequently, a major contribution of the Disablement Process is the emphasis on key social concepts. The Disablement Process takes into account “behaviors and

attributes that increase risks of or that provide buffers to functional limitations and disability" (Whiteneck 2006: 52). Additionally, the Disablement Process model can be applied to the majority of disability onset situations including lifelong and late-life disability (Verbrugge and Jette 1994). Because this model emphasizes that disability is a process and ultimately the result of a gap between person and environment, it is well suited for understanding the dynamic nature of disability. Furthermore, the Disablement Process establishes the potential for disability prevention and recovery.

**The International Classification of Functioning, Disability, and Health (ICF)**

Figure 3.3 depicts the most recent ICF model of disability. One striking difference between the Nagi and Disablement Process models and the ICF model is the concepts utilized. The WHO underwent a dramatic shift in language when updating the ICF. The motivation for the change in language was to deemphasize individual disabilities and highlight levels of health (WHO 2001). Furthermore, the shift in language highlights that disability is not experienced by a minority of individuals but a majority: "ICF thus 'mainstreams' the experience of disability and recognizes it as a universal human experience" (WHO 2001: 3). There has been a push from some US researchers to adopt the ICF language. Most notably, Dr. Alan Jette, contends that gerontologists in the US need to move "toward a common language" (Jette 2005; Jette 2006; IOM 2007; Jette 2009a; Jette 2009b). According to Jette (2006), "[t]he ICF framework holds great promise to provide a synthesis of earlier models of disablement and to provide . . . a universal language with which to discuss disability and related phenomena" (p. 727). Furthermore, Jette (2005; 2006; 2009a) argues that the ability to communicate across disciplines and borders is fundamental.

When comparing the ICF to other models of disability (i.e., Nagi model and the Disablement Process), Jette (2009a) states that "[t]he ICF framework, like Nagi's Disablement Model, attempts to provide a coherent biopsychosocial view of health states from a biological, personal, and social perspective" (p. 1165). Additionally, Jette also notes that there are remarkable similarities between the concepts; "[t]he main concepts included within the Nagi and ICF models are strikingly similar although the terms used to represent them are quite different" (Jette 2006: 730). In both models, the outcome (disability or participation restriction) begins with an underlying condition(s); Nagi uses "active pathology" while the ICF uses "health condition." Health condition is a general term for any disease, disorder, injury, trauma, or anomaly (WHO 2001). According to the WHO (2002), aging is classified as a potential health condition. Next, both models use "impairment" to refer to problems with bodily functions; however, the ICF differentiates between body functions (e.g., visual acuity, power of muscles, sensation of pain, etc) and structures (e.g., anatomical parts) (WHO 2001; Badley 2008). According to Jette (2006), Nagi's "functional limitations" are similar to the ICF model's "activity limitation." In the Nagi model, functional limitations are "limitation in performance at the level of the whole organism or person" (Jette 2006: 731), whereas activity limitations are difficulties executing a task or action (WHO 2001). Similar to functional limitations, activity limitations occur at the whole body-person level (WHO 2001). Finally, disability is defined in the Nagi model as "limitation in performance of socially defined roles and tasks within a sociocultural and physical environment" (Jette 2006:731), while "participation restriction is defined as "problems an individual may experience in involvement in life situations (WHO 2001: 10). Both disability and

participation restriction are defined in terms of social expectations. According to the Institute of Medicine (IOM), participation restriction is most closely related to disability in that both signify a gap in capacities and "performance of social roles in given physical and social environments" (IOM 2007: 39). Moreover, both models recognize that disability or participation restriction is a dynamic process that may be influenced by numerous contextual factors.

Similar to the Disablement Process, the ICF also incorporates various contextual factors. Where the Disablement Process identifies extra- and intra-individual factors as important contextual factors shaping the disabling process, the ICF identifies environmental and personal factors as key contextual factors. The ICF defines environmental factors as external factors such as "social attitudes, architectural characteristics, legal and social structures, as well as climate, terrain and so forth" and personal factors as internal factors such as "gender, age, coping styles, social background, education, profession, past and current experience, overall behaviour pattern, character and other factors that influence how disability is experienced by the individual" (WHO 2001: 8). Both the Disablement Process and the ICF models differentiate between external and internal factors.

Although there are advocates of the ICF model of disability, there is also resistance among US researchers in adopting the model. There are a number of reasons cited for the opposition including a loss of pathway, undefined domains, and difficulty applying. For example, Drs. Jack M. Guralnik and Luigi Ferrucci (2009), two leading gerontological scholars, contend that the greatest limitations with the ICF model stems from the lack of aggregation between activities and participation. Additionally,

the authors note that the undefined domains equate to a loss of pathway (Guralnik and Ferrucci 2009). Another leading researcher, Dr. Vicki A. Freedman also expresses the potential pitfalls of the ICF model. Freedman (2009) also comments on the lack of precision regarding the domains and highlights researchers' unwillingness to step away from widely used empirical measures of disability (i.e., Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL)). Furthermore, Freedman (2009) highlights that the ICF is not a dynamic model; the following quote summarizes Freedman's position about adopting the ICF model: "Understandably, some researchers — even those eager to embrace more widely accepted and broadly conceived language — may be uncomfortable parting from a dynamic model with clear concepts, a set of prespecified testable relationships, and validated measures, for a new language not yet fully formulated" (Freedman 2009: 1172). These critiques are echoed by the IOM's Committee on Disability in America. The committee identified essential areas of improvement for the ICF including distinguishing between activity-participation measures, adding quality of life as a key concept, expanding the understanding of personal and environmental factors, and "incorporating a dynamic model of the enabling/disabling process" (IOM 2007: 42).

Even among the critiques of the ICF, the ICF language is lauded. Drs. Jack M. Guralnik and Luigi Ferrucci (2009) praise the ICF language and reiterate the importance of language for "perceptions and reactions to disability" (p.1169). Dr. Freedman (2009) also expresses that having an internationally agreed upon language for the study of disability has many potential benefits. The IOM's Committee on Disability in America notes that the ICF has provided an important innovation by providing a nomenclature

with “positive descriptions of human functioning and not just the negative consequences of disease or injury, a feature that is very important to the disability advocacy community” (IOM 2007: 42). Creating a model that reflects the ICF language, but addresses the major critiques, is necessary for advancement in research on functional health.

## The Participation Restriction Pathway

The Participation Restriction Pathway (PRP) (see Figure 3-4 and 3-5) incorporates aspects of both the Disablement Process and ICF model. The PRP attempts to isolate the best attributes from both models and synthesize them while using previous empirical evidence to aid in conceptualization. In doing so, it addresses the main critiques put forth by many aging researchers. First, the main pathway is very similar to the Disablement Process pathway; however, the ICF language and definitions are utilized. Further, activity limitations are broken into two specific stages—act limitations and task limitations. Maintaining a pathway from underlying condition to participation restriction is vital, especially in relation to latelife disability, given that previous empirical research has established that functional limitation is an important antecedent for ADL/IADL impairment (Guralnik 1995; Lawerence and Jette 1996).

Another major criticism of the ICF model is the unspecified domains for activity and participation. Previous research has attempted to disentangle the activity and participation domains. For example, Jette, Haley, and Kooyoomjian (2003) completed a study using factor analysis and discovered two separate activity dimensions (i.e., mobility activities and daily activities) and one participation dimension (i.e., social participation). In the Jette et al. (2003) study, mobility activities included difficulty walking and climbing stairs, which are typically referred to as functional limitations in US

research. Daily activities included measures of personal care, dressing, washing dishes, and using common utensils, which are analogous to ADL and IADL measures. Social participation included measures of taking care of errands, volunteering, and keeping in touch with others. Similarly, Badley (2008) differentiated between two components of activity limitations, acts and tasks. According to Badley (2008), acts occur "independent of context or purpose" and "serve as a link between body functions and structures and tasks" (p. 2339), where tasks happen in daily life within a specific context. In regards to previous literature and the Nagi concepts, acts are most closely related to functional limitations and tasks are comprised of ADLs and IADLs. Badley's (2008) third component, societal involvement, recognizes that participation is socially and culturally situated and emphasizes difficulty performing roles including work, leisure, social and civic life.

The PRP distinguishes between two stages of activity limitations: act limitations and task limitations. Examples of act limitations include difficulty walking, standing, gripping, lifting, or thinking (Badley 2008). Act limitations can be measured using the same operationalization used in previous literature for functional limitations. Act limitations provide a bridge from body functions and structure impairments to task limitations. An example of a task limitation is difficulty dressing. Tasks limitations often require a "range of acts" and are executed within a particular context (Badley 2008: 2339). By differentiating between act limitations and task limitations, the PRP enables researchers to draw from previous literature and utilize recognized measures of functional health. The final stage of the PRP is participation restriction, which refers to difficulty performing socially defined roles. Social participation measures such as

difficulty taking care of household finances, household chores, traveling, visiting with others, or taking part in social activities are examples of participation restriction (Jette et al. 2003). Table 3-2 presents a summary of the concepts used for the Nagi model, ICF model, and the PRP model. From the ICF to the PRP model, the definitions of the concepts are identical with the exception of activity limitation. In the PRP model, the definition reflects the two separate domains for activity limitations.

As mentioned earlier, although the terms are quite different, the concepts utilized by the Nagi/The Disablement Process models and the ICF models are extremely similar. A commonality in both sets of models includes separating the levels of functioning for each concept. In Figure 3-4, the levels of functioning, from body-level to whole-person in social context, are represented; the body-level corresponds to body functions and structure impairments and whole-person level corresponds to activity limitation, while participation restriction corresponds to whole-person in social context level. Additionally, the PRP model highlights the dynamic nature of the participation restriction process. For example, both onset and recovery are explicitly modeled. In Figure 3-4, dominant pathways (onset) are shown for each stage of the participation restriction process; however, non-dominant pathways (recovery) are illustrated using dotted lines. Although the dotted lines that represent recovery point from one stage to the previous stage, recovery does not necessarily move linearly. Stages may be skipped, and recovery may occur within a stage (i.e., the severity at a given stage may be reduced). To illustrate, severe act limitation may be reclassified as mild act limitation following rehabilitation.

**Contextual Factors**

Although the ICF is mostly applauded for attempting to highlight the role of contextual factors, it is also criticized for lumping personal and environmental factors together. One of the suggestions from the IOM's Committee on Disability in America was to further develop the relationship between personal and environmental factors. The PRP underscores the importance of contextual factors for onset and recovery. Additionally, it advances the understanding of the relationship between environmental factors and personal factors. Figure 3-5 represents this relationship. In Figure 3-5, environmental factors are broken into two categories: social and attitudinal environment and physical environment. Social and attitudinal environmental factors include policies, social support, and community resources/services, while physical environmental factors include physical features and availability of healthy environments.

Personal factors are also broken into two categories: non-modifiable and modifiable factors. Demographic (e.g., gender, age, race/ethnicity, socioeconomic status (SES), and marital status) and personality characteristics (e.g., coping mechanisms, affect) are examples of non-modifiable factors. Modifiable factors include lifestyle choices and health behaviors (e.g., diet, physical activity, smoking status). The relationship between environmental and personal factors is conceptualized as environmental factors having a larger impact shaping personal factors. However, personal factors are also recognized as having the potential to shape environmental factors. The level of analysis is also depicted on the left-hand side of Figure 3-5. The influence of environmental factors tends to occur at the macro level, while influence of personal factors occurs at the micro level.

**Facilitators and Barriers**

Comparable to the Disablement Process' interventions and exacerbators, the ICF uses the concepts of facilitators and barriers to identify possible factors that influence disability development. Facilitators include substances (e.g., medication) or devices (e.g., prostheses) that alter the nature of the impairment as well as "scene-setting" contextual factors like modifying a room or access to personal help, and social norms/legislation (Badley 2008). On the other hand, barriers may include "lack of necessary substances or devices" (Badley 2008: 2340). In the PRP model, the concepts of facilitators and barriers are also incorporated and are vital for understanding the role of contextual factors on onset and recovery. Facilitators and barriers may influence the pace at which an individual moves through the participation restriction process and influence likelihood of recovery for any given stage of the participation restriction process. Contextual Factors initially influence onset of health conditions (similar to the Disablement Process' use of risk factors) and then subsequently influence the following levels of functioning through facilitators and barriers. Exposure to facilitators and barriers is heavily influenced by contextual factors including access to resources such as high quality healthcare. In relation to modifiable risk factors, the concepts of facilitators and barriers may influence participation in positive health behaviors through personal factors, social support, leisure time, healthcare access, and physical environment attributes.

**Recovery and Recovery-Facilitators**

Recovery is somewhat neglected in the literature and it is often treated as onset in reverse; however, recovery is unique. Even though recovery is generally overlooked, recovery from ADL impairment occurs more often than normally characterized; a study

conducted by Hardy and Gill (2004) found that 81% of persons with ADL impairment recovered although much of the recovery was short-lasting. Similar to onset, recovery from activity limitation or participation restriction is greatly influenced by facilitators and barriers, yet the role of facilitators and barriers differ from their role at onset. Arguably barriers are more important for onset than recovery, while facilitators—particularly recovery-facilitators that introduce an agent of change—are central to recovery. Figure 3-6 illustrates the relationship of contextual factors and recovery-facilitators on recovery. Although activity limitation and participation restriction are explicitly represented, recovery can occur at any stage of the participation restriction process. Recovery is any positive gain in functional health; therefore, recovery may be experienced within the same stage of the PRP or passing from one threshold to another. To demonstrate recovery within the same stage, an individual with severe ADL impairment (task limitation) may use rehabilitation to move from severe ADL impairment to mild ADL impairment. Likewise, the same individual may cross the threshold and may no longer report ADL impairment; however s/he may still have mobility limitation (act limitation). It is also important to note that recovery may be short- or long-term (recovery maintenance) and the types of contextual factors and facilitators could vary on the type of recovery (Hardy and Gill 2005).

Among contextual factors, there is an important interplay between environmental factors and personal factors. As mentioned earlier, recovery-facilitators introduce an agent of change. This could be a change in personal behavior (e.g., positive change in health behavior) or change in environmental factors (e.g., medical intervention). The interplay between environmental and personal factors is complicated because there

may be personal attributes that lead individuals to seek medical interventions such as rehabilitation. Barriers are always present in the recovery model; however, they interfere with recovery. An individual without access to high quality medical care or the resources to manipulate his or her environment has barriers in place that prevent recovery. A frequent example of recovery-facilitators in the functional health literature is interventions. Interventions typically address multiple contextual factors and advocate changes in behavior; common recovery-facilitators used in functional health recovery include changes in physical activity, nutrition, and technology (Daniels et al. 2010). Changes in MRFs are recovery-facilitators to consider, and gaining a more comprehensive understanding of contextual factors that trigger changes in MRFs will aid researchers and clinicians in developing future interventions.

## Summary

The PRP addresses many of the major critiques of the ICF, while incorporating the ICF taxonomy and language. First, the PRP, drawing from the Nagi and Disablement Process models, maintains a pathway from condition to participation restriction. A pathway illustrates that participation restriction onset, especially in latelife, is most often a process passing through stages. There is empirical evidence supporting this claim. Moreover, a pathway accounts for the dynamic nature of the participation restriction process. It enables researchers to contemplate both onset and recovery in which interventions aimed at prevention, recovery, or slowing the process can be designed and implemented. Second, the PRP model underscores the role of contextual factors (i.e., environmental and personal factors) on participation restriction onset. Using the concepts of facilitators and barriers, the PRP demonstrates how contextual factors may influence the initial onset of the health condition and the speed at which an

individual progresses through the subsequent stages or likelihood of recovery. Furthermore, the PRP advances the understanding of the relationship between environmental and personal factors in relation to functional health. Finally, the PRP utilizes the language set forth by the ICF, which highlights the levels of health and functioning instead of emphasizing disability. Not only does the ICF language have the potential to move away from stigmatizing and marginalizing terminology, but it also takes into account relative experiences and quality of life. Because participation restriction is socially and culturally defined, it recognizes that individuals may vary due to contextual factors. By adopting the ICF language and maintaining a pathway, the PRP gives US researchers the opportunity to communicate with aging researchers around the world, while also having the ability to draw from previous empirical literature. This model enables US researchers to continue to use common functional health measures (e.g., ADL measures), but also encourages researchers to further the operationalization of the participation restriction. The decades of US functional health data that have already been collected will not fall out of fashion with the PRP model, yet the model also urges researchers to continue to develop and fine-tune measures of functional health.

**The Participation Restriction Pathway and Activity Limitation**

The PRP is informed by previous models of disability and empirical evidence. Another notable contribution of the PRP model is the distinction between activity limitation components. The PRP model distinguishes between act and task limitations. This distinction speaks to one of the chief criticisms of the ICF model. The domains of activity and participation are treated separately. Both conceptually and empirically, previous literature supports the notion that the domains of activity and participation are

in fact independent. Finally, the PRP also improves on previous models by addressing recovery in a more meaningful way. Facilitators and barriers are discussed in relation to onset and recovery. The PRP distinguishes recovery-facilitators to underscore the significance of a positive trigger on recovery.

According to the PRP, activity limitation is an antecedent of participation restriction—there is empirical evidence, which supports this assertion. Previous research has demonstrated that activity limitation is a robust predictor of participation restriction (Wilkie et al. 2007; Chau et al. 2009; Arnadottir et al. 2011). Moreover, these recent studies have also underscored the significance of contextual factors on participation restriction. For example, Arnadottir et al. (2011) found that environmental contextual factors (i.e., living in an urban area) and personal contextual factors (i.e., physical activity and higher cognitive functioning) were positively associated with perceived participation restriction, while other personal contextual factors (i.e., older ages and depressive symptoms) were negatively associated with perceived participation restriction. Similarly, Chau et al. (2009) identified numerous personal contextual factors that predicted participation restriction; being female, older ages, more depressive symptoms, and living in a residential care facility were all associated with increased likelihood of participation restriction. Prior literature has shown activity limitation and contextual factors to be important predictors of participation restriction.

This study does not test the entire PRP model, but instead uses the PRP to inform and investigate activity limitation and MRFs among a late midlife cohort. Both domains of activity limitation, act and task limitation, are explored. This project examines a specific subset of personal factors, MRFs, but it is also interested in non-

modifiable personal factors with regards to social status. The relationship between MRFs and key social statuses on activity limitation onset/recovery is assessed. Additionally, this research explores changes in MRFs (recovery-facilitators) by taking a closer look at the important personal factors that predict MRFs. The analyses for this research draws from the PRP and emphasize the importance of contextual factors for functional health outcomes. Chapter 4 discusses the methodology and analytic strategy for this project. Chapter 5 examines act limitations transitions (onset and recovery) using mobility limitation measures, while Chapter 6 investigates task limitations transitions (onset and recovery) using ADL measures. Chapter 7 explores the predictors of positive change in MRFs. Lastly, Chapter 8 discusses the results from all three analytical chapters in terms of research implications and recommendations.

Table 3-1. Comparison Nagi and the Disablement Process Concepts

| Concept | Nagi | The Disablement Process |
|---|---|---|
| Pathology | A mobilization of the body's defenses against a condition; an interruption in the normal body processes while the body attempts to regain a normal state. | The biochemical and physiological abnormalities that are detected and medically labeled as disease, injury, or congenital/developmental conditions. |
| Impairment | An anatomical, physiological, intellectual, or emotional abnormality or loss. | Dysfunctions and significant structural abnormalities in specific body systems. |
| Functional Limitations | Restrictions in completion activities or obligations at the whole organism or person level. | Restrictions in performing fundamental physical and mental actions used in daily life by one's age-sex group. |
| Disability | Limitation in performance of socially defined roles and tasks within a socio-cultural and physical environment | Experienced difficulty doing activities in any domain of life due to health or physical problem. |

Source: Nagi 1965; Verbrugge and Jette 1994

Table 3-2. Comparison of Nagi, ICF, and PRP Model Concepts

| Nagi | ICF | PRP |
|---|---|---|
| *Active Pathology*—interruption or interference with normal processes, and effort of the organism to regain normal state | *Health Conditions*—diseases, disorders, and injuries | *Health Conditions*—diseases, disorders, and injuries |
| *Impairment*—anatomical, physiological, mental or emotional abnormalities | *Body Function*—physiological functions of body systems<br><br>*Body Structures*—anatomical parts of the body<br><br>*Impairments*—problems in body functions or structure | *Body Function*—physiological functions of body systems<br><br>*Body Structures*—anatomical parts of the body<br><br>*Impairments*—problems in body functions or structure |
| *Functional Limitation*—limitation in performance at the level of the whole organism or person | *Activity*—the execution of a task or action by an individual<br><br>*Activity Limitation*—difficulties an individual may have in executing activities | *Activity Limitation*—difficulties an individual may have in executing acts or tasks<br>*Act Limitations*—difficulties completing an action regardless of context<br>*Task Limitations*—difficulties completing actions required for daily life within a given context |
| *Disability*—limitation in performance of socially defined roles and tasks within a sociocultural and physical environment | *Participation*—involvement in a life situation<br><br>*Participation Restriction*—problems an individual may experience in involvement in life situations | *Participation*—involvement in a life situation<br><br>*Participation Restriction*—problems an individual may experience in involvement in life situations |

