ILLNESS PERCEPTIONS AND SELF-MANAGEMENT IN LATE-LIFE CHRONIC DISORDERS

by

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Background: As chronic disorders become increasingly prevalent among persons 50 years of age and older, understanding how an individual perceives an illness in the context of disease characteristics (physical vs. mental), and what self-management strategies are adopted in response to these perceptions becomes an important issue.

Purpose: The aims of this study were 1) to examine the associations between illness perceptions, self-efficacy, and self-management, and 2) to identify similarities and differences among persons (≥ 50 years of age) with type 2 diabetes (T2DM) and those with mild cognitive impairment (MCI), treating the conditions as exemplars of late-life physical and mental disorders.

Methods: This cross-sectional study used secondary analyses of existing datasets. The coherence and causality subscales of the Revised Illness Perception Questionnaire, Brief Illness Perception Questionnaire, Self-efficacy for Managing Chronic Disease, Risk Evaluation and Education for Alzheimer's disease health behavior measure, and four-item Morisky Medication Adherence Scale, were used. In Aims 1 and 2, we performed hierarchical linear and logistic regression analyses while controlling for covariates to examine the associations between illness perceptions, self-efficacy, and self-management among persons with MCI and those with T2DM. In Aim 3, we conducted multivariate analysis of covariance (MANCOVA) and hierarchical linear regression to compare illness perceptions between the T2DM and MCI groups.

Results: Regardless of the disease characteristics (physical [T2DM] or mental [MCI]), illness perceptions or its interactions with covariates were associated with either self-efficacy or self-management behaviors ($p < .05$) among participants with chronic disorders. Coherence was an important factor of self-management in both T2DM ($b = .306$, $p = .035$) and MCI ($b = .051$, $p = .089$) groups when the interactions terms were added to the models. With the exception of the consequences dimension, each dimension of illness perception was significantly different between the T2DM and MCI groups.

Conclusion: Future research should incorporate illness perceptions in the context of disease characteristics (physical vs. mental), sociodemomegraphics, and comorbid conditions into development of interventions aimed at improving both self-efficacy and self-management among older adults with chronic disorders, which may result in one's positive health outcomes such as quality of life.

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Preface

I could not have successfully finished my PhD journey without all of the individuals who have provided me with tremendous support, patience, and encouragement. First, I would like to thank my dissertation committee members, each of whom has provided unwavering support throughout my doctoral training and the dissertation project. Thank you to *Dr. Jennifer Lingler* for believing in me when I did not believe in myself, and for being honest with me. I do not know what I would have done without her guidance in the development of my dissertation work and beyond. Her sincerity, integrity, and compassionate nature are just a few of her qualities that continue to inspire me. Truly, I have been blessed to have her in my life. Thank you to *Dr. Catherine Bender* for her invaluable advice and guidance from writing my dissertation project to submitting the manuscript. She has always been willing to share her expertise and taught me how to become a real nurse researcher. I have really enjoyed her PhD-level course, *Theoretical Foundations of Research,* which made me to establish the theoretical groundwork for my dissertation project. Thank you to *Dr. Susan Sereika* for opening my eyes to how to use rigorous statistical approaches. Hands-on work with her has provided me with the assets for my dissertation work and other research projects. I count myself so lucky for having had her mentorship. Thank you to *Dr. Steven Albert* who has provided insights into the public health significance of my dissertation work. I have also learned a lot from his class, *Clinical Aspects of Dementia Care*. I was the only student in his class, so it made me feel special and I gained comprehensive knowledge about dementia care.

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1.0 Proposal Introduction

The following dissertation proposal, *Illness Perceptions and Self-management in Late-life Chronic Disorders*, is prepared according to the Doctoral Manuscript Dissertation Guidelines from the University of Pittsburgh School of Nursing. In response to the National Institute of Nursing Research (NINR)'s Strategic Plan focus "Self-Management: Improving Quality of Life for Individuals with Chronic Illness", I propose to examine illness perceptions and self-management in late-life chronic disorders using a novel approach that compares individuals experiencing physical health conditions to those experiencing mental health conditions to enhance our understanding of how people experience late-life chronic disorders. In **Manuscript 1**, I will examine how persons with mild cognitive impairment (MCI) perceive their memory problems and what self-management strategies are performed in association with those perceptions, treating MCI as an exemplar of a common late-life mental health disorder. In **Manuscript 2,** I will examine the associations between illness perceptions, self-efficacy, and medication adherence in persons with type 2 diabetes mellitus (T2DM), treating T2DM as an exemplar of a late-life physical health disorder. **Manuscript 3** will use multivariate analysis of covariance (MANCOVA) to identify similarities and differences in illness perceptions between older adults experiencing MCI and T2DM. The findings from this study will provide the foundation to develop behavioral interventions, disease management guidelines, or protocols for increasing physical or mental health in the older adult population, with significant nursing and public health implications.

1.1 Specific Aims

As chronic disorders become increasingly prevalent among persons 50 years of age and older, understanding how an individual perceives an illness and what self-management strategies are adopted in response to these perceptions becomes an important issue. Evidence suggests, for example, that not smoking, exercising regularly, avoiding alcohol consumption, maintaining a healthy body weight, and getting a sufficient amount of sleep are among the most common behavioral determinants of health for chronic disorder prevention (Liu et al., 2016). While a wide range of factors likely contribute to one's preventative health behaviors, the performance of such behaviors may be also influenced by one's thoughts and feelings about what health conditions they may be susceptible to. Among individuals who are diagnosed with specific conditions, the adoption of recommended secondary prevention behaviors or health behaviors for self-management may depend on what an individual's health condition means to them, a concept which is referred to as **illness perceptions** (Leventhal, Brissette, & Leventhal, 2003).

Based on the characteristics of a disorder, including signs, symptoms, etiology, and pathophysiology, chronic disorders affecting older adults may fall into broad categories, those which affect physical health (e.g., type 2 diabetes mellitus [T2DM], cancers, chronic respiratory diseases) and those which affect mental health (e.g., mild cognitive impairment [MCI], Alzheimer's disease [AD], depression). Even though clinicians, scientists, and public health experts increasingly recognize the complex overlay of physical and mental health disorders, it is plausible older adults may hold distinct views regarding what they perceive as physical versus mental health disorders. Persons with physical health disorders such as T2DM may have more expected perceptions about the treatment and prognosis; however, those with mental health disorders such as MCI may hold uncertain and equivocal beliefs on their conditions. Specifically,

while the adverse consequences of T2DM can be prevented by a widely agreed upon set of self-management like taking medications, exercising, and maintaining healthy eating habits (American Diabetes Association [ADA], 2018), effective ways to arrest age-related cognitive impairment (e.g., MCI, AD) have not been identified. This can lead to the potential for misunderstanding, stigma, anxiety, and, even suicide ideation in the face of disease progression with no treatment (Karlawish, 2011; Milne & Karlawish, 2017). In addition, late-life physical disorders such as T2DM can be treated with lifestyle changes and medications (ADA, 2018), therefore, affected individuals may have higher **self-efficacy**, a strong judgement in their ability to accomplish a task for future health outcomes. Despite the possibility of such fundamental differences in how affected individuals perceive their chronic disorders, direct comparisons of illness perceptions among persons diagnosed with different late-life health disorders is lacking. Most research on both illness perceptions and self-management for late-life chronic disorders has focused on specific physical or mental health disorders one at a time. This proposed study will fill this significant gap by examining T2DM and MCI, which are two common types of late-life physical and mental disorders, and will make a substantial contribution to future research and clinical practice. The broad, long-term goals of the proposed program of research are to 1) improve and promote self-management of late-life chronic disorders, and 2) reduce the personal and societal burden of chronic disorders.

I will use quantitative methods to examine and gain insight into illness perceptions and self-management of chronic disorders, particularly T2DM and MCI. **The primary purpose of this study is to examine the association between illness perceptions and self-management among persons with T2DM and those with MCI, and to identify similarities and differences in illness perceptions between those two conditions.** I will conduct a quantitative, cross-sectional, and

descriptive study through secondary analyses of existing data from several independent studies. **The Common Sense Model** (Leventhal et al., 2003), which is the most widely used and empirically validated theoretical model of illness perceptions, will guide the proposed study. Hence, the specific aims of this study are:

Specific Aim 1. To examine the association between illness perceptions and self-management among persons with MCI.

Specific Aim 2. To examine the associations between illness perceptions, self-efficacy, and medication adherence among persons with T2DM.

Specific Aim 3. To identify similarities and differences in illness perceptions of T2DM and MCI, as common examples of late-life physical and mental chronic disorders.

Findings from the proposed study will provide the foundation for the future directions in developing interventions, strategies, as well as policies for the older population with chronic disorders. Furthermore, these findings will also have applications in other chronic disorder contexts, including both physical and mental health conditions.

1.2 Background

Illness Perceptions in Chronic Disorders: Making Sense of Potentially Life-long Health Threats

Receiving a new diagnosis, learning one is at particular risk for a disease, or newly experiencing symptoms of a yet undiagnosed illness, can lead an individual to begin forming thoughts and feelings about a threat to one's physical or mental health. Leventhal's (2003) **Common Sense Model (CSM),** an empirically validated conceptual framework, guides the proposed study to understand such **illness perceptions** and how they impact ongoing and future health threats (see Figure1). The CSM identified five main dimensions of illness perceptions: 1) *identity*- one's beliefs about the symptoms they view as being part of the disease; 2) *consequences*- the expected outcomes of the illness; 3) *cause*- one's beliefs about the cause of the illness; 4) *timeline*- one's beliefs that how long the illness will last (e.g., acute, chronic, cyclic); and 5) *cure/control*- an individual's beliefs whether they can control the illness or not. Two more dimensions, *illness coherence*- one's belief that the illness is understandable or being confused; and *emotional representations*- how the illness affects the individual emotionally (e.g., angry, upset), were later added to the CSM (Moss-Morris et al., 2002).

While acute health conditions (e.g., cold, heart attack) allow us to expect symptoms and a short timeline, chronic health conditions, both physical (e.g., T2DM, hypertension, heart failure) and mental (e.g., MCI, AD, depression) disorders are sometimes completely asymptomatic and not easily noticeable, suggesting that persons with chronic disorders may have different illness perceptions as compared to those with acute disorders. There has been research on illness perceptions in participants with a wide range of chronic disorders, including coronary artery disease (CAD) (Noureddine, Massouh, & Froelicher, 2013), hypertension (Chen, Tsai, & Chou, 2011; Stallings, 2016), T2DM (Al-Amer, Ramjan, Glew, Randall, & Salamonson, 2016; Martinez,

Lockhart, Davies, Lindsay, & Dempster, 2018), schizophrenia (Hussain, Imran, Hotiana, Mazhar, & Asif, 2017), and depression (Antoniades, Mazza, & Brijnath, 2017). Noureddine and colleagues (2012) found that the majority of the participants perceived CAD to be a chronic timeline with serious consequences. In a study by Stallings (2016), personal control, treatment control, and illness coherence were high within a sample of individuals with hypertension. Interestingly, in sharp contrast to such physical health conditions, ambiguity regarding the disease as being chronic and cyclic has surfaced in analyses of persons with schizophrenia (Hussain et al., 2017) and depression (Brown et al., 2001).

In the CSM, illness perceptions are also described as underlying factors in the initiation or maintenance of one's self-management behaviors. In a study of persons with hypertension, Chen et al. (2011) found that illness identity was related to adherence to therapeutic regimens, suggesting that the beliefs regarding illness-related symptoms (e.g., headache) are associated with one's self-reported self-management behaviors such as healthy diet, exercise, or medication taking. Kaptein and colleagues (2008) found that people who believed their asthma has an acute timeline were less likely to use a peak flow meter or to keep routine health care visits for asthma. Beliefs about treatment control were also significantly related to one's adherence to medication in both physical and mental chronic disorders. Individuals who felt their treatment could effectively control their disease, for example, blood pressure (Ross, Walker, & MacLeod, 2004) or bipolar disorder (Averous, Charbonnier, Lagouanelle-Simeoni, Prosperi, & Dany, 2018) were more likely to take their medications as prescribed. However, existing research has focused more on adults in mid-life, not late-life. In view of the fact that the prevalence of late-life chronic disorders is increasing due to the greater longevity, aging may provide an important context that could impact such relation of illness perceptions to one's self-management.

Despite the activation of illness perceptions may result in one's following self-management behaviors in both physical and mental chronic disorders, research on such association, illness perceptions and self-management, from the perspective of the disease characteristics is lacking. In addition, direct comparisons of illness perceptions in physical versus mental health disorders have not been conducted.

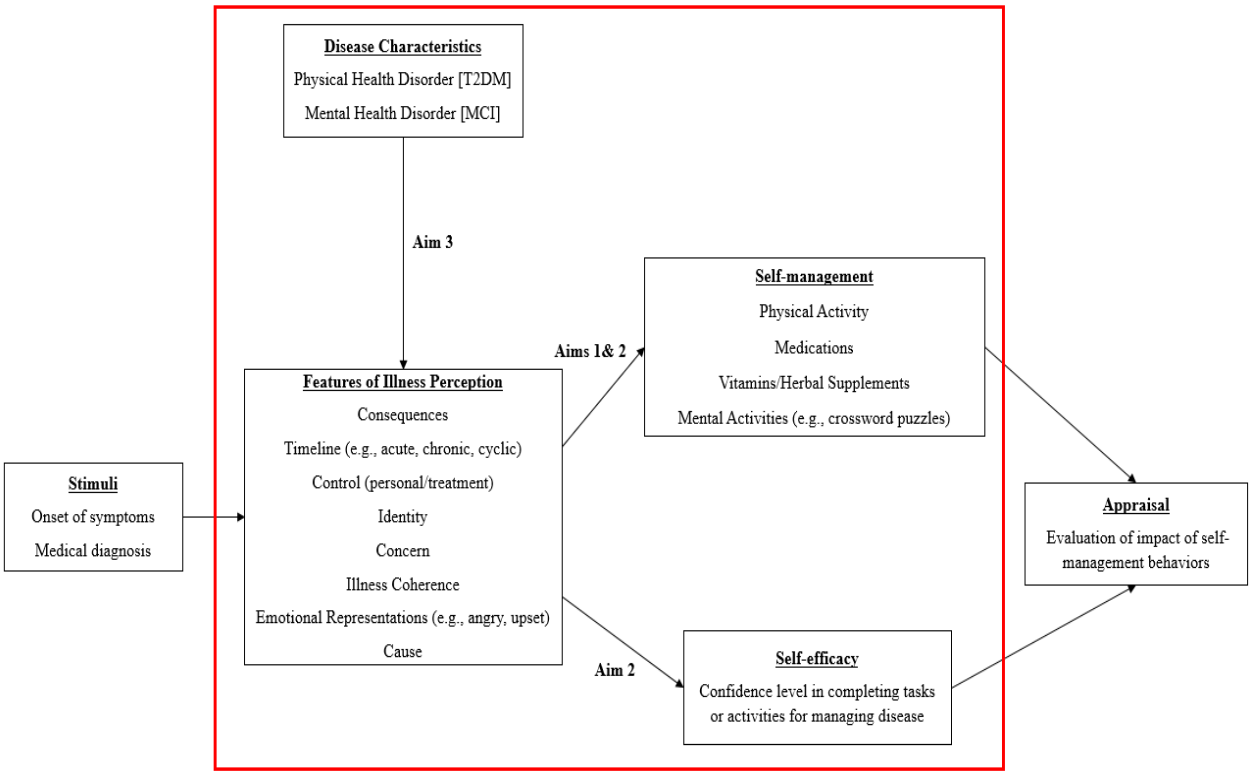

Figure 1. Conceptual Framework of Illness Perceptions and Self-management in Late-life Chronic Disorders (Adapted from Leventhal et al. [2003])

Illness Perceptions in Late-life Physical Health Disorder: T2DM

A number of chronic physical disorders including heart disease, cancer, stroke, and T2DM pose increasing risks as people age (Centers for Disease Control and Prevention [CDC], 2017a). Diabetes, especially T2DM, which is a common and life-long chronic physical disorder among

older adults, continues to contribute to death despite the fact that effective medications including oral medications and insulin are available. Blood glucose level in persons with T2DM can be appropriately controlled by performing self-management behaviors such as physical activity, healthy diets, or medication taking, and those behaviors reduce the risk of severe complications associated with T2DM (ADA, 2018). As a potential key factor to engaging in such behaviors, developing an understanding of individuals' illness perceptions in late-life T2DM in this line of research is a critical issue.

Recent evidence suggests that persons with T2DM hold a strong belief that their condition is chronic (Al-Amer et al., 2016; Hemphill, Stephens, Rook, Franks, & Salem, 2013) and T2DM leads to serious consequences (Al-Amer et al., 2016). In a study by Al-Amer and colleagues (2016), the participants typically perceive themselves to have a clear understanding and high personal control over the disease. Taken together, these illness perceptions might point to an increased tendency to perform T2DM-related self-management behaviors. Yet, reports on engagement in such behaviors among persons with T2DM suggest wide variability. Regarding the emotional component of illness perception, one study (van Esch, Nijkamp, Cornel, & Snoek, 2014) showed that despite the participants perceiving themselves to have a good understanding about their symptoms and disease, T2DM does not considerably affect them emotionally, indicating that, typically, persons with T2DM do not feel angry, scared, or depressed in response to their diagnosis or its manifestations.

However, the above-described research on illness perceptions in T2DM has limitations. The studies by Al-Amer et al. (2016) and Van Esch et al. (2014) were not limited to the older population, included adults aged 18 and older. Hemphill and colleagues (2013) focused on late-life T2DM, but investigated only one dimension of illness perceptions, timeline perceptions of

T2DM (e.g., acute or chronic). These are problematic because research involving older population who have diverse beliefs on their disease is important to enhance our understanding of unique characteristics of illness perceptions in late-life T2DM.

Illness Perceptions in Late-life Mental Health Disorder: MCI

MCI has been described as an intermediate condition between normal cognition and AD. Persons with MCI experience mild cognitive changes that are noticeable, but do not affect the ability to perform activities of daily living (Petersen et al., 1999). Since the concept of MCI was introduced by Petersen and colleagues (1999), it has become an increasingly important topic in the field of late-life mental health. While persons with amnestic MCI experience memory impairment predominantly, those with non-amnestic MCI are more likely to have impairment of other cognitive domains such as language, attention/executive function, or visuospatial skills (Petersen, 2004). According to the recent report from the American Academy of Neurology (AAN), MCI prevalence increases with age and the cumulative incidence for the conversion to dementia in older adults with MCI followed for 2 years was 14.9% (Petersen et al., 2018). However, this impairment does not necessarily lead to development of AD, and in some individuals, MCI reverts to normal cognition or remains stable (Alzheimer's Association [AA], 2017), indicating that persons with MCI may feel confused or uncertain about their memory problems and its possibility of progression to AD.

Research indicates that certain dimensions of illness perceptions, such as illness coherence, emotional representations (e.g., angry, scared, upset), and beliefs about causality, may be particularly important in the population of MCI. For example, Lin, Gleason, and Heidrich (2012) found that one third of participants believed MCI would convert to dementia, whereas most

participants were not sure about the prognosis of their memory problems. Concerns about uncertainty have also surfaced in qualitative research. In a metasynthesis of 17 qualitative interviews examining the experience of living with MCI (Gomersall et al., 2015), ambiguity was a key theme, suggesting that persons with MCI experienced difficulties in making sense of their memory problems. Lingler and colleagues (2006) also found that the participants expressed uncertainty and unpredictability about MCI, and those feelings may be linked to one's comprehensibility of the disease because individuals who feel confused about their memory issues would not have a clear picture of risk factors of MCI or their future plans. In stark contrast to physical health conditions such as T2DM, emotional representations (e.g., feelings of anger, anxiety, or worry) are important in the MCI population because of uncertainty regarding the disease. Fear (Beard & Neary, 2013) and anxiety (Samsi et al., 2014) have also emerged in qualitative interviews, and memory or thinking difficulties were related to higher emotional upset among persons with MCI (Lingler, Terhorst, Schulz, Gentry, & Lopez, 2016)

Although there is no proven means of preventing further cognitive decline in MCI, Langa and Levine (2014) have laid out an evidence-based guideline for self-management of MCI regardless of subtype of MCI, either amnestic or non-amnestic MCI. It is, therefore, necessary to examine the extent to which the individual's beliefs regarding the cause of the illness, because these beliefs can influence following self-management behaviors (Weiner, 1985, 1986). One study suggests that persons with MCI believed the disease is controllable by personal strategies or medical treatment (Lin, Gleason, & Heidrich, 2012). A more recent study of attribution of MCI etiology (Rodakowski, Schulz, Gentry, Garand, & Lingler, 2014) revealed the participants most frequently attributed uncontrollable factors (e.g., heredity, normal aging) to MCI etiology.

However, research on such association, individuals' illness perceptions about the cause of the disease and self-management in persons with MCI is lacking.

Self-management & Self-efficacy in Chronic Disorders: Catalysts for One's Health & Well-being

Self-management is a promising strategy to manage a chronic health condition, which has become a public health issue of increasing significance. Basically, in the context of health care, self-management refers to the actions taken by individuals to promote their own health and well-being (Starfield, Hyde, Gervas, & Heath, 2008). Examples of self-management include lifestyle changes and medication management. Identifying an individual's self-management is a first step to reduce the burden of chronic disorders because it provides basic information in development of future interventions aiming at optimizing self-management behaviors. Evidence shows that engaging in self-management behaviors may reduce the risk of complications and death from chronic disorders (Aune et al., 2017; Warburton, Nicol, & Bredin, 2006). In a prospective study examining health behavior changes after diagnosis of chronic disorders (heart disease, diabetes, cancer, stroke, and lung disease), Newsom and colleagues (2012) found that people changed their lifestyles such as smoking habits and alcohol consumption to reduce risk of complications and death. Although those self-management behaviors may be influenced by factors such as one's illness perceptions (Leventhal, Leventhal, & Breland, 2011; Leventhal, Weinman, Leventhal, & Phillips, 2008), Newsom et al. (2012) did not investigate what factors are associated with such behaviors, and focused solely on physical disorders, despite the increasing importance of late-life mental disorders such as MCI.

Along with lifestyle changes, **medication adherence** is another important self-management behavior to reduce the risk of adverse health outcomes and health care costs (Piette,

Heisler, & Wagner, 2004). In recent review studies of chronic physical or mental disorders (Abegaz, Shehab, Gebreyohannes, Bhagavathula, & Elnour, 2017; Engelkes, Janssens, de Jongste, Sturkenboom, & Verhamme, 2015; Martin-Vazquez, 2016), the investigators examined the levels of medication adherence. Although adherence to medication may be attributable to one's illness perceptions, such association was not investigated in the studies by Abegaz et al. (2017), Engelkes et al. (2015), and Martin-Vazquez (2016).

Additionally, **self-efficacy,** an individual judgement of how well one can perform the behaviors required to achieve positive outcomes (Bandura, 1977), plays a critical role in one's successful health outcomes. Improving one's self-efficacy is a key goal of psychosocial interventions for persons with chronic disorders such as hypertension (Kim & Song, 2015), diabetes (Pascoe, Thompson, Castle, Jenkins, & Ski, 2017), heart failure (Rajati et al., 2014) and fatty liver disease (Javanmardifard, Ghodsbin, Kaviani, & Jahanbin, 2017). Evidence suggests that one's illness perceptions are related to self-efficacy (Bonsaksen, Lerdal, & Fagermoen, 2012; Lau-Walker, 2006). Schüz and colleagues (2012) found that older adults with multiple chronic health conditions who believed their disease to be under personal and treatment control were more likely to have higher self-efficacy for dealing with different demanding situations. One study showed that certain dimensions of illness perceptions, identity, consequences, and control were associated with one's self-efficacy for managing insulin dependent diabetes (Griva, Myers, Newman, & Health, 2000). However, previous research has investigated young adults aged between 15 and 25 years (Griva et al., 2000) or certain dimensions of illness perceptions (Schuz, Wurm, Warner, & Ziegelmann, 2012), suggesting that research on the association between more diverse aspects of illness perceptions and self-efficacy in late-life chronic disorders is needed as a first step to develop interventions at improving one's self-efficacy for managing chronic health conditions.

Self-management and Self-efficacy in Late-life Physical Disorder: T2DM

Diabetes, particularly T2DM affects people who are 50 and older, and the percentage increases with age, estimating 25% of people aged 65 years or older had diabetes in 2015 (CDC, 2017). The ADA updates "Standards of Medical Care in Diabetes" and experts recommend lifestyle management (e.g., physical activity, eating habits), which is a fundamental aspect of successful diabetic management (ADA, 2018), along with an appropriate pharmacologic therapy.

Since the first report of the treatment of diabetes was introduced in 1906 (ADA, 2014a), a growing body of literature has identified the importance of medication adherence throughout the individual's lifetime because good glycemic control has been correlated with reduced risk of diabetic complications and health care resource utilization (Asche, LaFleur, & Conner, 2011). In a systematic review and meta-analysis of 48 studies, McGovern and colleagues (2018) analyzed literature identifying the types of medication which are related to better medication adherence. Although contributing factors such as one's illness perceptions are associated with adherence to medication in chronic disorders (Bolman, Arwert, & Vollink, 2011; Tanenbaum et al., 2015), McGovern et al. (2018) compared medication adherence and persistence depending on medication classes, and did not examine such contributing factors. Previous cross-sectional or cohort studies have assessed medication adherence in persons with T2DM (Ashur, Shah, Bosseri, Morisky, & Shamsuddin, 2015; McAdam-Marx et al., 2014; Radwan, Elsous, Al-Sharif, & Abu Mustafa, 2018); however, the investigators did not focus on the disease in late-life (Ashur et al., 2015; McAdam-Marx et al., 2014; Radwan et al., 2018) nor did the association between illness perceptions and medication adherence was not investigated (McAdam-Marx et al., 2014; Radwan et al., 2018).

Although one's self-efficacy and its association with illness perceptions are also critical factors in achieving successful health outcomes (Bonsaksen et al., 2012; Lau-Walker, 2006), few studies investigated such factors among persons with T2DM. One study (Al-Amer et al., 2016) examined such association among adults with T2DM; however, they included adults who are 18 years of age or older, suggesting that the investigators did not focus on late-life T2DM.