Source: Nagi 1965; WHO 2001; Jette 2006

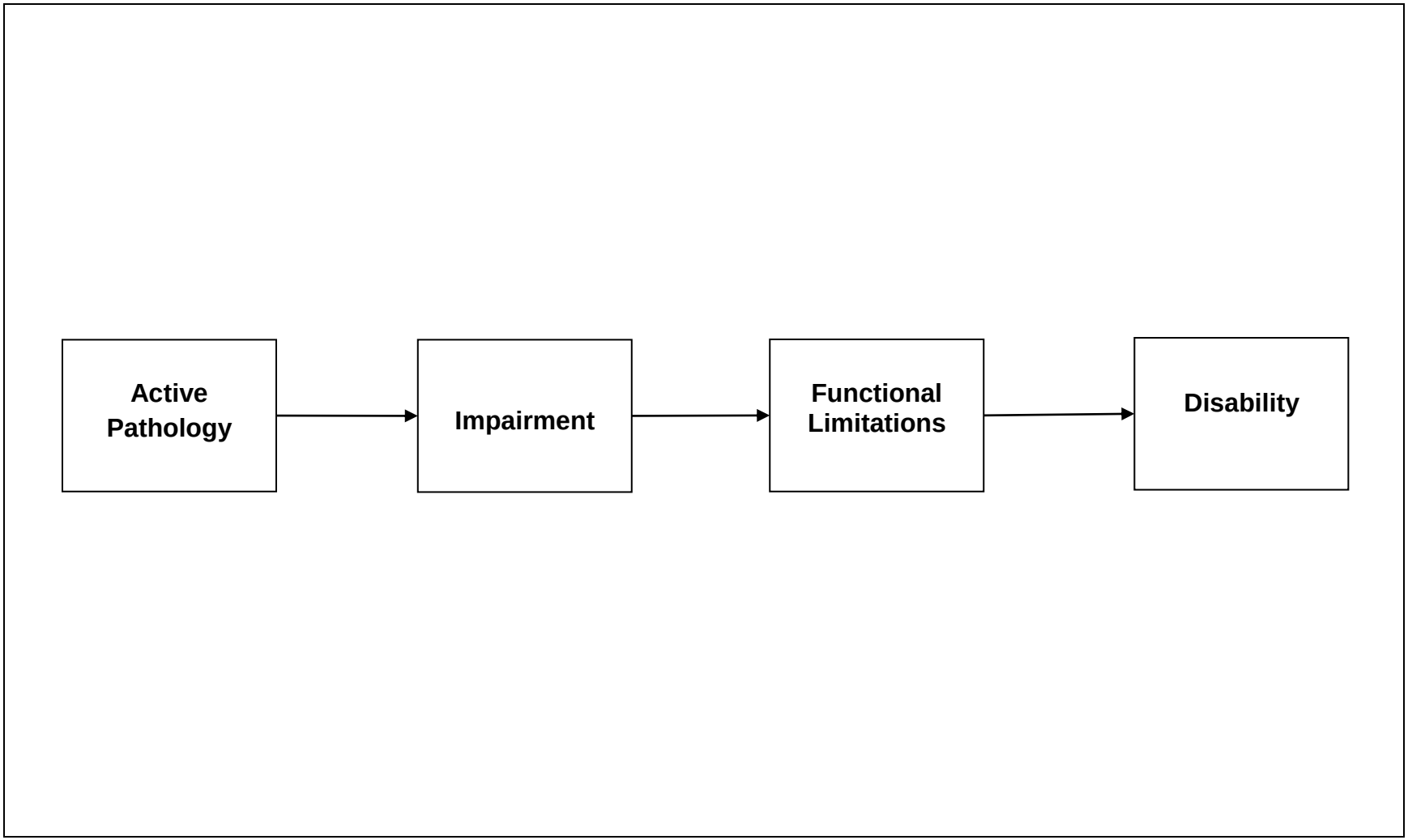



Figure 3-1. Nagi Model of Disability

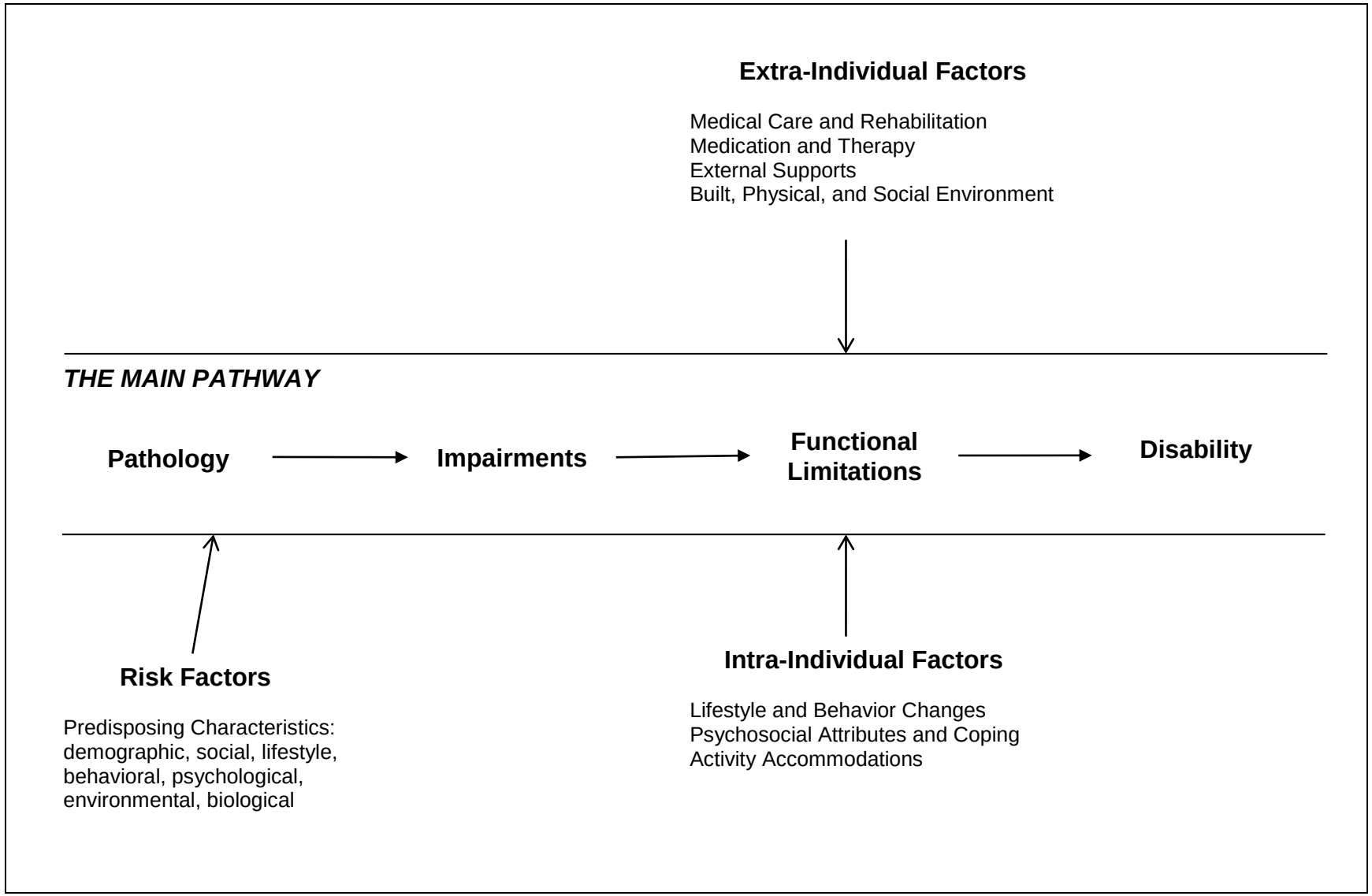



Figure 3-2. The Disablement Process

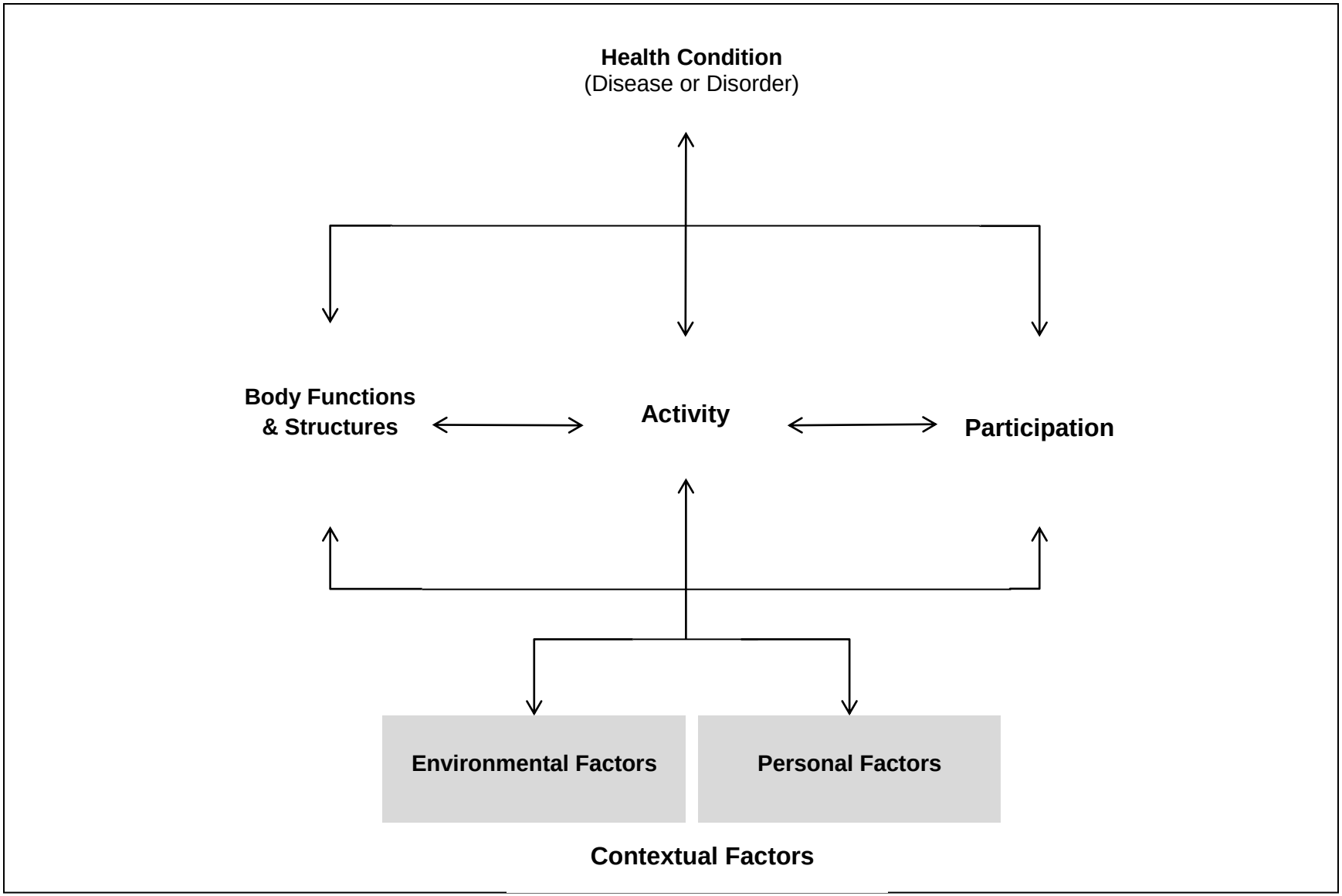



Figure 3-3. International Classification of Functioning, Disability and Health (ICF) Model

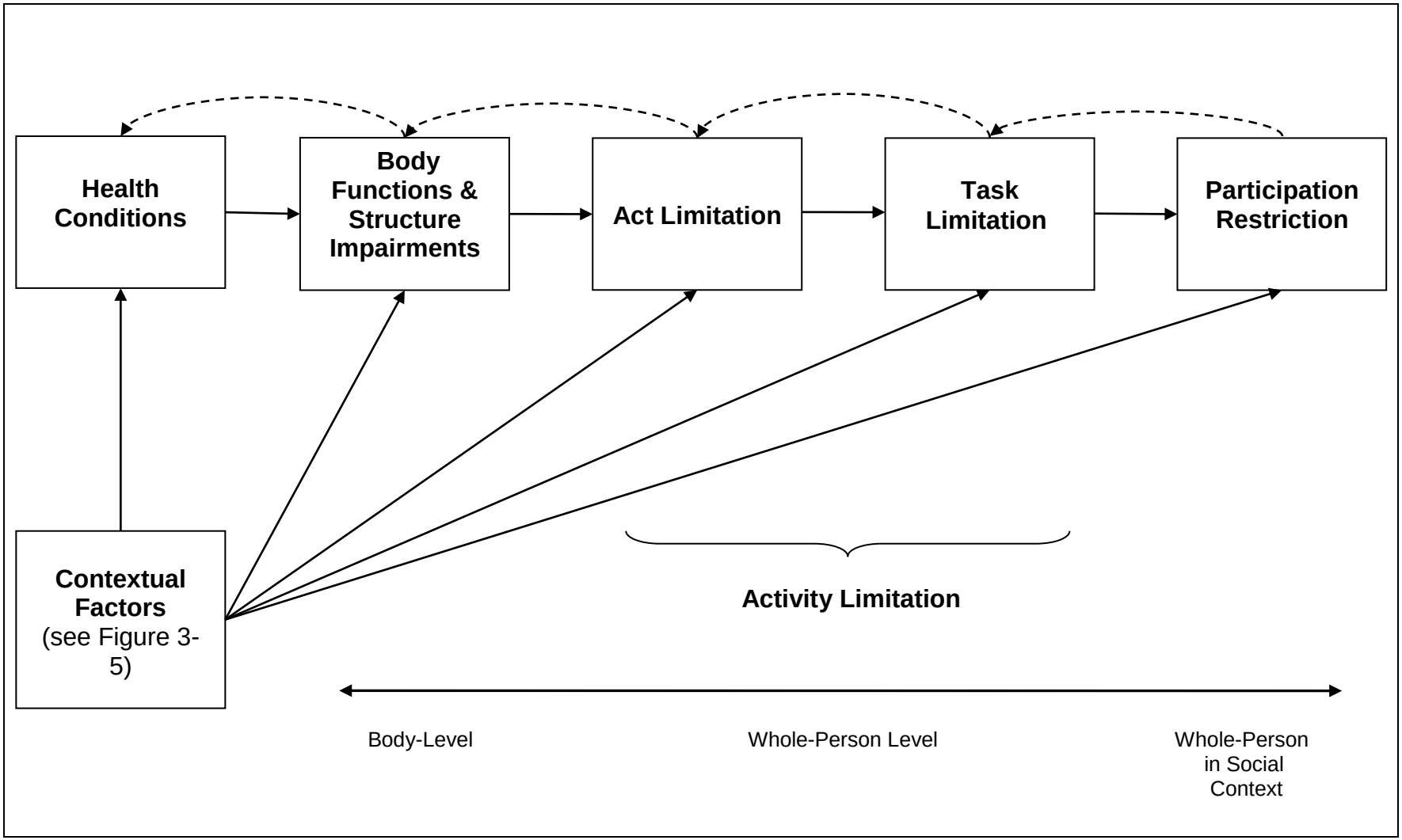



Figure 3-4. Participation Restriction Pathway

Note: Contextual Factors initially influence onset of health conditions and then subsequently influence the following levels of functioning through facilitators and barriers.

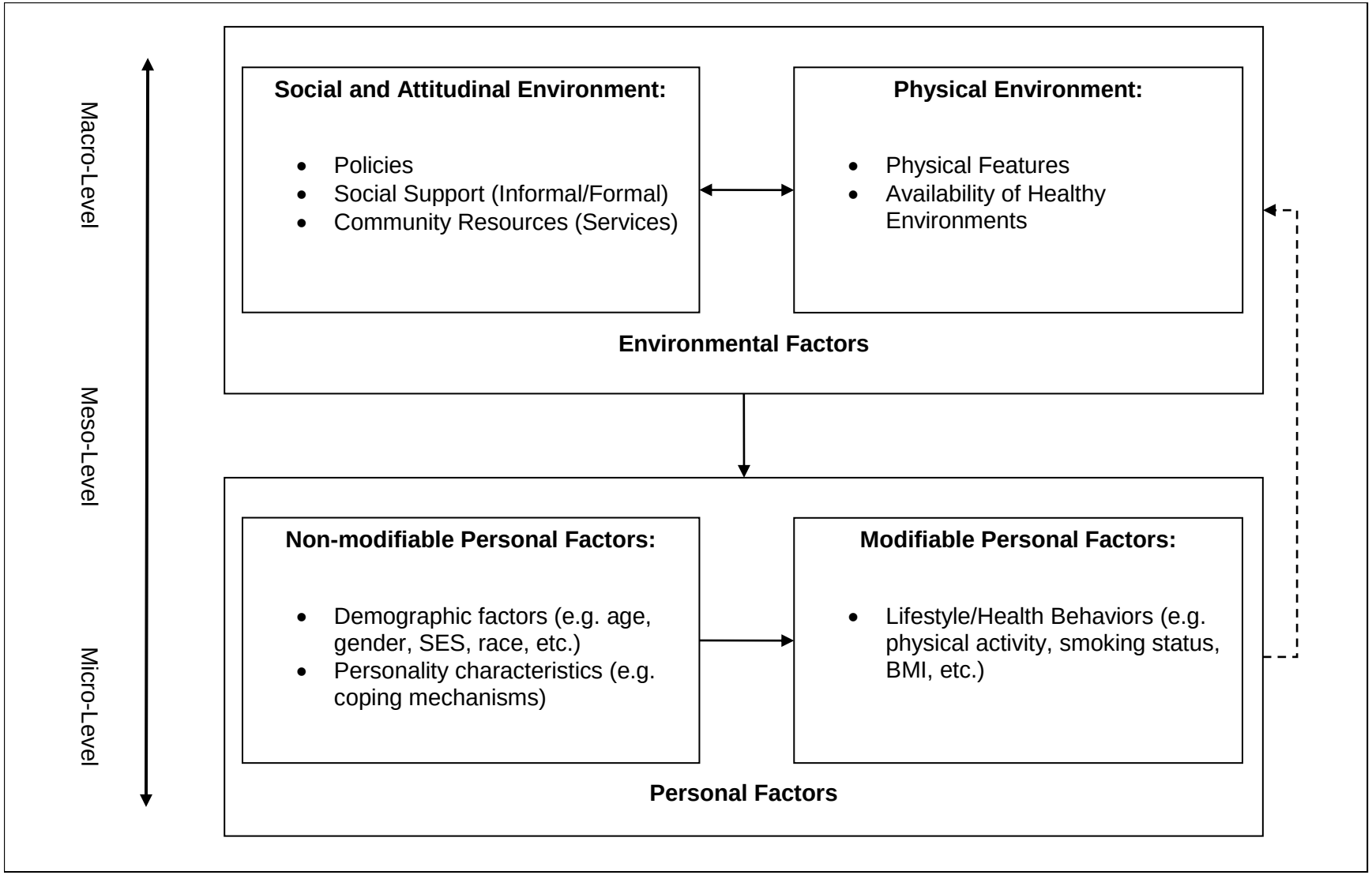



Figure 3-5. Detailed Diagram of Contextual Factors

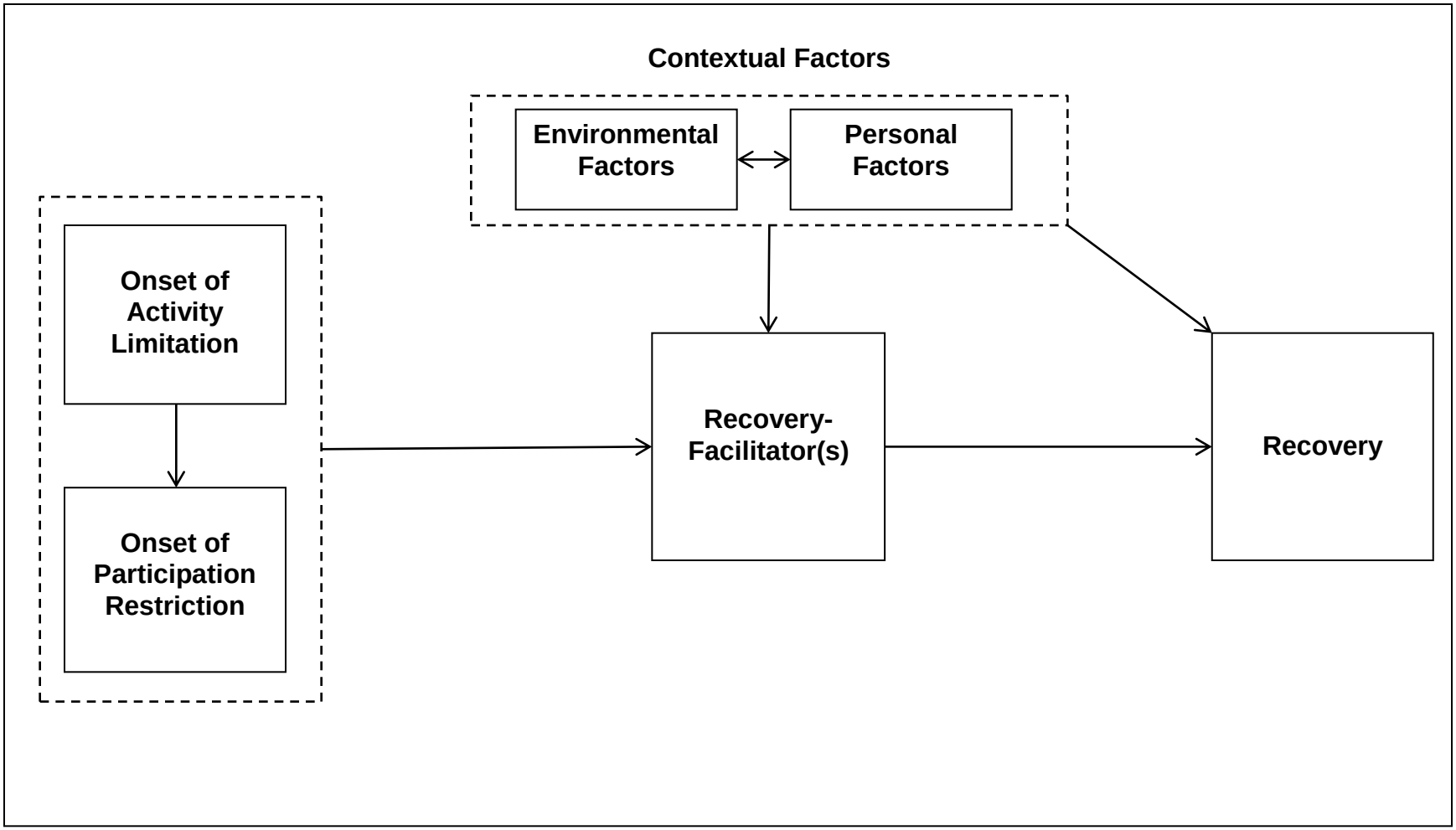



Figure 3-6. Contextual Factors, Recovery-Facilitators, and Recovery

# CHAPTER 4
# METHODOLOGY AND ANALYTIC STRATEGY

The method employed for this project was chosen as to highlight the role of MRFs in relation to activity limitation (i.e., act and task limitation) on key social statuses. Additionally, the methodology utilized features the predictors of a positive change in MRFs. Chapter 4 reviews the data, measures, and analytic strategy in depth.

## Methodology

### Data

To complete this research, Waves 2 through 8 (1994-2006) of the Health and Retirement Study (HRS) are used, which is sponsored by the National Institute of Aging (grant number NIA U01AG009740) and is conducted by the University of Michigan (HRS 2006). The HRS is an ongoing nationally-representative longitudinal survey of a late midlife cohort (b. 1931-1941) and their spouses (regardless of the spouse's age). Blacks/African Americans, Hispanics, and Florida residents were oversampled. The first interviews were conducted as structured face to face interviews in 1992, and then two year follow-up telephone surveys have been used. Some proxy interviews have been conducted after the death of a respondent usually by the individual “most familiar” with the respondent—often the surviving spouse (HRS 2006). The initial sample size was approximately 12,654 people in 7,704 households. The HRS uses a multi-stage, clustered probability frame and the response rate for the original HRS baseline sample was 81.4%. Response rates for subsequent waves have varied from 84.0% to 89.1%. In 2004, it was estimated that 15.9% of the original HRS baseline sample had died. Exit interviews were given to proxies for respondents who died between waves.

Additionally, to assist in the data management and analysis of this project, the most recent RAND HRS Data file was used; the RAND HRS Data file is a user friendly, longitudinal data set created from original HRS data by the National Institute on Aging and the Social Security Administration (RAND 2008). Specifically, the RAND HRS data file "contains cleaned and processed variables with consistent and intuitive naming conventions, model-based imputations and imputation flags" (St. Clair et al. 2009: 2). The RAND data file pays special attention to the cross-wave concordance so that the longitudinal potential of HRS is maximized (St. Clair et al. 2009). The HRS has a wealth of health information including functional health measures. It also has many years of follow-up and a large number of respondents, which makes it very well suited for this study.

**Sample**

Respondents born between 1931 and 1941 are included in the analysis. This consists of the original HRS cohort and their spouses who were born between 1931 and 1941. Of the original HRS sample (12,654), there were 9,814 (77.6%) respondents who fit the above criteria. In 2004 (Wave 7), there were 7,224 (57.1%) respondents still active in the HRS. For this analysis, Wave 1 was excluded because of concordance issues with the dependent variable; from Wave 1 to Wave 2, functional health measures, including mobility limitation measures, underwent a change in wording. Thus, this study employs Waves 2-8 (1994-2006).

**Sample Mortality**

Although the HRS cohort represents a relatively young (i.e., late midlife) cohort, it is important to understand mortality patterns and predictors of mortality for the sample. Table 4-1 presents the frequency of living status per wave. From Wave 2 to Wave 8,

1,717 respondents died in the 12 year period of the study. Between each wave, approximately 2-4% of respondents died. Wave 2 had the fewest amount of deaths (1.76%), while Wave 8 had the most deaths (4.26%). Table 4-2 depicts a summary of findings from discrete-time event history analysis with multiple competing events (i.e., mortality and attrition) predicting mortality of respondents, which were ascertained from multinomial logistic regression; the odds ratios of mortality by socio-demographic characteristics, modifiable risk factors, mobility Limitation, and ADL limitation are presented. Among socio-demographic characteristics, men, Black respondents, older respondents, and non-married respondents were more likely to have died between waves during the study. Protective socio-demographic characteristics included being female, higher levels of education, being White or Hispanic, and being married. All of the MRF measures were significant predictors of mortality; both physical activity and higher BMI scores were protective, while smoking (both former and current smokers) increased a respondent's likelihood of dying during the study. Because this project is interested in activity limitation, mobility limitation and ADL limitation were both included in the sample mortality analysis. Mobility limitation and ADL limitation were remarkably strong predictors of mortality. Respondents with mobility limitation were almost three times more likely to die, while respondents with ADL limitation were over two times more likely. Loss to mortality represented approximately 18% of the attrition for the entire study, and a keener assessment of the sample mortality highlights health disparities and the role of MFRs and activity limitation on premature death.

**Measures**

This study focuses on activity limitation and MRFs. More specifically, this study explores two separate domains of activity limitation, act limitation and task limitation, in

relation to modifiable risk factors. Chapter 5 examines the role of MRFs on the relationship between socio-demographic characteristics and act limitation, while Chapter 6 examines the role of MRFs on the relationship between socio-demographic characteristics and task limitation. Chapter 7 explores the predictors of positive change in MRFs including socio-demographic characteristics and act limitation.

**Dependent variable—act limitation**

Act limitation, specifically mobility limitation, is the dependent variable utilized in Chapter 5. There are mobility measures for all seven waves of analysis. Mobility limitation measures were self-reported. The mobility limitations are comprised of five questions: 1) difficulty walking across the room; 2) difficulty walking one block; 3) difficulty walking several blocks; 4) difficulty walking up one flight of stairs; 5) difficulty walking up several flights of stairs. The answer categories for the question for Waves 2-8 are: "yes," "no," "can't do," or "don't do." The RAND data file created summary "some difficulty" measures of mobility limitation for those respondents that answers "yes." The summary index for the mobility limitations ranges from 0 to 5, where 0 is having no difficulty with any of the mobility limitations and 5 is having some difficulty with all five measures.

**Dependent variable—task limitation**

Task limitation is the dependent variable employed for Chapter 6. Task limitation was operationalized as Activities of Daily Living (ADL) limitation. An ADL index was created using four standard ADL measures: 1) difficulty bathing/showering; 2) difficulty dressing; 3) difficulty eating; and 4) difficulty getting in/out of bed. The ADL measures were all self-reported. Respondents who had "any difficulty" for each task were assigned a value of "1" for that ADL task. Respondents who had difficulty completing all

of the ADL tasks were assigned the maximum value of the index (4) and those respondents who had no difficulty completing any of the ADL tasks were assigned the lowest value of the index (0).

Both the mobility measures and ADL measures were prefaced by the same prompt:

> We are interested in whether people have difficulty with various activities because of a health or physical problem. Please tell me how difficult each of the following activities is for you. Exclude any difficulties that you expect to last less than three months (HRS 2006).

The summary indices were collapsed into dichotomous measures (no difficulty vs. any difficulty) for act and task limitations. Act and task limitation transitions were defined as onset and recovery. Respondents who previously reported no limitations (no difficulty) and then acquired limitations (any difficulty) in the subsequent wave experienced "onset" (see Figure 4-1). Respondents who previously reported having limitations (any difficulty) and then reported no limitations (no difficulty) in the subsequent wave experienced "recovery." The inclusion of both act and task limitation onset and recovery is important because it highlights the risk factors for activity limitation decline, but also the potential for recovery. Moreover, examining activity limitation recovery demonstrates the dynamic nature of the participation restriction process.

**Dependent variable—positive change in modifiable risk factors**

For each MRF, a categorical measure was created so that onset of positive change in MRF could be estimated. Physical activity was measured as a dichotomous variable, where participating in vigorous exercise or sports was assigned a value of "1". The positive change in physical activity represents a respondent starting to exercise or play sports. Smoking status was measured as a three-category dummy variable with

“never smoked,” “former smoker,” and “current smoker” as the categories. Never smoked was the reference group. The positive change in smoking status reflects a respondent quitting smoking. Finally, a trichotomous variable was created for BMI: 1) underweight; 2) healthy weight; and 3) overweight. Respondents who reported a BMI score of less than 18.5 were classified as underweight, while respondents reporting a BMI score between 18.5 and 25 were classified as healthy weight. Respondents with BMI scores of greater than 25 were classified as overweight. The positive change in weight indicated that a respondent moved from either underweight or overweight to a healthy weight.

**Independent variables—modifiable risk factors**

There are three independent variables of interest (modifiable risk factors): physical activity, smoking status, and BMI. Physical activity was measured from a single question, which asks respondents if they participate in vigorous exercise or sports 3 or more times a week. The physical activity measure was as a dichotomous variable, where participating in vigorous exercise or sports was assigned a value of “1”. Smoking status was measured as a three-category dummy variable with “never smoked,” “former smoker,” and “current smoker” as the categories. Never smoked was the reference group. The smoking status measure was constructed from two questions: 1) “Have you ever smoked cigarettes?” and 2) “Do you smoke cigarettes now?” BMI was measured as a continuous variable constructed from weight and height measures. All modifiable risk factors are treated as time-varying measures.

**Independent variables—socio-demographic characteristics**

This analysis is also concerned with activity limitation onset disparities among a number of key social statuses including gender, race/ethnicity, and education. Also,

there is interest in mobility limitation recovery among these groups. A dichotomous dummy variable was created for gender (female=1). A four-category dummy variable was created for race and ethnicity with White (reference), Black, Hispanic, and Other Race as the categories. Education was measured as the number of years of formal education. Gender, race/ethnicity, and education are treated as time-fixed variables.

**Independent variables—covariates**

Additional covariates are also introduced including two socio-demographic variables: age and marital status. Age is treated as a time-fixed measure (i.e., relative age within sample) and measured at Wave 2 (baseline), while marital status is treated as a time-varying variable. In addition to age and marital status, several health measures are also introduced. Measures of morbidity status and healthcare access and utilization are included as time-varying covariates. Morbidity status is measured using chronic conditions and self-rated health (SRH). Eight individual conditions are included: high blood pressure, diabetes, cancer, lung disease, heart problems, stroke, arthritis, and psychological problems (i.e., emotional, nervous, or psychiatric problems). SRH is measured using the following question, “Would you say your health is excellent, very good, good, fair, or poor?” Originally, the answer category was coded as “1” for excellent and “5” for poor. The answer categories were reversed so that excellent health was on the high-end (5) and poor health was on the low-end (1). Finally, healthcare access and utilization were measured using type of insurance coverage, doctor visits in the past 2 years, and hospitalizations in the past 2 years. Health insurance coverage was determined by self-reports of having private insurance (personal or spousal), government insurance, or no insurance. Respondents with any type of private insurance were categorized as having “private insurance,” while those with government

insurance, but no private insurance were categorized as having “government insurance, ” and respondents reporting no private insurance or government insurance coverage were categorized as having “no insurance.” Both doctor visits and hospitalizations were self-reported and were measured at the beginning of the interval about the past two years. All healthcare access and utilization measures are treated as time-varying.

**Analytic Strategy**

The analyses for Chapter 5 and 6 were completed in two main steps. First, bivariate analyses were completed examining the relationship of activity limitation and modifiable risk factors as well as modifiable risk factors and socio-demographic characteristics, and activity limitation and socio-demographic characteristics at Wave 2. Second, discrete-time event history modeling with multiple competing events was estimated using multinomial logistic regression (see Allison 1984). For the activity limitation onset models, the risk group at the beginning of each interval was respondents without any activity limitations and possible outcomes included: no limitation (stable), any limitation (onset), and attrited. For the activity limitation recovery models, the risk group at the beginning of each interval was respondents with any limitations and possible outcomes included: any limitation (stable), no limitation (recovery), and attrited (see Figure 4-1). Although attrition is explicitly modeled, the results for attrited are not presented. Odds ratios were then ascertained for each variable. The analyses were unweighted because many of the attributes that the weights are calculated for (e.g., gender, race/ethnicity, and marital status) are included in the analysis. Previous research has suggested that the unweighted data are less biased than the weighted data (Winship and Radbill 1994; Botoseneanu and Liang 2010). Model 1, for both onset and recovery, includes socio-demographic

characteristics: gender, race/ethnicity, education, age, and marital status. Model 2 includes only modifiable risk factors: physical activity, smoking status, and BMI. In Model 3, socio-demographic and modifiable risk factors are included. Model 4 (full model) introduces morbidity status and healthcare access (and utilization). The recovery models for both act and task limitation do not include the healthcare utilization measures. Recovery-facilitators are particularly important for recovery and, unfortunately, there were no variables available that would adequately measure utilizing healthcare for recovery purposes. For example, utilizing rehabilitation services represents healthcare utilization for recovery purposes. For the task limitation onset and recovery models only, a fifth model was included. Because act limitation is a precursor to task limitation, Model 5 introduced a measure of act limitation so that task limitations could be examined net of mobility limitation. Overall, this modeling strategy was employed so that the relationship between modifiable risk factors and socio-demographic characteristics was underscored. The following two chapters (Chapters 5 and 6) present the results from the analyses. Chapter 5 summarizes the findings relating to act limitations, while Chapter 6 summarizes the findings relating to task limitations.

Chapter 7 examines positive changes in MRFs. Similar to Chapter 5 and 6, a series of discrete-time event history models with multiple competing events were created to estimate positive change in MRFs. Three sets of models were used to assess predictors of MRFs: 1) onset of physical activity; 2) onset of former smoker; and 3) onset of healthy weight. The risk group for each set of models was respondents not participating in the positive behavior at the beginning of the previous interval. For

instance, the risk group for onset of physical activity was respondents not participating in physical activity, while respondents who currently smoked were the risk group for onset of former smoker. The risk group for onset of healthy weight was respondents who were underweight or overweight. Attrition was modeled as a competing event; however, results for attritted respondents were not presented. Four models were employed for each outcome measure of positive change in MRF. Model 1 includes only socio-demographic characteristics and intervals, while Model 2 introduces the other MRFs. Model 3 introduces act limitation to the model and Model 4 adds health measures (i.e., morbidity status and healthcare access). The analytic strategy for Chapter 7 was employed to highlight the role of personal contextual factors (i.e., non-modifiable and modifiable) on positive changes in MRFs. Additionally, as it is important to understand the influence of MRFs on activity limitation, it is also vital to explore the influence of activity limitation on positive changes in MRFs. Each chapter discusses the findings in relation to MRFs and socio-demographic characteristics, which are further considered in the concluding chapter, Chapter 8. These analyses are also noteworthy because the results lay a foundation for the examination Healthy-Adjusted Life Expectancy (HALE). HALE is a derivative of ALE, but it is a more inclusive term that can be applied to other health states besides disability. In the future, these analyses can be used to look at HALE for act and task limitation.

Table 4-1. Distribution of Respondents by Living Status

| | Alive | Dead | Percentage |
|---|---|---|---|
| Wave 2 (yr. 1994) | 9,370 | 168 | 1.76 |
| Wave 3 (yr. 1996) | 9,137 | 205 | 2.19 |
| Wave 4 (yr. 1998) | 8,761 | 208 | 2.32 |
| Wave 5 (yr. 2000) | 8,385 | 266 | 3.07 |
| Wave 6 (yr. 2002) | 7,937 | 332 | 4.01 |
| Wave 7 (yr. 2004) | 7,588 | 231 | 2.95 |
| Wave 8 (yr. 2006) | 6,903 | 307 | 4.26 |

Source: *Health and Retirement Study*

Table 4-2. Odds Ratios of Mortality, by Socio-demographic Characteristics, Modifiable Risk Factors, Mobility Limitation, ADL Limitation, and Time

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|
| Socio-demographic Characteristics: | | | | | |
| Gender (female=1) | 0.52*** | 0.57*** | 0.50*** | 0.57*** | 0.51*** |
| Race and Ethnicity: | | | | | |
| White (ref.) | -- | -- | -- | -- | -- |
| Black/African American | 1.38*** | 1.40*** | 1.41*** | 1.31*** | 1.34*** |
| Other Race | 1.36 | 1.39 | 1.38 | 1.28 | 1.29 |
| Hispanic | 0.74** | 0.80* | 0.84 | 0.75* | 0.80* |
| Education | 0.93*** | 0.94*** | 0.97*** | 0.96*** | 0.98*** |
| Age | 1.09*** | 1.09*** | 1.08*** | 1.08*** | 1.08*** |
| Marital Status: | | | | | |
| Married/Partnered (ref.) | -- | -- | -- | -- | -- |
| Divorced/Separated | 1.94*** | 1.65*** | 1.52*** | 1.48*** | 1.43*** |
| Widowed | 1.81*** | 1.62*** | 1.52*** | 1.50*** | 1.47*** |
| Never Married | 1.67*** | 1.53** | 1.42* | 1.44* | 1.37* |
| Modifiable Risk Factors: | | | | | |
| Physical Activity | -- | 0.36*** | 0.50*** | 0.43*** | 0.53*** |
| Smoking Status: | | | | | |
| Never Smoked (ref.) | -- | -- | -- | -- | -- |
| Former Smoker | -- | 1.83*** | 1.69*** | 1.76*** | 1.67*** |
| Current Smoker | -- | 2.26*** | 1.96*** | 2.18*** | 1.97*** |
| BMI | -- | 0.96*** | 0.94*** | 0.95*** | 0.94*** |
| Mobility Limitation | -- | -- | 3.51*** | -- | 2.87*** |
| ADL Limitation | -- | -- | -- | 3.20*** | 2.15*** |
| Intervals | | | | | |
| Interval 1 (ref.) | -- | -- | -- | -- | -- |
| Interval 2 | 1.14* | 1.38* | 1.21* | 1.18 | 1.11 |
| Interval 3 | 1.44*** | 1.81*** | 1.59*** | 1.54*** | 1.44*** |
| Interval 4 | 1.95*** | 2.51*** | 2.17*** | 2.17*** | 2.01*** |
| Interval 5 | 1.42*** | 1.76*** | 1.48*** | 1.54*** | 1.39*** |
| Interval 6 | 2.05*** | 2.18*** | 1.88*** | 1.98*** | 1.80*** |
| Intercept | -7.63*** | -6.81*** | -7.06*** | -6.84*** | -7.11*** |
| Likelihood Ratio | 688.7*** | 1108.2*** | 1490.4*** | 1360.8*** | 1592.0*** |
| Degrees of Freedom | 28 | 36 | 38 | 38 | 40 |

Source: *Health and Retirement Study* Notes: *0.01 < p ≤ 0.05; ** 0.01 ≤ p < 0.001; *** p ≤ 0.001

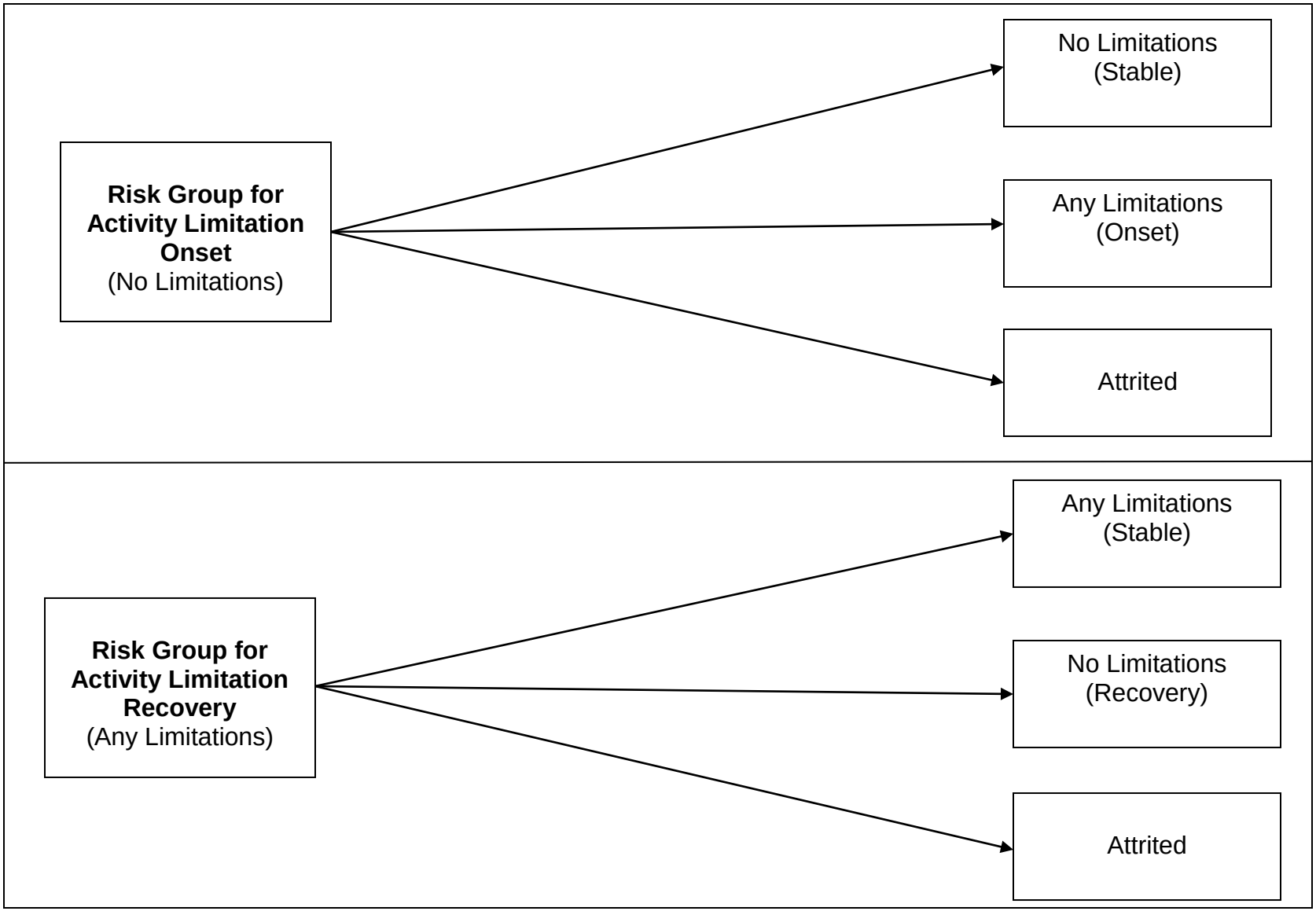



Figure 4-1. Model of State Space for Activity Limitation Transitions

# CHAPTER 5
# ACT LIMITATION TRANSITIONS AMONG LATE MIDLIFE ADULTS

According to the Participation Restriction Pathway (PRP), act limitation is the first stage of activity limitation. Act limitation is defined as difficulty completing an action regardless of context. Standing, breathing, thinking, or walking are examples of acts. Act limitations link body functions and structures impairments to task limitations. Compared to task limitation (ADL impairment), the research exploring act limitation is much more limited; however, several notable studies have found act limitation to be a strong and consistent predictor of task limitation onset (Kelley-Hayes et al. 1992; Guralnik et al. 1995; Guralnik and Ferrucci 2003). According to the PRP model, act limitations are precursors to task limitations. Because of this distinction, act limitations present a unique opportunity to view the participation restriction process through a life course perspective. Additionally, act limitations represent a potential for intervention to slow or prevent subsequent task limitation and possibly participation restriction. Chapter 5 examines act limitation transitions, specifically onset and recovery, among a late midlife cohort. Furthermore, the analyses performed in Chapter 5 concentrate on MRFs in relation to act limitations as well as potential gender, race/ethnicity, and education act limitation disparities. Figure 5-1 is a translational diagram of the PRP for Chapter 5. In respect to the PRP, Chapter 5 explores personal contextual factors and act limitations. Personal contextual factors are broken into two categories: modifiable personal factors and non-modifiable personal factors. Modifiable personal factors are measured using three MRFs: 1) physical activity; 2) smoking status; and 3) BMI. Non-modifiable personal factors are measured using key socio-demographic characteristics such as gender, race/ethnicity, and education. Act limitation is measured using mobility

limitation. By gaining a more complete understanding of act limitations and MRFs, researchers may be able to develop a greater understanding of the participation restriction process while emphasizing possible areas for intervention, which may ultimately lead to a higher quality of life for entire the aging population.