Self-management in Late-life Mental Disorder: MCI

As people age, the quality of mental health becomes an important concern for older adults. Although no medications or interventions have been established as effective at delaying or preventing progression from MCI to AD, nationwide efforts remain underway and experts have agreed that, most likely, lifestyle interventions (e.g., aerobic exercise, mental activity) will be required to stabilize or reverse the course of MCI (Langa & Levine, 2014). In line with this, the recent guideline from the AAN suggests that regular exercise and cognitive interventions may be beneficial in enhancing either an overall health or cognitive function (Petersen et al., 2018). This mounting evidence of the value of interventions for persons with MCI underscores the significance of one's self-management, which have been typically linked to secondary prevention, aiming to detect or treat memory problems early on.

Research on self-management in persons at risk for AD has shown mixed results. In a study of health behavior changes by Chao and colleagues (2008), participants were likely to initiate taking medications/vitamins and change their lifestyle (e.g., changes in diet or exercise). A more recent investigation reported that cognitive stimulation was the most frequent behavior to be adopted among persons with MCI (Morgan, Garand, & Lingler, 2012). Lin et al. (2012) also found that the participants highly engaged in dementia prevention behaviors such as mental stimulation

and physical exercise. Although illness perceptions may affect one's initiation or maintenance of behaviors for managing health threats (Leventhal et al., 2003), as described above, such an association, illness perceptions and self-management behaviors, has not been investigated in the context of MCI. This fact highlights the compelling need for researchers to identify such association among persons with MCI.

1.3 Significance

The significance of modifiable factors for early detection and prevention of late-life chronic disorders has led to increasing focus on individuals' own beliefs on the illness and their self-management strategies. As demonstrated in Background section, above, despite the need for understanding one's illness perceptions depending on the disease characteristics (physical vs. mental health), significant gaps remain as there has been no research on differences and similarities of illness perceptions between physical [T2DM] and mental [MCI] disorders. Building on previous research on chronic disorders, there is also a need to examine illness perceptions and self-management behaviors because those behaviors may differ by the characteristics of the disorder and individuals' own beliefs as threat to health. In response to the NINR's Strategic Plan focus "Self-Management: Improving Quality of Life for Individuals with Chronic Illness", I propose to identify the individual's illness perceptions and its associations with self-efficacy and self-management using secondary analyses of existing two NIH-funded datasets to establish the groundwork for either future research or clinical practice.

This theory-driven proposed study is significant because of its potential to guide the conduct of future research, including the development of interventions aiming at promoting appropriate self-management behaviors for persons with chronic disorders. In addition to this, our findings may also inform clinical practice as health care professionals may appropriately incorporate individuals' patterns of illness perceptions and self-management behaviors into clinical evaluation.

1.4 Innovation

As the field of chronic disorder research moves toward identifying secondary prevention strategies, the timing of this proposed study corresponds to this movement because persons with T2DM and those with MCI will represent key targets for treatments to delay or stop disease progression. Using several novel and innovative methodological approaches, I will identify an individual's illness perceptions and self-management, including self-efficacy, which are potential key factors in developing effective interventions. First, I will use two quantitative data from T2DM and MCI participants ages 50 and older, which will provide information on clinical and public health practices for persons from late-life physical and mental disorder groups into research. **To my knowledge, this proposed study is the first investigation to compare illness perceptions of two common late-life chronic disorders. The exemplar conditions we have identified, T2DM and MCI, are both receiving substantial attention as prevalent and growing late-life physical and mental health conditions.** In addition to this, an innovative way to categorize the attributions of MCI etiology (See Methods section in Aim 1) will allow us to group individuals' beliefs into two categories, potentially uncontrollable or controllable factors. The novelty of the proposed study is the plan to apply findings from this approach to help comprehensive understanding of illness perceptions and how these perceptions are associated with self-efficacy and self-management, which may be useful for designing educational and intervention programs.

1.5 Preliminary Studies

My first exposure to research on late-life chronic disorder was as a student in the Masters of Science in Nursing and certificate for gerontological nurse practitioner programs in Korea. During that time, I served as a research assistant and began to understand older adults' chronic health conditions, with a particular emphasis on mental health issues such as MCI and AD. I published my thesis project titled, "A study of cognitive impairment, knowledge, and attitudes about Alzheimer's disease among community-dwelling older adults in Korea."

Kim, H. & Jung, D. (2015). A study of cognitive impairment, knowledge and attitudes about Alzheimer's disease among community-dwelling older adults in Korea. *The Korean Gerontological Society, 35*(3), 731-743.

As a preliminary work, this study examined over 200 community-dwelling older adults and described basic knowledge and perceptions about AD in older adults who have not been diagnosed with cognitive impairment. Through my mentor's funded grants, I remained actively involved in various research projects on the older population and recently co-authored a publication in *Geriatric Nursing.*

Jung, D., Byun, J., Lee, M., & **Kim, H.** (2017). Psychometric testing of Korean versions of self-efficacy and outcome expectations for restorative care activities scales. *Geriatric Nursing, 38*(3), 207-212.

Building on those research experiences, I have actively participated in research projects as a graduate student researcher (GSR) at the University of Pittsburgh Health Policy Institute and School of Nursing since 2016. Under the grant from the Stern Center for Evidence-based Policy (PI: James), *Health Policy Related to Informal Caregiving,* with a focus on translation from research to practice to policy, I performed literature reviews using a systematic review software

DistillerSR, and actively worked with other groups, including collaborations with database analysis and policy modeling groups to examine the effect of integrating informal caregivers into discharge planning on resource use in older adults. This experience brought interdisciplinary researchers together in pursuit of common goals and have provided valuable research training opportunities outside the School of Nursing. Working as a GSR for Dr. Jennifer Lingler's grant from the National Institutes of Health (NIH) National Institute on Aging (NIA) (R01-AG046906), *Return of Amyloid Imaging Research Results in MCI,* not only supports by own personal interest in illness perceptions and self-management, but provides me with conceptual and methodological skills that will be applied in the proposed study. Working as a GSR with the MCI population fits into my own research. Our work was recently presented at an international conference in San Francisco, California.

Lingler, J. H., Hu, L., **Kim, H.,** Mattos, M., & Morris, J. (2017, July). *How do Patients with Mild Cognitive Impairment and Their Care Partners Perceive the Potential Utility of PET Amyloid Imaging?* Poster presentation at the 21st International Association of Gerontology and Geriatrics World Congress, San Francisco, CA.

The manuscript of this qualitative work examining motivations for, and perceived drawbacks of, amyloid imaging among 30 MCI care dyads (persons with MCI + their care partners) is currently under review.

Lingler, J. H., Roberts, J. S., **Kim, H.,** Morris, J., Lu, H., Mattos, M., McDade, E., & Lopez, O. L. (2018 under review). Decisions regarding amyloid imaging among scan candidates with mild cognitive impairment.

As an assignment in my doctoral-level course, *Research Instrumentation,* I tested the psychometric properties of *the Health Behavior Assessment* for persons with MCI using Dr.

Lingler's dataset (R01-AG046906) and my results were presented as *Correlates of Health Behaviors among Persons with Mild Cognitive Impairment* at the 28th Greater Pittsburgh Nursing Research Conference.

Kim, H. & Lingler, J. H. (2016, October). *Correlates of Health Behaviors among Persons with Mild Cognitive Impairment.* Oral presentation at the 28th Greater Pittsburgh Nursing Research Conference, Pittsburgh, PA.

To extend this line of work, I received internal research funding from the University of Pittsburgh School of Nursing, *Judith A. Erlen Nursing PhD Student Research Award*, to support my planned dissertation study on illness perceptions and self-management behaviors among persons with MCI.

To obtain the data for Aims 2 and 3 of the proposed study, I contacted Dr. Catherine Bender, a co-principal investigator (PI) of the Habit Study, and she provided the requested data (P01 NR010949). I have already screened these data through Dr. Susan Sereika's PhD-level advanced statistics course, *Advanced Quantitative Methods for Health Science Research,* gained a better understanding of the essential body of knowledge on T2DM, and established the feasibility of the proposed study. This work is recently accepted for presentation at a regional conference in Newark, New Jersey.

Kim, H., Sereika, S. M., & Bender, C. M. (2018, April). *Illness Perceptions for Persons with Type 2 Diabetes: Associations with Health Outcomes*. Poster presentation at the 30th Annual Scientific Sessions of the Eastern Nursing Research Society, Newark, NJ.

Taken together, my research experiences and training have provided me with the core competencies and knowledge, and allowed me to solidify the groundwork to conduct the proposed study. This proposed study expands my research efforts, in particular, my recently funded research on illness perceptions and self-management behaviors among persons with MCI.

1.6 Research Design and Methods

I will conduct secondary analyses to examine illness perceptions and self-management in late-life chronic disorders, specifically MCI and T2DM, as these conditions represent common examples of largely mental (MCI) and physical (T2DM) disorders affecting older adults. Cross-sectional data from a cohort of individuals with MCI (P50-AG005133), and baseline data from two NIH-supported clinical trials, the Result Study (R01-AG046906) and the Habit Study (P01-NR010949), will be used.

1.6.1 Manuscript 1

Common Late-life Mental Disorder: MCI

Aim 1: To examine the association between illness perceptions and self-management among persons with MCI.

Design. A quantitative, cross-sectional, and descriptive study of illness perceptions and self-management in MCI will be conducted (see Figure 2). I will combine two datasets to form a cohort of at least 130 persons with MCI. One set of data was collected as part of a study examining how persons with MCI and their care partners make sense of their memory problems and diagnosis. The other set of data (R01-AG046906) was collected as part of NIH-funded clinical trial, the Result Study, which was designed to determine the effect of receiving brain amyloid imaging research results on the understanding of MCI as a potential precursor to dementia. For the Result Study, only baseline data will be used for the proposed study.

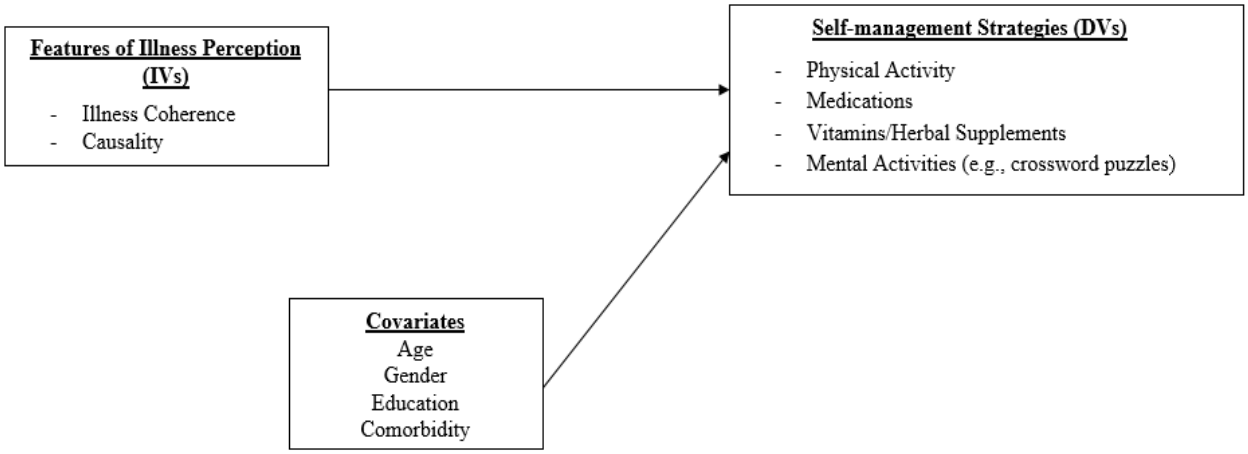

Figure 2. Conceptual Framework (Aim 1) Adapted from Levental et al. (2003)

Sample and Setting. For the first dataset, a total of 63 persons with MCI were referred to the parent study by staff from the University of Pittsburgh Alzheimer's Disease Research Center (ADRC; P50-AG005133). Of those, 3 (4.8%) individuals declined, and the remaining 60 (95.2%) MCI participants provided written informed consent to this parent study. The second sample will be used from the Result Study dataset (R01-AG046906) and was also recruited from the ADRC and included written informed consent. The data collection of the Result Study is ongoing; however, I will include at least the 70 participants who are currently enrolled. In both studies, persons with MCI were included if they a) are ≥ 50 years of age; b) had an ADRC consensus diagnosis of MCI; c) reside within 50 miles of the University of Pittsburgh; d) have a care partner (family member or kin-like friend); and e) provided written informed consent to participate. Exclusion criteria for both studies were a) being medically unstable individuals and b) having evidence of active, untreated primary psychiatric disorders (e.g., depression, anxiety disorder). While those parent studies also included care partners of the MCI participants (e.g., family members, kin-like friends), **I will include only persons with MCI in the proposed analysis.**

Measures. Data describing the sample characteristics will be abstracted from each consenting person's ADRC record. These data included basic sociodemographic (e.g., age, sex, race, level of education) and clinical (e.g., MCI subtype, duration of diagnosis) information, each participant's cognitive function, and depressive symptomatology. Aim 1 key variables are described below with citations providing psychometric property evidence. See Appendix A for the copies of each measure which I will use for this proposed study.

Key Variables.

Illness Perceptions. The illness coherence component of illness perceptions will be measured using the illness coherence subscale of the Revised Illness Perception Questionnaire (IPQ-R) (Moss-Morris et al., 2002). In both parent studies, this subscale was adapted for administration to persons with MCI and assessed perceived ambiguity concerning the meaning of MCI, contains 5 items, each rated on a 5-point Likert scale (strongly disagree [1] to strongly agree [5]) and summed to provide an overall rating. As recommended by Moss-Morris et al. (2002), the general IPQ-R phrasing, "my illness" was replaced with condition-specific terminology, "my memory or thinking difficulties" in the parent studies. Cronbach's alpha for the coherence construct was .821 within this sample of persons with MCI (Lingler et al., 2016).

In terms of the causality component of illness perceptions, participants were asked to list in rank order the three most important factors that they believe caused their memory or thinking difficulties. Of those three ranked factors, I will use the first ranked factor to examine the association between causality component and self-management behaviors. The categorization approach developed by Anderson, McCaul, and Langley (2011) will be adapted to describe attributions of MCI etiology either as potentially controllable or uncontrollable factors. While a study by Anderson and colleagues (2011) grouped the responses into 10 categories (e.g., lifestyle,

heredity/genetics, mental inactivity, aging, brain dysfunction, other medical problems, environment, stress), I will use two broader categories, either as potentially controllable or uncontrollable factors. Potentially controllable factors will be included such as stress, diet habits, overwork, alcohol, and smoking. Uncontrollable factors will be included such as aging, heredity, and personality.

MCI-related Self-management Behaviors. In the first parent study, self-management behavior data were collected in two ways: chart review at the ADRC (to identify clinical recommendations made at the time of diagnosis) and by asking participants to self-report self-management behaviors that were initiated following the MCI diagnosis. In the proposed study, both of these data sources will be used and self-management behavior data will be manually recoded by the PI and undergraduate student research assistants to address the items assessed by the Risk Evaluation and Education for Alzheimer's disease (REVEAL) Health Behavior measure (Chao et al., 2008), which was the self-management behavior measure in the second parent study, the Result Study. The original REVEAL Health Behavior measure consists of eight items, which are "Yes (1)" or "No (0)" choices related to changes made specifically for the purpose of AD prevention (e.g., diet, physical activity, medications). First, of those eight items, I will use the nominal-scaled (Yes [1] or No [0]) five self-management behaviors - physical activity, medications, vitamins, herbal supplements, and mental activities. Of those five, vitamins and herbal supplements will be treated as one category. Therefore, the final MCI-related self-management behavior items in this proposed study will focus on: 1) physical activity, 2) medications, 3) vitamins/herbal supplements, and 4) mental activities (e.g., crossword puzzles, luminosity) with "Yes (1)" or "No (0)" choices for each item. Next, the ratio-scaled self-management behaviors will be also used to count the total number of performing MCI-related health behaviors using none (0) to all (4) scaling.

Sociodemographic Factors. Sociodemographic information, including age (in years), gender (male or female), race (white or non-white), education (less than 12 years or 12 or more years of education), and marital status (married or not married) will be extracted from the ADRC records.

Clinical Factors. Duration of MCI symptoms and diagnosis (in months), MCI type (amnestic or non-amnestic), and the number of comorbid conditions will be abstracted from the participants' ADRC record. To characterize each participant's global cognitive status and level of depressive symptomatology, the total score of the Mini-Mental State Examination (MMSE) (Folstein, Folstein, & McHugh, 1975) and the Hamilton Rating Scale for Depression (HAM-D or HRSD) (Hamilton, 1960) will be also retrieved from the participants' last annual ADRC visit records (corresponding most closely to the date of illness perception and self-management behavior data collection). The MMSE is a 30-point measure that assesses five areas of cognitive function. A score of greater than or equal to 24 points indicates a normal cognition. Cronbach's alpha for the MMSE ranges from 0.62 to 0.81 in samples of older adults (Kabátová, Puteková, Martinková, & Súkenníková, 2016; Tombaugh, McDowell, Kristjansson, & Hubley, 1996) and demonstrated good concurrent and construct validity (McPherson, Berry, & Pentland, 1997; Razani et al., 2009). The HRSD consists of 21 items, but the scoring is based upon the first 17. Eight items are scored on a 5-point Likert scale, ranging from 0 to 4 and nine items are scored on a 3-point scale from 0 to 2. Cronbach's alpha for the 17-item HAM-D has reported at 0.83 in a sample of persons with chronic major depression (Rush et al., 2003) and validity ranges from 0.65 to 0.90 with global measures of depression severity (Pincus, Rush, First, & McQueen, 2000).

Procedure. In both parent studies, trained research assistants conducted face-to-face interviews, rather than self-administered report, in a private location (participants' home or private room at the ADRC). For this proposed study, inter-rater reliability of the causality component of illness

perceptions will be accomplished. The causality component will be categorized into two domains, potentially controllable or uncontrollable factors. Two trained researchers will code and enter the data separately, and then, inter-rater reliability of the coded data, representing the extent to which the level of agreement between raters, will be assessed. To confirm whether the raters yield a high agreement of the each of the causality items, Cohen's kappa coefficient (κ), a statistical measure of inter-rater reliability for qualitative (categorical) items, will be used. Values for kappa over 0.75 will be considered as excellent agreement between two raters (Fleiss, Cohen, & Everitt, 1969). Similarly, as described above, self-management behavior data from the parent studies will be coded in two ways, 1) coded as each of self-management behaviors, and 2) a total number of self-management behaviors, depending on our analytic purpose. Data will be stored in locked filing cabinets at the University of Pittsburgh School of Nursing and access will be limited to users whose rights have been designated by the PI.

Data Analysis Plan for Aim 1. Prior to analysis, all data will be screened using descriptive and exploratory data analysis methods. The ranges for each of the variables will be checked to identify whether the values are within the possible range of responses. Based on the variable's level of measurement and observed data distribution, appropriate descriptive statistics will be computed to characterize the total sample. Nominal variables, including gender, race, level of education, marital status, and MCI type, will be summarized using modes, frequency counts (n), and percentages (%). For highly ordinal and approximate interval scaled variables, mean and standard deviation (SD) will be calculated. These variables include the participants' total scores for the MMSE, HRSD, and illness coherence subscale of the IPQ-R. In addition to those descriptive statistics, mean, SD, range, and minimum/maximum values will be computed for ratio-scaled variables such as age and the number of comorbid conditions. If the interval and ratio-scaled variables are non-normally

distributed, median and semi-quartile range (SQR) (or inter-quartile range [IQR]) will be also computed as an alternative to mean and SD. The amount and pattern of missing data will be explored and an appropriate imputation strategy (e.g., stochastic regression, multiple imputation) will be performed. Cases with standardized scores (z-scores) exceeding the absolute value of 3.29 ($p < .001$, two-tailed test) will be considered as potential univariate outliers. In addition to inspection of z-scores, histograms, box plots, and normal probability plots will be used to identify univariate outliers. To reduce the influence of outliers, identified univariate outliers from continuous type interval/ratio scaled variables will be transformed to the next highest/lowest (non-outlier) values plus one-unit increment higher/lower. For outliers from categorical variables, I will collapse the sparse categories meaningfully to maintain as much information as possible. Both graphical (box plots) and statistical (Mahalanobis distance) procedures will be used to detect multivariate outliers. Any case with a Mahalanobis distance great than 22.46, which is the critical chi-square (χ^2) value for 6 degrees of freedom (df) at a critical value of .001 (df is based on the number of variables), will be identified as a multivariate outlier. If the outliers are properly part of the intended population, appropriate steps such as score alteration or variable transformation will be taken to reduce their impact. After applying appropriate remedial strategies, I will screen the data again to determine if the amended data are free of outliers. To assess multicollinearity for the independent variables (IVs), the correlation coefficient (r) and the variance inflation factor (VIF) will be estimated. The r will be calculated for each pair of the IVs and if any of the r values is greater than .08, there is a possibility to have multicollinearity between the IVs. I will also check the VIF, which is a more rigorous approach than correlation coefficient. If the VIF goes beyond 10, I will consider data transformation (e.g., centering the variables) to reduce the impact of multicollinearity. Since both logistic and linear regression analyses will be conducted to examine

the association between illness perceptions and self-management behaviors, underlying assumptions will be also checked. The normality of sampling distributions will be assessed by either statistical (skewness and kurtosis) or graphical (frequency histograms, normal probability plots) methods. Box-Tidwell approach (Hosmer & Lemeshow, 1989) will be used to check linearity in the logit for a linear relationship between continuous IVs and the logit transform of the dependent variable (DVs), 1) physical activity, 2) medications, 3) vitamins/herbal supplements, and 4) mental activities when using logistic regression. For linear regression, linearity will be checked through bivariate scatter plots between IVs and the total number of self-management behaviors. If the assumption of linearity is violated (e.g., curvilinear relationship), appropriate data transformation, for example, square of the variables or recoding the variables into dummy variables, will be performed.

To examine the association between two dimensions of illness perceptions (illness coherence and causality) and self-management behaviors, I will perform both logistic and linear regression analyses. First, binary logistic regression will be used to examine the association between the primary IVs (illness coherence and causality) and the DVs, each of the self-management behaviors (physical activity, medications, vitamins/herbal supplements, and mental activities). Based on previous research (Chao et al., 2008) sociodemographic data (age, gender, and education) and the number of comorbid conditions will be included as potential covariates in the analysis. Next, I will perform linear regression to test the association between each primary IV (illness coherence and causality) and DV (a total number of performing self-management behaviors). Potential covariates, sociodemographic information (age, gender, and education) and the number of comorbid conditions, will be also included in this analysis. In addition, since amnestic and non-amnestic MCI have distinct characteristics, using chi-square test of

independence (χ^2) or Fisher's exact test (cells with expected count less than 5), I will compare a total number of performing self-management behaviors between amnestic and non-amnestic MCI groups to identify differences in the magnitude of self-management behaviors as an exploratory purpose. I will also compare a total number of performing self-management behaviors based on illness coherence (high or low groups; the level of illness coherence will be determined based on datasets), and causality (controllable or uncontrollable factors). All analyses will be performed using IBM® SPSS® Statistics (Version 25.0, IBM Corp., Armonk, New York) and hypothesis testing will be two-sided at a significance level of .05.

Sample Size Justification for Aim 1. Precautions are needed to ensure that we have achieved a representative sample of the MCI population, however, the number of participants in this proposed study is fixed since I will use two parent studies. Nevertheless, the fixed sample size of at least 130 participants with MCI will have adequate statistical power to detect meaningful effects. The subject-to-variable ratio should be 10:1 (Nnadi-Okolo, 1990), indicating that the sample size of 130 would allow for as many as 13 predictors in each model. Also, according to Green (1991), at least 110 participants (N 104 + k [the number of IVs]) are needed for a medium effect (R^2= .07; β= .20), suggesting that I have enough sample for Aim 1.

1.6.2 Manuscript 2

Common Late-life Physical Disorder: T2DM

Aim 2: To determine the associations between illness perceptions and a) self-efficacy, and b) medication adherence among persons with T2DM.

Design. Using a secondary data analysis, a quantitative, cross-sectional, and descriptive study of illness perceptions, self-efficacy, and medication adherence among persons with T2DM will be conducted (see Figure 3). I will use baseline data from the Habit Study, which was one of the NINR-funded P01 projects (P01-NR010949) examining a habit-training (routinization) intervention to improve medication adherence in adults with T2DM. The long-term goal of this parent study was to develop a simple and cost-effective intervention that promotes both medication adherence and health outcomes (e.g., health-related quality of life), and effectively translates to clinical practice.

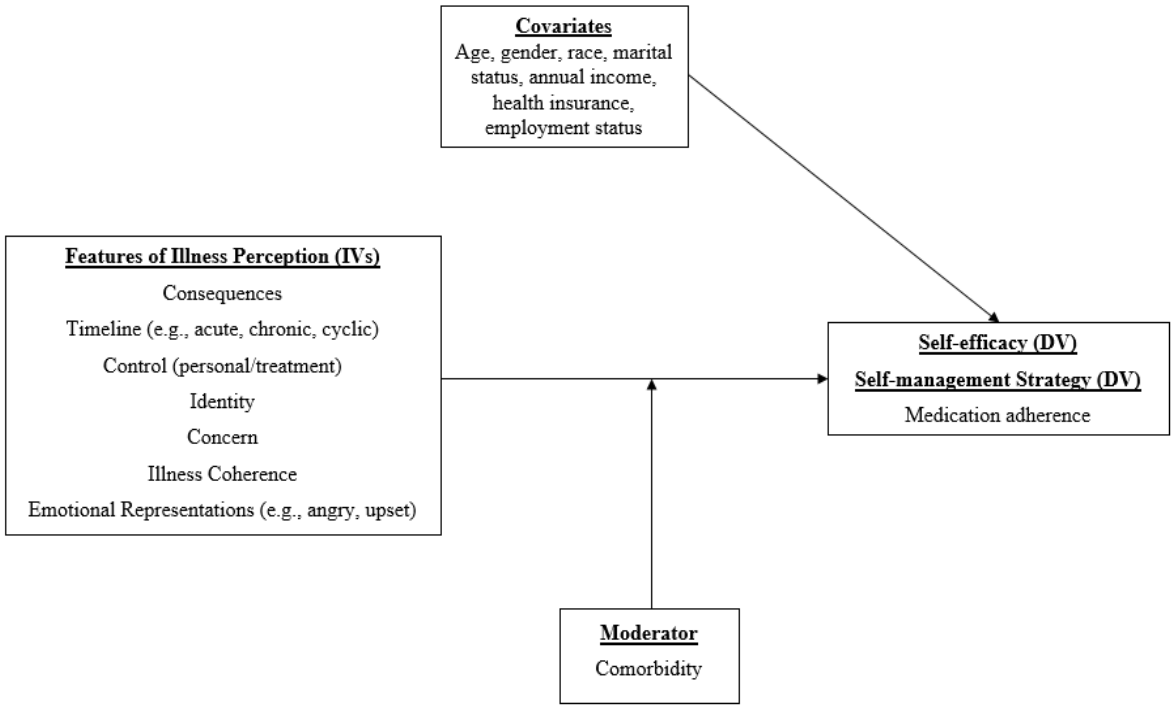

Figure 3. Conceptual Framework (Aim 2) Adapted from Leventhal et al. (2003)

Sample and Setting. The Habit Study comprised a sample of 167 adults aged 40 years and older who are in treatment for T2DM with hypertension and/or hypercholesterolemia from outpatient clinical practice sites within the University of Pittsburgh Medical Center (UPMC) Health System. The following criteria were used to determine subject eligibility for the parent study. 1) being at least 40 years of age; 2) taking one or more medications prescribed by a physician; 3) self-managing their medications; 4) being an English speaker, and 5) having access to a telephone. Exclusion criteria for the parent study were 1) having medications managed by others; 2) being unable or unwilling to use a medication diary or electronic event monitor; and 3) participating in other intervention research. **Since I will focus on "late-life" chronic disorders, participants who are younger than 50 years of age (n = 20) will be excluded from this proposed study. Except for this age restriction, there are no additional inclusion and exclusion criteria for Aim 2.**

Measures. The self-reported battery of questionnaires was comprised of the parent study measures. Sociodemographic information (e.g., age, sex, marital status), clinical characteristics (e.g., number and type of comorbid conditions), and primary independent (each domain of illness perceptions) and dependent (self-efficacy and medication adherence) variables will be included in this proposed study. Key measures for Aim 2 are described below, along with citations providing evidence of their psychometric properties. Copies of each standardized instrument are included in Appendix A.

Key Variables.

Illness Perceptions. The Brief Illness Perception Questionnaire (Brief IPQ) (Broadbent, Petrie, Main, Weinman, 2006) the modified version of the Illness Perception Questionnaire (IPQ) (Weinman, Petrie, Moss-Morris, & Horne, 1996) and the Illness Perception Questionnaire-Revised (IPQ-R) (Moss-Morris et al., 2002) is comprised of nine items about an individual's perceptions of illness. All items, *consequences, timeline, personal control, treatment control, identity, illness concern, illness coherence, and emotional representations,* except the *causal representation* item, were rated using 0 (not at all) to 10 (extremely) Likert scaling. The last item, *causal representation* item, asks the individuals to list the three most relevant causal factors in their illness, which will be only used for the descriptive purposes in this proposed study for Aim 2 because the item is an open-ended question adapted from the IPQ-R (Moss-Morris et al., 2002). The Brief IPQ, a nine-item questionnaire, is more useful in some situations, for example, when assessing very ill or frail populations, or limited time is allowed for assessment because the Brief IPQ is simple and less time is required so that the individuals can complete the questionnaire more quickly. The Brief IPQ is widely used to investigate in a wider range of chronic disorders such as hypertension (Perez, 2015; Saarti et al., 2016), T2DM (Al-Amer et al., 2016; Martinez et al., 2018), and depression

(Brown et al., 2011). For the Habit Study, the general Brief IPQ phrasing, 'illness', was replaced with 'diabetes' and higher scores in items indicate increases in the dimension measured. The original Brief IPQ has been used to examine the individual's illness perceptions across a number of illnesses and has demonstrated good test-retest reliability and validity (Broadbent et al., 2006).

Self-efficacy. The Self-Efficacy for Managing Chronic Disease (SEMCD) (Lorig, Sobel, Ritter, Laurent, & Hobbs, 2001). I will be used to assess the participants' confidence level in completing tasks or activities for managing T2DM. This scale consists of six items and each of items are rated on a 10-point scale ranging from 1 (not at all confident) to 10 (totally confident), with higher scores reflecting higher levels of self-efficacy. The term, 'your illness' was replaced with 'your diabetes' in the parent study to capture the participants' self-efficacy for managing their T2DM. Respondents are asked to rate their confidence to manage 1) their fatigue; 2) physical discomfort or pain; 3) emotional distress; and 4) any other symptoms or health problems, and confidence to do 5) tasks and activities for managing the health conditions to reduce the need to see a doctor, and 6) things to other than just taking medications. The summary score for the scale is the mean of the six items and if more than two items are missing, the summary score is considered as missing (Lorig et al., 2001). The SEMCD has demonstrated good internal consistency reliability, with Cronbach alpha ranges from 0.87 to 0.93 in samples of various chronic conditions (Freund, Gensichen, Goetz, Szecsenyi, & Mahler, 2013; Lorig et al., 2001; Ritter & Lorig, 2014).

Medication Adherence. The 4-item Morisky Medication Adherence Scale (MMAS-4) (Morisky, Green, & Levine, 1986) is a generic self-reported, medication-taking behavior scale with all items having dichotomous response choices (Yes [0] or No [1]). The MMAS-4 is simple to administer and widely used to identify barriers to medication adherence. The MMAS-4 has been validated in a broad range of chronic disorders (Elm et al., 2007; Morisky et al., 1986; Toll, McKee, Martin,

Jatlow, & O'Malley, 2007). While the original items are summed to give a range of scores from 0 to 4 with lower scores meaning better medication adherence, I will reverse the scores of the items, such that higher total scores indicate better adherence to medication in this proposed study. The first two items, forgetfulness and carelessness, are related to the unintentional non-adherence to medication. The last two items, stopping medication taking when feeling better or worse, are assessing the intentional medication non-adherence. The internal consistency of the MMAS-4 showed Cronbach's alpha of 0.61 (Morisky et al., 1986).

Sociodemographic and Clinical Factors. Self-reported baseline data on sociodemographic information, including age (in years), gender (male or female), marital status (married or not married), level of education (< 12 years or ≥ 12 years of education), employment status (working, retired, or not working), annual income (under $20,000, $20,000 to $39,999, $40,000 to $59,999, $60,000 to $ 79,999, or ≥ $80,000), health insurance (yes or no), and ethnicity/racial background (Caucasian, African-American, or Asian), will be used for this proposed study. While information on the number of comorbid conditions will be used to investigate its potential moderating roles of illness perceptions, self-efficacy, and medication adherence, type of comorbid conditions will be only used for the descriptive purposes.

Data Analysis Plan for Aim 2. Data will be analyzed using SPSS® Statistics Version 25.0 (IBM Corp., Armonk, New York). Prior to analysis for Aim 2, as described in the "Data Analysis Plan for Aim 1", all data for Aim 2 will be screened for anomalies (e.g., outliers, missing data, violations of statistical assumptions) using descriptive and exploratory data analysis methods. Based on the variable's level of measurement and observed data distribution, appropriate descriptive statistics (means with SDs for normally distributed ratio/interval variables, medians with IQRs for non-normally distributed ratio/interval variables and ordinal variables, and modes with ranges and

frequencies with percentages for nominal variables) will be used to characterize the total sample. The amount and pattern of missing data will be explored. Depending on the mechanisms of missing data (e.g., missing completely at random [MCAR], missing at random [MAR], missing not at random or nonignorable missingness [NMAR]), appropriate strategies will be used for dealing with missing data. For example, missing data due to non-response, stochastic regression approach will be considered based on other variables as predictor variables. One participant (0.68%) from the Habit Study will be excluded from the analysis because this participant did not answer any of the Brief IPQ questionnaire items. Univariate and multivariate outliers will be screened. Identified potential outliers will also be treated as described in Aim 1. See "Data Analysis Plan for Aim 1" section for detailed methods of outlier detection and handling in analysis for Aim 2. Key assumptions of linear regression, such as linear relationships between IVs and DVs, normality, and homoscedasticity of the model residuals, and no serious multicollinearity, will be also checked using statistical and/or graphical methods. If linearity is violated, I will consider applying nonlinear transformations such adding higher-order terms of the regressors (e.g., IV^2) or log transformations to either the IVs (each dimension of illness perceptions) and/or DVs (self-efficacy and medication adherence). The bivariate (Pearson's *r*) correlations will be computed to see whether a statistically significant linear relationship exists between the potential covariate/confounding variables (age, gender, level of education, race, marital status, annual income, health insurance, and employment status) and the IVs (each domain of illness perceptions). As described in Data Analysis Plan for Aim 1, if the relationship is nonlinear, either transformations or recoding into dummy variables will be considered to enhance linearity. The potential moderating variable (the number of comorbid conditions) will be incorporated into the models both individually and collectively. Model assessment (residual analysis and assessment of potential influential observations in terms

of estimation of predicted values, regression coefficients, and standard errors for regression coefficients) will be performed for all fitted models.

Using hierarchical linear regression, I will investigate the associations between illness perceptions, self-efficacy for managing T2DM, and medication adherence, where the level of statistical significance is set at .05 for two-sided hypothesis testing. More precisely, a hierarchical multiple linear regression analysis will be performed, while controlling for age, level of education, race, marital status, annual income, health insurance, and employment status, to limit possible confounding. The hierarchical expansion of regression models will include the main effect of the number of comorbid conditions and the interactions of each of the primary IVs (each dimension of illness perceptions) with the possible moderating variable (the number of comorbid conditions) because comorbidity might have interaction or modifying effects on self-management behaviors in late-life chronic disorders (Chao et al., 2008; Schuz, Wolff, Warner, Ziegelmann, & Wurm, 2014). This will be conducted in such a way that four successive linear regression models are estimated for each of the DVs based on the literature review and the thorough screening of the data. In first block, a model with only covariates or confounders (age, education, race, marital status, annual income, health insurance, and employment status) will be estimated. In second block, the primary IVs (each dimension of illness perceptions) will be added, and in third block, I will add the possible moderating variable (the number of comorbid conditions). In the final model, interaction terms between primary IVs (each dimension of illness perceptions) and the possible moderating variable (the number of comorbid conditions) will be added to assess interaction on the DVs, self-efficacy for managing T2DM and medication adherence. The change in R^2 will be produced using F-test at each block which allows to see the increase in variance accounted for when the next block is added. The zero-order correlation, the partial correlation, and the part

correlation between IVs (each domain of illness perceptions) and DV (self-efficacy and medication adherence) will be also estimated to see if there are any associations between each IV and the DV which are not explained by the other predictors in the model.

Sample Size Justification for Aim 2. Although the number of sample size is fixed (N = 147) for Aim 2, this proposed study has the sufficient sample size and effect size to produce the reliable research results. Based on previous research (Green, 1991; Nnadi-Okolo, 1990), at least 14 IVs and 119 participants are needed for multiple regression model, indicating that this study will have enough statistical power to detect significant effects.

1.6.3 Manuscript 3

Mental and Physical Disorders in Late-life: MCI and T2DM

Aim 3: To identify similarities and differences in illness perceptions between MCI and T2DM, as common examples of late-life mental and physical disorders.

Design. To identify similarities and differences of illness perceptions in persons with MCI and those with T2DM, a quantitative, cross-sectional, and descriptive study of illness perceptions in these two chronic disorder populations will be conducted (see Figure 4). I will use existing baseline data from two research studies, the Result Study and the Habit Study. The purpose of the first parent study for Aim 3, the Result Study, was to examine benefits and burdens of receiving brain amyloid scan among persons with MCI. The second parent study, the Habit Study, was conducted to test the effects of a 12-month intervention on medication adherence and health outcomes among persons with T2DM. Using secondary analysis of existing data may have some limitations. Chief among such limitations of this proposed study is that the data were not collected for all individuals with late-life physical and mental disorders, and for all geographic regions of interest, indicating that our sample may not represent a whole chronic disorder population. However, these two NIH-funded parent studies provide the opportunity to examine illness perceptions of two common late-life chronic disorders with standardized measurements, which were assessed by trained research personnel.

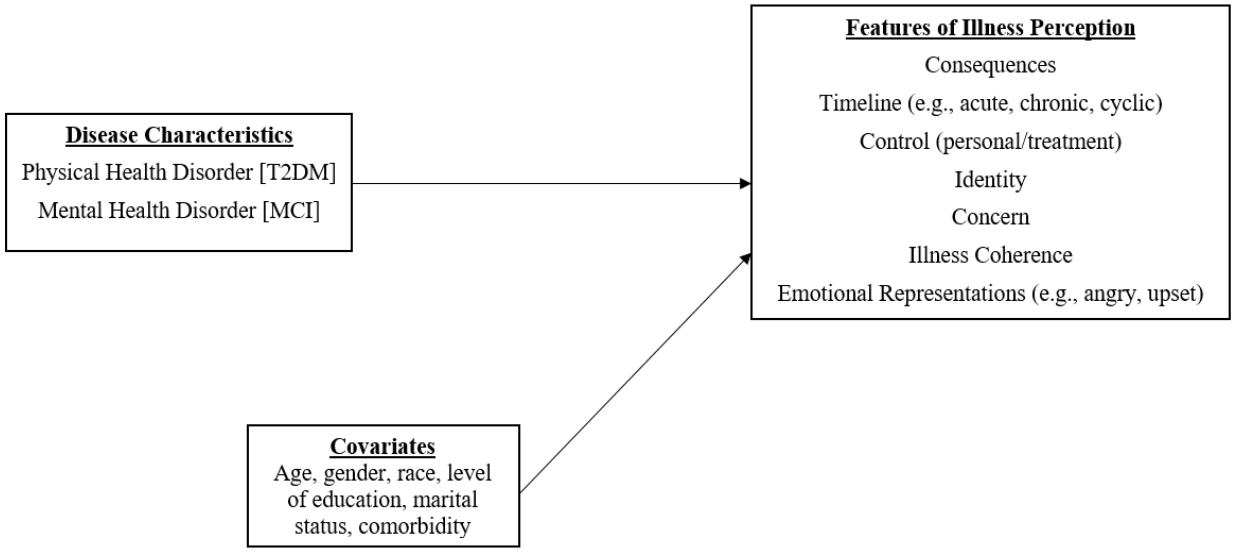

Figure 4. Conceptual Framework (Aim 3) Adapted from Leventhal et al. (2003)

Sample and Setting. The first sample of this proposed study for Aim 3, will be extracted from the Result Study (R01-AG046906). The Result Study recruited persons with MCI and their care partners in collaboration with the University of Pittsburgh ADRC (P50-AG005133) and Advanced Center for Intervention and Services Research for Late-life Mood Disorders. See "Sample and Setting" section in Aim 1 for detailed inclusion and exclusion criteria for the Result Study. Although the first parent study also recruited the MCI participant's care partner to examine the effect of receiving amyloid imaging research results at the dyadic level, **I will only include persons with MCI, not their care partners. Except for this selection criterion, there are no additional inclusion and exclusion criteria for the sample of the Result Study for Aim 3.**

The data for the second sample of Aim 3 will be obtained from the Habit Study (P01-NR010949), a randomized controlled trial designed to improve medication adherence among persons with T2DM. See "Sample and Setting" section in Aim 2 for detailed inclusion and exclusion criteria for the Habit Study. As described in the methods to address Aim 2, **participants**

who are younger than 50 years of age will be excluded from this analysis since I will focus on late-life (≥ 50 years of age) chronic disorders. Except for this selection criterion, there are no additional inclusion and exclusion criteria for the sample of the Habit Study for Aim 3.

Measures. All data for Aim 3 of the proposed study will be obtained from two parent studies, the Result Study and the Habit Study. While baseline data of the Result Study were collected by trained research assistants using a face-to-face interview in participants' home or the ADRC, data of the Habit Study were obtained using a self-administered battery of questionnaires. Only sociodemographic and clinical information for the first parent study (Result Study) were abstracted from each participant's ADRC record to reduce participant burden. A detailed description of Aim 3 key variables is provided below. See Appendix A for the copies of each instrument.

Key Variables.

Illness Perceptions. The Brief IPQ (Broadbent et al., 2006) will be used to assess illness perceptions of MCI and T2DM. A detailed description of the Brief IPQ measure is provided in the "Measures" section in Aim 2. The Brief IPQ consists of nine items, *consequences, timeline, personal control, treatment control, identity, illness concern, illness coherence, emotional representations, and causal representation,* each rated on an 11-point (0 to 10) Likert scale except the *causal representation* item, which is an open-ended question. Since the original version of the Brief IPQ can be modified to assess unique characteristics of the illness and its symptoms, the term 'illness' was replaced with 'my memory or thinking difficulties' and 'diabetes' in the Result Study and the Habit Study, respectively.

Sociodemographic and Clinical Factors. To characterize the first sample, I will obtain baseline data on sociodemographic (e.g., age, sex, marital status, level of education) and clinical (e.g., duration of MCI diagnosis, MCI type, family history of dementia) information of the Result Study

abstracted from the ADRC records. Baseline sociodemographic and clinical information of the Habit Study will be also used to characterize the second sample, which was obtained using standardized sociodemographic and comorbid questionnaires (Sereika & Engberg, 2006) including age, sex, marital status, level of education, employment status, annual income, racial background, and the number of comorbid conditions.

Procedure. For this proposed investigation, the baseline datasets from two parent studies, the Result Study and the Habit Study, will be concatenated to analyze as one dataset based on sociodemographic and clinical factors, and each dimension of illness perceptions. Of the nine items measuring illness perceptions, the causal representation item will be only used for the descriptive purposes, as outlined above in Key Variable section (see Illness Perceptions variable), since the item is an open-ended question.

Data Analysis Plan for Aim 3. Prior to analysis, as described on the "Data Analysis Plan for Aims 1 and 2", each of the datasets from the Result Study and the Habit Study will be screened separately and collectively using the merged dataset to ultimately be used for the analysis (See Data Analysis Plan for Aims 1 and 2" for detailed data screening methods). First, I will split the files by the grouping variable (MCI vs. T2DM) to conduct the data screening. The datasets of Result Study (n = at least 70) and the Habit Study (n = 146) will be separately screened for anomalies using descriptive and exploratory data analysis methods to examine persons with MCI and those with T2DM. Appropriate descriptive statistics will be used to characterize each sample based on the variable's level of measurement and observed data distribution. Missing data will be appropriately handled depending on its mechanisms (e.g., MCAR, MAR, NMAR). Potential outliers will be treated as described in Aim 1. Data transformation (e.g., square root, logarithmic) and/or categorization (dichotomizing, trichotomizing) will be performed as needed. Residual plots and

bivariate scatterplots will be used to ensure the model assessment and display relations graphically. The linear relationships between potential covariates or confounders (sociodemographic variables including age, gender, race, level of education, and marital status, and the number of comorbid conditions) and eight dimensions of illness perceptions will be assessed. Potential covariates or confounders will be also examined for possible associations with the IV (grouping variable; See Data Analysis Plan for Aim 1 for multicollinearity check) and 2) the DVs (each illness perceptions) and if significant associations are found, will be controlled for in the analysis. After combining these two datasets, assumption of homogeneity of regression slopes will be checked whether the relationships between potential covariates or confounders and each separate illness perception is the same in MCI and T2DM groups. Homogeneity of group variance-covariance matrices will be also examined to test whether or not the variances and covariances between MCI group and T2DM group are equal. Group comparisons will be performed for all sociodemographic variables by disease characteristics, MCI and T2DM. Two-sample *t*-tests (for normally distributed variables) or Mann-Whitney U-test (for non-normally distributed variables) will be used for continuous-type variables, and χ^2 test of independence or Fisher's exact test will be used for categorical variables before analyzing DVs, each dimension of illness perceptions

To identify similarities and differences in illness perceptions between MCI and T2DM, I will perform multivariate analysis of covariance (MANCOVA), which is a multivariate generalization of analysis of covariance (ANCOVA), where there are several DVs with potential covariates. Eight dimensions of illness perceptions (consequences, timeline, personal control, treatment control, identity, illness concern, illness coherence, and emotional representations), except the causal representation item, will be included as the set of primary DVs. For the causal representation item, the first ranked response will only be used for the descriptive purposes, since

the item is an open-ended question. Wilks' lambda (λ) test will be performed to see whether illness perceptions are significantly associated with disease characteristics, MCI and T2DM. If there are significant differences are found, univariate ANCOVA will be conducted to determine how the individual illness perceptions differ for disease characteristics. The partial eta-squared (partial η^2) will be also calculated to estimate the effect size for group (MCI vs. T2DM) mean differences. To explore the associations for the individual illness perceptions, the Bonferroni correction will be performed. All analyses will be performed using IBM® SPSS® Statistics (Version 25.0, IBM Corp., Armonk, New York) and the level of statistical significance will be set at .05 for two-sided hypothesis testing.

Sample Size Justification for Aim 3. Since the sample size will be fixed (N = at least 216), we calculated the effect size for Aim 3 rather than estimating the sample size. Using PASS Version 15.0, power and effect size for the two-group were computed and compared with Cohen's guidelines (Cohen, 1988) (0.2: small effect, 0.5: moderate effect, 0.8: large effect). The two-sample Hotelling's T-squared test statistic was used with a significance level of .05. Sample sizes of 146 in T2DM group and 70 in MCI group achieve 77% power to detect an effect size of 0.27 which represents the difference between the group means of the 8 response variables, adjusted by the variance-covariance matrix.

1.7 Potential Limitations and Alternative Approaches

The primary purpose of this proposed study is to examine illness perceptions and self-management behaviors, depending on the disease characteristics, either physical (T2DM) or mental (MCI) health conditions. Although this study is the first theory-based, data-driven examination of late-life physical and mental disorders, there are potential methodological issues associated with study outcomes. First, due to the nature of the secondary analyses of existing data, the datasets, which will be used for this study, were not originally collected to test my research questions. This can be problematic because additional data may be needed for further testing for the aims or research questions. For example, although self-efficacy may play a potential mediating role in the relationship between illness perceptions and self-management behaviors (Bandura, 1977), this proposed study cannot examine the role of self-efficacy because in the Habit Study, self-efficacy was assessed only at baseline. Measurements can be another issue because the parent studies used self-report approaches to measure the participants' self-efficacy and self-management behaviors. Responses may be exaggerated due to social desirability bias, which may affect the results of this proposed study. In addition, the REVEAL Health Behavior measure (Chao et al., 2008) and MMAS-4 (Morisky et al., 1986) are not strong instruments in terms of its psychometric properties, although the instruments are appropriate for capturing MCI or T2DM-related self-management behaviors. These potential issues can be mitigated through close consultation with the PIs of the parent studies, Drs. Lingler and Bender, by delving into the circumstances of the original data generation and processing. For example, to reduce the possible response bias, I will consider to use objective measures such as medication diary or electronic event monitor if possible. Another major issue is that sample which I will use for this study (individuals ages 50 and older) may have more than one chronic disorders because approximately 75% of older adults has multiple

chronic conditions in the United States (Ward, Schiller, & Goodman, 2014). As such, it is possible that they may have multiple illness perceptions regarding their health conditions, but this limitation can be minimized because in both parent studies, the term "my illness" was replaced with "diabetes" or "my memory or thinking difficulties" to capture their specific perceptions on T2DM or MCI. As was shown above, representativeness of the target population should be also considered because the data were not collected for all chronic disorder population and all geographic regions. However, this study is significant and innovative as it can be used to guide the conduct of future research and clinical practice in this field.

Table 1. Flow of Study Activities

Activity	**2-month Periods (Estimated March 2018 to January 2019)**			
	Mar. - May	June - Aug.	Sept. - Nov.	Dec. - Jan.
Obtain IRB approval	**X**			
Hire and train URMP students	**X**	**X**		
Data management & screening	**X**	**X**		
Data Analyses		**X**	**X**	
Dissemination of findings			**X**	**X**

1.8 Publications

Refereed Articles * = Data Based

1. *Jung, D., Lee, K., & **Kim, H.** (2013). The effects of exercise program for bed-ridden dementia elderly adults who resided in nursing home. *Journal of Korean Physical Education Association for Girls and Women, 27*(3), 179-191.
2. *Jung, D., **Kim, H.,** & Byun, J. (2013). A study of knowledge, attitude, and self-efficacy for preventing falls among long-term care facility direct care workers in Korea. *The Korean Journal of Women's Health, 14*(1), 81–96.
3. *Jung, D., Shin, S., & **Kim, H.** (2013). Students' satisfaction on GNP educational program. *Journal of Korean Gerontological Nursing, 16*(1), 1-8.
4. Jung, D., Shin, S., & **Kim, H.** (2014). A fall prevention guideline for older adults living in long-term care facilities. *International Nursing Review, 61*(4), 525-533.
5. ***Kim, H.,** & Jung. D. (2015). A study of cognitive impairment, knowledge and attitudes about Alzheimer's disease among community-dwelling older adults in Korea. *The Korean Gerontological Society, 35*(3), 731-743.
6. *Jung, D., Byun, J., Lee, M., & **Kim, H.** (2017). Psychometric testing of Korean versions of self-efficacy and outcome expectations for restorative care activities scales. *Geriatric Nursing, 38*(3), 207-212.

In Review

1. *Lingler, J. H., Roberts, J. S., **Kim, H.,** Morris, J., Lu, H., Mattos, M., McDade, E., & Lopez, O. L. (2018 under review). Decisions Regarding Amyloid Imaging among Scan Candidates with Mild Cognitive Impairment.