These analyses focus on mobility limitation (i.e., difficulty walking and climbing stairs) as a measure of act limitation. Previous research has established mobility limitations as important predictors of subsequent task limitation (ADL/IADL impairment), institutionalization, and mortality (Guralnik et al. 1995; Tinetti et al. 1995; Melzer, Lan, and Guralnik 2003). A recent study of Medicare beneficiaries found that almost half of US adults 65 years or older reported difficulty walking a quarter mile; furthermore, the results indicated that of those older adults with mobility limitation approximately 20% did not report ADL/IADL limitation, task limitation (Hardy et al. 2010). Mobility limitation is widespread among older adults and an important predictor of other health outcomes; therefore, further research is warranted. Investigating mobility limitation onset and recovery in relation to MRFs provides a more comprehensive understanding of the participation restriction process and may enable researchers to isolate key areas for prevention and intervention.

## Bivariate Analysis

A summary of bivariate associations for socio-demographic characteristics, modifiable risk factors, and mobility limitation is presented in Table 5-1. Bivariate associations based on $\chi^2$ statistic (generated using cross-tabulation) are shown as percentages, while associations based on Comparison of Means (t-test) show the average and the standard deviation in parentheses. The different tests were used to account for the level of measurement. Among the socio-demographic characteristics, a

gendered relationship exists at Wave 2. Women (43.6%) were more likely to have mobility limitation compared to men (24.5%). Race and ethnic differences are also present. White (32.3%) respondents, compared to non-White respondents, were less likely to have mobility limitation, while Black/African American (43.8%) respondents, compared to non-Black/African American respondents, and Hispanic (47.2%) respondents, compared to non-Hispanic respondents, were more likely to have mobility limitation. Belonging to another racial category besides White or Black was not significantly associated with mobility limitation. The average education level for respondents with mobility limitation was 11.2 years compared to 12.6 years for respondents without mobility limitation. Women, racial and ethnic minorities, and those with lower levels of education were more likely to have mobility limitation.

In Table 5-1, the bivariate relationships for MRFs and mobility limitation are also presented. Approximately 20% of respondents with mobility limitations were physically active, while nearly double, approximately 40%, were not physically active. Compared to non-current smokers, current smokers (43.4%) were more likely to have mobility limitation, while those who never smoked (32.6%) were less likely to have mobility limitation. Former smokers (34.5%) were also less likely to have mobility limitation, compared to current smokers. The average BMI for respondents with mobility limitation was 28.7, while the BMI for respondents without mobility limitation was 26.4. Physical inactivity, being a current smoker, and higher BMIs were associated with mobility limitation.

Table 5-2 shows the bivariate associations among socio-demographic characteristics and MRFs. Compared to men (23.0%), women (19.2%) were less likely

to be physically active. Women were more likely to have never smoked (45.9%) and men were more likely to be former smokers (48.4%) and current smokers (26.0%). BMI was not significantly different for men and women. Black/African American (17.3%) respondents were less likely to be physically active. Compared to other groups, both White (21.9%) and other race (24.5%) respondents were more likely to be physically active. Hispanic (43.3%) and other race (48.5%) respondents were more likely to have never smoked, whereas White (40.8%) respondents were more likely to be former smokers and Black/African American (26.1%) were more likely to be current smokers. Black/African American (28.9) and Hispanic (30.0) respondents, on average, had higher BMIs, while White (26.8) and other race (26.1) respondents had lower BMIs. Physically active respondents, on average, had more years of education (12.6) than physically inactive respondents. On average, current smokers (11.5) had fewer years of education, while those who never smoked (12.3) and former smokers (12.3) had more years. Because education and BMI are both interval measures, a Pearson Correlation test was used to examine this bivariate association. A weak negative association exists for education and BMI; more years of education were associated with lower BMIs. Men, White and other race respondents, and those with higher levels of education were more likely to be physically active. Being male or Black/African American, and having fewer years of education were linked to current smoking status. Finally, being Black/African American or Hispanic and having lower levels of education were associated with higher BMIs.

## Multivariate Analysis

### Mobility Limitation Onset

Table 5-3 presents the descriptive characteristics for the initial mobility limitation onset risk group (i.e., respondents without mobility limitation at Wave 2) (N=5,016). The average age was 55.6 years. Men comprised over-half (53%) of the onset risk group. The majority of the risk group was White (76.4%). The average number years of formal education was 12.6 years—approximately equivalent to a high school education. Additionally, the majority of respondents was married or partnered (80.5%). A little over a quarter of the risk group was physically active (i.e., participated in vigorous exercise/sports 3 or more times per week). Current smokers represented 21.2% of the risk group, while former smokers represented 40.4%, and 38.4% of the risk group had never smoked. The average BMI was 26.4—above a healthy BMI range of 18.5 to 24.9.

Table 5-4 displays a summary of the findings acquired from multinomial logistic regression analyses for mobility limitation onset by socio-demographic characteristics, MRFs, morbidity status, healthcare and utilization, and time. Odds ratios are presented. The Likelihood Ratios for all models were statistically significant at an alpha level of less than 0.001. In Model 1, gender, race (i.e., Black/African American), education, age, and divorced/separated were statistically significant. Gender (OR=1.55) has a particularly pronounced effect in which women were more likely to experience mobility limitation onset. Compared to White respondents, Black (OR=1.25) respondents were also at an increased risk of mobility limitation onset. Older respondents (OR=1.03) and divorced/separated (OR=1.14) respondents were more likely to experience mobility limitation decline. Education (OR=0.93) had a protective effect on the onset of mobility limitation. In Model 2, modifiable risk factors are presented. Physical activity (OR=0.60)

had a strong protective effect on mobility limitation onset, while current smokers (OR=1.55) or higher BMIs (OR=1.08) were associated with increased likelihood of mobility limitation onset. These findings were in line with previous literature. Looking at the Likelihood Ratios for Model 1 (LR=738.5; df=28) and Model 2 (LR=896.6; df=18), it appeared that, as a group, MRFs explain more the variation in the dependent variable. In other words, Model 2 compared to Model 1 had a better model fit. However, examining Model 2 (LR=896.6; df=18), Model 3 (LR=1503.4; df=36), and Model 4 (LR=2566.1; df=62), the Likelihood Ratio increased substantially for each subsequent model, indicating a better fit. Model 3 included both socio-demographic characteristics and MRFs. From Model 1 to Model 3, the relationship between gender and mobility limitation onset increased in magnitude suggesting a suppressor effect; female (OR=1.75) respondents were more likely to have mobility limitation onset net of MRFs. For race and ethnicity, being Black/African American was no longer a significant predictor; it appears that MRFs mediated the original association between race (i.e., Black/African American) and mobility limitation seen in Model 1. Education (OR=0.94) remains relatively stable from Model 1 to Model 3 with the introduction of MRFs. Age (OR=1.04) also remains relatively stable, while divorced/separated was no longer significant (mediated) in Model 3. In Model 3, all of the MRFs measures were significant. Once again, physical activity (OR=0.64) was associated with lower likelihood mobility limitation onset. Former smokers (OR=1.14) and current smokers (OR=1.65) were more likely to experience mobility decline. It is important to note that with the introduction of socio-demographic characteristics being a former smoker became a

significant predictor. Finally, higher levels of BMI (OR=1.09) was also associated with high likelihood of onset.

In the full model (Model 4), additional covariates were introduced (i.e., morbidity status and healthcare access and utilization). Of the socio-demographic characteristics, only gender and education were significant in the full model. Women (OR=1.79) were more likely to experience mobility limitation onset, while those with higher levels of education (OR=0.97) were less likely to experience mobility limitation onset. The modifiable risk factor variables persist in the full model; current smokers (OR=1.51) and respondents with higher BMIs (OR=1.08) were more likely to have mobility limitation decline, while physically active (OR=0.70) respondents were less likely. A number of chronic conditions were significant in the full model: diabetes (OR=1.16), lung disease (OR=1.63), heart problems (OR=1.35), stroke (OR=1.25), arthritis (OR=1.64), and psychological problems (OR=1.58) were all associated with a higher risk of mobility limitation onset. Higher ratings of SRH (OR=0.72) was associated with reduced likelihood of mobility limitation onset. Among the healthcare access and utilization measures, insurance coverage was significantly associated. Compared to private insurance, government insurance coverage (OR=1.23) and no insurance coverage (OR=1.12) were linked with higher risk of mobility limitation onset. Prior hospitalizations (OR=1.19) increased a respondent's likelihood of experiencing mobility limitation decline. It is important to note that the interval measures illustrated a general trend of increased likelihood of mobility limitation onset over time, although the significance of intervals varied across the models.

**Mobility Limitation Recovery**

Table 5-5 presents the descriptive characteristics for the initial mobility limitation recovery risk group (i.e., respondents with mobility limitation at Wave 2) (N=3,095). The average age was 56.0 years. A little over 64% of the recovery risk group was women, yet for the onset risk group the majority of respondents were men. The majority of the risk group was White (66.5%); however, racial and ethnic minorities represented a larger portion of the recovery risk group compared to the onset risk group. The average number years of formal education was 11.2 years, which was over a full year (1.4 years) less than the onset risk group. Additionally, the majority of respondents were married or partnered (80.5%) and only a little over 11% of the recovery risk group was physically active. Current smokers represented 28.9% of the risk group, while former smokers represented 38.0%, and 33.1% of the risk group had never smoked. The average BMI was 28.7, which was higher than the onset risk group.

Table 5-6 displays a summary of the findings acquired from multinomial logistic regression analyses for mobility limitation recovery by socio-demographic characteristics, MRFs, morbidity status, healthcare access, and time. Because adequate measures of recovery-facilitators were not available, only healthcare access was included in the full model as a proxy of quality of healthcare. Odds ratios were presented. The Likelihood Ratios for all models were statistically significant at an alpha level of less than 0.001. In Model 1, gender, ethnicity (i.e., Hispanic), education, and marital status were statistically significant. Women (OR=0.78) were less likely to experience mobility limitation recovery, while Hispanic (OR=1.50) respondents and respondents with higher levels of education (OR=1.07) were more likely to report increased mobility limitation recovery. Compared to married respondents,

divorced/separated (OR=0.72), widowed (OR=0.78), and never married (OR=0.79) respondents were less likely to experience mobility limitation recovery. In Model 2, all of the MRFs were significant. Physical activity had a particularly pronounced effect, in which physically active (OR=1.83) respondents were more likely to experience mobility limitation recovery. Former (OR=0.87) and current (OR=0.60) smokers had a decreased likelihood of mobility limitation recovery. Respondents with higher BMIs (OR=0.95) were less likely to experience recovery. Looking at the Likelihood Ratios for Model 1 (LR=473.9; df=28) and Model 2 (LR=724.4; df=18), it appeared that, as a group, MRFs explain more the variation in the dependent variable. In other words, Model 2 compared to Model 1 had a better model fit. However, examining Model 2 (LR=724.4; df=18), Model 3 (LR=1033.3; df=36), and Model 4 (LR=2553.5; df=58), the Likelihood Ratio increased substantially for each subsequent model, indicating a better fit.

Model 3 includes both socio-demographic characteristics and MRFs. Unlike the findings for mobility limitation onset, from Model 1 to Model 3, the majority of relationships between socio-demographic characteristics and mobility limitation recovery remained relatively stable. Women (OR=0.74), divorced/separated (OR=0.79), widowed (OR=0.85), and never married (OR=0.75) respondents as well as those with higher BMIs (OR=0.95) were less likely to experience mobility limitation recovery. However, being Hispanic (OR=1.48), higher levels of education (OR=1.07), and physical activity (OR=1.77) were associated with an increased likelihood of mobility limitation recovery.

The full model (Model 4), including the additional covariates of morbidity status and healthcare access, has numerous significant predictors of mobility limitation recovery. Among the socio-demographic characteristics, women (OR=0.65) and never married respondents (OR=0.82) had lower likelihoods of mobility limitation recovery. Black/African American became significant in the final model, which suggests that morbidity status and healthcare access and utilization act as suppressors. In the full model, being Black (OR=1.26), compared to White respondents, was associated with a higher likelihood of recovery. Hispanic (OR=1.51) respondents continue to have an increased likelihood of mobility limitation recovery. The relationship between mobility limitation recovery and education became insignificant with the addition of morbidity status and healthcare access. Additionally, in the full model, age became significant. The findings suggest that older (OR=1.02) respondents were more likely to experience mobility limitation recovery. The relationship between never married respondents and mobility limitation recovery persisted in Model 4; compared to married respondents, never married respondents (OR=0.82) were less likely to have mobility limitation recovery. Physical activity (OR=1.41) continued to be associated with an increased likelihood of mobility limitation recovery, while former smokers (OR=0.90), current smokers (OR=0.68), and respondents with higher BMIs (OR=0.95) continued to be at a lower risk of mobility limitation recovery. Only one chronic condition, cancer, was not significantly associated with mobility limitation recovery. Respondents reporting having high blood pressure (OR=0.86), diabetes (OR=0.88), lung disease (OR=0.54), heart problems (OR=0.72), arthritis (OR=0.66), and psychological problems (OR=0.78) were less likely to have mobility limitation recovery. SRH was a strong predictor of mobility

limitation recovery. Higher ratings of SRH (OR=1.50) were associated with increased likelihood of recovery. Finally, government health insurance (OR=0.78) was associated with decreased likelihood of mobility limitation recovery. Also, there was a general trend over the four models of decreased likelihood of experiencing mobility limitation recovery over time; this may explain the peculiar age result in the final model.

**Summary**

These results demonstrate the complex relationship between mobility limitation transitions and MRFs as well as complicated links between MRFs and socio-demographic characteristics. In regards to mobility limitation onset, the role of MRFs was not consistent for gender, race/ethnicity, and education. This highlights the complex and dynamic nature of mobility limitation onset. Unexpectedly, MRFs had little influence on the relationship between gender, race/ethnicity, and education and mobility limitation recovery, which underscores the importance of non-modifiable risk factors. There is a wealth of research demonstrating the importance of MRFs and mobility limitation onset (see Davison et al. 2002 Visser et al. 2002; Patel et al. 2006; Sainio et al. 2007; Stenholm et al. 2007; Mänty et al. 2009). These results reiterate the importance of MRFs in relation to mobility limitation onset and the need for health promotion; however, these results also emphasize the importance of non-modifiable risk factors. For example, in the full model for mobility limitation onset, gender and education disparities persist even after controlling for MRFs and numerous health covariates. Furthermore, the relationship between mobility limitation recovery and gender, race/ethnicity, and education does not appear to be appreciably influenced by MRFs. Individual health promotion in the absence of understanding social context cannot radically reduce act limitation disparities given the importance of non-modifiable risk factors. Future research

should endeavor to identify successful community-level health interventions for mobility limitation onset; additionally, researchers should investigate mobility limitation recovery to aid in understanding and creating interventions. Given the traditionally disadvantaged status of racial and ethnic minorities in the US, it is valuable to understand the mechanisms that lead to increased likelihood of mobility limitation recovery.

Table 5-1. Bivariate Analysis of Socio-Demographic Characteristics and Modifiable Risk Factors by Mobility Limitation

| | Mobility Limitation[a] |
|---|---|
| Socio-demographic Characteristics | |
| Gender | |
| Female | 43.6%*** |
| Male | 24.5%*** |
| Race/Ethnicity | |
| White | 32.8%*** |
| Black/African American | 43.8%*** |
| Other Race | 38.2% |
| Hispanic | 47.2%*** |
| Education | 11.2 (3.3)*** |
| | |
| Modifiable Risk Factors | |
| Physically Active | |
| Yes | 19.5%*** |
| No | 40.4%*** |
| Smoking Status | |
| Never Smoked | 32.6%*** |
| Former Smoker | 34.5%* |
| Current Smoker | 43.4%*** |
| Body Mass Index (BMI) | 28.7 (6.2)*** |

Notes: [a]Bivariate associations are based on $\chi^2$ statistics generated by Cross-tabulations (shown as percentages) or Comparison of Means (shown as mean with standard deviation); *$0.01 < p \leq 0.05$; ** $0.01 \leq p < 0.001$; *** $p \leq 0.001$.
Source: *Health and Retirement Study* (1994)

Table 5-2. Bivariate Analysis of Socio-demographic Characteristics and Modifiable Risk Factors

| | Physically Active | Smoking Status | | | Body Mass Index |
|---|---|---|---|---|---|
| Socio-demographic Characteristics | | Never Smoked | Former Smoker | Current Smoker | |
| Gender | | | | | |
| Female | 19.2%*** | 45.9%*** | 31.9%*** | 22.3%*** | 27.2 (5.7) |
| Male | 23.0%*** | 25.7%*** | 48.4%*** | 26.0%*** | 27.3 (4.3) |
| Race/Ethnicity | | | | | |
| White | 21.9%*** | 35.3%*** | 40.8%*** | 23.9% | 26.8 (4.9)*** |
| Black/African American | 17.3%*** | 36.5% | 37.4% | 26.1%* | 28.9 (5.9)*** |
| Other Race | 24.5%*** | 48.5%** | 26.7%*** | 24.9% | 26.1 (5.0)** |
| Hispanic | 18.9% | 43.3%*** | 36.2% | 20.5%* | 30.0 (4.7)*** |
| Education | 12.6 (3.0)*** | 12.3 (3.3)*** | 12.3 (3.2)*** | 11.5 (3.2)*** | -0.09*** |

Notes: [a]Bivariate associations are based generated by Cross-tabulations, Comparison of Means (t-test), or Pearson's Correlation Test; *0.01 < p ≤ 0.05; ** 0.01 ≤ p < 0.001; *** p ≤ 0.001
Source: *Health and Retirement Study* (1994)

Table 5-3. Descriptive Statistics for Mobility Limitation Onset Initial Risk Group

| | Distribution Information[a] |
|---|---|
| Age | 55.6 (3.1) |
| Gender: | |
| Female | 47.0% |
| Male | 53.0% |
| Race and Ethnicity: | |
| White | 76.4% |
| Black | 14.6% |
| Other Race | 2.0% |
| Hispanic | 7.0% |
| Education (# yrs of formal schooling) | 12.6 (3.0) |
| Marital Status: | |
| Married/Partnered | 80.5% |
| Divorced/Separated | 11.6% |
| Widowed | 6.1% |
| Never Married | 1.8% |
| Physical Activity | 26.4% |
| Smoking Status: | |
| Never Smoked | 38.4% |
| Former Smoker | 40.4% |
| Current Smoker | 21.2% |
| Body Mass Index (BMI) | 26.4 (4.1) |

Notes: [a]Percentages shown for nominal variables; mean and (standard deviation) shown for continuous variables.
Source: *Health and Retirement Study* (1994)

Table 5-4. Odds Ratios of Mobility Limitation Onset, by Socio-demographic Characteristics, Modifiable Risk Factors, Morbidity Status, Healthcare Access & Utilization, and Time (Initial Risk Group: N=5,016)

| | Model 1 | Model 2 | Model 3 | Model 4 |
|---|---|---|---|---|
| Socio-demographic Characteristics: | | | | |
| Gender (female=1) | 1.55*** | -- | 1.75*** | 1.79*** |
| Race and Ethnicity: | | | | |
| White (ref.) | -- | -- | -- | -- |
| Black/African American | 1.25*** | -- | 1.04 | 0.98 |
| Other Race | 1.05 | -- | 1.14 | 1.23 |
| Hispanic | 1.01 | -- | 0.96 | 0.97 |
| Education | 0.93*** | -- | 0.94*** | 0.97*** |
| Age | 1.03*** | -- | 1.04*** | 1.01 |
| Marital Status: | | | | |
| Married/Partnered (ref.) | -- | -- | -- | -- |
| Divorced/Separated | 1.14* | -- | 1.09 | 1.04 |
| Widowed | 1.01 | -- | 0.93 | 0.89 |
| Never Married | 1.09 | -- | 1.08 | 0.94 |
| Modifiable Risk Factors: | | | | |
| Physical Activity | -- | 0.60*** | 0.64*** | 0.70*** |
| Smoking Status: | | | | |
| Never Smoked (ref.) | -- | -- | -- | -- |
| Former Smoker | -- | 1.00 | 1.14*** | 1.07 |
| Current Smoker | -- | 1.55*** | 1.65*** | 1.51*** |
| BMI | -- | 1.08*** | 1.09*** | 1.08*** |
| Morbidity Status: | | | | |
| Chronic Conditions: | | | | |
| High Blood Pressure | -- | -- | -- | 1.03 |
| Diabetes | -- | -- | -- | 1.16** |
| Cancer | -- | -- | -- | 1.05 |
| Lung Disease | -- | -- | -- | 1.63*** |
| Heart Problems | -- | -- | -- | 1.35*** |
| Stroke | -- | -- | -- | 1.25* |
| Arthritis | -- | -- | -- | 1.64*** |
| Psychological Problems | -- | -- | -- | 1.58*** |
| Self-Rated Health | -- | -- | -- | 0.72*** |
| Healthcare Access & Utilization | | | | |
| Insurance Coverage: | | | | |
| Private Health Insurance (ref.) | -- | -- | -- | -- |
| Government Insurance | -- | -- | -- | 1.23*** |
| No Insurance | -- | -- | -- | 1.12* |
| Doctor Visits (past 2 years) | -- | -- | -- | 1.05 |
| Hospitalizations (past 2 years) | -- | -- | -- | 1.19*** |
| Intervals | | | | |
| Interval 1 (ref.) | -- | -- | -- | -- |
| Interval 2 | 0.97 | 1.14* | 1.13* | 1.07*** |
| Interval 3 | 1.07 | 1.24*** | 1.22*** | 1.00 |
| Interval 4 | 1.28*** | 1.49*** | 1.47*** | 1.18** |
| Interval 5 | 1.34*** | 1.58*** | 1.57*** | 1.15* |
| Interval 6 | 1.42*** | 1.48*** | 1.50*** | 1.02 |
| Intercept | -2.27*** | -3.58*** | -5.25*** | -3.00*** |
| Likelihood Ratio | 738.5*** | 896.6*** | 1503.4*** | 2566.1*** |
| Degrees of Freedom | 28 | 18 | 36 | 62 |

Source: *Health and Retirement Study*. Notes: *0.01 < p ≤ 0.05; ** 0.01 ≤ p < 0.001; *** p ≤ 0.001

Table 5-5. Descriptive Statistics for Mobility Limitation Recovery Initial Risk Group

| | Distribution Information[a] |
|---|---|
| Age | 56.0 (3.1) |
| Gender: | |
| Female | 64.4% |
| Male | 35.6% |
| Race and Ethnicity: | |
| White | 66.5% |
| Black | 20.3% |
| Other Race | 2.0% |
| Hispanic | 11.2% |
| Education (# yrs of formal schooling) | 11.2 (3.3) |
| Marital Status: | |
| Married/Partnered | 80.5% |
| Divorced/Separated | 17.1% |
| Widowed | 11.1% |
| Never Married | 4.2% |
| Physical Activity | 11.4% |
| Smoking Status: | |
| Never Smoked | 33.1% |
| Former Smoker | 38.0% |
| Current Smoker | 28.9% |
| Body Mass Index (BMI) | 28.7 (6.2) |

Notes: [a]Percentages shown for nominal variables; mean and (standard deviation) shown for continuous variables.
Source: *Health and Retirement Study* (1994)

Table 5-6. Odds Ratios of Mobility Limitation Recovery, by Socio-demographic Characteristics, Modifiable Risk Factors, Morbidity Status, Healthcare Access, and Time (Initial Risk Group: N=3,095)

| | Model 1 | Model 2 | Model 3 | Model 4 |
|---|---|---|---|---|
| Socio-demographic Characteristics: | | | | |
| Gender (female=1) | 0.78*** | -- | 0.74*** | 0.65*** |
| Race and Ethnicity: | | | | |
| White (ref.) | -- | -- | -- | -- |
| Black/African American | 1.01 | -- | 1.08 | 1.26*** |
| Other Race | 0.96 | -- | 0.86 | 0.94 |
| Hispanic | 1.50*** | -- | 1.48*** | 1.51*** |
| Education (# of formal yrs) | 1.07*** | -- | 1.07*** | 1.01 |
| Age | 1.01 | -- | 1.00 | 1.02* |
| Marital Status: | | | | |
| Married/Partnered (ref.) | -- | -- | -- | -- |
| Divorced/Separated | 0.72*** | -- | 0.79*** | 0.93 |
| Widowed | 0.78*** | -- | 0.85* | 0.97 |
| Never Married | 0.79** | -- | 0.75** | 0.82* |
| Modifiable Risk Factors: | | | | |
| Physical Activity | -- | 1.83*** | 1.77*** | 1.41*** |
| Smoking Status: | | | | |
| Never Smoked (ref.) | -- | -- | -- | -- |
| Former Smoker | -- | 0.87** | 0.81*** | 0.90* |
| Current Smoker | -- | 0.60*** | 0.61*** | 0.68*** |
| BMI | -- | 0.95*** | 0.95*** | 0.95*** |
| Morbidity Status: | | | | |
| Chronic Conditions: | | | | |
| High Blood Pressure | -- | -- | -- | 0.86** |
| Diabetes | -- | -- | -- | 0.88* |
| Cancer | -- | -- | -- | 0.90 |
| Lung Disease | -- | -- | -- | 0.54*** |
| Heart Problems | -- | -- | -- | 0.72*** |
| Stroke | -- | -- | -- | 0.50*** |
| Arthritis | -- | -- | -- | 0.66*** |
| Psychological Problems | -- | -- | -- | 0.78*** |
| Self-Rated Health | -- | -- | -- | 1.50*** |
| Healthcare Access | | | | |
| Insurance Coverage: | | | | |
| Private Health Insurance (ref.) | -- | -- | -- | -- |
| Government Insurance | -- | -- | -- | 0.78*** |
| No Insurance | -- | -- | -- | 1.03 |
| Intervals | | | | |
| Interval 1 (ref.) | -- | -- | -- | -- |
| Interval 2 | 0.94 | 0.81** | 0.82** | 0.91 |
| Interval 3 | 0.90 | 0.80*** | 0.80*** | 1.01 |
| Interval 4 | 0.82** | 0.73*** | 0.72*** | 0.92 |
| Interval 5 | 0.75*** | 0.68*** | 0.67*** | 0.95 |
| Interval 6 | 0.65*** | 0.66*** | 0.65*** | 0.96 |
| Intercept | -2.08*** | 0.40*** | 0.17 | -1.21** |
| Likelihood Ratio | 473.9*** | 724.4*** | 1033.3*** | 2553.5*** |
| Degrees of Freedom | 28 | 18 | 36 | 58 |

Source: *Health and Retirement Study* Notes: *0.01 < p ≤ 0.05; ** 0.01 ≤ p < 0.001; *** p ≤ 0.001

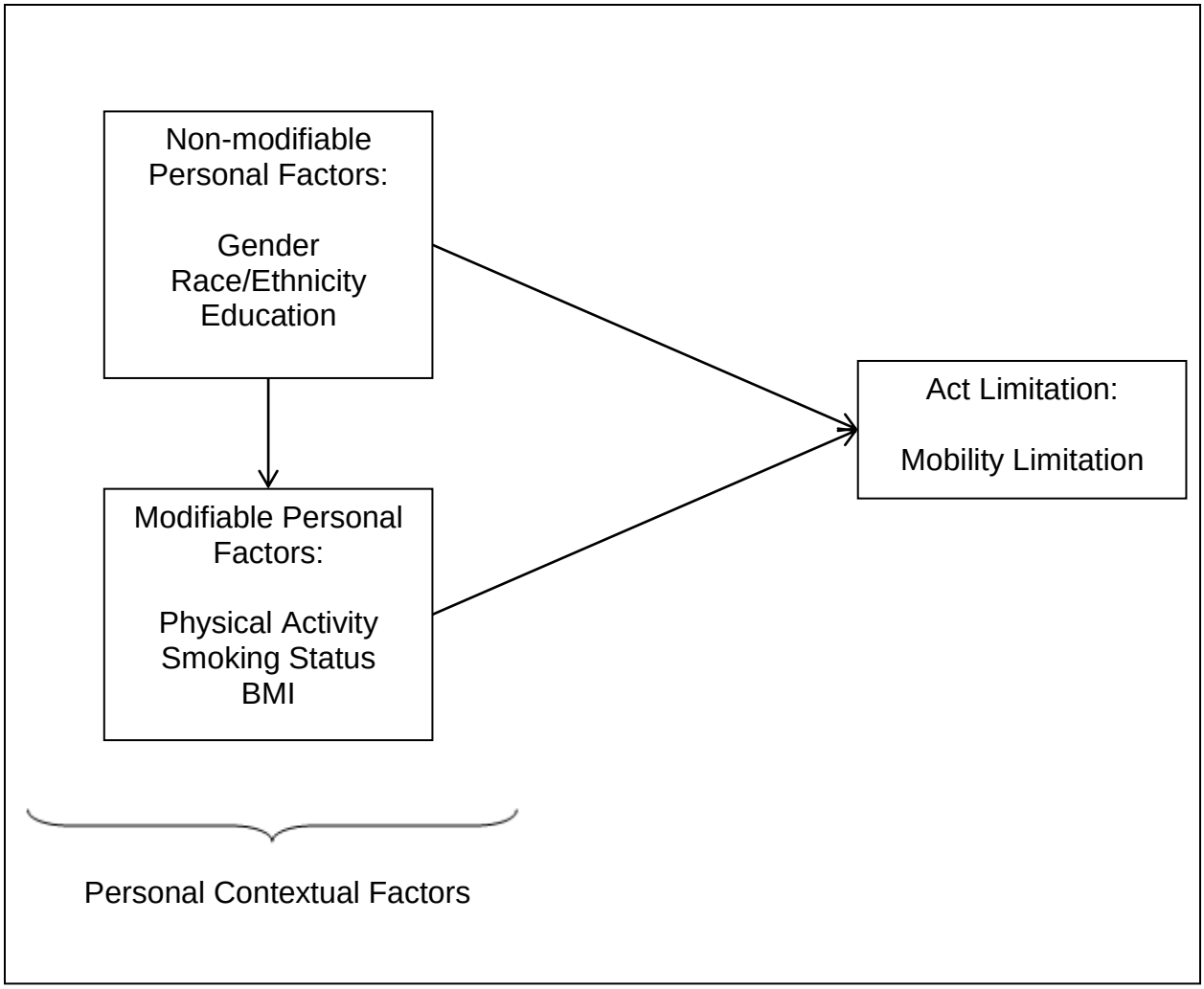



Figure 5-1. Translational Diagram of the Participation Restriction Pathway for Chapter 5

# CHAPTER 6
# TASK LIMITATION TRANSITIONS AMONG LATE MIDLIFE ADULTS

The PRP model treats task limitation as the second stage of activity limitation. Typically, task limitation follows act limitation because task limitation involves a range of acts. Task limitation is conceptualized as the stage directly preceding participation restriction onset. Participation restriction is socially and culturally defined and often results from severe task limitation. Task limitation can be measured using standard functional health measures (i.e., Activities of Daily Living (ADL)), which enables researchers to compare current measures to previous data. Examining task limitation in relation to modifiable risk factors is important because participation restriction onset is dynamic. Chapter 6 explores task limitation transitions, specifically onset and recovery, among a late midlife cohort. Additionally, Chapter 6 investigates the role of modifiable risk factors on task limitations and socio-demographic characteristics. By examining both onset and recovery, and gaining a more complete understanding of modifiable risk factors, these analyses highlight the potential of recovery and may provide areas of researchers that could slow the participation restriction process. This research underscores the importance of contextual factors and functional health. Figure 6-1 is a translational diagram of the PRP for Chapter 6, which explores personal contextual factors and task limitation, net of act limitation. Personal contextual factors are broken into two categories: modifiable personal factors and non-modifiable personal factors. Modifiable personal factors are measured using three MRFs: 1) physical activity; 2) smoking status; and 3) BMI. Non-modifiable personal factors are measured using key socio-demographic characteristics such as gender, race/ethnicity, and education. Chapter 6 utilizes ADLs to measure task limitation. Prior literature has found that

following ADL impairment individuals experience higher rates of mortality and institutionalization (Scott et al. 1997; Gaugler et al. 2007).

Another component of this analysis is to examine task limitation net of act limitation. Act limitation bridges body structures and function impairment and task limitation. Act limitation is an important antecedent of task limitation, so it is important to explore task limitation while controlling for act limitation. Figure 6-2 illustrates a survival curve for both act limitation (mobility limitation) onset and task limitation (ADL limitation onset). Over the course of the study, a greater number of respondents experienced mobility limitation onset compared to ADL limitation onset. The rate of onset appears to be very similar for mobility limitation and ADL limitation throughout the duration of the study. The relationship between act limitation and task limitation is crucial to understand because moving from act limitation to task limitation may be prevented or slowed.

**Bivariate Analysis**

The bivariate relations between ADL limitation and mobility limitation, socio-demographic characteristics, and modifiable risk factors are presented in Table 6-1. Only 1% of the sample had ADL limitation without mobility limitation. Of those with mobility limitation, 16.5% had ADL limitation. Women (7.3%), compared to men (5.8%), were more likely to have ADL limitation. Black/African American (11.6%) and Hispanic (7.8%) respondents were more likely to have ADL limitation compared to non-Black/African American and non-Hispanic respondents, respectively. White (4.5%) respondents were less likely to have ADL limitation compared to non-White respondents, and the association between other race and ADL limitation was not significant. The average number of years of formal education for respondents with ADL limitation was 10.2 years, while respondents without ADL limitation completed, on

average, 12.4 years of education. Of respondents that were physically active, only 1.7% had ADL limitation. Former and current smoking status was not significantly associated; however, respondents who never smoked were less likely to have ADL limitation. Finally, the average BMI for respondents with ADL limitation was 28.9. Higher BMIs were associated with ADL limitation.

## Multivariate Analysis

### ADL Limitation Onset

Table 6-2 presents the descriptive characteristics for the initial ADL limitation onset risk group (i.e., respondents without ADL limitation at Wave 2) (N=8,034). The average age was 55.7 years. Women comprised of over-half (52.9%) of the onset risk group. The majority of the risk group was White (74.6%). The average number years of formal education was 12.2 years—approximately equivalent to a high school education. Additionally, the majority of respondents was married or partnered (76.2%). Approximately 22% of the risk group was physically active (i.e., participated in vigorous exercise/sports 3 or more times per week). Current smokers represented 23.8% of the risk group, while former smokers represented 40.4% and 38.4% of the risk group had never smoked. The average BMI was 27.1, which is above a healthy BMI range of 18.5 to 24.9. Compared to mobility limitation onset, ADL limitation onset was very similar with the only notable difference being gender composition. More women comprised the ADL limitation onset risk group, while more men than women were included in the mobility limitation onset risk group.

Table 6-3 displays a summary of the findings acquired from multinomial logistic regression analyses for ADL limitation onset by socio-demographic characteristics, modifiable risk factors, morbidity status, healthcare and utilization, act limitation, and

time. Odds ratios are presented. The Likelihood Ratios for all models were statistically significant at an alpha level of less than 0.001. In Model 1, race (i.e., Black/African American), education, age, and marital status (i.e., divorced/separated and widowed) were statistically significant. Being Black/African American (OR=1.48) were associated with an increased likelihood of experience ADL limitation onset. Higher levels of education (OR=0.89) had a protective effect on the onset of ADL limitation. Both being divorced/separated (OR=1.66) or widowed (OR=1.29) were associated with higher likelihood of ADL limitation onset. Divorced/separated respondents were at a particularly higher at risk with ADL limitation onset compared to married/partnered respondents. In Model 2, all of the modifiable risk factors were significantly associated. Physical activity (OR=0.48) had a strong protective effect on ADL limitation onset, while former smoking status (OR=1.17) or current smoking status (OR=1.71), and higher BMIs (OR=1.08) were associated with increased likelihood of ADL limitation onset. Current smoking status also had a markedly strong association with ADL limitation decline. Looking at the Likelihood Ratios for Model 1 (LR=817.9; df=28) and Model 2 (LR=812.4; df=18), it appears that, as a group, MRFs explain more the variation in the dependent variable. In other words, Model 2 compared to Model 1 had a better model fit. However, examining Model 2 (LR=817.9; df=18), Model 3 (LR=1400.1; df=36), Model 4 (LR=3129.4; df=62), and Model 5 (LR=3337.2; df=64) the Likelihood Ratio increased substantially for each subsequent model, indicating a better fit.

Model 3 includes both socio-demographic characteristics and modifiable risk factors. From Model 1 to Model 3, the relationship between being Black/African American (OR=1.36) and ADL limitation onset remained relatively stable, although the

magnitude of the association slightly attenuated. Similarly, education (OR=0.91) remained relatively stable and continued to have a protective effect on ADL limitation onset. Both the relationships for divorced/separated (OR=1.55) or widowed (OR=1.20) persisted in Model 3 as significant predictors; the relationships were negligibly attenuated with the introduction of modifiable risk factors. Age (OR=1.02) became significant in Model 3; however, the association was in the opposite direction then would be expected. All of the modifiable risk factors, physical activity (OR=0.52), former smoker (OR=1.19), current smoker (OR=1.56), BMI (OR=1.09), continue to be significant, and their relationship to ADL limitation onset remained stable with very small reductions to magnitude.

In Model 4, additional covariates were introduced (i.e., morbidity status and healthcare access and utilization). Black/African American, education, and divorced/separated were the only significant socio-demographic characteristics in the model. Black/African American (OR=1.33) or divorced/separated (OR=1.27) respondents were more likely to experience ADL limitation onset, while those with higher levels of education (OR=0.97) were less likely to experience ADL limitation onset. In Model 4, former smoking status was no longer significant. The other modifiable risk factor variables continued to be significant in the full model; current smokers (OR=1.22) and respondents with higher BMIs (OR=1.04) were more likely to have ADL limitation decline, while physically active (OR=0.71) respondents were less likely. A number of chronic conditions were significant in the full model; diabetes (OR=1.14), lung disease (OR=1.34), stroke (OR=1.70), arthritis (OR=1.93), and psychological problems (OR=1.64) were all associated with a higher risk of ADL limitation onset. Higher ratings

of SRH (OR=0.60) were associated with reduced likelihood of ADL limitation onset. All of the healthcare access and utilization measures were significantly associated. Compared to private insurance, government insurance coverage (OR=1.54) and no insurance coverage (OR=1.18) were linked with higher risk of ADL limitation onset. Prior hospitalizations (OR=1.23) or doctor's visits (OR=1.23) were associated with a higher likelihood of experiencing ADL limitation decline.

In the final model (Model 5), mobility limitations were added. With the introduction of mobility limitations, gender becomes significant in the final model. Women (OR=0.85) were less likely to experience ADL limitation onset. Additionally, being Hispanic becomes a significant predictor in the last model. Being Black/African American (OR=1.38) or Hispanic (OR=1.33) was associated with increased risk of ADL limitation onset. More years of education (OR=0.97) continued to lower a respondent's likelihood, while being divorced/separated continued to increase a respondent's likelihood of ADL limitation onset. Once again, physical activity (OR=0.79) had a protective effect. Current smokers (OR=1.16) and respondents with higher BMIs (OR=1.03) were more likely to experience ADL decline. Diabetes (OR=1.09), lung disease (OR=1.24), stroke (OR=1.71), arthritis (OR=1.77), and psychological problems (OR=1.57) were all associated with a higher risk of ADL limitation onset. Higher ratings of SRH (OR=0.66) were associated with reduced likelihood of ADL limitation onset. All of the healthcare access and utilization measures persisted in the final model. Government insurance coverage (OR=1.48) and no insurance coverage (OR=1.16) continued to be associated with higher risk as well as prior hospitalizations (OR=1.19) or doctor's visits (OR=1.24). Mobility limitations (OR=2.17) had an exceptionally strong association with ADL

limitation onset. Respondents with mobility limitations were more than two times more likely to experience ADL limitation onset.

**ADL Limitation Recovery**

Table 6-4 presents the descriptive characteristics for the initial mobility limitation recovery risk group (i.e., respondents with mobility limitation at Wave 2) (N=949). The average age was 56.0 years. The majority (58.8%) of the recovery risk group was women. Close to half (49.7%) of the risk group was White; however, racial and ethnic minorities represented a larger portion of the recovery risk group (i.e., ADL limited) compared to the onset risk group. The average number years of formal education were 10.2 years, which were two full years less than the onset risk group. Additionally, the majority of respondents was married or partnered (58.4%), yet non-married/partnered respondents comprised a greater portion of the recovery risk group (i.e., ADL limited) compared to the onset risk group. Only a little over 5% of the recovery risk group was physically active. Current smokers represented 26.7% of the risk group, while former smokers represented 41.8%, and 31.5% of the risk group had never smoked. The average BMI was 28.9, which was higher than the onset risk group.

Table 6-5 displays a summary of the findings acquired from multinomial logistic regression analyses for ADL limitation recovery by socio-demographic characteristics, modifiable risk factors, morbidity status, healthcare and utilization, and time. Odds ratios are presented. The Likelihood Ratios for all models were statistically significant at an alpha level of less than 0.001. In Model 1, race (i.e., Black/African American), education, and marital status (i.e., divorced/separated and widowed) were statistically significant. Being Black/African American (OR=0.77) were less likely to experience ADL limitation recovery. Those with higher levels of education (OR=1.03) were more likely to

report increased ADL limitation recovery. Compared to married respondents, divorced/separated (OR=0.81) and widowed (OR=0.77) respondents were less likely to experience ADL limitation recovery. In Model 2, physical activity (OR=1.87) had a particularly pronounced effect. Physical active respondents were more likely to recover from ADL limitation. Current (OR=0.79) smoking status were associated with decreased likelihood of ADL limitation recovery. Respondents with higher BMIs (OR=0.98) were less likely to experience recovery. Looking at the Likelihood Ratios for Model 1 (LR=53.2; df=28) and Model 2 (LR=212.1; df=18), it appears that, as a group, MRFs explain more the variation in the dependent variable. In other words, Model 2 compared to Model 1 had a better model fit. However, examining Model 2 (LR=212.1; df=18), Model 3 (LR=819.2; df=36), Model 4 (LR=819.2 df=58), and Model 5 (LR=852.0; df=60) the Likelihood Ratio increased substantially for each subsequent model, indicating a better fit.

Model 3 includes both socio-demographic characteristics and modifiable risk factors. From Model 1 to Model 3, the majority of relationships between socio-demographic characteristics and ADL limitation recovery were relatively stable. Education (OR=1.02) continued to be associated with higher likelihood of recovery. Older ages (OR=0.97) were linked to lower likelihood of ADL limitation recovery. The associations between modifiable risk factors and ADL limitation recovery also remained stable from Model 2 to Model 3. Respondents with higher BMIs (OR=0.99) or current smokers (OR=0.77) were less likely to experience ADL limitation recovery. Physical activity (OR=1.79) was associated with an increased likelihood of ADL limitation recovery.