Selected Presentations

1. Jung, D., Ma, Y., & **Kim, H.** (2013, June). *The effects of the evidence-based prevention protocol on fall knowledge, fall attitude, and fall prevention self-esteem of care workers in a long-term care facility.* Poster presentation at the 20th International Association of Gerontology and Geriatrics World Congress of Gerontology and Geriatrics Sessions. Seoul, Korea.
2. Jung, D., Shin, S., & **Kim, H.** (2014, November). *A fall prevention guideline for older adults living in long-term care facilities.* Poster presentation at the Gerontological Society of America's 67th Annual Scientific Meeting Sessions. Washington, DC.
3. Jung, D., **Kim, H.,** & Byun, J. (2015, June). *A study on self-efficacy, outcome expectations, knowledge, and job satisfaction regarding function-focused care among nursing home caregivers in Korea.* Poster presentation at the International Council of Nurses (ICN) 2015 Conference. Seoul, Korea.
4. **Kim, H.,** & Lingler, J. H. (2016, October). *Correlates of health behaviors among persons with mild cognitive impairment.* Oral presentation at the 28th Greater Pittsburgh Nursing Research Conference, Pittsburgh, PA.
5. Lingler, J. H., Hu, L., **Kim, H.,** Mattos, M., & Morris, J. (2017, July). *How do patients with mild cognitive impairment and their care partners perceive the potential utility of PET amyloid imaging?* Poster presentation at the 21st International Association of Gerontology and Geriatrics World Congress, San Francisco, CA.
6. **Kim, H.,** Sereika, S. M., & Bender, C. M. (2018, April). *Illness Perceptions for Persons with Type 2 Diabetes: Associations with Health Outcomes.* Poster presentation at the 30th Annual Scientific Sessions of the Eastern Nursing Research Society, Newark, NJ.

1.9 Research Participant Risk and Protection

The proposed study will be exempted from the U.S. Department of Health and Human Services (HHS) human subject regulations because I will conduct secondary analyses of existing datasets. Ethical approvals for all parent studies were obtained from the University of Pittsburgh Institutional Review Board prior to data collection.

Human Participants Involvement and Characteristics. I will include at least 130 individuals for the first manuscript, 60 individuals from the first dataset and at least 70 from the Result Study (R01 AG046906). All participants of the parent studies were persons with mild cognitive impairment and provided written informed consent before participating in the studies. The following criteria were used to determine subject eligibility for the parent studies.
1) current ADRC consensus diagnosis of MCI; 2) at least 50 years of age; 3) community-dwelling; and 4) have a family member or kin-like friend who also agreed to participate. Individuals were excluded if they have active, untreated primary psychiatric disorders (e.g., major depression, anxiety disorder based on screening with the HAM-D).

While the parent study of the second manuscript, the Habit Study (P01 NR010949), originally included 167 persons with type II diabetes mellitus aged 40 and older, I will include persons aged 50 or above to examine late-life chronic disorder. The following criteria were used to determine subject eligibility for the Habit Study. 1) at least 40 years of age; 2) take one or more medications prescribed by a physician; 3) must be self-managing their medications; and 4) English speaker and have access to a telephone. The last manuscript will combine two datasets, the Result Study and the Habit Study, the above inclusion and exclusion criteria will be applied.

Inclusion of persons with potentially impaired decisional capacity. For the parent studies involving persons with MCI, determinations of capacity to consent to the parent studies were based on a participant's ability to express an understanding the study's purpose, procedures, risks, and benefits during a one on one discussion with a member of the research team (investigator or trained project director).

Sources of Materials. The parent studies will provide all the data necessary for this proposed study. The sources of materials for the parent studies involving persons with MCI are retrieved from REDCap, a web-based system, which provides secure data entry with real-time validation. Permission to extract data from existing databases was obtained from participants during the informed consent process. The Habit Study baseline self-reported data were stored on the secure centralized server and only the PI and the project coordinator of the Habit Study have access to subject identities.

Potential Risks and Benefits of the Proposed Research. The date from the parent studies will remain de-identified for the proposed study so that this study has no direct risks to the participants. However, the findings from this study may suggest a number of avenues for future research. This study may provide an opportunity to persons with late-life chronic disorders to manage their health status more effectively in the future. This may be beneficial for planning purposes.

Procedures for Protection against Risk. Data safety monitoring board was assembled for all of the parent studies and the PI of this proposed study will regularly meet with Drs. Lingler and Bender to ensure the data are properly used and analyzed for scientific inquiry. The investigators of all

parent studies highlighted to participants that study participation is voluntary and will not affect clinical care at UPMC Health System or involvement with the University of Pittsburgh. Study participants were given the opportunity to refuse to participate in the studies. To minimize the risk of breach of confidentiality, unique numeric identifiers were used to each participant of all parent datasets. These files were stored under lock and key and will be accessed only by the PI and the research member. Identities of participants will not be revealed in publications or presentations derived from this project.

Importance of Knowledge to be Gained. Given the dearth of information about illness perceptions and self-management strategies in late-life chronic disorders based on the disease characteristics (physical vs. mental health conditions), the knowledge derived from this study will provide a new understanding of the self-management behaviors associated with one's beliefs on their disease and symptoms. Findings from this proposed study may inform the future development of interventions to improve self-management of late-life chronic disorders in this population.

Inclusion of Women, Minorities and Children. Since almost 50% of our sample is women, we expect an approximately equal representation of men and women. The majority of participants of parent studies were Caucasian, which does reflect the racial and ethnic distribution of older population in Pittsburgh and the surrounding region. No individuals were excluded from participation based on race, gender, or medical conditions like HIV status. This proposed study will exclude children under the age of 18 because the purpose of this research is to examine illness perceptions and self-management strategies among persons with T2DM and MCI aged 50 and

older, which are age-related chronic physical and mental health conditions that do not affect children.

2.0 Manuscript 1: Mild Cognitive Impairment

2.1 Abstract

Purpose: The purpose of this study was to investigate the association between illness perceptions (dimensions of coherence and causality) and self-management behaviors among older adults with mild cognitive impairment (MCI).

Methods: We conducted a cross-sectional study of illness perceptions and self-management behaviors (physical activity, cognitive-enhancing medications, vitamin/herbal supplements, and mental activities) using a secondary analysis of pooled exiting datasets. The coherence and causality subscales of the Revised Illness Perception Questionnaire and the Risk Evaluation and Education for Alzheimer's disease health behavior measure were used. Hierarchical linear and logistic regression analyses were performed while controlling for covariates to examine the associations between illness perceptions and 1) the total number of self-management behaviors, and 2) each self-management behavior, respectively.

Results: Our final sample (N = 144) was on average (±*SD*) 71.9 ± 9.06 years of age and exhibited higher education attainment with a mean 16.7 ± 2.7 years of education. The majority were Caucasian (92.4%) and diagnosed with amnestic MCI (83.3%). While perceptions of coherence (p = .76) and causality (p = .96) were not significant predictors of total number of self-management behaviors, we observed a significant interaction of coherence and sex to total number of self-management behaviors (b = - .089, p = .025) suggesting that higher coherence was associated with performing more self-management behaviors in the female group. An interaction of coherence and years of education was significant to physical activity (OR = .957, 95% CI = [.922, .993]),

indicating that higher coherence of MCI was associated with performing less physical activity and such association was limited to participants who had higher levels of education.

Conclusion: Findings demonstrate that illness perceptions may be important factors for self-management behaviors among older adults with MCI. Health care professionals should take into account unique illness perceptions and sociodemographic characteristics when discussing the symptoms or disease management of older adults with MCI. Future research should examine whether or not other dimensions of illness perception are associated with self-management behaviors.

2.2 Introduction

As the world's older population continues to increase at an unprecedented rate, the corresponding increase in prevalence of cognitive dysfunction in older adults has become a pressing issue. Nearly 6 million people in the United States are living with Alzheimer's disease (AD) (AA, 2019). In addition, mild cognitive impairment (MCI) has received worldwide attention because MCI is considered a potential precursor to AD (Petersen, 2004; Petersen et al., 1999). Persons with MCI experience cognitive changes that are noticeable, yet these changes generally do not affect the individual's ability to perform activities of daily living (Petersen, 2004; Petersen et al., 1999). Considering that many clinical trials have failed to stop or delay AD (Mehta, Jackson, Paul, Shi, & Sabbagh, 2017), new fields of research should develop both pharmacologic and nonpharmacological interventions, which not only may serve as secondary prevention strategies for AD, but also could bring hope to persons with MCI. Fortunately, nationwide efforts are underway to do just this; moreover, experts agree that a combination of pharmacologic and

lifestyle interventions will be required to stabilize and/or reverse the course of MCI (Karssemeijer et al., 2017; Petersen et al., 2018).

Research in other populations suggests that disease management for chronic disorders, which include self-management behaviors, may be influenced by a given individual's perceptions about a given disease and its symptoms (Abubakari, Cousins, Thomas, Sharma, & Naderali, 2016; Hagger, Koch, Chatzisarantis, & Orbell, 2017). Given the subtle nature of MCI symptoms (e.g., cognitive/memory changes that may easily be mistaken for normal cognitive aging), an important research question is whether or not affected individuals would pursue such interventions should they become available.

Illness Perceptions (perceived coherence and causality) in Mild Cognitive Impairment

Receiving a diagnosis of or experiencing a set of symptoms for a particular ailment often leads individuals to form thoughts and feelings about their health condition. One way to conceptualize such thoughts is Leventhal's (2003) *Common Sense Model (CSM) of Self-Regulation,* which is an empirically validated framework that explains the processes by which individuals formulate perceptions of ongoing or future health threats (i.e., illness perceptions), create action plans, and perform self-management behaviors in accordance with their illness perceptions. Five dimensions of illness perceptions, identity (i.e., symptom experiences), consequences (e.g., work, family, and personal relationships), cause, timeline (i.e., acute vs. chronic), and cure/control (i.e., controllability over the disease), were proposed by Leventhal et al. (1984, 2003). Later, coherence (i.e., understandable vs. confusing/unclear), emotional representations (i.e., negative feelings such as anger, anxiety) (Moss-Morris et al., 2002), and concerns (Broadbent et al., 2006) dimensions were added to the illness perceptions model.

In the context of MCI, affected persons certainly possess their own thoughts about their cognitive or memory issues. Indeed, research indicates that two of the aforementioned dimensions of illness perceptions, perceived coherence about and causality of the disease, may be particularly salient in persons with cognitive changes (Lingler et al., 2016; Matchwick, Domone, Leroi, & Simpson, 2014). Regarding coherence, previous research using qualitative methods or small sample sizes, has shown that while there is variability in levels of illness coherence among those diagnosed with MCI, it is not uncommon for such individuals to voice uncertainty about the cognitive changes they are experiencing and what these changes may mean for the future (Lingler et al., 2006). The extent to which having more or less illness coherence impacts the performance of self-management behaviors in MCI is unknown. Regarding the causality of late life cognitive changes, previous studies have shown that older individuals attribute these changes to a wide array of factors, some controllable (e.g., lifestyle) and others uncontrollable (e.g., heredity) (Anderson, McCaul, & Langley, 2011; Rodakowski et al., 2014). Such differences in the perceived causality of cognitive changes may be another important dimension related to intention to perform self-management behaviors for AD prevention (Anderson et al., 2011). Andersen et al. (2011) reported that cognitive healthy older adults believed lifestyle to be the most important factor causing AD and such beliefs were associated with their intention to adopt the behaviors leading to AD prevention. In contrast, individuals with MCI mostly attributed uncontrollable factors (e.g., heredity and normal aging) to cognitive impairment etiology (Rodakowski et al., 2014).

Self-management Behaviors in Mild Cognitive Impairment

Although self-management is a promising strategy to enhance individuals' treatment regimens and quality of life (National Institutes of Health, 2010), research on the actual

performance of such behaviors among persons at risk for AD has shown mixed results. For example, in a study of individuals exhibiting no cognitive complaints but testing positive for an AD risk gene (Chao et al., 2008), participants were likely to either initiate taking medications/vitamins or change their lifestyle (e.g., changes in diet or exercise) for the purpose of AD prevention. In a study of a symptomatic population at risk for AD, cognitive stimulation was the most frequent behavior to be adopted among persons with MCI (Morgan et al., 2012). Similarly, Lin et al. (2012) reported that participants with MCI were readily engaged in the potential dementia prevention behaviors of mental stimulation and physical exercise. Given that the ultimate effectiveness of any such intervention depends upon its potential to reduce health risks in chronic disorders (Grady & Gough, 2014; Tanenbaum et al., 2015), caution is warranted in assuming that if an intervention to alter the course of MCI is identified, then those at risk would engage in the necessary health behaviors to take full advantage of potential benefits of the intervention.

Although unique illness perceptions of individuals—especially perceived coherence about and causality of the disease—may result in following self-management behaviors as describe above, such an association (e.g., illness perception and self-management) has not been investigated in older adults with MCI. Indeed, previous investigations on MCI have explored either illness perceptions of individuals or their health behaviors. Therefore, little is understood about how the beliefs about MCI or its symptoms are associated with self-management behaviors of these individuals. Against this backdrop, the primary purpose of the study described herein was to examine the association between illness perceptions and self-management behaviors among older adults with MCI, while addressing not only perceptions of coherence (i.e., perceived understanding of MCI), but also causality (i.e., perceived cause of MCI).

2.3 Methods

2.3.1 Study Design, Sample, and Setting

Using a secondary analysis of two pooled existing, independent datasets, a quantitative, cross-sectional, and descriptive study of illness perceptions and self-management among persons with MCI was conducted (see Figure 5). One set of data was collected to examine how persons with MCI and their care partners make sense of memory problems and diagnosis of patients (hereafter, referred to as *MCI Perspectives Project [MCIPP]),* and the other set of data was obtained from the *Result Study,* a clinical trial designed to determine the effect of receiving brain amyloid imaging research results on the understanding of MCI (NIH R01-AG046906). For the MCIPP, a total of 63 persons with MCI were referred to the study by staff from the University of Pittsburgh Alzheimer's Disease Research Center (ADRC) (NIH P50-AG005133). Of those, three (4.76%) individuals declined to participate, and the remaining 60 (95.2%) provided written informed consent. For the Result Study, individuals were recruited form the ADRC, and only the baseline data were used for this investigation, which included 90 participants. For the parent studies corresponding to both datasets, persons with MCI were included if they a) were 50 years of age or older, b) had an ADRC consensus diagnosis of MCI; c) resided within 50 miles of the University of Pittsburgh; d) had a care partner (e.g., family member or kin-like friend), and e) were provided written informed consent to participate. Exclusion criteria for both parent studies comprised a) being medically unstable and b) exhibiting evidence of active, untreated primary psychiatric disorders (e.g., depression and anxiety disorder). Although both parent studies included care partners, we excluded them from this analysis and focused on persons with MCI. Both parent studies and this study were approved by the University of Pittsburgh Institutional Review Board.

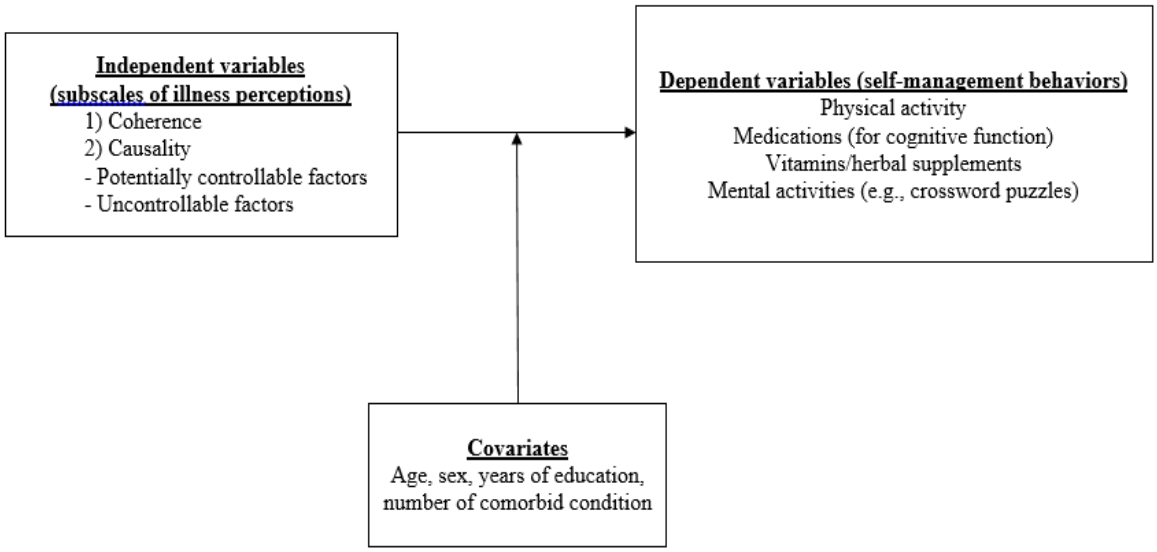

Figure 5. Conceptual Framework (Aim 1) Adapted from Leventhal et al. (2003)

2.3.2 Measures

Illness Perceptions: Coherence and Causality

The coherence component of participant illness perception was measured using the coherence subscale of the Revised Illness Perception Questionnaire (IPQ-R) (Moss-Morris et al., 2002). In both parent studies, this subscale was adapted for administration to persons with MCI. As such, the subscale contained five items, each rated on a 5-point Likert scale (i.e., from *strongly disagree* [1] to *strongly agree* [5]), that assessed perceived understanding about cognitive/memory changes, and the scores from these items were summed to provide an overall rating. For this analysis, the original scores of the first four items were reversed so that higher overall scores indicate a better perceived understanding about MCI. As recommended by Moss-Morris et al. (2002), the general term *my illness* was replaced with the condition-specific term *my memory or thinking difficulties*

in each parent study. The Cronbach's alpha for the coherence construct was .82 for the MCI sample (Lingler et al., 2016) and .87 for our sample, respectively.

In terms of the causality component of illness perception, participants from the parent studies were asked to list, in rank order, the three most important factors that they believed caused their memory or thinking difficulties. Of those three factors, the first ranked factor was used to examine the association between the causality component and self-management behaviors. Although two parent studies used different approaches to assess perceived cause of MCI (i.e., the MCIPP adapted Anderson et al. (2011)'s categorization approach and the Result Study used the original open-ended question), we used two broad categories either as potentially controllable or uncontrollable factors as Rodakowski et al. (2014) categorized the attribution of MCI etiology. Among perceived causes of MCI in the MCIPP, *stress/worry, behaviors, family problems/worries, overwork, alcohol, lifestyle,* and *poor physical/mental health* fell into the potentially "controllable" factors, whereas "uncontrollable" factors included *heredity, germ/virus, poor medical care in the past, normal aging, disease of old age, accident/injury, personality, other medical conditions (e.g., cancer treatment),* and *baseline learning/cognitive deficit.*

MCI-related Self-management Behaviors

In the MCIPP, self-management behavior data were collected by not only the ADRC chart review, but also asking participants to self-management behaviors that were initiated following the MCI diagnosis. These self-management behavior data were independently recoded by the PI (HK) and a research assistant using the items assessed by the Risk Evaluation and Education for Alzheimer's disease (REVEAL) health behavior measure (Chao et al., 2008) which was also the self-management behavior measure in the Result Study. The original REVEAL health behavior

measure consists of eight items, which yielded yes or no response related to changes made for the purpose of AD prevention (e.g., diet, physical activity, and medications). Of those eight items, the five self-management behaviors (i.e., *physical activity, cognitive-enhancing medications, vitamins, herbal supplements,* and *mental activities*) were used, based on the literature review, and vitamins and herbal supplements were treated as one category. The final four MCI-related self-management behavior items deployed were the following: 1) physical activity; 2) cognitive-enhancing medications (i.e., prescribed by a physician); 3) vitamins and/or herbal supplements; and 4) mental activities (e.g., crossword puzzles and Luminosity). Participants responded either *yes* (1) or *no* (0) for each item. Additionally, the ratio-scaled count of self-management behaviors were used yielding a 5-point scale ranging from *none* (0) to *all* (4).

Sociodemographic and Clinical Information

Sociodemographic and clinical information was extracted from ADRC records, which corresponded most closely to the dates of collection of illness perception and self-management behavior data. Sociodemographic data comprised age, sex, race, years of education, and marital status. Clinical information included duration of MCI diagnosis (in months), MCI type (amnestic or non-amnestic), and the number of comorbid conditions. To characterize the global cognitive status of each participant, the total scores of the Mini-Mental State Examination (MMSE) (Folstein et al., 1975) were retrieved from the last annual ADRC visit records for each participant. These MMSE total scores range from 0 to 30, where scores of 24 or greater reflect normal cognition. The Cronbach's alpha for the MMSE ranges from 0.62 to 0.81 in samples of older adults (Kabátová et al., 2016; Tombaugh et al., 1996) and the MMSE features good concurrent and construct validity (McPherson et al., 1997; Razani et al., 2009).

2.3.3 Procedure

In both parent studies, trained research assistants conducted face-to-face interviews in a private location (i.e., in the homes of participants or in a private room at the ADRC) to collect the data. Inter-rater reliability was accomplished for the causality subscale of illness perceptions of the Result Study and the self-management behavior measure of the MCIPP.

To categorize the original open-ended responses of the causality subscale into two broad domains (i.e., potentially controllable and uncontrollable factors), the PI and a trained research assistant coded and entered the Result Study data separately. The inter-rater reliability of all coded data was assessed using Cohen's kappa coefficient (κ) to confirm whether or not the raters achieved high agreement for the original causality responses. Indeed, κ for the causality subscale was 0.91, which indicates an excellent agreement between two raters (Fleiss et al., 1969).

Similarly, self-management behavior data from the MCIPP Study were also coded in the same say. The PI and a trained research assistant reviewed the health behavior questionnaires from the MCIPP and separately recoded each item using the REVEAL health behavior measure (Chao et al., 2008). The κ of each coded health behavior item data ranged from 0.91 to 1, which suggests a strong agreement between the raters. Disagreements between the two raters were resolved via discussion.

2.3.4 Data Analysis

Prior to analysis, we identified six participants (4%) who had participated in both parent studies. Their data were removed from the Result Study because time of data collection of the MCIPP is more relevant to the aims of this study. All data were screened for anomalies (e.g.,

outliers, missing data, and violations of statistical assumptions) using descriptive and exploratory analyses. The datasets from the two parent studies were then pooled to form one dataset, based on the key variables. Commensurate with the level of measurement and observed data distribution of each variable, appropriate descriptive statistics were computed to characterize the total sample (e.g., mean, median, modes, standard deviations [SDs], and interquartile ranges). The amount and pattern of missing data were evaluated, and six participants (4.17%) were identified as missing data for the causality item. Of those six participants, four did not answer the item, one believed that he/she does not have any cognitive issues, and one indicated that his/her memory issues were caused by both potentially controllable (i.e., high cholesterol and diet) and uncontrollable (i.e., previous health history) factors. For incomplete data (2.78%; n = 4), Little's MCAR test was used to assess whether the missingness was completely at random (MCAR) or not. Covariates comprised age, sex, years of education, and the number of comorbid conditions, based on the data screening and our review of the literature (Chao et al., 2008).

Hierarchical linear regression was used to examine the association between each primary independent variable (IV) (i.e., coherence and causality) and the dependent variable (i.e., total number of self-management behaviors) among older adults with MCI, while controlling for covariates. These hierarchical linear regression models were next expanded to include the main effect of the primary IVs and their interactions with each covariate. Specifically, only covariates were entered into the first block. Subsequently, a particular IV, coherence or causality, was added to the second block. In the final block, an interaction term between each IV and each covariate was entered to the model to assess for the possible moderating effect of the covariate on the relationship between a particular IV and the total number of self-management behaviors.

To investigate the association between a particular dimension of illness perception (i.e., coherence or causality) and each self-management behavior (i.e., physical activity, cognitive-enhancing medications, vitamins/herbal supplements, and mental activities), a particular primary IV was entered into hierarchical logistic regression models, while controlling for identified covariates. Similar to how we performed the hierarchical linear regression analyses, only covariates were included in the first block; subsequently, a particular IV (i.e., coherence or causality) was added to the second block. In the final block, interaction terms between a particular IV and each covariate were added to the model. In both our hierarchical linear and logistic regression analyses, mean centering was applied to the variables of age, years of education, and the number of comorbid conditions to minimize multicollinearity between these variables and their interaction terms with the primary IVs. For all fitted models, we conducted residual analysis and assessment of influence diagnostics in terms of (1) the predicted values of potential influential observations, (2) regression coefficients, and (3) the standard errors for regression coefficients. The level of statistical significance for two-tailed hypothesis testing was set at .05, and all analyses were performed using IBM® SPSS® Statistics Version 26.0 (Armonk, NY).

2.4 Results

2.4.1 Sample Characteristics

The data of 144 older adults with MCI were analyzed in this study (see Table 2). In terms of the causality item, data from six of the 144 participants were excluded from our analysis because their answers to the questionnaire were either incomplete (n = 4) or invalid (n = 2). We did not

observe any significant differences in the participants who did not completely fill out the causality item (n = 4) and those who did (n = 138). Therefore, we chose a listwise deletion with a 4.8% sample drop-out rate. Little's MCAR test (x^2= 3.710, *df* = 5, *p* = .592) demonstrated that the missingness of data was completely at random, further supporting the decision to include only those participants who completed the causality item.

Our final sample was on average 71.9 (*SD* = 9.06) years of age and exhibited high levels of education attainment, with an average of 16.7 (*SD* = 2.73) years of education. Over half of the participants were male (58.3%; n = 84) and nearly half were currently married or living as married (47.3%; n = 68). Most were Caucasian (92.4%; n = 133) and diagnosed with amnestic MCI (83.3%; n = 120).

Table 2. Sample Characteristics

(N = 144)

Characteristic	Mean ± SD (Min–Max)	n (%)
Age (years)	71.91 ± 9.06 (50–96)	
Education (years)	16.73 ± 2.73 (12–21)	
Sex		
Female		60 (41.7)
Male		84 (58.3)
Race		
Caucasian		133 (92.4)
African-American		10 (6.9)
Native Hawaiian/Pacific Islander		1 (0.7)
Marital Status		
Currently married		59 (41.0)
Living as married		9 (6.3)
Never married		60 (41.7)
Widowed		12 (8.3)
Separated		1 (0.7)
Divorced		3 (2.1)
Number of Comorbid Conditions (excluding MCI)	1.85 ± 1.27 (0–6)	
MMSE Total Score	27.22 ± 2.00 (20–30)	
Time Since Diagnosis (months)	15.61 ± 24.71 (0–135)	
MCI Type		
Amnestic MCI		120 (83.3)
Non-amnestic MCI		24 (16.7)

Note. SD = standard deviation; Min = minimum; Max = maximum; MCI = mild cognitive impairment; MMSE = Mini-Mental State Examination.

2.4.2 Perceptions of Coherence and Causality in Older Adults with MCI

Table 3 describes illness perceptions of coherence and causality and self-management behaviors (i.e., physical activity, cognitive-enhancing medications, vitamins/herbal supplements, and mental activities) among participants with MCI. Our sample exhibited moderate levels of understanding about MCI with the coherence mean score of 16.04 (*SD* = 4.74), and the majority of participants (82%; n = 118) attributed their cognitive changes to uncontrollable factors. Regarding self-management behaviors, 74% (n = 106) of the participants performed at least one or more self-management behaviors for the purpose of preventing or delaying further cognitive problems. Among these self-management behaviors, mental activities (e.g., crossword puzzles) were the least frequently performed behaviors (60%; n = 87); in contrast, taking vitamins or herbal supplements was the most commonly reported behavior (74%; n = 107).

Our hierarchical multivariate linear regression demonstrates that the association of perceived coherence of MCI with self-management behaviors by itself ($p > .05$) was not statistically significant, after controlling for covariates (i.e., age, sex, years of education, and the number of comorbid conditions). However, we observed some trends and a significant association when the interaction terms were added to the model (see Table 3). We observed a trend for the association between the interaction (i.e., coherence and age) and self-management behaviors ($b = .004$, $p = .053$), which indicates that participants who have higher levels of perceived coherence were likely to perform more self-management behaviors as compared to those with low perceived coherence of MCI, but this association is limited to the older age group. The interaction between coherence and sex was significantly associated with self-management behaviors ($b = -.089$, $p = .025$), which suggests that higher perceived coherence of MCI was related to more performance of self-management behaviors and such association was limited to the female group. As shown in

Table 4, no statistically significant associations were found between the perceived causality of MCI and self-management behaviors through hierarchical multivariate linear regression ($p \geq .05$).

The results of hierarchical multivariate logistic regression for each self-management behavior (i.e., physical activity, cognitive-enhancing medications, vitamin/herbal supplements, and mental activities) are presented in Tables 5 through 8. As indicated by the non-significant Hosmer-Lemeshow test ($p = .480$) (see Table 5), the final model of the relationship between coherence and physical activity showed a good fit of all included variables. Although the perceived coherence of the participants was not a statistically significant factor of any self-management behavior in block 2 ($p \geq .05$), its interaction with years of education generated a statistically significant relationship with physical activity ($p = .02$, odds ratio [OR] = .957, 95% confidence interval [CI] = [.922, .993]) (see Table 5), which suggests that higher perceived coherence of MCI was related to less physical activity for preventing further cognitive changes, but this relationship was limited to participants who had more higher levels of education. We also observed an association trend between physical activity and the interaction (i.e., coherence and age) ($p = .056$, OR = 1.011, 95% CI = [1.000, 1.021]), which indicates that participants who had higher levels of perceived coherence of MCI were likely to perform physical activity compared to those with low perceived coherence, but such trend was limited to the older participants. As indicated in Table 6, the final model of the association between the variables of coherence and vitamins/herbal supplements indicated a good fit of included variables as the Hosmer-Lemeshow test did not yield a statistically significant result ($p = .359$). We observed association trends between taking vitamin/herbal supplements and two interactions, interaction of coherence and age ($p = .083$, OR = 1.009, 95% CI = [.999, 1.018]), and interaction of coherence and sex ($p = .071$, OR = .841, 95% CI = [.697, 1.015]) (see Table 6). Specifically, as compared to participants who had low levels of

coherence of MCI, those with higher levels of coherence of MCI were likely to take vitamins or herbal supplements and this trend was observed in the older participants. We also observed that male participants who had higher levels of coherence of MCI were likely to taking less vitamins or herbal supplements as compared to female participants.

In terms of causality, non-significant *p* values resulting from Hosmer-Lemeshow tests for the final models of cognitive-enhancing medications ($p = .189$) and mental activities ($p = .229$) were indicators of good fit of all included variables (see Table 7 and Table 8). As shown in Table 7 and Table 8, we observed no statistically significant associations between the perceived causality of MCI and any self-management behavior, when the causality variable was entered into each of the hierarchical multivariate logistic regression analyses. However, we did observe an association trend between cognitive-enhancing medications and the interaction (i.e., causality and the number of comorbid conditions) ($p = .081$, OR = .301, 95% CI = [.078, 1.158]) (see Table 7), which indicates that more numbers of comorbid conditions were associated with not taking cognitive-enhancing medications among participants who believed that their cognitive changes were caused by controllable factors. Moreover, as shown in Table 8, we found an association trend between mental activities and the interaction (i.e., perceived causality and the number of comorbid conditions) ($p = .054$, OR = 2.085, 95% CI = [.987, 4.402]), which suggests that participants who had more comorbid conditions are likely to engage in mental activities as compared to those with less comorbid conditions, but this trend was limited to participants who believed that their cognitive changes were caused by controllable factors.

Table 3. Hierarchical Linear Regression Model of Coherence as a Predictor of Count of Self-management Behaviors

(N = 144)

		Count of Self-management Behaviors								
		Model 1			Model 2			Model 3		
		Unstandardized Regression Coefficients								
Block	Predictor	*b*	SE	*p* value	*b*	SE	*p* value	*b*	SE	*p* value
1	(Constant)	1.757	0.848	0.040	1.822	0.877	0.040	1.502	3.230	0.643
	Age (years)	-0.011	0.010	0.292	-0.010	0.010	0.296	-0.067	0.033	0.041
	Male[a]	-0.063	0.183	0.730	-0.066	0.184	0.720	1.438	0.665	0.032
	Education (years)	0.019	0.033	0.561	0.021	0.033	0.536	0.213	0.119	0.076
	Comorbid condition[b]	0.017	0.071	0.813	0.018	0.071	0.801	0.199	0.246	0.419
2	Coherence				-0.006	0.019	0.760	0.051	0.030	0.089
3[c]	Coherence × age							0.004	0.002	0.053
	Coherence × male							-0.089	0.039	0.025
	Coherence × education							-0.012	0.007	0.103
	Coherence × comorbid condition							-0.009	0.014	0.516
	R^2		0.010			0.011			0.089	
	Adjusted R^2		<0.001			<0.001			0.027	

Note. SE = standard error.

[a]Female was treated as the reference category for sex.

[b]The number of comorbid conditions was calculated with the exception of mild cognitive impairment.

[c]For interactions with age, education, and number of comorbid conditions, age, education, and number of comorbid conditions were mean centered due to multicollinearity.

Table 4. Hierarchical Linear Regression Model of Causality as a Predictor of Count of Self-management Behaviors

(N = 144)

		Count of Self-management Behaviors								
		Model 1			Model 2			Model 3		
		Unstandardized Regression Coefficients								
Block	Predictor	*b*	SE	*p* value	*b*	SE	*p* value	*b*	SE	*p* value
1	(Constant)	1.653	0.857	0.056	1.648	0.868	0.060	1.640	0.914	0.075
	Age (years)	-0.005	0.010	0.643	-0.005	0.011	0.656	-0.007	0.011	0.547
	Male[a]	-0.026	0.185	0.889	-0.026	0.185	0.890	-0.053	0.203	0.793
	Education (years)	-0.001	0.034	0.974	-0.001	0.034	0.971	0.014	0.037	0.708
	Comorbid condition[b]	0.019	0.071	0.786	0.019	0.073	0.798	-0.021	0.085	0.806
2	Causality				0.012	0.265	0.964	-0.071	0.401	0.860
3[c]	Causality × age							0.025	0.043	0.565
	Causality × male							0.275	0.605	0.650
	Causality × education							-0.101	0.107	0.350
	Causality × comorbid condition							0.099	0.176	0.575
	R^2	0.002			0.002			0.017		
	Adjusted R^2	<0.001			<0.001			<0.001		

Note. SE = standard error.

[a]Female was treated as the reference category for sex.

[b]The number of comorbid conditions was calculated with the exception of mild cognitive impairment.

[c]For interactions with age, education, and number of comorbid conditions, age, education, and number of comorbid conditions were mean centered due to multicollinearity.

Table 5. Hierarchical Logistic Regression Model of Coherence as a Predictor of Physical Activity and Cognitive-enhancing Medications

(N = 144)

		Physical Activity						Cognitive-enhancing Medications					
		Model1		Model 2		Model 3		Model 1		Model 2		Model 3	
Block	Predictor	b	OR [95% CI]	b	OR [95% CI]	b	OR [95% CI]	b	OR [95% CI]	b	OR [95% CI]	b	OR [95% CI]
1	(Constant)	-0.801	0.449	-0.885	0.413	-3.764	0.023	1.462	0.391	1.728	5.628	0.570	1.768
	Age (years)	-0.033	0.967 [0.927, 1.008]	-0.034	0.967 [0.927, 1.008]	-0.188	0.829* [0.696, 0.987]	-0.002	0.998 [0.960, 1.038]	-0.002	0.998 [0.960, 1.038]	0.043	1.044 [0.909, 1.198]
	Male[a]	-0.194	0.824 [0.389, 1.747]	-0.192	0.825 [0.389, 1.749]	1.507	4.515 [0.180, 113.101]	-0.388	0.679 [0.333, 1.383]	-0.402	0.669 [0.327, 1.367]	0.830	2.294 [0.153, 34.488]
	Education (years)	0.129	1.138† [0.989, 1.309]	0.127	1.136† [0.986, 1.309]	0.845	2.328** [1.232, 4.401]	-0.114	0.892† [0.784, 1.015]	-0.108	0.897 [0.788, 1.022]	-0.255	0.775 [0.477, 1.260]
	Comorbid condition[b]	0.183	1.201 [0.904, 1.596]	0.181	1.199 [0.901, 1.594]	0.652	1.920 [0.659, 5.595]	0.068	1.070 [0.811, 1.413]	0.071	1.074 [0.812, 1.420]	-0.164	0.849 [0.317, 2.270]
2	Coherence			0.008	1.008 [0.932, 1.091]	0.092	1.097 [0.949, 1.267]			-0.022	0.978 [0.908, 1.054]	0.024	1.024 [0.907, 1.155]
3[c]	Coherence × age					0.010	1.011† [1.000, 1.021]					-0.003	0.997 [0.988, 1.006]
	Coherence × male					-0.093	0.911 [0.758, 1.096]					-0.081	0.922 [0.785,1.083]
	Coherence × education					-0.044	0.957* [0.922, 0.993]					0.010	1.010 [0.980, 1.041]
	Coherence × comorbid Condition					-0.023	0.977 [0.920, 1.037]					0.014	1.015 [0.959, 1.074]
	Model fitness (Hosmer-Lemeshow)	0.564		0.615		0.480		0.286		0.646		0.981	
	Omnibus test (Chi-square (*df*), *p*)	6.684 (4), 0.154		6.728 (5), 0.242		17.390 (9), 0.043		5.097 (4), 0.278		5.434 (5), 0.365		7.585 (9), 0.576	
	Model predictivity (Nagelkerke R^2)	0.064		0.065		0.161		0.048		0.051		0.071	

Note. OR = odds ratio; CI = confidence interval.

†$p < .10$; *$p < .05$; **$p < .01$

[a]Female was treated as the reference category for sex.

[b]The number of comorbid conditions was calculated with the exception of mild cognitive impairment.

[c]For interactions with age, education, and number of comorbid conditions, age, education, and number of comorbid conditions were mean centered due to multicollinearity.

Table 6. Hierarchical Logistic Regression Model of Coherence as a Predictor of Vitamins/Herbal Supplements and Mental Activities

(N = 144)

		Vitamins/Herbal Supplements						Mental Activities					
		Model1		Model 2		Model 3		Model 1		Model 2		Model 3	
Block	Predictor	b	OR [95% CI]	b	OR [95% CI]	b	OR [95% CI]	b	OR [95% CI]	b	OR [95% CI]	b	OR [95% CI]
1	(Constant)	0.584	1.794	0.797	2.218	-0.585	0.557	-1.877	0.153	-1.955	0.142	-0.776	0.460
	Age (years)	-0.029	0.971 [0.931, 1.013]	-0.029	0.972 [0.932, 1.014]	-0.147	0.864† [0.743, 1.004]	0.008	1.008 [0.971, 1.047]	0.008	1.008 [0.971, 1.047]	-0.082	0.922 [0.809, 1.050]
	Male[a]	0.151	1.162 [0.531, 2.544]	0.141	1.151 [0.525, 2.524]	3.072	21.577† [0.858, 542.602]	0.142	1.152 [0.573, 2.317]	0.145	1.156 [0.574, 2.325]	1.976	7.215 [0.463, 112.456]
	Education (years)	0.027	1.027 [0.892,1.183]	0.031	1.032 [0.895, 1.190]	0.413	1.511 [0.863, 2.646]	0.061	1.063 [0.937, 1.205]	0.059	1.061 [0.934, 1.205]	0.307	1.359 [0.836, 2.208]
	Comorbid condition[b]	-0.056	0.946 [0.696, 1.285]	-0.052	0.949 [0.697, 1.292]	0.886	2.425 [0.798, 7.369]	-0.110	0.895 [0.681, 1.177]	-0.112	0.894 [0.680, 1.175]	-0.096	0.908 [0.342, 2.413]
2	Coherence			-0.020	0.980 [0.904, 1.062]	0.095	1.099 [0.950, 1.273]			0.007	1.007 [0.937, 1.082]	0.080	1.083 [0.956, 1.227]
3[c]	Coherence × age					0.009	1.009† [0.999, 1.018]					0.006	1.006 [0.998, 1.015]
	Coherence × male					-0.173	0.841† [0.697, 1.015]					-0.108	0.898 [0.765, 1.054]
	Coherence × education					-0.023	0.977 [0.945, 1.011]					-0.016	0.984 [0.956, 1.014]
	Coherence × comorbid condition					-0.055	0.947 [0.886, 1.012]					0.001	1.001 [0.947, 1.058]
	Model fitness (Hosmer-Lemeshow)	0.779		0.576		0.359		0.351		0.306		0.113	
	Omnibus test (Chi-square (*df*), *p*)	2.358 (4), 0.670		2.599 (5), 0.762		11.683 (9), 0.232		2.163 (4), 0.706		2.198 (5), 0.821		7.445 (9), 0.591	
	Model predictivity (Nagelkerke R^2)	0.024		0.026		0.115		0.020		0.021		0.068	

Note. OR = odds ratio; CI = confidence interval; †$p < .10$

[a]Female was treated as the reference category for sex.

[b]The number of comorbid conditions was calculated with the exception of mild cognitive impairment.

[c]For interactions with age, education, and number of comorbid conditions, age, education, and number of comorbid conditions were mean centered due to multicollinearity.

Table 7. Hierarchical Logistic Regression Model of Causality as a Predictor of Physical Activity and Cognitive-enhancing Medications

(N = 138)

		Physical Activity						Cognitive-enhancing Medications					
		Model1		Model 2		Model 3		Model 1		Model 2		Model 3	
Block	Predictor	b	OR [95% CI]	b	OR [95% CI]	b	OR [95% CI]	b	OR [95% CI]	b	OR [95% CI]	b	OR [95% CI]
1	(Constant)	-0.832	0.435	-0.971	0.379	-0.338	0.713	1.223	3.396	1.463	4.317	0.863	2.369
	Age (years)	-0.028	0.972 [0.931, 1.015]	-0.026	0.974 [0.932, 1.018]	-0.033	0.968 [0.924, 1.014]	0.009	1.009 [0.967, 1.052]	0.005	1.005 [0.963, 1.048]	0.008	1.008 [0.965, 1.054]
	Male[a]	-0.142	0.868 [0.405, 1.860]	-0.139	0.870 [0.406, 1.867]	0.124	1.133 [0.487, 2.631]	-0.329	0.720 [0.347,1.495]	-0.339	0.713 [0.342, 1.484]	-0.402	0.669 [0.305, 1.469]
	Education (years)	0.105	1.111 [0.963, 1.281]	0.103	1.108 [0.961, 1.278]	0.086	1.090 [0.935, 1.272]	-0.152	0.859* [0.751, 0.983]	-0.147	0.863* [0.754, 0.988]	-0.139	0.870† [0.753, 1.005]
	Comorbid condition[b]	0.195	1.216 [0.912, 1.621]	0.179	1.196 [0.892, 1.604]	0.143	1.153 [0.814, 1.634]	0.081	1.084 [0.818, 1.438]	0.119	1.126 [0.840, 1.510]	0.258	1.294 [0.925, 1.811]
2	Causality			0.294	1.341 [0.480, 3.750]	0.978	2.660 [0.554, 12.773]			-0.643	0.526 [0.166, 1.663]	-0.788	0.455 [0.073, 2.845]
3[c]	Causality × age					-0.014	0.986 [0.791, 1.228]					-0.016	0.984 [0.806, 1.201]
	Causality × male					-2.062	0.127 [0.006, 2.615]					0.477	1.612 [0.079, 32.936]
	Causality × education					0.270	1.310 [0.760, 2.259]					-0.498	0.608 [0.276, 1.340]
	Causality × comorbid Condition					0.340	1.405 [0.614, 3.215]					-1.202	0.301† [0.078, 1.158]
	Model fitness (Hosmer-Lemeshow)	0.488		0.801		0.024		0.869		0.442		0.189	
	Omnibus test (Chi-square (*df*), *p*)	4.965 (4), 0.291		5.274 (5), 0.383		9.175 (9), 0.421		6.822 (4), 0.146		8.097 (5), 0.151		14.563 (9), 0.104	
	Model predictivity (Nagelkerke R^2)	0.050		0.053		0.091		0.066		0.078		0.138	

Note. OR = odds ratio; CI = confidence interval; †$p < .10$

[a]Female was treated as the reference category for sex.

[b]The number of comorbid conditions was calculated with the exception of mild cognitive impairment.

[c]For interactions with age, education, and number of comorbid conditions, age, education, and number of comorbid conditions were mean centered due to multicollinearity.

Table 8. Hierarchical Logistic Regression Model of Causality as a Predictor of Vitamins/Herbal Supplements and Mental Activities

(N = 138)

		Vitamins/Herbal Supplements						Mental Activities					
		Model1		Model 2		Model 3		Model 1		Model 2		Model 3	
Block	Predictor	b	OR [95% CI]	b	OR [95% CI]	b	OR [95% CI]	b	OR [95% CI]	b	OR [95% CI]	b	OR [95% CI]
1	(Constant)	0.290	1.337	0.236	1.266	0.124	1.132	-1.873	0.154	-1.963	0.140	-1.868	0.154
	Age (years)	-0.024	0.976 [0.935, 1.019]	-0.023	0.977 [0.935, 1.021]	-0.028	0.972 [0.928, 1.018]	0.015	1.016 [0.976, 1.057]	0.017	1.017 [0.976, 1.060]	0.014	1.014 [0.971, 1.058]
	Male[a]	0.178	1.195 [0.545, 2.622]	0.179	1.196 [0.545, 2.625]	0.073	1.075 [0.455, 2.542]	0.176	1.193 [0.585, 2.431]	0.180	1.197 [0.587, 2.442]	0.010	1.010 [0.462, 2.211]
	Education (years)	0.027	1.028 [0.891, 1.185]	0.026	1.026 [0.889, 1.184]	0.070	1.073 [0.918, 1.254]	0.027	1.027 [0.902, 1.170]	0.025	1.025 [0.900, 1.168]	0.062	1.064 [0.924, 1.226]
	Comorbid condition[b]	-0.068	0.934 [0.687, 1.270]	-0.076	0.927 [0.679, 1.267]	-0.174	0.841 [0.576, 1.227]	-0.114	0.892 [0.676,1.177]	-0.125	0.883 [0.666, 1.171]	-0.340	0.712† [0.501, 1.010]
2	Causality			0.140	1.150 [0.388, 3.412]	-0.264	0.768 [0.120, 4.907]			0.197	1.218 [0.442, 3.355]	-0.617	0.539 [0.093, 3.137]
3[c]	Causality × age					0.069	1.072 [0.897, 1.280]					0.054	1.056 [0.881, 1.265]
	Causality × male					1.076	2.932 [0.222, 38.711]					1.206	3.340 [0.281, 39.672]
	Causality × education					-0.296	0.744 [0.481, 1.150]					-0.186	0.830 [0.545, 1.264]
	Causality × comorbid Condition					0.191	1.210 [0.569, 2.574]					0.735	2.085† [0.987, 4.402]
	Model fitness (Hosmer-Lemeshow)	0.634		0.151		0.266		0.526		0.834		0.229	
	Omnibus test (Chi-square (*df*), *p*)	1.820 (4), 0.769		1.883 (5), 0.865		5.011 (9), 0.833		1.844 (4), 0.764		1.988 (5), 0.851		8.738 (9), 0.462	
	Model predictivity (Nagelkerke R^2)	0.019		0.020		0.052		0.018		0.019		0.083	

Note. OR = odds ratio; CI = confidence interval; †$p < .10$

[a]Female was treated as the reference category for sex.

[b]The number of comorbid conditions was calculated with the exception of mild cognitive impairment.

[c]For interactions with age, education, and number of comorbid conditions, age, education, and number of comorbid conditions were mean centered due to multicollinearity.

2.5 Discussion

In light of a growing number of persons affected by age-related cognitive disorders, we examined the association between illness perceptions—specifically the dimensions of coherence and causality—and self-management behaviors among older adults with MCI. Our results suggest that, among older adults with MCI, illness perceptions (i.e., perceived coherence of or causality of MCI) or its interactions with covariates (i.e., age, sex, years of education, and the number of comorbid conditions) may be associated with self-management behaviors for the purpose of preventing AD. Considering that diagnosis of and treatment for MCI still continue to evolve, some older adults with MCI may experience difficulty in making sense of their diagnosis or treatment for cognitive changes associated with MCI. Indeed, concerns over the ambiguity or uncertainty of these cognitive changes are found in qualitative (Gomersall et al., 2015) and quantitative (Lin et al., 2012) studies of persons with MCI. According to research in other populations, such perceptions may affect the performance of self-management behaviors (Brandes & Mullan, 2014; Hagger et al., 2017).

Previous studies of the MCI population have revealed mixed findings about whether or not self-management behaviors (e.g., physical activity, cognitive-enhancing medications, or cognitive training) can either improve cognition or prevent disease progression in persons with MCI (Lam, Chan, Leung, Fung, & Leung, 2015; Nakatsuka et al., 2015; Suzuki et al., 2013). Nevertheless, clinicians and public health experts agree that these behaviors have overall health benefits, and may play a role in good cognitive health (Petersen et al., 2018). Previous studies have investigated either illness perceptions (Lin et al., 2012; Lingler et al., 2016) or the health behavior changes (Christensen et al., 2015; Morgan et al., 2012) among persons at increased risk of AD; therefore,

our finding of an association between illness perceptions and self-management behaviors certainly contributes to the literature.

Our result is congruent with a meta-analysis of chronic disorders that higher perceived coherence was related to better treatment adherence (Brandes & Mullan, 2014). However, our findings were limited when interactions were added to the model, which suggests that sociodemographic factors or comorbid conditions of individuals should be considered when interpreting our results. Previous research has shown that age was related to self-management behaviors among those with chronic disorders. Interestingly, while in a study of Ory et al. (2014) reported a greater improvement in self-management behaviors among those with chronic disorders aged 50 to 64 years compared to those aged 65 years or older, our results suggest that a positive relationship between coherence and the total number of self-management behaviors actually increased with age among our participants with MCI. This relationship between coherence and self-management behaviors was limited to our female participants; yet, other sociocultural factors such as the levels of resource use or social support, likely play an important role in engaging in self-management behaviors and adhering to them (Grady & Gough, 2014; Mathew, Gucciardi, De Melo, & Barata, 2012).

As such, we did examine the association between perceived coherence of MCI and each self-management behavior, and only the interaction between coherence and years of education among the participants was significantly related to physical activity. This suggests that a positive association between perceived coherence and physical activity increased with lower education levels. However, this finding must be interpreted with caution because our participants reported having received 16 years of education on average, rendering them more highly educated. Sociocultural factors of this sort should be considered in subsequent studies among this population.

Although we observed no association between the perceived causality of MCI and the total number of self-management behaviors, we did observe non-additive trends not only between causality and cognitive-enhancing medications, but also between causality and mental activities among participants with MCI. These findings suggest that participants who perceived their cognitive changes are being caused by controllable factors such as lifestyle or stress were less likely to take cognitive-enhancing medications if they presented more comorbid conditions. In contrast, participants who perceived their cognitive changes as being caused by controllable factors were more likely to engage in mental activities (e.g., doing crossword puzzles) if they presented more comorbid conditions. Although we targeted only perceptions of MCI, these perceptions—and perceptions of illnesses in general—likely are affected by the other health conditions of the patients (Schuz et al., 2014). Indeed, multicomorbidity is common among older adults, which suggests that future research is needed to understand the potential role of comorbid conditions among older adults with MCI.

Interestingly, although the majority of our participants perceived that their cognitive changes were caused by uncontrollable factors, they still performed at least one or more self-management behaviors for preventing further cognitive decline, which is congruent with other findings in the literature. Namely, in a study of asymptomatic individuals at high risk for AD, Chao et al. (2008) found a similar pattern: those expressing a risk gene for AD were more likely than those who did not express the risk gene to change their heath behaviors to delay cognitive changes. Although aging and heredity are key factors for developing AD, a growing consensus about the potential benefits of maintaining a healthy lifestyle (e.g., regular exercise and cognitive training) may be one reason why we observed the self-management behaviors that we did among our participants with MCI (Petersen et al., 2018). Nevertheless, more in-depth studies will be needed

to expose all of the factors contributing to such self-management behaviors in older adults with MCI.

We must acknowledge the limitations of this study. First, performing a secondary analysis of existing datasets prevented us from examining other important variables that may be related to our key variables. For example, although understanding the perceived coherence and causality of MCI among the individuals comprising the MCI population is important, other dimensions of illness perception also may be associated with their self-management behaviors. Second, the cross-sectional design of the study is another limitation because it cannot provide evidence of any temporal relationship between illness perceptions and self-management behaviors among our participants with MCI; therefore, this study is unable to establish a cause and effect relationship between these factors. Third, results of our study cannot readily be generalized to the broader MCI population because the majority of our participants were Caucasian with relatively high levels of education. Finally, because data analyzed in this study except sociodemographic and clinical information were generated from participant self-reporting, potential bias certainly could taint our results. Although the parent studies conducted face-to-face interviews to minimize such bias, participants may have provided biased estimates of their self-assessed illness perceptions and self-management behaviors, which could result in an under or over estimation of our results. Despite these limitations, our findings suggest clinical implications that health care professionals should take into account individual's illness perceptions, sociodemographic characteristics, and comorbid conditions when discussing the symptom or disease management of older adults with MCI.