Model 4 introduces additional covariates of morbidity status and healthcare access. No socio-demographic characteristics were significant in the fourth model. Only physical activity and BMI were significant modifiable risk factors. Physically active (OR=1.46) respondents were more likely to experience recovery, while higher BMIs were associated with lower likelihood of recovery. Three chronic conditions were significantly associated with ADL limitation recovery. Respondents reporting having lung disease (OR=0.83), stroke (OR=0.57), and arthritis (OR=0.77) were less likely to have ADL limitation recovery. SRH was a strong predictor of ADL limitation recovery with higher ratings of SRH (OR=1.49) being associated with increased likelihood of recovery. Finally, government health insurance (OR=0.56) was associated with decreased likelihood of ADL limitation recovery.

In the fifth model, mobility limitations were introduced. Again, no socio-demographic characteristic variables were significant predictors. Both physical activity and BMI were significant predictors; physical activity was associated with higher risk of recovery, while higher BMIs were associated with lower risk of recovery. Two chronic conditions, stroke (OR=0.58) and arthritis (OR=0.77), were the only chronic conditions significant in the final model. Higher ratings of SRH (OR=1.44) were associated with increased likelihood of ADL limitation recovery. Government insurance coverage (OR=0.57) continued to be associated with lower risk of recovery. Mobility limitations (OR=0.48) were association lower likelihood of ADL limitation recovery.

**Summary**

Several socio-demographic characteristics were key predictors for ADL limitation onset: race, education, and marital status. In the first model, Black/African American respondents were much more likely to experience ADL limitation onset compared to

White respondents. This relationship persisted throughout the models; however, the associated attenuated slightly when modifiable risk factors were introduced. Higher levels of education were associated with lower likelihood of ADL limitation; the strength of this relationship also attenuated with the addition of modifiable risk factors, but persisted in the later models. Finally, marital status, specifically being divorced/separated, was a significant predictor of ADL limitation onset. Of the modifiable risk factors, physical activity, current smoking status, and BMI were important predictors. Physically active respondents were less likely to experience ADL limitation onset, while current smoking status and higher BMIs were associated with higher likelihood of ADL limitation onset.

In the final model (Model 5), mobility limitation was a very strong predictor of ADL limitation onset; respondents with mobility limitation were two times more likely to experience ADL limitation. Additionally, controlling for mobility limitation, gender and ethnicity (i.e., Hispanic) became significant predictors of ADL limitation onset—this suggests that mobility limitation has a suppressor effect on these associations. In Model 5, women were less likely to experience ADL limitation onset compared to men, after controlling for mobility limitation and other factors. Alternatively, Hispanic respondents were at an increased likelihood of ADL limitation onset.

In the first model for ADL limitation recovery, numerous socio-demographic characteristics were significant predictors: race (i.e., Black/African American), education, age, and marital status (i.e., divorced/separated and widowed). Yet, in the final models no socio-demographic characteristics were significantly associated with ADL limitation recovery. Among modifiable risk factors, physical activity and BMI were

important predictors. Physically active respondents were more likely to recover from ADL limitation, while those respondents with higher BMIs were less likely. In the final model (Model 5), stroke, government health insurance, and mobility limitation were strongly associated with reduced recovery.

Overall, there is evidence that racial and ethnic minorities as well as respondents with lower level of education were at a greater risk of ADL limitation onset, net of mobility limitation. Divorced/separated respondents were also more likely to experience ADL limitation onset, which highlights the importance of social support on functional health decline. Modifiable risk factors, especially physical activity, were important predictors; however, in Model 3, the introduction of modifiable risk factors did not considerably influence the socio-demographic associations with ADL limitation onset. Unlike ADL limitation onset, socio-demographic characteristics, in the final models, were not significant predictors of ADL limitation recovery. Modifiable risk factors did persist as important predictors. These results demonstrate the importance of health promotion, yet they also emphasize the role of socio-demographic characteristics and social structure on ADL limitation onset. Furthermore, the strongest predictor of onset or recovery was mobility limitation which emphasizes the significance of mobility limitations as an antecedent of ADL limitation.

Table 6-1. Bivariate Analysis of Mobility Limitation, Socio-Demographic Characteristics and Modifiable Risk Factors by ADL Limitation

| | ADL Limitation[a] |
|---|---|
| Mobility Limitation | |
| Yes | 16.5%*** |
| No | 1.0%*** |
| Socio-demographic Characteristics | |
| Gender | |
| Female | 7.3%** |
| Male | 5.8%** |
| Race/Ethnicity | |
| White | 4.5%*** |
| Black/African American | 11.6%*** |
| Other Race | 8.5% |
| Hispanic | 7.8%*** |
| Education | 10.2 (3.8)*** |
| Modifiable Risk Factors | |
| Physically Active | |
| Yes | 1.7%*** |
| No | 8.0%*** |
| Smoking Status | |
| Never Smoked | 5.7%* |
| Former Smoker | 6.9% |
| Current Smoker | 7.3% |
| Body Mass Index (BMI) | 28.9 (6.6)*** |

Notes: [a]Bivariate associations are based on $\chi^2$ statistics generated by Cross-tabulations (shown as percentages) or Comparison of Means (shown as mean with standard deviation); *$0.01 < p \leq 0.05$; ** $0.01 \leq p < 0.001$; *** $p \leq 0.001$.
Source: *Health and Retirement Study* (1994)

Table 6-2. Descriptive Statistics for ADL Limitation Onset Initial Risk Group

| | Distribution Information[a] |
|---|---|
| Age | 55.7 (3.1) |
| Gender: | |
| Female | 52.9% |
| Male | 47.1% |
| Race and Ethnicity: | |
| White | 74.6% |
| Black | 15.7% |
| Other Race | 1.9% |
| Hispanic | 7.8% |
| Education (# yrs of formal schooling) | 12.2 (3.1) |
| Marital Status: | |
| Married/Partnered | 76.2% |
| Divorced/Separated | 12.9% |
| Widowed | 7.4% |
| Never Married | 3.5% |
| Physical Activity | 22.1% |
| Smoking Status: | |
| Never Smoked | 36.8% |
| Former Smoker | 39.4% |
| Current Smoker | 23.8% |
| Body Mass Index (BMI) | 27.1 (4.9) |

Notes: [a]Percentages shown for nominal variables; mean and (standard deviation) shown for continuous variables.
Source: *Health and Retirement Study* (1994)

Table 6-3. Odds Ratios of ADL Limitation Onset, by Socio-demographic Characteristics, Modifiable Risk Factors, Morbidity Status, Healthcare Access & Utilization, Mobility Limitations, and Time (Initial Risk Group: N=8,034)

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|
| Socio-demographic Characteristics: | | | | | |
| Gender (female=1) | 1.08 | -- | 1.06 | 0.95 | 0.85** |
| Race and Ethnicity: | | | | | |
| White (ref.) | -- | -- | -- | -- | -- |
| Black/African American | 1.48*** | -- | 1.36*** | 1.33*** | 1.38*** |
| Other Race | 1.13 | -- | 1.23 | 1.17 | 1.16 |
| Hispanic | 1.12 | -- | 1.14 | 1.28 | 1.33*** |
| Education (# of formal yrs) | 0.89*** | -- | 0.91*** | 0.97*** | 0.97*** |
| Age | 1.01 | -- | 1.02** | 0.99 | 0.99 |
| Marital Status: | | | | | |
| Married/Partnered (ref.) | -- | -- | -- | | |
| Divorced/Separated | 1.66*** | -- | 1.55*** | 1.27*** | 1.27*** |
| Widowed | 1.29*** | -- | 1.20** | 1.04 | 1.06 |
| Never Married | 1.17 | -- | 1.20 | 0.97 | 0.96 |
| Modifiable Risk Factors: | | | | | |
| Physical Activity | -- | 0.48*** | 0.52*** | 0.71*** | 0.79*** |
| Smoking Status: | | | | | |
| Never Smoked (ref.) | -- | -- | -- | -- | -- |
| Former Smoker | -- | 1.17** | 1.19*** | 1.05 | 1.04 |
| Current Smoker | -- | 1.71*** | 1.56*** | 1.22** | 1.16* |
| BMI | -- | 1.09*** | 1.06*** | 1.04*** | 1.03*** |
| Morbidity Status: | | | | | |
| Chronic Conditions: | | | | | |
| High Blood Pressure | -- | -- | -- | 0.97 | 0.96 |
| Diabetes | -- | -- | -- | 1.14* | 1.09* |
| Cancer | -- | -- | -- | 1.06 | 1.06 |
| Lung Disease | -- | -- | -- | 1.34*** | 1.24** |
| Heart Problems | -- | -- | -- | 1.04 | 0.98 |
| Stroke | -- | -- | -- | 1.70*** | 1.71*** |
| Arthritis | -- | -- | -- | 1.93*** | 1.77*** |
| Psychological Problems | -- | -- | -- | 1.64*** | 1.57*** |
| Self-Rated Health | -- | -- | -- | 0.60*** | 0.66*** |
| Healthcare Access & Utilization | | | | | |
| Insurance Coverage: | | | | | |
| Private Health Insurance (ref.) | -- | -- | -- | -- | -- |
| Government Insurance | -- | -- | -- | 1.54*** | 1.48*** |
| No Insurance | -- | -- | -- | 1.18* | 1.16* |
| Doctor Visits (past 2 years) | -- | -- | -- | 1.34** | 1.27* |
| Hospitalizations (past 2 years) | -- | -- | -- | 1.23*** | 1.19*** |
| Act Limitations (Mobility) | -- | -- | -- | -- | 2.17*** |
| Intervals | | | | | |
| Interval 1 (ref.) | -- | -- | -- | -- | -- |
| Interval 2 | 0.81** | 0.98 | 0.97 | 0.85* | 0.83** |
| Interval 3 | 0.76*** | 0.91 | 0.90 | 0.67*** | 0.67*** |
| Interval 4 | 0.78** | 0.92 | 0.92 | 0.65*** | 0.64*** |
| Interval 5 | 0.82** | 0.96 | 0.95 | 0.58*** | 0.57*** |
| Interval 6 | 0.98 | 0.98 | 0.99 | 0.56*** | 0.56*** |
| Intercept | -2.06*** | -4.40*** | -4.27*** | -1.79*** | -2.09*** |
| Likelihood Ratio | 817.9*** | 812.4*** | 1400.1*** | 3129.4*** | 3337.2*** |
| Degrees of Freedom | 28 | 18 | 36 | 62 | 64 |

Source: *Health and Retirement Study;* Notes: *0.01 < p ≤ 0.05; ** 0.01 ≤ p < 0.001; *** p ≤ 0.001

Table 6-4. Descriptive Statistics for ADL Limitation Recovery Initial Risk Group

| | Distribution Information[a] |
|---|---|
| Age | 56.0 (3.1) |
| Gender: | |
| Female | 58.8% |
| Male | 41.2% |
| Race and Ethnicity: | |
| White | 49.7% |
| Black | 29.4% |
| Other Race | 2.5% |
| Hispanic | 18.4% |
| Education (# yrs of formal schooling) | 10.2 (3.8) |
| Marital Status: | |
| Married/Partnered | 58.4% |
| Divorced/Separated | 22.8% |
| Widowed | 14.9% |
| Never Married | 3.9% |
| Physical Activity | 5.2% |
| Smoking Status: | |
| Never Smoked | 31.5% |
| Former Smoker | 41.8% |
| Current Smoker | 26.7% |
| Body Mass Index (BMI) | 28.9 (6.6) |

Notes: [a]Percentages shown for nominal variables; mean and (standard deviation) shown for continuous variables.
Source: *Health and Retirement Study* (1994)

Table 6-5. Odds Ratios of ADL Limitation Recovery, by Socio-demographic Characteristics, Modifiable Risk Factors, Morbidity Status, Healthcare Access, Mobility Limitations, and Time (Initial Risk Group: N=949)

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|
| Socio-demographic Characteristics: | | | | | |
| Gender (female=1) | 0.99 | -- | 1.01 | 1.03 | 1.08 |
| Race and Ethnicity: | | | | | |
| White (ref.) | -- | -- | -- | -- | -- |
| Black/African American | 0.77*** | -- | 0.79** | 0.91 | 0.92 |
| Other Race | 0.66 | -- | 0.65 | 0.78 | 0.75 |
| Hispanic | 0.88 | -- | 0.84 | 0.91 | 0.90 |
| Education (# of formal yrs) | 1.03*** | -- | 1.02* | 1.00 | 1.00 |
| Age | 0.97* | -- | 0.97** | 0.98 | 0.98 |
| Marital Status: | | | | | |
| Married/Partnered (ref.) | -- | -- | -- | | |
| Divorced/Separated | 0.81* | -- | 0.86 | 0.93 | 0.94 |
| Widowed | 0.77** | -- | 0.81* | 0.89 | 0.90 |
| Never Married | 0.81 | -- | 0.83 | 0.77 | 0.78 |
| Modifiable Risk Factors: | | | | | |
| Physical Activity | -- | 1.87*** | 1.79*** | 1.46*** | 1.37*** |
| Smoking Status: | | | | | |
| Never Smoked (ref.) | -- | -- | -- | -- | -- |
| Former Smoker | -- | 0.98 | 0.97 | 1.00 | 1.01 |
| Current Smoker | -- | 0.79* | 0.77** | 0.93 | 0.95 |
| BMI | -- | 0.98*** | 0.99** | 0.98** | 0.99** |
| Morbidity Status: | | | | | |
| Chronic Conditions: | | | | | |
| High Blood Pressure | -- | -- | -- | 0.99 | 1.01 |
| Diabetes | -- | -- | -- | 0.94 | 0.95 |
| Cancer | -- | -- | -- | 1.05 | 1.05 |
| Lung Disease | -- | -- | -- | 0.83* | 0.84 |
| Heart Problems | -- | -- | -- | 1.10 | 1.10 |
| Stroke | -- | -- | -- | 0.57*** | 0.58*** |
| Arthritis | -- | -- | -- | 0.77** | 0.77** |
| Psychological Problems | -- | -- | -- | 0.87 | 0.87 |
| Self-Rated Health | -- | -- | -- | 1.49*** | 1.44*** |
| Healthcare Access & Utilization | | | | | |
| Insurance Coverage: | | | | | |
| Private Health Insurance (ref.) | -- | -- | -- | -- | -- |
| Government Insurance | -- | -- | -- | 0.56*** | 0.57*** |
| No Insurance | -- | -- | -- | 0.94 | 0.95 |
| Act Limitations (Mobility) | -- | -- | -- | -- | 0.48*** |
| Intervals | | | | | |
| Interval 1 (ref.) | -- | -- | -- | -- | -- |
| Interval 2 | 0.86 | 0.79 | 0.77 | 0.78* | 0.78* |
| Interval 3 | 1.01 | 0.92 | 0.90 | 1.03 | 1.04 |
| Interval 4 | 0.92 | 0.85 | 0.82 | 1.01 | 1.02 |
| Interval 5 | 1.00 | 0.95 | 0.92 | 1.15 | 1.16 |
| Interval 6 | 0.70** | 0.72** | 0.69** | 1.01 | 1.01 |
| Intercept | 1.07 | 0.22 | 1.87** | 0.89 | 1.66* |
| Likelihood Ratio | 53.2*** | 212.1*** | 303.8*** | 819.2*** | 852.0*** |
| Degrees of Freedom | 28 | 18 | 36 | 58 | 60 |

Source: *Health and Retirement Study*; Notes: *0.01 < p ≤ 0.05; ** 0.01 ≤ p < 0.001; *** p ≤ 0.001

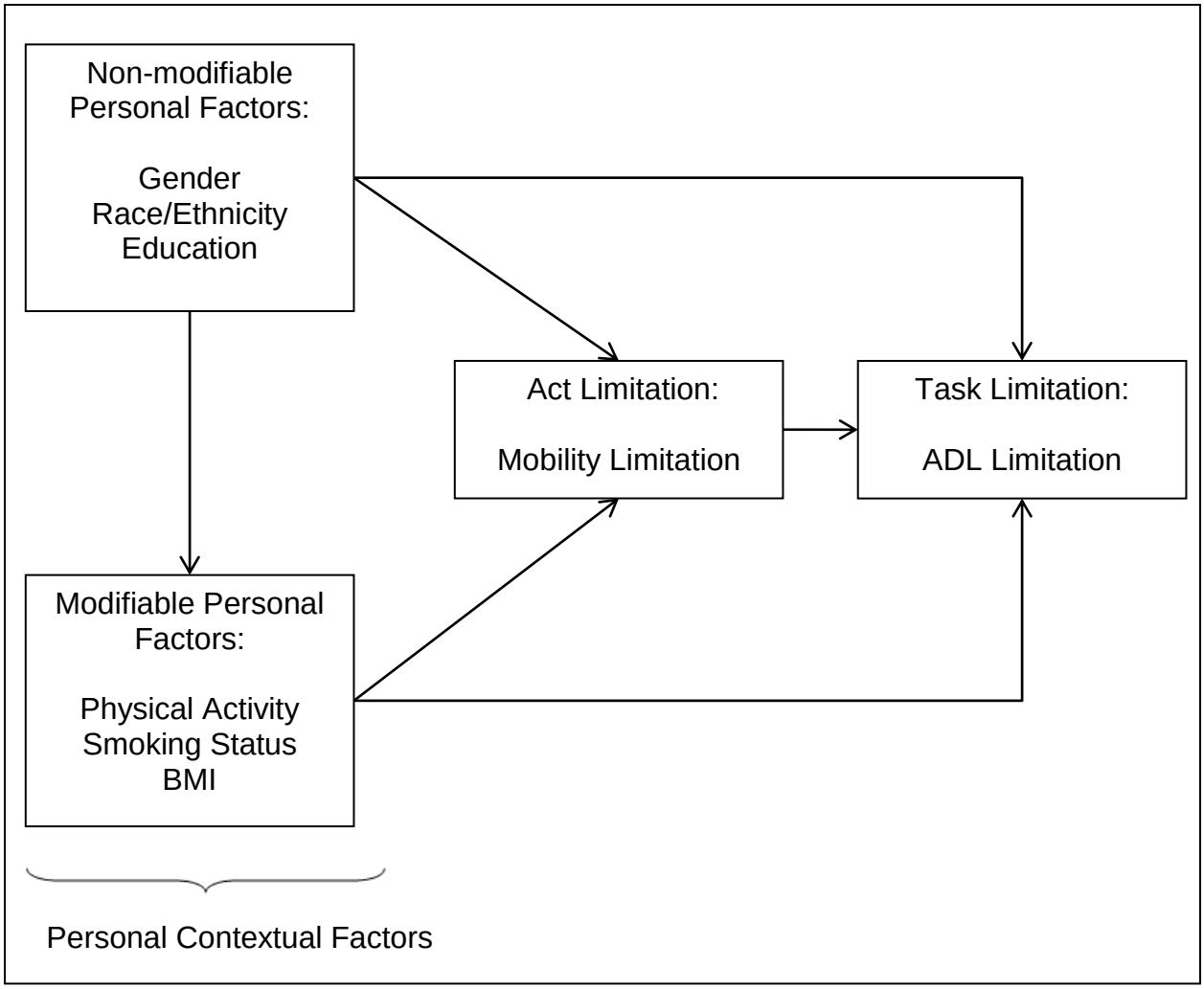
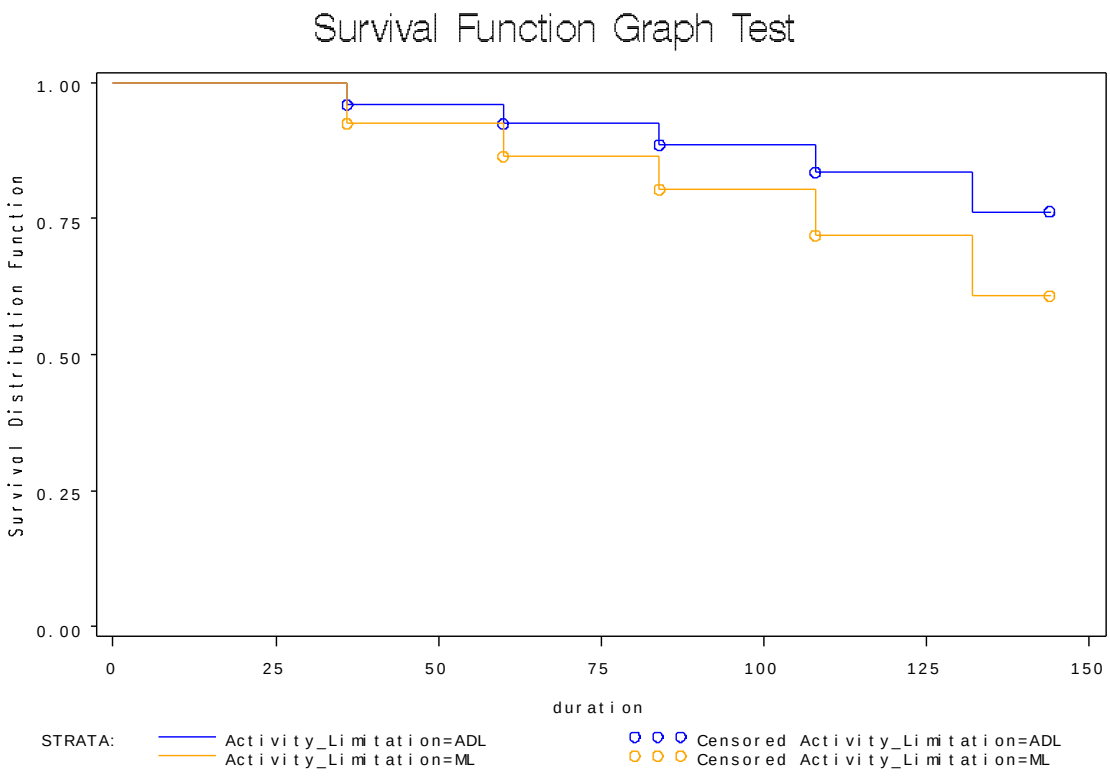



Figure 6-1. Translational Diagram of the Participation Restriction Pathway for Chapter 6