3.0 Manuscript 2: Type 2 Diabetes

3.1 Abstract

Background: Illness perceptions, patients' beliefs about their health condition, may affect medication adherence as well as self-efficacy for managing the condition among persons with type 2 diabetes (T2DM).

Objectives: The aims of this study were to investigate the associations between illness perceptions, self-efficacy, and medication adherence among older adults with T2DM and explore whether the number of comorbid conditions moderates these associations.

Methods: This secondary analysis of cross-sectional data used baseline data from persons with T2DM (≥50 years of age). Self-administered questionnaires, including the Brief Illness Perception Questionnaire, Self-efficacy for Managing Chronic Disease, and four-item Morisky Medication Adherence Scale, were used. Hierarchical multiple linear regression analyses were performed.

Results: Participants (N = 146) were 57.5% (n = 84) female, 67.1% (n = 98) Caucasian, and on average 64.4 ± 8.65 years of age. Six dimensions of illness perceptions (i.e., consequences, personal control, treatment control, identity, concerns, and emotional representations) were associated with self-efficacy for managing T2DM. Five dimensions (i.e., timeline, personal control, treatment control, coherence, and emotional representations) were significant predictors of medication adherence. While the number of comorbid conditions (excluding T2DM) was significantly associated with self-efficacy for managing T2DM in all models ($p < .001$), the number of comorbid conditions was not associated with medication adherence.

Conclusion: This study suggests that illness perceptions may play a critical role in self-efficacy for managing T2DM and medication adherence among older adults with T2DM. Future research should incorporate an individual's illness perceptions into development of interventions that may improve both self-efficacy and medication adherence.

3.2 Introduction

Diabetes, especially type 2 diabetes (T2DM), is one of the most common chronic illnesses among persons 50 years of age and older. The long-term complications of diabetes including cardiovascular disease, neuropathy, and kidney damage can be prevented by a widely agreed upon set of self-management strategies such as taking medication. However, given recent research that trends in glycemic control has not improved over the years (Lipska et al., 2017), medication adherence rates in T2DM remain low, including among older adults. Treatment nonadherence may result in poor therapeutic benefit from prescribed drugs. For example, physicians may adjust patients' dose of frequency for better blood sugar control because they assume that drugs are being taken as ordered, but are not successfully controlling the blood glucose. Various factors likely contribute to one's adherence to medication including a person's thoughts and feelings about their disease and its symptoms, a concept which is referred to as *illness perceptions* (Leventhal et al., 1984, 2003).

Illness perceptions, one's beliefs about an illness after receiving a diagnosis, have been shown to predict both coping behaviors and illness-specific outcomes across an array of conditions (Groarke, Curtis, Coughlan, & Gsel, 2004; Hallas, Wray, Andreou, & Banner, 2011; Velez-Velez & Bosch, 2016). *Common Sense Model (CSM) of Self-Regulation* is an empirically validated

conceptual framework focusing on the individual's illness perceptions and self-management of health threats (Leventhal et al., 2003). Five main dimensions, *identity* (symptom experiences), *consequences* (serious consequences of the disease), *cause* (causes of the disease), *timeline* (acute vs. chronic), and *cure/control* (controllability over the disease), were identified (Leventhal et al., 1984, 2003). Later, Moss-Morris et al. (2002) and Broadbent et al. (2006) added *coherence* (perceived understanding about the disease), *emotional representations* (negative feelings related to the disease such as anxiety and anger), and *concern* (levels of worry about the disease) items to the illness perception model.

Self-efficacy refers to an individual's confidence in the performance of behaviors required to achieve positive outcomes (Bandura, 1977). Applying this concept to self-management of T2DM suggests that self-efficacy for managing T2DM may play a critical role in one's health behaviors and ultimately, health outcomes. Previous research on chronic disorders has found that an individual's beliefs about the disease are associated with his or her confidence in the ability to perform or maintain self-management activities (Schuz et al., 2012; Zelber-Sagi et al., 2017).

The number of comorbid conditions is another emerging issue in older adults with chronic disorders (Gerteis et al., 2014). The likelihood of having two or more health conditions is common with age, and such comorbidity may prevent older adults from having confidence in self-managing T2DM or adhering to medication and ultimately, this may impose another challenge to management of T2DM.

The *primary aims* of this study were to investigate the associations between illness perceptions, and a) self-efficacy for managing T2DM, and b) medication adherence among older adults with T2DM. The *secondary aims* were to explore whether the number of comorbid

conditions (excluding T2DM) moderates the associations between each dimension of illness perception, and a) self-efficacy for managing T2DM, and b) medication adherence (Figure 6).

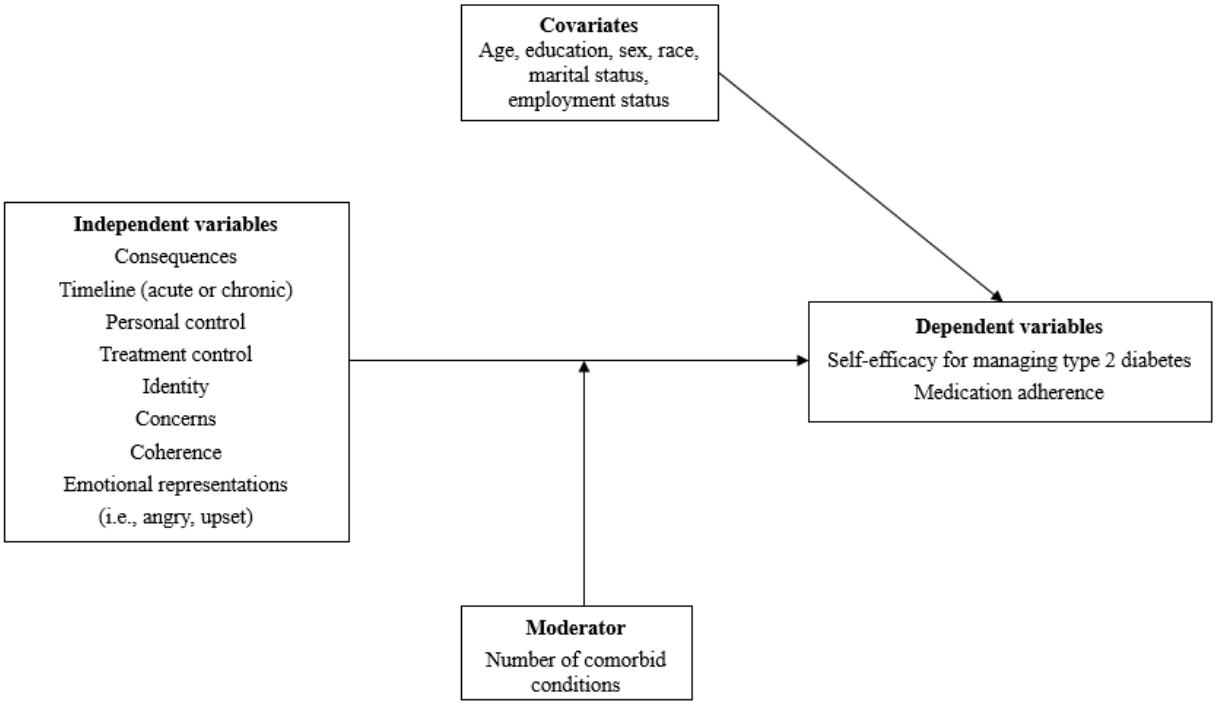

Figure 6. Conceptual Framework (Aim 2) Adapted from Leventhal et al. (2003)

3.3 Methods

3.3.1 Study Design, Sample, and Setting

For this secondary analysis, a quantitative, cross-sectional, and descriptive design was employed. We used baseline data from the Habit Study (NIH P01-NR010949), which is a

randomized controlled trial to examine a habit-training intervention designed to improve medication adherence among adults with T2DM.

The Habit Study comprised a sample of 167 adults who were receiving treatment for T2DM from outpatient clinical practice sites within the University of Pittsburgh Medical Center Health System. The following were the eligibility criteria for the parent study: 1) minimum 40 years of age; 2) in treatment for T2DM; 3) taking one or more T2DM medications prescribed by a physician; 3) self-managing their medications; 4) English speaking, and 5) access to a telephone. Exclusion criteria were 1) having medications managed by others; 2) being unable or unwilling to use a medication diary or electronic event monitor; and 3) participating in another intervention research study. Since we focused on "late-life" T2DM, 20 participants (12%) who are younger than 50 years of age were excluded from this analysis. The parent study and this study were approved by University of Pittsburgh Institutional Review Board.

3.3.2 Measures

Illness Perceptions

The self-reported Brief Illness Perception Questionnaire (Brief IPQ) (Broadbent et al., 2006) has nine items to measure participants' illness perceptions. All items, consequences, timeline, personal control, treatment control, identity, concerns, coherence, and emotional representations, except the causality item, were rated using an 11-point Likert scaling of 0 (not at all) to 10 (extremely). The open-ended causality item was excluded from our analysis. The Brief IPQ has been used in multiple chronic disorders such as hypertension (Perez, 2015; Saarti et al., 2016), T2DM (Al-Amer et al., 2016; Martinez et al., 2018), and depression (Brown et al., 2011). The Brief IPQ has demonstrated good psychometric properties among persons with chronic

conditions (Broadbent et al., 2006). Internal consistency for the Brief IPQ in this sample was 0.60. The original term, 'illness' was replaced with 'diabetes' to capture participants' unique perceptions about T2DM in this study.

Self-efficacy for Managing Type 2 Diabetes

The Self-Efficacy for Managing Chronic Disease (SEMCD) (Lorig et al., 2001) was used to assess the participants' confidence level in completing tasks or activities for managing T2DM. This self-reported scale consists of six items with each item being rated on a 10-point Likert scale ranging from 1 (not at all confident) to 10 (totally confident). A mean of the six items is calculated, where higher scores indicate greater self-efficacy for managing the chronic condition (Lorig et al., 2001). The SEMCD has demonstrated good internal consistency, with Cronbach's alpha ranging from 0.87 to 0.93 in samples having chronic conditions (Freund et al., 2013; Lorig et al., 2001; Ritter & Lorig, 2014). Internal consistency of the SEMCD in this sample was 0.92.

Medication Adherence

The 4-item Morisky Medication Adherence Scale (MMAS-4) (Morisky et al., 1986) is a generic self-reported, medication-taking behavior scale with all items having dichotomous response choices (yes or no). With its usefulness in clinical settings to identify or monitor the non-adherent patients (Tan, Patel, & Chang, 2014) the MMAS-4 has been validated in a range of health conditions with Cronbach's alpha of 0.61 (Elm et al., 2007; Morisky et al., 1986; Tan et al., 2014; Toll et al., 2007). When scoring the MMAS-4 to yield a total score, we reversed the original scores of the items, such that higher total scores indicated better adherence to prescribed medications in

this study. The internal consistency of the MMAS-4 based on Cronbach's alpha for this sample was of 0.40.

Sociodemographic Characteristics and Comorbid Conditions

Baseline sociodemographic information (i.e., age, years of education, sex, race, marital status, health insurance, and employment status) and the number of comorbid conditions were collected via self-report using the questionnaires developed by the Center for Research in Chronic Disorders at the University of Pittsburgh School of Nursing (Sereika & Engberg, 2006).

3.3.3 Data Analysis

Initially, data were screened for anomalies (e.g., outliers, missing data, and violations of statistical assumptions) using descriptive and exploratory data analysis methods. Based on the variable's level of measurement, appropriate descriptive statistics (e.g., means, medians, modes, SDs, and interquartile ranges) were used to characterize the sample. The amount and pattern of missing data were explored and 1 participant (0.68%) was excluded from the analysis as the Brief IPQ was not completed by this participant. Identified univariate outliers for the variables of years of education and the number of comorbid conditions were winsorized to reduce influence on regression results. For example, high extreme values of years of education and the number of comorbid conditions were altered to the next highest values plus one-unit increment higher. Due to severe departures from normality, the timeline and coherence items of the Brief IPQ were each dichotomized as 0 to 9 versus 10. While data transformation was considered for the SEMCD score due to negative skewness, we report the results using the untransformed variable since similar results were obtained when using the transformed score. Pearson product-moment correlations

were first computed to explore associations among the potential covariate/confounding (i.e., age, years of education, sex, race, marital status, and employment status), and moderating (number of comorbid conditions) variables, the targeted predictors (each dimension of illness perception), and the dependent variables (self-efficacy for managing T2DM and medication adherence). Mean centering was used for the number of comorbid conditions to limit multicollinearity between the number of comorbid conditions and its interaction terms with each dimension of illness perception when exploring moderation.

Hierarchical multiple linear regression was used to investigate the associations between each dimension of illness perception and the outcome variables of self-efficacy for managing T2DM and medication adherence, while controlling for covariates (i.e., age, years of education, sex, race, marital status, and employment status). To explore possible moderation by the number of comorbid conditions, hierarchical multiple linear regression models were expanded to include the main effect of the number of comorbid conditions and its interactions with each dimension of illness perception. This was conducted in such a way that four sequential linear regression models were estimated for the self-efficacy for managing T2DM and medication adherence based on the literature review and data screening. In the first block, only covariates were included in the model. In the second block, a particular dimension of illness perception, was added, and in the third block, the number of comorbid conditions was included. An interaction term between a particular illness perception dimension and the number of comorbid conditions was added to the final block to assess the number of comorbid conditions as a possible moderator of the associations between a particular dimension of illness perception and the dependent variables. Model assessment (i.e., residual analysis and assessment of potential influential observations in terms of predicted values, regression coefficients, and standard errors for regression coefficients) was performed for all fitted

models. Analyses were performed using SPSS® Statistics (Version 25.0, IBM Corp., Armonk, NY) and the level of statistical significance was set at .05.

3.4 Results

3.4.1 Sample Characteristics

A total of 146 older adults with T2DM were included in this study. Our sample was predominantly Caucasian (67.1%) and had health insurance (95.2%), and on average (±*SD*) 64.4 ± 8.65 years of age with 14.0 ± 2.8 years of education, and six comorbid conditions (excluding T2DM) (Table 9). About half (51.4%) were married or living with a partner, and 41.8% were employed full or part-time. As reported in Table 10, the highest mean score among the illness perception dimensions was on the timeline (8.77 ± 2.01), while identity was the lowest dimension (4.10 ± 2.49).

Table 9. Sample Characteristics

(N = 146)

Characteristics	Mean ± SD (Min-Max)	n (%)
Age (years)	64.38 ± 8.65 (50–94)	
Education (years)	13.97 ± 2.82 (8–25)	
Sex		
Female		84 (57.5)
Male		62 (42.5)
Race		
Caucasian		98 (67.1)
African-American		46 (31.5)
Asian		2 (1.4)
Marital Status		
Currently married		70 (47.9)
Living with a partner		5 (3.4)
Never married		19 (13.0)
Widowed		28 (19.2)
Separated		5 (3.4)
Divorced		19 (13.0)
Health Insurance		
Yes		139 (95.2)
No		7 (4.8)
Employment Status		
Currently working (full-time/part-time)		61 (41.8)
Retired or not working		85 (58.2)
Number of comorbid conditions (excluding type 2 diabetes)	6.45 ± 3.4 (0–22)	

Notes. Min = minimum; Max = maximum; SD = standard deviation.

Table 10. Scores of Illness Perceptions

(N = 146)

Dimension of Illness Perceptions (possible score: 0 – 10)	Mean	SD	Median	Range
Consequences	4.74	2.64	5	0 – 10
Timeline	8.77	2.01	10	1 – 10
Personal Control	6.60	2.08	7	2 – 10
Treatment Control	7.97	1.96	8	2 – 10
Identity	4.10	2.49	4	0 – 10
Concerns	4.45	2.99	5	0 – 10
Coherence	8.16	2.36	9	0 – 10
Emotional Representations	7.28	2.34	8	0 – 10

Note. SD = standard deviation.

3.4.2 Illness Perceptions and Self-efficacy for Managing Type 2 Diabetes

Of eight illness perception dimensions, six dimensions (i.e., consequences, personal control, treatment control, identity, concerns, and emotional representations) were significantly associated ($p < .05$) with self-efficacy for managing T2DM, after controlling for covariates (i.e., age, years of education, sex, race, marital status, and employment status) in each hierarchical linear regression model. Participants' perceived consequences of T2DM were the most significant predictor of self-efficacy for managing T2DM (b = -0.233, $p< 0.001$ [block 2]; b = -0.182, p = 0.001 [block 3]; b = -0.191, $p< 0.001$ [block 4]) (Table 11).

Participants' higher perceptions about both personal control and treatment control over T2DM were associated with better self-efficacy for managing T2DM (personal control: b = 0.308, p <0.001 [block 2], b = 0.269, p <0.001 [block 3]; b = 0.272, p <0.001 [block 4]; treatment control: b = 0.335, p <0.001 [block 2]; b = 0.324, p <0.001 [block 3]; b = 0.323, p <0.001 [block 4]), and

remained significant when the number of comorbid conditions and interaction terms were added to the model (Tables 13 and 14). A significant association was found between perceived identity (i.e., symptom experiences) and self-efficacy for managing T2DM (b = -.251, p < .001 [block 2]; b = -.214, p < .001 [block 3]; b = -.213, p < .001 [block 4]), which suggests that lower levels of T2DM-related symptom experiences were associated with better self-efficacy for managing T2DM (Table 15). Likewise, a significant association was found between perceived concerns about T2DM and self-efficacy for managing T2DM (b = -.227, p < .001 [block 2]; b = -.182, p < .001 [block 3]; b = -.182, p < .001 [block 4]), suggesting that participants who have less concerns about T2DM were more likely to have higher levels of self-efficacy for managing T2DM (Table 16). As shown Table 17, participants' emotional representations, such as feelings of anger or being scared about T2DM, were the most significant predictors of self-efficacy for managing T2DM (b = .244, p < .001 [block 2]; b = .231, p < .001 [block 3]; b = .251, p< .001 [block 4]), indicating that lower levels of negative feelings caused by T2DM were related to better self-efficacy for managing T2DM in this sample.

Expansion of the hierarchical linear regression models to examine the number of comorbid conditions (excluding T2DM) as a possible moderator revealed no significant interactions between each dimension of illness perception and the number of comorbid conditions on self-efficacy for managing T2DM. However, significant independent associations between the number of comorbid conditions with self-efficacy for managing T2DM were found in all models (p < .05), which suggests that less number of comorbid conditions were related to better self-efficacy for managing T2DM.

3.4.3 Illness Perceptions and Medication Adherence

Five dimensions of illness perception (i.e., timeline, personal control, treatment control, coherence, and emotional representations) were statistically significant predictors of medication adherence after controlling for covariates ($p < .05$) in each hierarchical linear regression model (Tables 12, 13, 14, 17, and 18).

As reported in Table 12, participants' chronic timeline perception about T2DM was associated with better medication adherence ($b = .350$, $p = .017$ [block 2]; $b = .348$, $p = .018$ [block 3]; $b = .349$, $p = .018$ [block 4]). Participants who believed T2DM is controllable were likely to have better medication adherence (personal control: $b = .094$, $p = .005$ [block 2], $b = .091$, $p = .007$ [block 3]; $b = .091$, $p = .007$ [block 4]; treatment control: $b = .111$, $p = .002$ [block 2]; $b = .110$, $p = .002$ [block 3]; $b = .111$, $p = .002$ [block 4]), and remained statistically significant when the number of comorbid conditions and interaction terms were added to the model (Tables 13 and 14). Coherence (i.e., perceived understanding about T2DM) was positively associated with adherence to medication ($b = .297$, $p = .040$ [block 2]; $b = .302$, $p = .037$ [block 3]; $b = .306$, $p = .035$ [block 4]) (Table 17). Table 18 shows the association between emotional representations and medication adherence among participants with T2DM, which indicates that participants' negative feelings caused by T2DM were the most robust predictors of adherence to medication ($b = .114$, $p < 0.001$ [block 2]; $b = .113$, $p < .001$ [block 3]; $b = .118$, $p < .001$ [block 4]).

Further expansion of the regression models to examine the main effect of the number of comorbid conditions on medication adherence revealed no significant associations between the number of comorbid conditions and medication adherence ($p \geq .05$). Also, no significant interactions were found between each dimension of illness perception with the number of comorbid conditions on medication adherence.

Table 11. Hierarchical Linear Regression Model of Consequences as a Predictor of Self-efficacy and Medication Adherence

(N = 146)

		Self-reported Self-efficacy for Managing Type 2 Diabetes								Self-reported Medication Adherence							
		Model 1		Model 2		Model 3		Model 4		Model 1		Model 2		Model 3		Model 4	
		Unstandardized Regression Coefficients								Unstandardized Regression Coefficients							
Block	Predictor	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value
1	(Constant)	4.056	0.007	5.938	<0.001	4.954	<0.001	5.327	<0.001	2.656	<0.001	2.888	<0.001	2.791	<0.001	2.895	<0.001
	Age (years)	0.029	0.105	0.024	0.163	0.036	0.028	0.033	0.047	0.005	0.527	0.005	0.582	0.006	0.496	0.005	0.572
	Education (years)	0.100	0.092	0.078	0.166	0.071	0.176	0.070	0.183	-0.016	0.561	-0.019	0.498	-0.019	0.485	-0.020	0.476
	Male[a]	-0.478	0.136	-0.437	0.149	-0.561	0.050	-0.564	0.048	0.145	0.336	0.150	0.319	0.138	0.363	0.137	0.367
	White[b]	-0.011	0.974	-0.132	0.696	0.169	0.601	0.081	0.804	0.160	0.340	0.145	0.387	0.175	0.310	0.150	0.390
	Married/living with a partner[c]	0.280	0.416	0.385	0.239	0.339	0.270	0.347	0.256	0.168	0.299	0.181	0.265	0.177	0.278	0.179	0.272
	Currently working[d]	0.553	0.093	0.312	0.322	0.107	0.720	0.144	0.630	-0.075	0.628	-0.104	0.505	-0.125	0.433	-0.114	0.473
2	Consequences			-0.233	<0.001	-0.182	0.001	-0.191	<0.001			-0.029	0.291	-0.024	0.395	-0.026	0.354
3	# of comorbid conditions[e]					-0.194	<0.001	-0.053	0.594					-0.019	0.417	0.020	0.705
4	Interaction[f]							-0.027	0.117							-0.008	0.413
	Adjusted R^2	0.040		0.147		0.247		0.255		0.001		0.002		<0.001		<0.001	

[a]Female was treated as the reference category for sex.

[b]Non-white was treated as the reference category for race.

[c]The combined category of never married, widowed, separated, or divorced was treated as the reference category for marital status.

[d]Participants who were retired or not working were treated as the reference category for employment status.

[e]The number of comorbid conditions was calculated with the exception of type 2 diabetes.

[f]Interaction refers to the two-way interactions of consequences x # of comorbid conditions.

Table 12. Hierarchical Linear Regression Model of Timeline as a Predictor of Self-efficacy and Medication Adherence

(N = 146)

		Self-reported Self-efficacy for Managing Type 2 Diabetes								Self-reported Medication Adherence							
		Model 1		Model 2		Model 3		Model 4		Model 1		Model 2		Model 3		Model 4	
		Unstandardized Regression Coefficients								Unstandardized Regression Coefficients							
Block	Predictor	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value
1	(Constant)	4.056	0.007	4.031	0.007	3.361	0.014	3.375	0.014	2.656	<0.001	2.639	<0.001	2.571	<0.001	2.573	<0.001
	Age (years)	0.029	0.105	0.027	0.136	0.040	0.018	0.040	0.020	0.005	0.527	0.004	0.660	0.005	0.555	0.005	0.560
	Education (years)	0.100	0.092	0.093	0.113	0.081	0.138	0.080	0.141	-0.016	0.561	-0.020	0.454	-0.022	0.426	-0.022	0.427
	Male[a]	-0.478	0.136	-0.449	0.160	-0.585	0.048	-0.566	0.057	0.145	0.336	0.165	0.267	0.151	0.310	0.153	0.308
	White[b]	-0.011	0.974	-0.122	0.735	0.204	0.546	0.199	0.556	0.160	0.340	0.085	0.612	0.118	0.490	0.117	0.493
	Married/living with a partner[c]	0.280	0.416	0.314	0.360	0.286	0.366	0.302	0.341	0.168	0.299	0.192	0.231	0.189	0.238	0.190	0.237
	Currently working[d]	0.553	0.093	0.527	0.108	0.227	0.459	0.219	0.475	-0.075	0.628	-0.092	0.543	-0.123	0.428	-0.123	0.427
2	Timeline[e]			0.514	0.102	0.498	0.085	0.505	0.081			0.350	0.017	0.348	0.018	0.349	0.018
3	# of comorbid conditions[f]					-0.227	<0.001	-0.272	<0.001					-0.023	0.309	-0.027	0.480
4	Interaction[g]							0.066	0.469							0.007	0.887
	Adjusted R^2	0.040		0.051		0.198		0.195		0.001		0.035		0.035		0.028	

[a]Female was treated as the reference category for sex.

[b]Non-white was treated as the reference category for race.

[c]The combined category of never married, widowed, separated, or divorced was treated as the reference category for marital status.

[d]Participants who were retired or not working were treated as reference category for employment status.

[e]Scores between 0 and 9 were treated as the reference category for the timeline variable.

[f]The number of comorbid conditions was calculated with the exception of type 2 diabetes.

[g]Interaction refers to the two-way interactions of timeline x # of comorbid conditions.