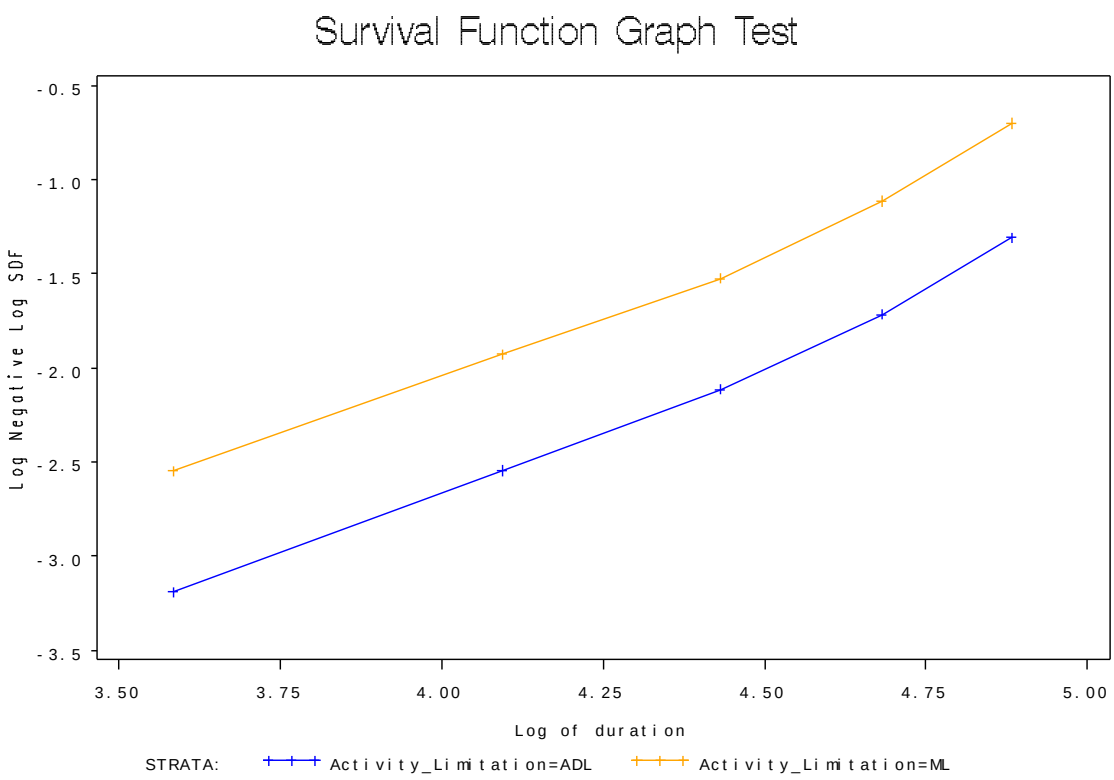




Figure 6-2. Survival Curve Illustrating Mobility Limitation and ADL Limitation Onset

# CHAPTER 7
# POSITIVE CHANGES IN MODIFIABLE RISK FACTORS AMONG LATE MIDLIFE ADULTS

Following the analyses from Chapters 5 and 6, Chapter 7 explores positive changes in MRFs. In regards to the PRP, a positive change in MRF reflects a recovery-facilitator. Figure 7-1 is a translational diagram of the PRP for Chapter 7. Contextual personal factors including modifiable personal factors and non-modifiable personal factors are investigated in Chapter 7. Given the significance of MRFs for activity limitation onset and recovery, it is important to understand the predictors of a positive change in MRFs. For both act and task limitation onset, MRFs were important antecedents of functional decline. Physical activity had a protective effect, while current smokers and higher BMIs were important negative risk factors. MRFs continued to be important predictors in the recovery models. Physically active respondents were more likely to recover, whereas respondents with higher BMI scores were less likely to recover from act and task limitation. Smoking status (i.e., former and current smokers) was associated with lower likelihood of recovery from act limitation; however it was not associated with task limitation. It is important to note that the models in Chapters 5 and 6 contribute to our understanding of duration. Because the MRFs in the activity limitation onset and recovery models are time varying, the relationships reflect the influence of MRFs over the duration of the study. Yet, researchers view positive changes in MRFs as a vehicle for improving individual and population health. It is valuable to take a closer look at positive changes in MRFs as they may be influential recovery-facilitators. Specifically, examining predictors of a positive change in MRFs may enable researchers to be better informed and more adept to develop interventions which address multiple domains of health promotion.

## Initiating Physical Activity

Table 7-1 presents the odds ratios of initiating physical activity (starting to exercise or play sports). The initial risk group (i.e., inactive respondents) had an N=6,608. The Likelihood Ratio for each model was significant at an alpha-level of less than 0.001, and each subsequent model from the model before had an increase in predictive power (i.e., larger Likelihood Ratios). In Model 1, the socio-demographic characteristics are presented. Being female (OR=0.80), Black/African American (OR=0.87), or Hispanic (OR=0.87) was associated with reduced likelihood of initiating physical activity. Non-married respondents (i.e., divorced/separated (OR=0.76), widowed (OR=0.82), and never married (OR=0.64) were also at a decreased risk of starting to participate in vigorous exercise. Higher levels of education (OR=1.03) were positively associated with a greater likelihood of initiating physical activity. Model 2 introduced other MRFs—specifically, smoking status and BMI. The majority of socio-demographic characteristics associations did not appreciably vary with the introduction of MRFs. The only exception was age, which became significant in Model 2. Older respondents (OR=0.99) were less likely to start exercising. Both former smokers (OR=0.93) and current smokers (OR=0.68) were also less likely to initiate physical activity. Similarly, respondents with higher BMI scores (OR=0.97) were less likely to begin participating in physical activity.

Model 3 includes the socio-demographic characteristics, MRFs, and adds mobility limitation. With the addition of mobility limitation, female respondents (OR=0.84), Black/African American or Hispanic respondents (OR=0.90, 0.79, respectively), and non-married respondents were still less likely to start exercising. Education and age were no longer significant in Model 3. Being a current smokers (OR=0.76) and higher BMI scores (OR=0.98) were both linked to lower likelihood of initiating physical activity.

Mobility limitation (OR=0.72) was associated with a reduced likelihood of initiating physical activity. The final model (Model 4), introduces morbidity status measures and healthcare access measures. Among the socio-demographic characteristics, female respondents (OR=0.80) and Hispanic respondents (OR=0.80) continued to be less likely to start exercising. In Model 4, Black/African American was no longer a significant predictor. Divorced/separated (OR=0.90) and never married (OR=0.68) respondents had a lower likelihood of initiating physical activity. Widowed was no longer a significant predictor with the introduction of morbidity status and healthcare access. Of the MRFs, being a current smoker (OR=0.79) and higher BMIs (OR=0.98) persisted in lowering the likelihood of initiating physical activity. Likewise, mobility limitation (OR=0.78) continued to be linked with lower chances of starting to participate in physical activity. Six out of eight chronic conditions were significantly associated with initiating physical activity. High blood pressure (OR=0.98), diabetes (OR=0.89), lung disease (OR=0.83), heart problems (OR=0.82), and psychological problems (OR=0.88) were all associated with a decreased likelihood of starting to exercise. Higher levels of SRH (OR=1.13) were positively associated with initiating physical activity. Additionally, an overall trend of declining likelihood of initiating physical activity over the duration of the study appeared.

**Cessation of Smoking**

Table 7-2 presents a summary of the findings for predictors of smoking cessation (quitting smoking). The initial risk group (i.e., current smokers) had an N=2,066. The Likelihood Ratios for each model were significant at an alpha-level of less than 0.001, and each subsequent model from the model before sees an increase in predictive power (i.e., larger Likelihood Ratios). Model 1 included the socio-demographic characteristics. Being Black/African American (OR=1.30) or Hispanic (OR=1.57) was

associated with higher likelihood of quitting smoking. Age (OR=1.04) and education (OR=1.04) were also positively associated; older respondents and those with more years of education were more likely to become a former smoker. With the addition of MRFs (Model 2), the relationships among the socio-demographic characteristics and quitting smoking were very similar. Among the other MRFs, BMI (OR=1.20) was the only measure significantly associated; higher BMI scores were linked to higher likelihood of quitting smoking. Model 3 introduces mobility limitation. Once again, from Model 2 to Model 3, the socio-demographic characteristics remained very similar. Divorced/separated was the only exception as it becomes significant in Model 3. Divorced/separated (OR=0.82) respondents were less likely to quit smoking. Higher BMI scores (OR=1.19) continued to be significantly associated with higher risk of quitting smoking. Mobility limitation (OR=1.08) was linked with higher likelihood of becoming a former smoker.

Model 4 introduces morbidity status and healthcare access. Being Black (OR=1.31) or Hispanic (OR=1.67) were associated with increased likelihood of quitting smoking. Older respondents (OR=1.04) and respondents with more years of education (OR=1.05) were also more likely to quit smoking. Divorced/separated (OR=0.84) respondents were less likely to become a former smoker. Higher BMI scores (OR=1.16) and mobility limitation (OR=1.09) increased the likelihood that a respondent would quit smoking. Among the morbidity status and healthcare access measures, only one variable was significantly associated with quitting smoking. Respondents with psychological problems (OR=0.80) were less likely to quit smoking. Among the interval

measures, there appears to be a general trend of cessation of smoking being more likely over the course of the study.

### Transition to Healthy Weight

Table 7-3 presents the findings for healthy weight onset. The initial risk group (i.e., respondents who were overweight or underweight) had an N=6,650. The Likelihood Ratios for each model were significant at an alpha-level of less than 0.001, and each subsequent model from the model before sees an increase in predictive power (i.e., larger Likelihood Ratios). In Model 1, socio-demographic characteristics, only one measure is significant. Older ages (OR=1.02) were associated with increased likelihood of a transition to healthy weight. In Model 2, socio-demographic characteristics and MRFs, age (OR=1.03) continues to be significant. Current smokers (OR=1.26) and physical active (OR=1.40) respondents were more likely to a transition to healthy weight. Model 3 introduces mobility limitation. Once again, older respondents (OR=1.03) were more likely to a transition to healthy weight as were current smokers (OR=1.32) and physical active (OR=1.25). From Model 2 to Model 3, the relationship between current smoking status and healthy weight onset increased in magnitude, while the relationship between physical activity and healthy weight attenuated. Mobility limitation (OR=0.87) was linked to a decreased likelihood of experiencing a transition to healthy weight.

In the final model, Model 4, morbidity status and healthcare access are included. Older respondents (OR=1.04) continued to be more likely to experience a transition to healthy weight. Similarly, current smokers (OR=1.29) and physically active (OR=1.25) respondents continued to be at an increased risk of experiencing healthy weight onset. Mobility limitation (OR=0.92) was linked to lower chances of experiencing a transition to

healthy weight. Of the morbidity status and healthcare access measures, five chronic conditions were significantly associated. High blood pressure (OR=0.70), diabetes (OR=0.63), cancer (OR=0.80), lung disease (OR=0.80), and arthritis (OR=0.86) were all associated with lower likelihood of experiencing a transition to healthy weight. An overall trend did not appear for the interval measures; however, Interval 5 was significant for all of the models and compared to Interval 1, respondents in Interval 5 were more likely to a transition to healthy weight.

## Summary

Examining the predictors of a positive change in MRFs presents the opportunity to delve deeper into understanding the role of MRFs and activity limitation. MRFs are important predictors of activity limitation onset and recovery; therefore, it is essential to understand the predictors and potential mechanisms that lead to a positive change in MRFs. MRFs are of interest to researchers because of their potential to shape population-level functional health. Physical activity was a powerful and reliable predictor of activity limitation onset and recovery. A positive change in physical activity (start exercising) was less likely to occur among women and racial and ethnic minorities. These populations are known to have lower rates of physical activity and higher rates of obesity, which makes them more susceptible to activity limitation onset. Additionally, smokers, higher BMI scores, and mobility limitation were linked to lower likelihood of initiating physical activity as well as a number of chronic conditions. Participation in positive or negative health behaviors can cluster—meaning individuals who participate in physical activity are less likely to smoke cigarettes or be overweight (Berrigan et al. 2003). Chapter 5 demonstrated that physical activity is a significant predictor of mobility

limitation onset and recovery. Likewise, mobility limitation is a significant predictor of whether or not an individual starts exercising.

Smoking cessation is another notable positive change in MRFs. Racial and ethnic minorities were more likely to quit smoking; however, it is important to note that racial and ethnic minorities are also more likely to be current smokers, which comprised the risk group. More years of education and older ages were also associated with quitting smoking. Higher BMI scores were linked with becoming a former smoker. A somewhat unexpected finding concerning mobility limitation was discovered. Mobility limitation was associated with higher likelihood of quitting smoking. In the full model, divorced/separated respondents and respondents with psychological problems were less likely to quit smoking.

Finally, moving from underweight or overweight categories to a healthy weight is another important positive change in MRFs. Generally, socio-demographic characteristics did not predict a transition to healthy weight. Older ages were associated with a transition to healthy weight, which is a peculiar finding. Previous literature examining weight loss in older ages has found a link between weight loss and higher risk of mortality and mobility decline (Launer et al. 1994; Losonczy et al. 1995). It is possible that respondents moving from the overweight classification to the healthy weight classification are experiencing a negative change in MRFs. Weight loss in midlife is associated with health benefits, but there is evidence that stable weight is protective in older ages (Losonczy et al. 1995). Another odd finding included smoking status. Current smokers were more likely to a transition to healthy weight. Smoking is known to have some weight loss benefits (Miyata et al. 1999), but once again this finding may

reflect health decline. Weight loss is a complicated subject and does not have the clear health benefits as physical activity and quitting smoking. As to be expected, physical activity was associated with healthy weight onset. Mobility limitation and a number of chronic conditions were associated with lower likelihood of healthy weight onset.

The predictors for each positive change in MRF varied, which underscores the complicated relationships between socio-demographic characteristics, other MRFs, mobility limitation, and morbidity status and positive change in MRFs. Mobility limitation was associated with lower likelihood of starting to exercise and a transition to healthy weight, yet mobility limitation was linked to an increased likelihood of quitting smoking—this finding may be due to current smokers being more at risk of mobility limitation. The healthiest respondents (never smoked and current former smokers) were not included in the analysis. It is clear that more research is needed to fully explore the predictors of a positive change in MRFs.

Table 7-1. Odds Ratios of Initiating Physical Activity, by Socio-demographic Characteristics, Modifiable Risk Factors, Mobility Limitation, Morbidity Status, and Time (Initial Risk Group: N=6,608)

| | Model 1 | Model 2 | Model 3 | Model 4 |
|---|---|---|---|---|
| Socio-demographic Characteristics: | | | | |
| Gender (female=1) | 0.80*** | 0.77*** | 0.84*** | 0.80*** |
| Race and Ethnicity: | | | | |
| White (ref.) | -- | -- | -- | -- |
| Black/African American | 0.87** | 0.89** | 0.90* | 0.94 |
| Other Race | 1.03 | 0.97 | 1.01 | 1.00 |
| Hispanic | 0.87* | 0.83** | 0.79*** | 0.80*** |
| Education | 1.03*** | 1.02*** | 1.00 | 0.99 |
| Age | 0.99 | 0.99* | 0.99 | 1.00 |
| Marital Status: | | | | |
| Married/Partnered (ref.) | -- | -- | -- | -- |
| Divorced/Separated | 0.76*** | 0.79*** | 0.86** | 0.90* |
| Widowed | 0.82*** | 0.85*** | 0.89* | 0.92 |
| Never Married | 0.64*** | 0.64*** | 0.69*** | 0.68*** |
| Modifiable Risk Factors: | | | | |
| Smoking Status: | | | | |
| Never Smoked (ref.) | -- | -- | -- | -- |
| Former Smoker | -- | 0.93* | 0.98 | 1.01 |
| Current Smoker | -- | 0.68*** | 0.76*** | 0.79*** |
| BMI | -- | 0.97*** | 0.98*** | 0.98*** |
| Mobility Limitation | -- | -- | 0.72*** | 0.78*** |
| Morbidity Status: | | | | |
| Chronic Conditions: | | | | |
| High Blood Pressure | -- | -- | -- | 0.98* |
| Diabetes | -- | -- | -- | 0.89* |
| Cancer | -- | -- | -- | 1.02 |
| Lung Disease | -- | -- | -- | 0.83** |
| Heart Problems | -- | -- | -- | 0.90* |
| Stroke | -- | -- | -- | 0.82* |
| Arthritis | -- | -- | -- | 1.02 |
| Psychological Problems | -- | -- | -- | 0.88* |
| Self-Rated Health | -- | -- | -- | 1.13*** |
| Healthcare Access & Utilization | | | | |
| Insurance Coverage: | | | | |
| Private Health Insurance (ref.) | -- | -- | -- | -- |
| Government Insurance | -- | -- | -- | 0.96 |
| No Insurance | -- | -- | -- | 0.99 |
| Intervals | | | | |
| Interval 1 (ref.) | -- | -- | -- | -- |
| Interval 2 | 0.46*** | 0.47*** | 0.50*** | 0.83* |
| Interval 3 | 0.51*** | 0.51*** | 0.55*** | 0.69*** |
| Interval 4 | 0.42*** | 0.42*** | 0.46*** | 0.69*** |
| Interval 5 | 0.17*** | 0.17*** | 0.19*** | 0.65*** |
| Interval 6 | 0.19*** | 0.19*** | 0.20*** | 0.60*** |
| Intercept | 0.04 | 1.42*** | 1.17*** | 0.61 |
| Likelihood Ratio | 2375.9*** | 2604.9*** | 3491.0*** | 3828.8*** |
| Degrees of Freedom | 28 | 34 | 36 | 62 |

Source: Health and Retirement Study Notes: *0.01 < p ≤ 0.05; ** 0.01 ≤ p < 0.001; *** p ≤ 0.001

Table 7-2. Odds Ratios of Cessation of Smoking, by Socio-demographic Characteristics, Modifiable Risk Factors, Mobility Limitation, Morbidity Status, and Time (Initial Risk Group: N=2,066)

| | Model 1 | Model 2 | Model 3 | Model 4 |
|---|---|---|---|---|
| Socio-demographic Characteristics: | | | | |
| Gender (female=1) | 0.97 | 1.00 | 0.98 | 0.98 |
| Race and Ethnicity: | | | | |
| White (ref.) | -- | -- | -- | -- |
| Black/African American | 1.30** | 1.28** | 1.28** | 1.31** |
| Other Race | 1.07 | 1.01 | 1.02 | 0.99 |
| Hispanic | 1.57*** | 1.56*** | 1.58*** | 1.67*** |
| Education | 1.04*** | 1.04*** | 1.05*** | 1.05*** |
| Age | 1.04*** | 1.04*** | 1.04*** | 1.04*** |
| Marital Status: | | | | |
| Married/Partnered (ref.) | -- | -- | -- | -- |
| Divorced/Separated | 0.85 | 0.84 | 0.82* | 0.84* |
| Widowed | 0.90 | 0.89 | 0.89 | 0.90 |
| Never Married | 0.90 | 0.91 | 0.90 | 0.92 |
| Modifiable Risk Factors: | | | | |
| Physical Activity | -- | 0.93 | 0.98 | 0.97 |
| BMI | -- | 1.20** | 1.19*** | 1.16* |
| Mobility Limitation | -- | -- | 1.08*** | 1.09*** |
| Morbidity Status: | | | | |
| Chronic Conditions: | | | | |
| High Blood Pressure | -- | -- | -- | 1.07 |
| Diabetes | -- | -- | -- | 1.13 |
| Cancer | -- | -- | -- | 0.89 |
| Lung Disease | -- | -- | -- | 1.03 |
| Heart Problems | -- | -- | -- | 1.17 |
| Stroke | -- | -- | -- | 1.02 |
| Arthritis | -- | -- | -- | 1.08 |
| Psychological Problems | -- | -- | -- | 0.80* |
| Self-Rated Health | -- | -- | -- | 1.05 |
| Healthcare Access & Utilization | | | | |
| Insurance Coverage: | | | | |
| Private Health Insurance (ref.) | -- | -- | -- | -- |
| Government Insurance | -- | -- | -- | 0.97 |
| No Insurance | -- | -- | -- | 1.00 |
| Intervals | | | | |
| Interval 1 (ref.) | -- | -- | -- | -- |
| Interval 2 | 1.26* | 1.28* | 1.24* | 1.27* |
| Interval 3 | 1.19 | 1.22 | 1.18 | 1.22 |
| Interval 4 | 1.36** | 1.39** | 1.35** | 1.38** |
| Interval 5 | 1.61*** | 1.66*** | 1.60*** | 1.63*** |
| Interval 6 | 1.43** | 1.43** | 1.38** | 1.43** |
| Intercept | -4.26*** | -5.10*** | -5.25*** | -5.36*** |
| Likelihood Ratio | 139.3*** | 200.1*** | 248.3*** | 326.5*** |
| Degrees of Freedom | 28 | 32 | 34 | 60 |