Table 13. Hierarchical Linear Regression Model of Personal Control as a Predictor of Self-efficacy and Medication Adherence

(N = 146)

		Self-reported Self-Efficacy for Managing Type 2 Diabetes								Self-reported Medication Adherence							
		Model 1		Model 2		Model 3		Model 4		Model 1		Model 2		Model 3		Model 4	
		Unstandardized Regression Coefficients								Unstandardized Regression Coefficients							
Block	Predictor	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value
1	(Constant)	4.056	0.007	2.575	0.070	2.154	0.103	2.065	0.119	2.656	<0.001	2.205	0.002	2.173	0.002	2.162	0.002
	Age (years)	0.029	0.105	0.021	0.222	0.034	0.037	0.035	0.032	0.005	0.527	0.003	0.742	0.004	0.660	0.004	0.650
	Education (years)	0.100	0.092	0.092	0.096	0.081	0.114	0.080	0.121	-0.016	0.561	-0.018	0.496	-0.019	0.477	-0.019	0.475
	Male[a]	-0.478	0.136	-0.449	0.135	-0.574	0.041	-0.563	0.045	0.145	0.336	0.154	0.295	0.144	0.329	0.145	0.327
	White[b]	-0.011	0.974	0.010	0.975	0.298	0.344	0.283	0.370	0.160	0.340	0.166	0.308	0.189	0.258	0.187	0.265
	Married/living with a partner[c]	0.280	0.416	0.441	0.175	0.396	0.189	0.406	0.179	0.168	0.299	0.217	0.173	0.214	0.180	0.215	0.180
	Currently working[d]	0.553	0.093	0.561	0.069	0.288	0.321	0.303	0.298	-0.075	0.628	-0.072	0.631	-0.093	0.544	-0.091	0.554
2	Personal control			0.308	<0.001	0.269	<0.001	0.272	<0.001			0.094	0.005	0.091	0.007	0.091	0.007
3	# of comorbid conditions[e]					-0.205	<0.001	-0.103	0.418					-0.016	0.485	-0.003	0.963
4	Interaction[f]							-0.015	0.397							-0.002	0.843
	Adjusted R^2	0.040		0.161		0.277		0.276		0.001		0.050		0.046		0.040	

[a]Female was treated as the reference category for sex.

[b]Non-white was treated as the reference category for race.

[c]The combined category of never married, widowed, separated, or divorced was treated as the reference category for marital status.

[d]Participants who were retired or not working were treated as the reference category for employment status.

[e]The number of comorbid conditions was calculated with the exception of type 2 diabetes.

[f]Interaction refers to the two-way interactions of personal control x # of comorbid conditions.

Table 14. Hierarchical Linear Regression Model of Treatment Control as a Predictor of Self-efficacy and Medication Adherence

(N = 146)

		Self-reported Self-efficacy for Managing Type 2 Diabetes								Self-reported Medication Adherence							
		Model 1		Model 2		Model 3		Model 4		Model 1		Model 2		Model 3		Model 4	
		Unstandardized Regression Coefficients								Unstandardized Regression Coefficients							
Block	Predictor	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value
1	(Constant)	4.056	0.007	1.977	0.174	1.386	0.297	1.406	0.292	2.656	<0.001	1.968	0.006	1.911	0.008	1.894	0.008
	Age (years)	0.029	0.105	0.027	0.105	0.040	0.011	0.040	0.012	0.005	0.527	0.005	0.567	0.006	0.475	0.006	0.444
	Education (years)	0.100	0.092	0.060	0.283	0.048	0.343	0.051	0.324	-0.016	0.561	-0.029	0.282	-0.030	0.265	-0.032	0.240
	Male[a]	-0.478	0.136	-0.171	0.576	-0.312	0.267	-0.320	0.258	0.145	0.336	0.246	0.100	0.233	0.122	0.239	0.114
	White[b]	-0.011	0.974	-0.119	0.721	0.199	0.521	0.198	0.525	0.160	0.340	0.124	0.445	0.155	0.350	0.156	0.348
	Married/living with a partner[c]	0.280	0.416	0.380	0.240	0.350	0.235	0.353	0.233	0.168	0.299	0.202	0.202	0.199	0.208	0.197	0.214
	Currently working[d]	0.553	0.093	0.515	0.095	0.222	0.437	0.217	0.448	-0.075	0.628	-0.087	0.560	-0.116	0.449	-0.112	0.466
2	Treatment control			0.335	<0.001	0.324	<0.001	0.323	<0.001			0.111	0.002	0.110	0.002	0.111	0.002
3	# of comorbid conditions[e]					-0.222	<0.001	-0.304	0.104					-0.021	0.334	0.047	0.639
4	Interaction[f]							0.010	0.650							-0.008	0.483
	Adjusted R^2	0.040		0.161		0.301		0.297		0.001		0.060		0.060		0.057	

[a]Female was treated as the reference category for sex.

[b]Non-white was treated as the reference category for race.

[c]The combined category of never married, widowed, separated, or divorced was treated as the reference category for marital status.

[d]Participants who were retired or not working were treated as the reference category for employment status.

[e]The number of comorbid conditions was calculated with the exception of type 2 diabetes.

[f]Interaction refers to the two-way interactions of treatment control x # of comorbid conditions.

Table 15. Hierarchical Linear Regression Model of Identity as a Predictor of Self-efficacy and Medication Adherence

(N = 146)

		Self-reported self-efficacy for Managing Type 2 Diabetes								Self-reported Medication Adherence							
		Model 1		Model 2		Model 3		Model 4		Model 1		Model 2		Model 3		Model 4	
		Unstandardized Regression Coefficients								Unstandardized Regression Coefficients							
Block	Predictor	*b*	*p* value	*b*	*p* value	*b*	*p* value	*B*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value
1	(Constant)	4.056	0.007	6.029	<0.001	5.135	<0.001	5.062	<0.001	2.656	<0.001	3.036	<0.001	2.955	<0.001	2.930	<0.001
	Age (years)	0.029	0.105	0.025	0.148	0.037	0.022	0.038	0.020	0.005	0.527	0.004	0.597	0.006	0.515	0.006	0.496
	Education (years)	0.100	0.092	0.069	0.220	0.062	0.237	0.064	0.222	-0.016	0.561	-0.022	0.427	-0.023	0.414	-0.022	0.433
	Male[a]	-0.478	0.136	-0.573	0.059	-0.679	0.017	-0.694	0.015	0.145	0.336	0.127	0.398	0.117	0.437	0.112	0.459
	White[b]	-0.011	0.974	-0.184	0.586	0.130	0.685	0.144	0.654	0.160	0.340	0.127	0.449	0.155	0.366	0.160	0.353
	Married/living with a partner[c]	0.280	0.416	0.264	0.416	0.242	0.423	0.220	0.471	0.168	0.299	0.165	0.305	0.163	0.311	0.156	0.339
	Currently working[d]	0.553	0.093	0.437	0.160	0.184	0.530	0.192	0.514	-0.075	0.628	-0.097	0.528	-0.120	0.444	-0.117	0.456
2	Identity			-0.251	<0.001	-0.214	<0.001	-0.213	<0.001			-0.048	0.094	-0.045	0.123	-0.045	0.126
3	# of comorbid conditions[e]					-0.203	<0.001	-0.161	0.033					-0.018	0.426	-0.004	0.921
4	Interaction[f]							-0.012	0.488							-0.004	0.660
	Adjusted R^2	0.040		0.149		0.263		0.261		0.001		0.014		0.012		0.006	

[a]Female was treated as the reference category for sex.

[b]Non-white was treated as the reference category for race.

[c]The combined category of never married, widowed, separated, or divorced was treated as the reference category for marital status.

[d]Participants who were retired or not working were treated as the reference category for employment status.

[e]The number of comorbid conditions was calculated with the exception of type 2 diabetes.

[f]Interaction refers to the two-way interactions of identity x # of comorbid conditions.

Table 16. Hierarchical Linear Regression Model of Concerns as a Predictor of Self-efficacy and Medication Adherence

(N = 146)

		Self-reported Self-efficacy for Managing Type 2 Diabetes								Self-reported Medication Adherence							
		Model 1		Model 2		Model 3		Model 4		Model 1		Model 2		Model 3		Model 4	
		Unstandardized Regression Coefficients								Unstandardized Regression Coefficients							
Block	Predictor	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value
1	(Constant)	4.056	0.007	6.668	<0.001	5.586	<0.001	5.644	<0.001	2.656	<0.001	3.048	<0.001	2.949	<0.001	2.998	<0.001
	Age (years)	0.029	0.105	0.012	0.498	0.026	0.117	0.026	0.124	0.005	0.527	0.003	0.755	0.004	0.650	0.004	0.679
	Education (years)	0.100	0.092	0.084	0.131	0.076	0.146	0.075	0.153	-0.016	0.561	-0.019	0.502	-0.019	0.487	-0.020	0.469
	Male[a]	-0.478	0.136	-0.565	0.060	-0.661	0.020	-0.643	0.025	0.145	0.336	0.132	0.380	0.123	0.415	0.138	0.366
	White[b]	-0.011	0.974	-0.167	0.616	0.134	0.677	0.111	0.732	0.160	0.340	0.136	0.415	0.164	0.341	0.145	0.406
	Married/living with a partner[c]	0.280	0.416	0.319	0.321	0.289	0.340	0.294	0.334	0.168	0.299	0.174	0.281	0.172	0.290	0.176	0.279
	Currently working[d]	0.553	0.093	0.275	0.379	0.077	0.795	0.081	0.786	-0.075	0.628	-0.116	0.457	-0.134	0.397	-0.131	0.410
2	Concerns			-0.227	<0.001	-0.182	<0.001	-0.182	<0.001			-0.034	0.165	-0.030	0.234	-0.030	0.230
3	# of comorbid conditions[e]					-0.191	<0.001	-0.160	0.052					-0.017	0.459	0.009	0.837
4	Interaction[f]							-0.007	0.657							-0.006	0.476
	Adjusted R^2	0.040		0.165		0.261		0.257		0.001		0.008		0.005		0.001	

[a]Female was treated as the reference category for sex.

[b]Non-white was treated as the reference category for race.

[c]The combined category of never married, widowed, separated, or divorced was treated as the reference category for marital status.

[d]Participants who were retired or not working were treated as the reference category for employment status.

[e]The number of comorbid conditions was calculated with the exception of type 2 diabetes.

[f]Interaction refers to the two-way interactions of concerns x # of comorbid conditions.

Table 17. Hierarchical Linear Regression Model of Coherence as a Predictor of Self-efficacy and Medication Adherence

(N = 146)

		Self-reported Self-efficacy for Managing Type 2 Diabetes								Self-reported Medication Adherence							
		Model 1		Model 2		Model 3		Model 4		Model 1		Model 2		Model 3		Model 4	
		Unstandardized Regression Coefficients								Unstandardized Regression Coefficients							
Block	Predictor	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value
1	(Constant)	4.056	0.007	3.845	0.011	3.136	0.024	3.309	0.018	2.656	<0.001	2.437	0.001	2.360	0.001	2.333	0.001
	Age (years)	0.029	0.105	0.030	0.093	0.044	0.010	0.042	0.012	0.005	0.527	0.006	0.440	0.008	0.351	0.008	0.341
	Education (years)	0.100	0.092	0.097	0.104	0.083	0.129	0.079	0.146	-0.016	0.561	-0.019	0.479	-0.021	0.447	-0.020	0.461
	Male[a]	-0.478	0.136	-0.397	0.232	-0.521	0.090	-0.555	0.071	0.145	0.336	0.229	0.139	0.215	0.164	0.220	0.157
	White[b]	-0.011	0.974	0.005	0.988	0.333	0.319	0.293	0.381	0.160	0.340	0.177	0.285	0.213	0.207	0.219	0.197
	Married/living with a partner[c]	0.280	0.416	0.285	0.409	0.258	0.417	0.223	0.481	0.168	0.299	0.173	0.281	0.170	0.289	0.175	0.276
	Currently working[d]	0.553	0.093	0.572	0.084	0.270	0.381	0.367	0.246	-0.075	0.628	-0.055	0.717	-0.088	0.571	-0.103	0.519
2	Coherence[e]			0.287	0.354	0.329	0.248	0.301	0.290			0.297	0.040	0.302	0.037	0.306	0.035
3	# of comorbid conditions[f]					-0.230	<0.001	-0.006	0.973					-0.025	0.272	-0.060	0.496
4	Interaction[g]							-0.027	0.187							0.004	0.679
	Adjusted R^2	0.040		0.039		0.188		0.192		0.001		0.025		0.026		0.020	

[a]Female was treated as the reference category for sex.

[b]Non-white was treated as the reference category for race.

[c]The combined category of never married, widowed, separated, or divorced was treated as the reference category for marital status.

[d]Participants who were retired or not working were treated as the reference category for employment status.

[e]Scores between 0 and 9 was treated as the reference category for the coherence variable.

[f]The number of comorbid conditions was calculated with the exception of type 2 diabetes.

[g]Interaction refers to the two-way interactions of coherence x # of comorbid conditions.

Table 18. Hierarchical Linear Regression Model of Emotional Representations as a Predictor of Self-efficacy and Medication Adherence

(N = 146)

		Self-reported self-efficacy for managing type 2 diabetes								Self-reported medication adherence							
		Model 1		Model 2		Model 3		Model 4		Model 1		Model 2		Model 3		Model 4	
		Unstandardized regression coefficients								Unstandardized regression coefficients							
Block	Predictor	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value
1	(Constant)	4.056	0.007	2.306	0.117	1.713	0.205	1.559	0.250	2.656	<0.001	1.836	0.009	1.780	0.011	1.737	0.014
	Age (years)	0.029	0.105	0.032	0.060	0.045	0.005	0.044	0.006	0.005	0.527	0.007	0.399	0.008	0.328	0.008	0.342
	Education (years)	0.100	0.092	0.077	0.171	0.065	0.207	0.072	0.167	-0.016	0.561	-0.027	0.315	-0.028	0.296	-0.026	0.334
	Male[a]	-0.478	0.136	-0.313	0.309	-0.451	0.112	-0.496	0.083	0.145	0.336	0.222	0.124	0.209	0.150	0.197	0.181
	White[b]	-0.011	0.974	-0.019	0.955	0.297	0.347	0.323	0.307	0.160	0.340	0.156	0.326	0.186	0.252	0.193	0.236
	Married/living with a partner[c]	0.280	0.416	0.392	0.235	0.361	0.232	0.347	0.250	0.168	0.299	0.221	0.155	0.218	0.160	0.214	0.169
	Currently working[d]	0.553	0.093	0.477	0.128	0.184	0.527	0.170	0.560	-0.075	0.628	-0.111	0.452	-0.138	0.357	-0.142	0.345
2	Emotional representations			0.244	<0.001	0.231	<0.001	0.251	<0.001			0.114	<0.001	0.113	<0.001	0.118	<0.001
3	# of comorbid conditions[e]					-0.223	<0.001	-0.104	0.356					-0.021	0.339	0.013	0.829
4	Interaction[f]							-0.016	0.258							-0.005	0.536
	Adjusted R^2	0.040		0.133		0.273		0.275		0.001		0.098		0.097		0.093	

[a]Female was treated as the reference category for sex

[b]Non-white was treated as the reference category for race

[c]The combined category of never married, widowed, separated, or divorced was treated as the reference category for marital status

[d]Participants who were retired or not working were treated as the reference category for employment status

[e]The number of comorbid conditions was calculated with the exception of type 2 diabetes

[f]Interaction refers to the two-way interactions of emotional representations x # of comorbid conditions

3.5 Discussion

The rapid aging of the world population is widely recognized as a contributor to the T2DM epidemic (CDC, 2017b). Among older adults with T2DM, self-efficacy and medication adherence may be the key factors for optimal health maintenance, and are likely to be influenced by one's perceptions about T2DM and its symptoms. This study examined the association of each of the 8 dimensions of illness perception separately with self-efficacy for managing T2DM and medication adherence in a sample of older adults with T2DM. Our analysis demonstrated that several dimensions of illness perception were significantly associated with self-efficacy for managing T2DM (six dimensions) and/or medication adherence (Five dimensions), which highlights the importance of perceptions about T2DM and its symptoms among older adults with T2DM.

Illness Perceptions and Self-efficacy for Managing Type 2 Diabetes

With the exception of the timeline and coherence dimensions, each dimension of illness perception was a strong predictor of self-efficacy for managing T2DM in this sample. Our findings regarding perceived consequences of, and concerns about, one's condition were consistent with previous research on chronic disorders (Al-Amer et al., 2016; Bonsaksen et al., 2012; Lau-Walker, 2004; Zelber-Sagi et al., 2017) in that lower perception of serious consequences of, and less worry about, the condition predicted higher self-efficacy for managing T2DM.

Dimensions of perceived personal control and treatment control were the most significant predictors of self-efficacy for managing T2DM. These findings are congruent with a previous study of Jordanian patients with T2DM wherein Al-Amer et al. (2016) found that higher levels of perceived personal control were associated with higher levels of self-efficacy for managing T2DM. These findings have clinical implications for nurses and other healthcare professionals who are

counselling older adults with T2DM, which suggests that nurses should assess patients' beliefs about their potential to control the course of their T2DM before or upon intervening to promote self-efficacy for managing the condition. Fewer symptom experiences may signal better control over the disease. Our finding of a significant relationship between reporting lower levels of diabetes symptoms (e.g., thirst, fatigue, and blurred vision) and reporting higher levels of self-efficacy for managing T2DM may reflect this. Interestingly, while in other samples of persons with chronic conditions (Bonsaksen et al., 2012; Timkova et al., 2018) reporting lower levels of illness-related emotional representations (e.g., anger or anxiety caused by the disease) have been associated with better self-efficacy, our findings showed that the participants with more feelings of anger or anxiety about T2DM tended to have higher self-efficacy for managing T2DM. Our sample endorsed higher scores on emotional representations compared to other T2DM samples (Al-Amer et al., 2016; Nie, Han, Xu, Huang, & Mao, 2018), which may be partially driving our findings. Nevertheless, further in-depth investigations of factors to affect the relationship between the dimension of emotional representations and self-efficacy for managing T2DM are needed in older adults. Since the number of comorbid conditions also predicted self-efficacy for managing T2DM, nurses and other healthcare professionals should take into account older adults' co-occurring health conditions when evaluating their self-efficacy for managing T2DM.

Illness Perceptions and Medication Adherence

Participants' perceptions of timeline, personal control, treatment control, coherence, and emotional representations, were significantly associated with medication adherence among older adults with T2DM.

While the dimensions of timeline and coherence were not associated with self-efficacy for T2DM, these dimensions were significant predictors of medication adherence in our sample. Our participants who felt that T2DM is chronic, and that the disease is easily understandable, were more likely to have better medication adherence. Patients may continue to take prescribed drugs if T2DM makes more sense to them (Nie et al., 2018), and/or if they believe living with T2DM is a life-long journey. Two perceived controllability variables, personal control and treatment control, explained medication adherence in the same way that they were associated with self-efficacy for managing T2DM; higher perceived personal controllability as well as treatment controllability over T2DM were associated with better adherence to medication. These findings are partially supported by previous work comparing illness perceptions between the moderate-high medication adherence and low medication adherence groups. Ashur et al. (2015) examined Libyans with T2DM and found that perception of treatment control was significantly lower in a low medication adherence group as compared to moderate-high adherence group. Our findings suggest that strong beliefs in medical treatment and patient empowerment are essential for optimal symptom and disease management which has implications for future interventions to improve medication adherence in older adults taking T2DM medication. Interestingly, more feelings of anger or upset about T2DM were also related to better medication adherence as this dimension predicted self-efficacy for managing T2DM in this sample. Additional research is needed to examine the influence of emotional representations on medication adherence in samples of older adults with chronic disorders (Lo, Chau, Woo, Thompson, & Choi, 2016; Miyazaki et al., 2018).

This study has some limitations. The cross-sectional design poses a significant limitation, given that illness perceptions for chronic disorders are formed over time (Tasmoc, Hogas, & Covic, 2013). This design also precludes determining the direction of relationships noted among the

variables. For example, self-efficacy and medication adherence could be influenced by diabetes-related illness perceptions, and self-efficacy may mediate the association between illness perceptions and medication adherence. Although duration of a disease may be another factor of self-efficacy and medication adherence, we were not able to test such a relationship because the parent study did not collect this information. The findings based on a sample of older adults (≥ 50 years) from the study with moderate sample size may not generalizable to the overall T2DM population. Limitations of the measurements should be also acknowledged. Use of self-reported questionnaires can be an issue due to response bias, which may affect the results of this study. Although MMAS-4 is easy and simple to administer, it has shown low internal consistency in this study which should be taken into account when interpreting the findings. Nevertheless, the value of our findings outweigh limitations because this study highlighted an important role of illness perceptions in self-efficacy for managing T2DM and medication adherence among older adults with T2DM. Further studies are needed to incorporate individuals' illness perceptions into development of bio-behavioral interventions aimed at improving adherence to T2DM medications and promoting good health and quality of life of older adults with the disease.

4.0 Manuscript 3: Type 2 Diabetes vs. Mild Cognitive Impairment

4.1 Abstract

Objective: The burden of chronic disorders impacting physical and mental health in late-life suggests the need to understand individuals' illness perceptions, taking into account disease characteristics (physical vs. mental). We identified similarities and differences in illness perceptions in older adults with type 2 diabetes (T2DM) and those with mild cognitive impairment (MCI) as exemplars of late-life physical and mental disorders.

Methods: We conducted a secondary analysis of existing baseline data from the two clinical trials. The Brief Illness Perception Questionnaire was used. Multivariate analysis of covariance (MANCOVA) and hierarchical linear regression were performed to compare illness perceptions between older adults with T2DM and those with MCI.

Results: Participants with MCI (n = 90) tended to be older and more educated than those with T2DM (n = 146) (*ps* < .001). Illness perceptions were different between the two groups when the dimensions of illness perception were examined multivariately ($p < .001$). Only the consequences dimension was not associated with participants' disease characteristics ($p = .962$) when each dimension of illness perception was examined. Participants with T2DM were more likely than those with MCI to view their health condition as being controllable through personal strategies ($p = .009$) and medical treatment ($p < .001$). Participants with T2DM endorsed having a more clear understanding ($p = .001$) and negative feelings (e.g., anger) ($p < .001$) about their condition as compared to those with MCI.

Conclusion: Findings suggest that older adults may view mental disorders differently than physical disorders, which have implications for future patient education and interventions to facilitate symptom management.

4.2 Introduction

Despite the fact that the number of older adults who are living with chronic disorders has been increasing in recent decades (National Institute of Aging, 2017), research on how older adults perceive their chronic conditions is absent. Chronic disorders are sometimes asymptomatic and not easily noticed so that thoughts and beliefs about the conditions may vary from individual to individual. Understanding individuals' beliefs about their health conditions is critical because activation of such beliefs may result in differences in self-management (e.g., treatment non-adherence and seeking social support) (Hagger et al., 2017; Leventhal, Phillips, & Burns, 2016).

Individuals have their own particular thoughts and feelings when experiencing physical symptoms or after receiving a medical diagnosis, this concept is known as illness perceptions (Leventhal et al., 2003). *Common Sense Model (CSM) of Self-Regulation* (Leventhal et al., 2003) is an empirically validated conceptual framework which explicates a set of individuals' thoughts about the disease. Illness perceptions comprise five main dimensions including 1) identity (symptoms of the disease), 2) consequences (perceived outcomes of the disease), 3) cause (perceived causes of the disease), 4) timeline (perception of how the disease will last; acute vs. chronic), and 5) cure/control (beliefs on whether the disease is curable or not) (Leventhal et al., 2003). Coherence (perceived levels of understanding about the disease), emotional representations (negative feelings caused by the disease such as anger and anxiety), and concerns (levels of worry)

were identified as additional dimensions of the CSM model (Broadbent et al., 2006; Moss-Morris et al., 2002).

Chronic disorders affecting older adults may fall into two broad categories, those which affect physical health (e.g., type 2 diabetes mellitus [T2DM], hypertension, arthritis) and those which affect mental health (e.g., mild cognitive impairment [MCI], Alzheimer's disease [AD], depression). Even though clinicians and public health experts increasingly recognize the complex overlay of physical and mental health disorders, older adults may hold distinct views regarding what they perceive as physical versus mental health disorders. Unlike physical health conditions, a relatively greater deal of stigma associated with late-life mental disorders may be one of the major culprits for differences in illness perceptions among older adults with physical disorder and those with mental disorder. Also, the ways of screening for, diagnosis of, or treatment for late-life mental health conditions are typically made by the consensus of experts, not made by the definite ways such as blood tests or X-rays, suggesting that affected older adults with mental disorders may have uncertain perceptions about their conditions. Such potential discrepancies in illness perceptions may be the key factor for performing or maintaining self-management behaviors (e.g., regular exercise, healthy diet, medication taking); therefore, prior to the symptom or disease management, understanding individuals' illness perceptions based on their disease characteristics (physical vs. mental) should be taken into consideration.

For example, since a diagnosis of mental disorder such as MCI is relatively ambiguous in the context of its etiology, treatment, or prognosis as compared to those of physical disorder such as T2DM, older adults with MCI may not be well informed of risk factors of, or management of the disease in comparison to those with T2DM. T2DM and MCI are receiving greater attention from researchers and health care professionals because they pose the greatest risks as people age

and are leading causes of death among U.S. older adults (CDC, 2019). Regarding MCI, as a potential precursor to AD, the fact that no definite ways to cure or manage the disease (Petersen et al., 2018) makes affected older adults may feel more anxious about their condition as compared to T2DM in that T2DM can be well managed by maintaining healthy lifestyle or taking medications (ADA, 2014b).

Because of such fundamental discrepancies between the disorders in the context of disease characteristics (physical vs. mental), and the lack of such investigation, there is a need to understand and address similarities and differences in illness perceptions among older adults with physical disorders [T2DM] and mental disorders [MCI]. The primary purpose of this study was to identify similarities and differences in illness perceptions between older adults with T2DM and those with MCI, treating each condition as exemplars of late-life physical and mental disorders (Figure 7).