Source: Health and Retirement Study

Notes: *0.01 < p ≤ 0.05; ** 0.01 ≤ p < 0.001; *** p ≤ 0.001

Table 7-3. Odds Ratios of Transition to Healthy Weight, by Socio-demographic Characteristics, Modifiable Risk Factors, Mobility Limitation, Morbidity Status, and Time (Initial Risk Group: N=6,650)

| | Model 1 | Model 2 | Model 3 | Model 4 |
|---|---|---|---|---|
| Socio-demographic Characteristics: | | | | |
| Gender (female=1) | 0.98 | 1.00 | 1.01 | 1.02 |
| Race and Ethnicity: | | | | |
| White (ref.) | -- | -- | -- | -- |
| Black/African American | 0.87 | 0.88 | 0.88 | 0.92 |
| Other Race | 1.08 | 1.01 | 1.04 | 1.05 |
| Hispanic | 0.98 | 1.02 | 0.98 | 0.97 |
| Education | 1.02 | 1.02 | 1.01 | 1.01 |
| Age | 1.02* | 1.03** | 1.03** | 1.04** |
| Marital Status: | | | | |
| Married/Partnered (ref.) | -- | -- | -- | |
| Divorced/Separated | 1.04 | 1.03 | 1.08 | 1.06 |
| Widowed | 1.12 | 1.14 | 1.19 | 1.19 |
| Never Married | 0.86 | 0.87 | 0.88 | 0.87 |
| Modifiable Risk Factors: | | | | |
| Smoking Status: | | | | |
| Never Smoked (ref.) | -- | -- | -- | -- |
| Former Smoker | -- | 0.91 | 0.94 | 1.00 |
| Current Smoker | -- | 1.26** | 1.32** | 1.29** |
| Physical Activity | -- | 1.40*** | 1.25*** | 1.25** |
| Mobility Limitation | -- | -- | 0.87*** | 0.92** |
| Morbidity Status: | | | | |
| Chronic Conditions: | | | | |
| High Blood Pressure | -- | -- | -- | 0.70*** |
| Diabetes | -- | -- | -- | 0.63*** |
| Cancer | -- | -- | -- | 0.80* |
| Lung Disease | -- | -- | -- | 0.80* |
| Heart Problems | -- | -- | -- | 1.02 |
| Stroke | -- | -- | -- | 1.21 |
| Arthritis | -- | -- | -- | 0.86* |
| Psychological Problems | -- | -- | -- | 1.12 |
| Self-Rated Health | -- | -- | -- | 0.98 |
| Healthcare Access & Utilization | | | | |
| Insurance Coverage: | | | | |
| Private Health Insurance (ref.) | -- | -- | -- | -- |
| Government Insurance | -- | -- | -- | 1.07 |
| No Insurance | -- | -- | -- | 1.10 |
| Intervals | | | | |
| Interval 1 (ref.) | -- | -- | -- | -- |
| Interval 2 | 1.04 | 0.95 | 1.00 | 0.98 |
| Interval 3 | 1.02 | 0.96 | 1.01 | 1.03 |
| Interval 4 | 1.18 | 1.11 | 1.18 | 1.20 |
| Interval 5 | 1.44*** | 1.38** | 1.48*** | 1.56*** |
| Interval 6 | 1.07 | 1.11 | 1.17 | 1.26 |
| Intercept | -2.21*** | -2.65*** | -2.51*** | -2.65*** |
| Likelihood Ratio | 58.8*** | 110.8*** | 152.4*** | 260.5*** |
| Degrees of Freedom | 28 | 34 | 36 | 62 |

Source: Health and Retirement Study

Notes: *0.01 < p ≤ 0.05; ** 0.01 ≤ p < 0.001; *** p ≤ 0.001

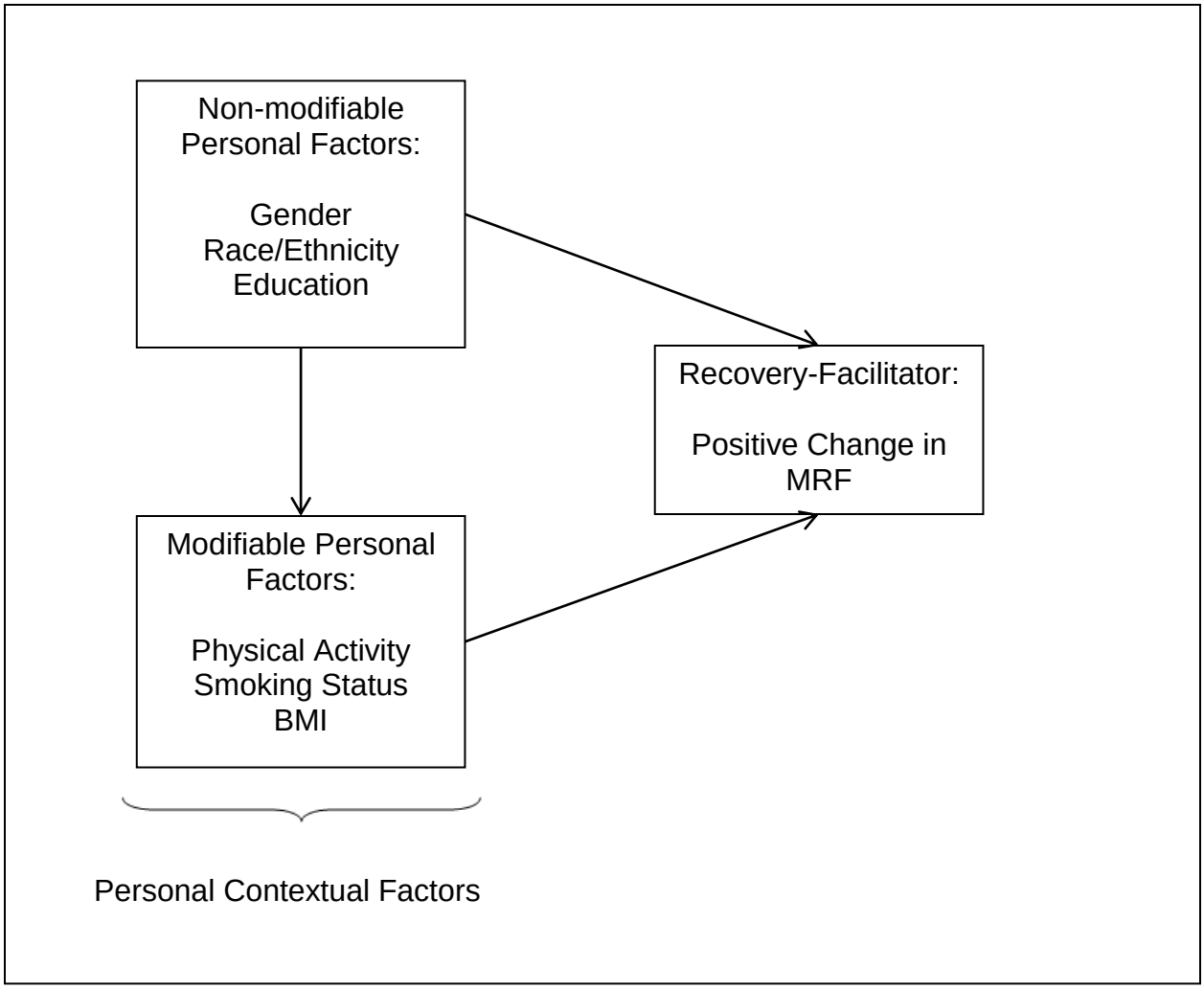



Figure 7-1. Translational Diagram of the Participation Restriction Pathway for Chapter 7

# CHAPTER 8
# DISCUSSION AND CONCLUSION

Studying activity limitations as an outcome presents researchers with an exceptional opportunity to explore functional health at an earlier stage of the participation restriction process. Studying modifiable risk factors also offers researchers the chance to explore areas for intervention. This project set out to explore the role of MRFs on the participation restriction process with an emphasis on gender, race/ethnic, and education disparities. Specifically, this project concentrated on three principal research questions: 1) what effect do MRFs have on act limitation? 2) what effect do MRFs have on task limitation? 3) what are the predictors of a positive change in MRFs? Chapter 8 concludes with discussing the overall results of this study as well as research implications, research limitations, and future recommendations.

## Act Limitation

The role of MRFs in influencing act limitation across various social statuses, specifically gender, race/ethnicity, and education, is complex. In general, MRFs are strong and consistent predictors of act limitation onset and recovery; however, the way in which they shape act limitation transitions varies greatly depending on the social status. For act limitation onset, the association between gender and act limitation increased with the introduction of MRFs, while the relationship between race/ethnicity attenuated. Education remained fairly stable across the models. Modifiable risk factors did not substantially influence the associations between socio-demographic characteristics and act limitation recovery. These results reiterate the importance of health promotion; however, they also underscore the importance of non-modifiable risk factors. It is crucial to view modifiable risk factors within the greater social structure so

that interventions may be developed that address the difficulties of health promotion among different communities.

### Task Limitation

Similar to act limitation transitions, MRFs were robust predictors of task limitation transitions. Yet, the inclusion of MRFs did not appreciably influence the relationship between socio-demographic characteristics and task limitation onset and recovery as a whole. For task limitation onset, net of act limitation (i.e., mobility limitation), gender, race, education, and marital status were all significant predictors as well as physical activity and BMI, while for task limitation recovery, only physical activity and BMI were significant predictors, controlling for act limitation. It is evident that there are important task limitation disparities, yet the influence of MRFs on these disparities appears to be minimal. Modifiable risk factors continue to be important predictors, but it is unclear about their potential for reducing task limitation disparities in regards to gender, race, and educational attainment.

### Positive Change in Modifiable Risk Factors

The predictors for positive changes in MRFs varied greatly with the specific outcome measures examined. Initiating physical activity demonstrated the persistent socio-demographic disparities surrounding physical activity. Women and racial/ethnic minorities as well as non-married individuals were less likely to start exercising. Other MRFs were also important predictors of initiating physical activity, where smokers and higher BMIs were indicative of lower likelihood of initiating physical activity. Mobility limitation was also associated with not starting to exercise. Quitting smoking was more likely to happen among racial/ethnic minorities, higher levels of education, and older ages. Oddly, higher BMIs and mobility limitation were linked with increased chance of

quitting smoking. It may be that respondents that were at an increased risk of being a current smoker are also at an increased risk of being a former smoker, so these at-risk populations experience a positive change, but the health benefits of quitting do not manifest until later. Finally, healthy weight onset was more likely for physically active individuals. Other seemingly counter-intuitive findings were also observed. Current smokers and older ages were associated with healthy weight onset. This could be a result of weight loss being associated in older ages with a decline in health status, and those in poor health moving from an overweight classification to a healthy weight classification. Mobility limitation and multiple chronic conditions were linked to lower likelihood of developing healthy weight. More research needs to be conducted examining the predictors of positive changes in MRFs--especially given the major implications of the obesity epidemic on population functional health.

## Research Implications

Health promotion is an area of interest for many researchers—it provides researchers and clinicians the opportunity to improve individual and population health. However, in many domains, the health of the US population continues to decline. This is especially noteworthy given the impact of MRFs on morbidity, functional health, and mortality. Understanding MRFs and health promotion over the life course and within a framework that is socially situated is imperative if researchers are to observe long-lasting and wide-spread changes in health status.

### The Participation Restriction Pathway

One major research implication of this project is the creation of the Participation Restriction Pathway (PRP) as a new model of functional health. The PRP draws from multiple previous models of functional health. It makes several unique contributions to

the literature by adopting the ICF language, while maintaining important aspects of the Nagi and the Disablement Process model. Additionally, the PRP incorporates empirical research to aid the conceptualization of the PRP stages. Specifically, the PRP distinguishes between two stages of activity limitation: act and task limitation. Using mobility limitation to measure act limitation and ADL limitation to measure task limitation, this project supports the separation of activity limitation into two distinct categories. To illustrate, mobility limitation was a strong predictor of subsequent ADL limitation onset. While this research did not test whether activity limitation was an antecedent of subsequent participation restriction, prior literature has established activity limitation as a robust predictor of participation restriction. Furthermore, the PRP contributes to our understanding of functional health by exploring the role of contextual factors on the participation restriction process. The PRP differentiated between environmental and personal contextual factors. Among the personal contextual factors, a distinction is made for modifiable and non-modifiable factors. This research focuses on personal factors, emphasizing modifiable risk factors, and activity limitation. Although this study underscored personal factors, the PRP reiterates the significance of environmental factors for shaping personal factors, which is echoed in the results of this project. Gender, race/ethnicity, and education disparities were exhibited in relation to act and task limitation—these non-modifiable personal factors often represent social position and systematic dis/advantage. Finally, the PRP, unlike previous models, explicitly tackles recovery. While functional health is often discussed as dynamic, previous models of functional health regularly ignore recovery. The PRP addresses recovery and employs the concept of recovery-facilitator to describe facilitators that act

as agents of change. This research analyzed the predictors of a positive change in MRFs, which furthered our knowledge of notable recovery-facilitators.

**Policy Implications**

The results of this study have important policy implications. In particular, this research is very informative for prevention policy. There are three types of prevention: primary, secondary, and tertiary prevention. The aim of primary prevention is the aversion of the underlying health condition. Secondary prevention refers to early detection of the health condition as well as management. An example of secondary prevention is screening for conditions such as breast cancer (IOM 2007). Finally, the goal of tertiary prevention is to avert secondary conditions (i.e., health conditions associated with the primary health condition) (IOM 2007).

Primary prevention endeavors to avoid onset of health condition(s). Health promotion, especially promoting participation in positive health behaviors, is essential to primary prevention. Although primary prevention is important, this research speaks to chiefly to secondary and tertiary prevention. Functional health and secondary prevention are interrelated. Functional health declines occur after the onset of an underlying health condition. As part of the managing the condition, functional health becomes a major concern. In managing functional health explicitly, secondary prevention may refer to avoiding moving from an earlier stage of the participation restriction process to a later stage. To illustrate, an individual through various facilitators may never move from act limitation to task limitation. Furthermore, recovery falls under the umbrella of secondary prevention because recovery is often a direct result of condition and/or functional health management.

Tertiary prevention endeavors to avert secondary conditions. The key dimensions of secondary conditions include a causal relationship with the primary condition, potentially preventable and modifiable, may vary in expression, and may increase the severity of the primary condition (IOM 2007). Examples of common secondary conditions are pain, obesity, depression, osteoporosis, and chronic lower limb edema (IOM 2007). Secondary conditions obviously have the potential to exacerbate functional limitations and reduce the chances of recovery. Managing primary and secondary conditions is of the utmost importance for maintaining a certain level of functioning. Whether or not an individual experiences a more severe type of impairment or moves through the Participation Restriction Pathway (PRP) may depend on tertiary prevention.

The significance of understanding proper prevention in relation to health policy is evident given the importance of functional health on both an individual and societal level. Prior research has shown that facilitators may slow functional health decline. To illustrate, a study conducted by Phelan et al. (2004) demonstrated the potential of interventions to reduce Activities of Daily Living (ADL) limitation. The risk factors addressed by the Health Enhancement Program (HEP) included “inadequate control or self-management of chronic conditions (hypertension or diabetes, for example), use of unnecessary psychoactive medications, physical inactivity, depression, and social isolation” (Phelan et al. 2004: 839). Many of the risk factors addressed by HEP related to key contextual factors.

Furthermore, these analyses should be explored in the light of Healthy People 2020, outlines the main national objectives for improving US population health (U.S. Department of Health and Human Services 2011). There are four overarching goals of

Healthy People 2020: 1) “attain high-quality, longer lives free of preventable disease, disability, injury, and premature death,” 2) “achieve health equity, eliminate disparities, and improve the health of all groups,” 3) “create social and physical environments that promote good health for all,” and 4) “promote quality of life, healthy development, and healthy behaviors across all life stages” (U.S. Department of Health and Human Services 2011: “About Healthy People” para. 5). More specifically, Healthy People 2020 delineates areas for improvement for disability including focusing on “well-timed interventions and services” and enabling persons with disabilities to interact with their environment without barriers (U.S. Department of Health and Human Services 2011: “Disability and Health” para. 4). Generally, Healthy People 2020 has lofty goals, yet the suggested interventions and resources for individuals with disabilities are remarkably sparse. Healthy People 2020 highlights four community interventions—two interventions related to more cancer-screening and the other two deal with increasing vaccination rates (U.S. Department of Health and Human Services 2011). Although cancer prevention and vaccination are important policy recommendations, the absence of discussion of other community-level interventions raises concerns about the likelihood of Healthy People 2020 meeting their goals in relation to disability. As policy makers continue to concentrate on the Healthy People 2020 goals with limited resources, this research can inform the type of interventions that are funded.

Interventions which address multiple contextual factors (e.g., HEP) including person and environmental factors need to be emphasized. MRFs cannot be changed without adequately confronting other important contextual factors like the non-modifiable person factors and environmental factors that expose individuals to many barriers. This

research underscores the need for community-level interventions that are multilevel and multipronged—many activity limitation disparities persisted even after controlling for MRFs; however, MRFs were important predictors. Community-level interventions that address obstacles preventing positive changes in MRFs may lead to better functional health outcomes within at-risk communities. Focusing on act limitation may be another fruitful avenue given that there is some evidence that recovery is more likely to happen at this stage of the participation restriction process. Inventions aimed at task limitation or participation restriction are also essential and should also be explored, but tackling functional health declines earlier in the PRP may prevent future task limitation and participation restriction.

## Research Limitations

Although this research contributes to extant literature, it must be viewed in light of the research limitations. One of the main limitations of this study is the two-year interval. It cannot establish at what point during the two-year interval respondents developed activity limitation onset or recovery. Although, annual or semi-annual data would have led to more precise estimates of activity limitation transitions, using the HRS had many benefits including many years of data and a younger cohort. With any analytic strategy, there are key limitations to consider. In relation to event-history analysis, specifically, censoring is a key limitation. Both left- and right-censoring occur when event-history analysis is employed. Left-censoring refers to the information (or lack thereof) of each respondent at the start point of the study. For example, a respondent may have a family medical history, personal attributes, or exposure to a toxic environment, which make him or her more susceptible to activity limitation decline. Right-censoring occurs after the study is concluded. Many respondents did not experience an activity limitation

transition during the study; however, they may experience an activity limitation transition following the study—it may be shortly following the study or many years later, but this information is not available. Finally, event-history analysis examines a change in state or the occurrence of an event, yet the outcome variables used in this research can only capture a passing of a threshold. To illustrate, functional health decline may be a gradual process with fine gradation among each stage of the PRP; however, using event-history to analyze function health, only depicts a move from one category to another and possibly neglects subtle changes in functional health status. Another limitation of this research is the attrition due to mortality and drop-outs. Attrition was included in the analysis as a competing event to minimize bias as best as possible.

Further limitations stem from the operationalization of key measures. Activity limitation, both act and task limitation, measures were self-reported. Moreover, act and task limitation measures did not take into account the severity of the limitation. Additionally, the MRFs measures were also self-reported, and many of the measures lacked sophistication. The physical activity measure only asked about vigorous exercise; however, the types physical activity older adults participate in tend to be low intensity (Dipietro 2001). In more recent waves of the Health and Retirement Study (HRS), the physical activity measure includes information about low intensity activity. Because of concordance issues, however, low intensity activity measures could not be used in this analysis. Other important MRFs were omitted from the analyses due to lack of information. For example, the HRS does not include information about dietary choices; therefore, this study was not able to account for nutrition or eating habits. Additionally, alcohol consumption was excluded. The HRS does have information

pertaining to alcohol consumption, but, the measures are not very useful. The HRS collected information about previous alcohol consumption, specifically whether a respondent was a current drinker or never drank. From this information, it is possible to establish whether a respondent is a current drinker, former drinker, or never drank; however, there is not information in all waves regarding the quantity of alcohol consumption. Given the potential benefits of moderate drinking, the information provided by the HRS is insufficient to include alcohol consumption in the analysis. Finally, there were no measures of recovery-facilitators that could be included in the recovery or positive change in MRFs analyses. While there are important limitations to consider, the results from this research still provide noteworthy findings.

## Future Research and Recommendations

In the future, researcher examining activity limitation and MRFs should include better measures of both. For example, a noted limitation of this research is the lack of a nuanced measure of physical activity. Future research would benefit from having a physical activity measure that reflected different types of physical activity including work or leisure activities. Current studies provide examples of alternative measures of physical activity. For example, the *National Health and Nutrition Examination Survey* (NHANES) include questions about vigorous physical activity as well as sedentary activities (e.g., number of hours on a computer or watching TV or movies) and moderate activity (e.g., walking or cycling). Another longitudinal study the *Americans' Changing Lives* (ACL) also incorporate more nuanced measures of physical activity; the ACL includes questions about gardening and walking. Future researchers should develop even more sophisticated measures that do not solely rely on retrospective self-reports.

The integration of surveillance data that uses pedometers or other technology to track physical activity would contribute greatly to the extant functional health literature.

Although there are previous studies using objective measures of activity limitations, many of the large nationally, representative panel studies (e.g., HRS) rely on self-reported functional health measures. The inclusion of objective measures (e.g., observed difficulty walking across the room) in these large panel studies would further our understanding of functional health. In addition, future research incorporating the severity of act and task limitation measures would allow researchers to broaden their understanding of each specific stage of the participation restriction process and enable them to discuss recovery within each stage. Other future studies should examine the effect of duration of MRFs versus change in MRFs. These results note the complicated nature of change in MRFs. In the future, researchers should disentangle the relationship between duration of healthy behavior and changes. For example, research aimed at looking at physical activity over the life course and trying to identify importance of long-term changes compared to short-term benefits expressly in terms of activity limitation recovery would greatly add to our understanding the role of MRFs and functional health recovery. Finally, future research targeted at identifying potential interactions between socio-demographic characteristics and MRFs may be able to parcel out the complex relations between non-modifiable and modifiable personal factors. To illustrate, previous research has suggested the participating in positive or negative MRFs tend to cluster among individuals by social position; therefore, interaction terms may aid in understanding the influence socio-demographic characteristics and MRFs on functional health outcomes.

Additionally, more research is needed to identify key recovery-facilitators to aid in intervention creation. The strategies employed by policy makers in regards to improving population health rely heavily on individual-level health; however, this research and other previous research underscore the influence of societal factors. Even participation in MRFs is shown to be shaped by contextual factors. Community-level interventions that address both micro- and meso-level barriers, while supporting facilitators in multiple life domains are an important avenue for researchers to explore. Without clear and effective interventions, it is possible that the functional health of the US population will decline. The future trends of activity limitations and participation restriction may be contingent on lifestyle changes on a population level. The gains in functional health could be reversed if health risk behaviors become more prevalent. Policy makers need to prioritize funding to programs that promote and support healthy lifestyle changes that address socio-cultural factors. As we look toward the future of US population health, MRFs hold the opportunity for improvement through the compression of morbidity, but also fears of increasing obesity and the expansion of morbidity loom. If the US does experience a wave of increasing poor functional health, the societal costs could be immense. The loss of worker productively and the need for more informal and formal care will place enormous burdens on the already over-burdened healthcare system and economy. On an individual level, the Baby Boomers and other future cohorts may be facing poor quality of life from worsening functional health including greater social isolation and poorer mental health. When asked about aging successfully, individuals reiterate central assumptions of functional health promotion including the desire to be free from disease, to function independently, and to have an active and engaged life

(see Phelan et al. 2004)—the PRP addresses each of those assumptions. This research provides evidence that MRFs hold the possibility for a reduction in activity limitation and ultimately a reduction in participation restriction. We all benefit from better functional health and creating opportunities to see meaningful improvement through community-level intervention and services must be a top priority for the US.

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