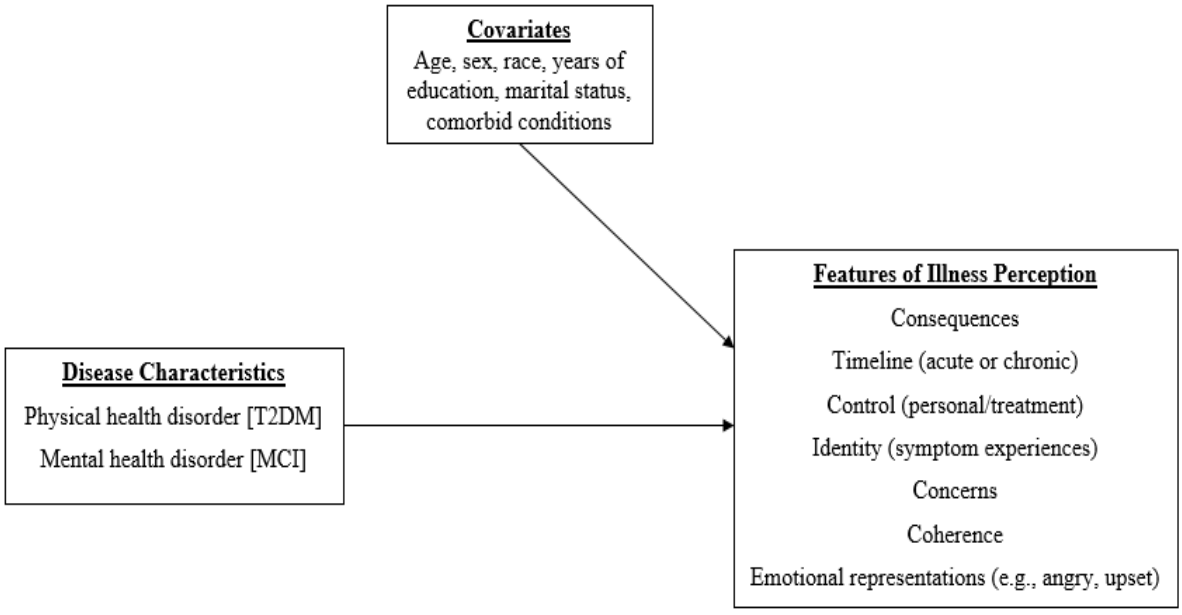

Figure 7 Conceptual Framework (Aim 3) Adapted from Leventhal et al. (2003)

4.3 Methods

4.3.1 Study Design, Sample, and Setting

In this secondary analysis, a quantitative, cross-sectional, descriptive study was conducted using existing baseline data from two clinical trials. For the T2DM parent study (NIH P01-NR010949), persons with T2DM (n = 167) were recruited from outpatient clinical practice sites within the University of Pittsburgh Medical Center (UPMC) Health System. Inclusion criteria for the T2DM parent study were as follows: 1) being at least 40 years of age and in treatment for T2DM; 2) taking one or more medications prescribed by a physician; 3) self-managing their medications; 4) being an English speaker; and 5) having access to a telephone. Exclusion criteria for the T2DM sample were as follows: 1) having medications managed by others; 2) being unable or unwilling to use a medication diary or electronic event monitor; and 3) participating in other intervention research. The MCI sample (n = 90) was recruited from the University of Pittsburgh Alzheimer's Disease Research Center (ADRC; NIH P50-AG005133). Inclusion criteria for the MCI parent study (NIH R01-AG046906) were as follows: 1) ≥ 50 years of age; 2) a current ADRC consensus diagnosis of MCI; 3) residence within 50 miles of the University of Pittsburgh; 4) having a care partner (e.g., family member or kin-like friend); and 5) providing written informed consent to participate. Exclusion criteria for the MCI sample were 1) being medically unstable and 2) having evidence of active, untreated primary psychiatric disorders (e.g., depression, anxiety disorder). As this investigation focused on "late-life" chronic disorders, participants with T2DM who were younger than 50 years of age (n = 20; 8%) were excluded from the analysis.

4.3.2 Measures

The Brief Illness Perception Questionnaire (Brief IPQ) (Broadbent et al., 2006) is comprised of nine questions about an individual's perceptions of illness and its symptoms. All items, consequences, timeline, personal control, treatment control, identity, concerns, coherence, and emotional representations, except the causality item, were rated using 0 (not at all) to 10 (extremely) Likert scaling. The causality item was not included in the analysis because the item is an open-ended question. The Brief IPQ is widely used to investigate illness perceptions in chronic conditions (Al-Amer et al., 2016; Martinez et al., 2018; Perez, 2015; Saarti et al., 2016) and has demonstrated good test-retest reliability and validity (Elizabeth Broadbent, Petrie, Main, & Weinman, 2006; E. Broadbent et al., 2015). The original term 'illness' was replaced with 'my memory or thinking difficulties' and 'diabetes' in the MCI and T2DM parent studies, respectively.

In the T2DM parent study, self-reported baseline data on sociodemographics and the number of comorbid conditions (in addition to T2DM) were collected using the CRCD questionnaires (Sereika & Engberg, 2006). For the MCI sample, sociodemographic information (i.e., age, sex, race, years of education, and marital status) and the number of comorbid conditions (in addition to MCI) were extracted from the ADRC records.

4.3.3 Procedure

Regulatory approval of this study was obtained from the University of Pittsburgh Institutional Review Board. All participants from the parent studies provided written informed consent prior to data collection. In the T2DM parent study, baseline sociodemographic and clinical information data were obtained using the standardized questionnaires (Sereika & Engberg, 2006).

In the MCI parent study, trained research assistants conducted face-to-face interviews to ensure the validity of participants' responses. Sociodemographic and clinical information data were abstracted from each consenting person's most recent ADRC record. Since two parent studies used the different questionnaires for the variables of number of comorbid conditions, several steps were taken to merge these variables into one variable. First, a master's-prepared nurse researcher reviewed and identified differences and similarities among the comorbid condition questionnaires. And then, adapted each comorbid condition item in the MCI parent study to the T2DM parent study questionnaire, the Center for Research in Chronic Disorders (CRCD) Comorbidity Questionnaire (Sereika & Engberg, 2006), because the items in the CRCD questionnaire included more comorbid conditions. If there is a discrepancy between the ADRC and the CRCD forms, the items were dropped from the final form. For example, we dropped the "vitamin B12 deficiency" item because while the ADRC form included this item, the CRCD form did not. Also, if each questionnaire investigated similar health conditions, we used more generalized items to include all the related health conditions. For example, while the CRCD questionnaire has an item for overall heart conditions, the ADRC form used the separate items for the heart conditions such as myocardial infarct, congestive heart failure, atrial fibrillation, and angina. If the MCI participants answered they have diagnosed with any of these heart conditions, we coded this participant as diagnosed with "heart conditions" using the CRCD questionnaire. After the researcher coded and entered the comorbid condition data based on the CRCD questionnaire, a doctorally prepared statistician reviewed this procedure to verify the data reliability. A total of 15 comorbid conditions were identified for this study.

4.3.4 Data Analysis

Prior to analysis, each of the datasets from the T2DM (n = 147) and MCI (n = 90) parent studies were screened using descriptive and exploratory methods separately and collectively for anomalies (e.g., outliers, missing data, violations of statistical assumptions). The baseline datasets from the two parent studies were concatenated for analysis as one dataset based on sociodemographic and clinical factors, and each dimension of illness perception. The analysis for this investigation was based on 236 participants because one individual (0.68%) from the T2DM parent study did not complete the Brief IPQ. Group comparisons were performed for all sociodemographic variables by participants' disease group (MCI or T2DM) using independent *t*-tests (for continuous-type variables) or chi-square tests of independence (for categorical variables) before analyzing each dimension of illness perception. Sociodemographic information and the number of comorbid conditions were examined as potential covariates for each dimension of illness perception.

First, multivariate analysis of covariance (MANCOVA) was performed to compare overall illness perceptions between the T2DM and MCI groups treating the eight dimensions of Brief IPQ as a set simultaneously. Sociodemographics and the number of comorbid conditions were also examined for possible associations with each illness perception variable and, if significant associations were found, they were controlled for in the analysis. With the exceptions of timeline and coherence dimensions, statistical assumptions were met for each dimension of illness perception in the model. Since the dimensions of timeline and coherence were severely negatively skewed, these variables were reflected and then a square root transformation of the scales was applied. We used both original and transformed variables, which did not change the conclusions drawn; therefore, the original variables were used in our analysis.

Next, a hierarchical multiple linear regression analysis was conducted for each dimension of illness perception because the multivariate tests were statistically significant (F [80, 1800] = 2.50, $p < .001$, Pillai's trace = .380), suggesting that the T2DM and MCI groups have significantly different illness perceptions about their conditions. For each dimension of illness perception, three successive linear regression models were estimated. In block one, a model with only covariates/confounding variables (i.e., age, sex, years of education, marital status, the number of comorbid conditions) was estimated. In block two, a primary independent variable (disease group; T2DM or MCI) was added, and in the final block, interaction terms between the disease group variable (T2DM or MCI) and possible covariates (i.e., age, years of education, number of comorbid conditions) were added to explore the interactions on each dimension of illness perception. To limit the multicollinearity effects, age, years of education, and number of comorbid conditions were centered when creating the interaction terms. All analyses were performed using SPSS® Statistics Version 25.0 (IBM Corp., Armonk, NY) and the level of statistical significance for two-sided hypothesis testing was set at .05.

4.4 Results

4.4.1 Sample Characteristics

Our sample (N = 236; n = 146 [T2DM], n = 90 [MCI]) included participants who were, on average of 67.5 ± 9.5 years of age, had 14.9 ± 3.0 years of education, predominantly Caucasian (76.7%; n = 181), and with a reported mean 5 number of comorbid conditions ranging from 1 to 11. Most participants reported living with a significant other or being married (61%; n = 144).

T2DM and MCI groups differed significantly across sociodemographic features, except the number of comorbid conditions (see Table 19).

Table 19. Sample Characteristics

(N = 236)

Variable	Total (N = 236)	T2DM (n = 146)	MCI (n = 90)	Test Statistic	*p*-value
Age (years) mean ± SD	67.48 ± 9.54	64.38 ± 8.65	72.51 ± 8.77	t(234) = -6.98	< .001
Education (years) mean ± SD	14.92 ± 2.98	13.97 ± 2.82	16.48 ± 2.55	t(234) = -6.89	< .001
Sex, n (%) male	116 (49.2)	62 (42.5)	54 (60)	$x^2(1) = 6.849$	.009
Race, n (%) white	181 (76.7)	98 (67.1)	83 (92.2)	$x^2(1) = 19.624$	< .001
Marital Status, n (%) Married/living with a partner	144 (61)	75 (51.4)	69 (76.7)	$x^2(1) = 14.979$	< .001
†Number of Comorbid Conditions (Range Min. – Max.)	4.98 ± 1.69 (1–11)	4.84 ± 1.58 (1–11)	5.22 ± 1.85 (2–10)	t(234) = -1.71	.089

Notes. SD = standard deviation; MCI = mild cognitive impairment; T2DM = type 2 diabetes; Min. = minimum; Max. = maximum.
†Number of comorbid conditions (in addition to MCI and T2DM) was calculated.

4.4.2 Illness Perceptions: Type 2 Diabetes vs. Mild Cognitive Impairment

As indicated in Table 20, the highest mean score among the illness perception dimensions was on the timeline (8.77 ± 2.01 [T2DM]; 8.29 ± 2.41 [MCI]) in both groups. The identity (4.10 ± 2.49) and consequences (4.24 ± 2.20) dimensions were the lowest mean scores in the T2DM and MCI groups, respectively. Results from hierarchical linear regression models testing similarities and differences in each dimension of illness perception between MCI and T2DM groups are summarized in Tables 21, 22, 23, and 24.

Consequences While participants with T2DM and those with MCI did not have significantly different perception of consequences of their health conditions, the interaction of participants' disease group (T2DM or MCI) and the number of comorbid conditions was significant (b = -.432, p = .027) to the consequences variable (see Table 21).

Timeline Participants' race was the powerful predictor of timeline perception which was statistically significant in each block of hierarchical regression analyses (Table 21). Disease group (T2DM or MCI) was associated with participants' perception of timeline (b = -.945, p = .008), and remained significantly when the interactions were added to the model (b = -.903, p = .013). There was a trend for the association between participants' perception of timeline and the interaction of the disease group and age (b = -.062, p = .065).

Personal control As seen in Table 22, participants' disease group variable (T2DM or MCI) was significantly associated with perception of personal control and remained significant when the interaction terms were added to the regression model (b = -.943, p = .009 [block 2]; b = -.893, p = .016 [block 3]). However, the interactions of participants' disease group variable and covariates were not significant to participants' perception of personal control.

Treatment control Age was associated with participants' perception about treatment controllability (b = -.035, p = .024) in block 1; however, this association disappeared when adding other predictors (see Table 22). Participants' disease group variable (T2DM or MCI) was significantly associated with perception of treatment control in both block 2 (b = -1.619, p < .001) and block 3 (b = -1.435, p < .001). The interaction of the disease group variable and participants' education attainment was significant (b = -.270, p = .011) to the treatment control.

Identity As reported in Table 23, disease group of participants (i.e., T2DM or MCI) was the most significant predictor of the identity variable (b = .987, p = .012 [block 2]; b = .922, p = .020 [block 3]). Interactions did not significantly predict identity variable when entered hierarchically into the analysis.

Concerns Disease group of participants (i.e., T2DM or MCI) was tested in block 2 and the result shows that the disease group was associated with participants' concerns about their health conditions (b = 3.273, p < .001), and remained significant when interaction terms were added to the model (b = 3.246, p < .001) (see Table 23). The interaction of the disease group variable and the number of comorbid conditions was statistically significant (b = -.563, p = .012) to the participants' concerns about their conditions.

Coherence As shown in Table 24, perceived coherence of participants (i.e., understanding of the conditions or its symptoms) was significantly associated with the disease group, T2DM or MCI (b = -1.265, p = .001), and this association remained significant when interactions were added to the model (b = -1.312, p = .001). The interaction of the disease group variable and age was significant (b = 0.080, p = 0.026) to the coherence variable.

Emotional representations Disease group variable (i.e., T2DM or MCI) of participants was a robust predictor of disease-related emotional representations (e.g., anger, anxiety) (b = -2.186, p <

.001) (see Table 24). Emotional representations remained significant (b = -2.113, p < .001) when interactions were added to the regression model, but we did not observe any interaction effect.

Table 20. Illness Perceptions in T2DM and MCI Participants

(N = 236)

	Mean (±SD)/Median Rating		
Dimension of Illness Perception (possible Score: 0–10)	Total (N = 236)	T2DM (n = 146)	MCI (n = 90)
Consequences	4.55 ± 2.49/4	4.74 ± 2.64/5	4.24 ± 2.20/4
Timeline	8.59 ± 2.18/10	8.77 ± 2.01/10	8.29 ± 2.41/10
Personal Control	6.24 ± 2.20/6	6.60 ± 2.08/7	5.66 ± 2.26/6
Treatment Control	7.32 ± 2.17/8	7.97 ± 1.96/8	6.26 ± 2.09/7
Identity	4.26 ± 2.35/4	4.10 ± 2.49/4	4.52 ± 2.10/4
Concerns	5.39 ± 3.10/6	4.45 ± 2.99/5	6.93 ± 2.64/8
Coherence	7.69 ± 2.36/8	8.16 ± 2.36/9	6.91 ± 2.17/7
Emotional Representations	6.36 ± 2.65/7	7.28 ± 2.34/8	4.86 ± 2.43/5

Notes. SD = standard deviation; MCI = mild cognitive impairment; T2DM = type 2 diabetes; Min. = minimum; Max. = maximum.

Table 21. Hierarchical Linear Regression Model of Disease Group (T2DM or MCI) as a Predictor of Consequences and Timeline

(N = 236)

		Consequences						Timeline					
		Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
		Unstandardized Regression Coefficients											
Block	Predictor	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value
1	(Constant)	7.460	<0.001	7.461	<0.001	6.710	0.001	8.547	<0.001	6.794	<0.001	5.464	0.003
	Age (years)	-0.027	0.129	-0.027	0.161	-0.028	0.259	-0.009	0.566	0.008	0.635	0.030	0.158
	Male[a]	0.151	0.664	0.151	0.665	0.175	0.614	-0.288	0.349	-0.282	0.352	-0.278	0.358
	White[b]	-0.366	0.400	-0.366	0.402	-0.428	0.329	1.017	0.008	1.068	0.005	1.041	0.007
	Education (years)	-0.105	0.071	-0.105	0.089	-0.114	0.135	0.027	0.600	0.075	0.163	0.062	0.355
	Married/ living with a partner[c]	<0.001	0.999	-0.001	0.999	-0.028	0.942	-0.173	0.595	0.012	0.970	0.024	0.942
	[†]Comorbid condition	0.137	0.163	0.137	0.166	0.340	0.012	-0.058	0.506	-0.037	0.668	-0.019	0.874
2	MCI[d]			0.001	0.999	0.020	0.962			-0.945	0.008	-0.903	0.013
[‡]3	MCI × age					-0.008	0.831					-0.062	0.065
	MCI × education					0.062	0.629					0.085	0.450
	MCI × comorbid condition					-0.432	0.027					-0.049	0.771
	R^2	0.045		0.045		0.068		0.036		0.065		0.082	
	Adjusted R^2	0.020		0.015		0.026		0.011		0.036		0.041	

Notes. MCI = mild cognitive impairment; T2DM = type 2 diabetes.

[†]Number of comorbid conditions (in addition to MCI and T2DM conditions) was calculated.

[‡]For interactions, age, education, and number of comorbid conditions were mean centered due to multicollinearity.

[a] Female was treated as the reference category for sex.

[b] Non-white was treated as the reference category for race.

[c] The combined category of never married, widowed, separated, or divorced was treated as reference category for marital status.

[d] T2DM was treated as the reference category for disease group.

Table 22. Hierarchical Linear Regression Model of Disease Group (T2DM or MCI) as a Predictor of Personal Control and Treatment Control

(N = 236)

		Personal Control						Treatment Control					
		Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
		Unstandardized Regression Coefficients											
Block	Predictor	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value
1	(Constant)	7.801	<0.001	6.052	<0.001	5.107	0.006	11.633	<0.001	8.630	<0.001	6.275	<0.001
	Age (years)	0.002	0.881	0.019	0.254	0.036	0.098	-0.035	0.024	-0.006	0.718	0.012	0.555
	Male[a]	-0.117	0.706	-0.111	0.716	-0.125	0.683	-0.540	0.072	-0.530	0.064	-0.578	0.042
	White[b]	-0.205	0.596	-0.153	0.688	-0.165	0.669	0.075	0.842	0.163	0.648	0.065	0.855
	Education (years)	-0.045	0.386	0.003	0.953	0.015	0.822	-0.074	0.136	0.008	0.878	0.107	0.087
	Married/ living with a partner[c]	-0.452	0.170	-0.267	0.422	-0.243	0.466	-0.304	0.340	0.014	0.964	0.059	0.849
	†Comorbid condition	-0.114	0.194	-0.093	0.284	-0.156	0.193	-0.096	0.256	-0.060	0.455	-0.079	0.472
2	MCI[d]			-0.943	0.009	-0.893	0.016			-1.619	<0.001	-1.435	<0.001
‡3	MCI × age					-0.040	0.248					-0.027	0.389
	MCI × education					-0.016	0.887					-0.270	0.011
	MCI x comorbid condition					0.129	0.454					0.049	0.757
	R^2	0.032		0.061		0.068		0.277		0.404		0.438	
	Adjusted R^2	0.007		0.032		0.027		0.053		0.137		0.156	

Notes. MCI = mild cognitive impairment; T2DM = type 2 diabetes.

†Number of comorbid conditions (in addition to MCI and T2DM conditions) was calculated.

‡For interactions, age, education, and number of comorbid conditions were mean centered due to multicollinearity.

[a] Female was treated as the reference category for sex.

[b] Non-white was treated as the reference category for race.

[c] The combined category of never married, widowed, separated, or divorced was treated as reference category for marital status.

[d] T2DM was treated as the reference category for disease group.

Table 23. Hierarchical Linear Regression Model of Disease Group (T2DM or MCI) as a Predictor of Identity and Concerns

(N = 236)

		Identity						Concerns					
		Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
		Unstandardized Regression Coefficients											
Block	Predictor	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value
1	(Constant)	5.146	<0.001	6.977	<0.001	7.233	<0.001	3.260	0.063	9.332	<0.001	9.774	<0.001
	Age (years)	-0.004	0.817	-0.022	0.237	-0.023	0.319	0.002	0.916	-.056	0.011	-0.081	0.004
	Male[a]	-0.101	0.763	-0.107	0.746	-0.067	0.838	-0.016	0.972	-.036	0.929	-0.002	0.996
	White[b]	-0.306	0.465	-0.360	0.385	-0.359	0.387	-0.132	0.809	-.312	0.533	-0.365	0.466
	Education (years)	-0.046	0.406	-0.096	0.100	-0.155	0.033	0.044	0.544	-.122	0.085	-0.128	0.142
	Married/ living with a partner[c]	-0.020	0.956	-0.213	0.553	-0.248	0.488	0.686	0.142	.044	0.920	-0.009	0.983
	[†]Comorbid condition	0.073	0.438	0.052	0.582	0.191	0.137	0.202	0.105	.130	0.253	0.399	0.010
2	MCI[d]			0.987	0.012	0.922	0.020			3.273	<0.001	3.246	<0.001
[‡]3	MCI × age					-0.012	0.735					0.053	0.228
	MCI × education					0.199	0.104					0.020	0.892
	MCI × comorbid condition					-0.305	0.100					-0.563	0.012
	R^2	0.013		0.041		0.066		0.024		0.196		0.223	
	Adjusted R^2	-0.013		0.011		0.025		-0.002		0.172		0.188	

Notes. MCI = mild cognitive impairment; T2DM = type 2 diabetes.

[†]Number of comorbid conditions (in addition to MCI and T2DM conditions) was calculated.

[‡]For interactions, age, education, and number of comorbid conditions were mean centered due to multicollinearity.

[a] Female was treated as the reference category for sex.

[b] Non-white was treated as the reference category for race.

[c] The combined category of never married, widowed, separated, or divorced was treated as reference category for marital status.

[d] T2DM was treated as the reference category for disease group.

Table 24. Hierarchical Linear Regression Model of Disease Group (T2DM or MCI) as a Predictor of Coherence and Emotional Representations

(N = 236)

		Coherence						Emotional Representations					
		Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
		Unstandardized Regression Coefficients											
Block	Predictor	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value	*b*	*p* value
1	(Constant)	9.336	<0.001	6.989	<0.001	8.630	<0.001	13.156	<0.001	9.101	<0.001	7.722	<0.001
	Age (years)	-0.026	0.123	-0.003	0.855	-0.031	0.165	-0.075	<0.001	-0.036	0.050	-0.012	0.614
	Male[a]	-0.485	0.140	-0.478	0.138	-0.485	0.130	-0.666	0.062	-0.652	0.052	-0.673	0.045
	White[b]	-0.510	0.215	-0.441	0.273	-0.408	0.312	0.192	0.665	0.312	0.455	0.294	0.486
	Education (years)	0.021	0.700	0.085	0.134	0.106	0.130	-0.051	0.391	0.060	0.308	0.079	0.285
	Married/ living with a partner[c]	-0.423	0.226	-0.174	0.617	-0.187	0.590	-0.615	0.104	-0.186	0.609	-0.151	0.677
	†Comorbid condition	0.134	0.150	0.162	0.077	0.134	0.281	-0.084	0.401	-0.036	0.702	-0.125	0.337
2	MCI[d]			-1.265	0.001	-1.312	0.001			-2.186	<0.001	-2.113	<0.001
‡3	MCI × age					0.080	0.026					-0.057	0.130
	MCI × education					-0.121	0.307					-0.027	0.830
	MCI × comorbid condition					0.073	0.684					0.182	0.330
	R^2	0.059		0.103		0.128		0.124		0.229		0.240	
	Adjusted R^2	0.034		0.076		0.089		0.101		0.206		0.206	

Notes. MCI = mild cognitive impairment; T2DM = type 2 diabetes.

†Number of comorbid conditions (in addition to MCI and T2DM conditions) was calculated.

‡For interactions, age, education, and number of comorbid conditions were mean centered due to multicollinearity.

[a] Female was treated as the reference category for sex.

[b] Non-white was treated as the reference category for race.

[c] The combined category of never married, widowed, separated, or divorced was treated as reference category for marital status.

[d] T2DM was treated as the reference category for disease group.

4.5 Discussion

The present study is the first investigation comparing older adults' illness perceptions in chronic disorders based on the disease characteristics, physical or mental conditions. As the field of research on chronic disorders moves toward identifying secondary prevention strategies, our investigation of T2DM and MCI participants will provide the clinical and public health significance of individuals' unique perceptions about their health conditions. Such perceptions are related to subsequent self-management behaviors, and ultimately may affect individuals' health outcomes such as quality of life (Dempster, Howell, & McCorry, 2015). Our analysis showed that, in general, illness perceptions were different between older adults with T2DM and those with MCI when the set of illness perception dimensions were examined multivariately. When the dimensions of illness perception were tested separately, with the exception of the consequences dimension, each dimension of illness perception was significantly associated with individuals' disease characteristics, T2DM or MCI.

Participants with T2DM were more likely than those with MCI to view their condition as being chronic and controllable. Similarly, participants with T2DM endorsed having a more clear understanding of, and more negative feelings (e.g., anger, upset) about their condition as compared to those with MCI. In contrast to these findings, persons with MCI were more likely to experience physical symptoms, and have higher levels of concerns about their condition compared to those with T2DM. Not surprisingly, the highest mean score was on the timeline dimension in both T2DM and MCI groups, suggesting that our participants tended to believe that their conditions will be long-lasting rather than short-term regardless of the disease characteristics.

Perceived controllability: physical disorder [T2DM] vs. mental disorder [MCI]

According to the state of the science for late-life chronic conditions, physical conditions (e.g., T2DM, hypertension, and arthritis) have more promising ways to prevent or delay the disease progression (e.g., lifestyle change and medication taking) as compared to mental conditions (e.g., MCI, AD, and depression). Our findings of significant differences in control perceptions between older adults with T2DM and those with MCI support such scientific phenomenon. Specifically, our analyses revealed that participants with T2DM tended to believe their condition as being more controllable through personal strategies and/or medical treatment as compared to those with MCI. These findings are congruent with previous studies of persons with physical conditions that higher levels of perceived personal and/or treatment controls were noted in both Stalling's (2016) study of 204 persons with hypertension and in Wierenga's (2017) study of 58 persons with heart failure. While physical disorders such as T2DM are manageable chronic conditions so that persons living with T2DM can live long and healthy if they maintain healthy life styles or take medications (if prescribed), the facts remain that no medications or interventions for MCI make patients feel less control over their condition. This may be the reason that our T2DM participants had significantly higher perceptions of both personal and treatment controls over their condition.

Given that control perceptions have been identified as a driver of problem-focused coping strategies (Hagger et al., 2017), lower disability, and positive health outcomes such as better functioning at work and better family relationships (Baines & Wittkowski, 2013; Broadbent et al., 2015) regardless of the disease characteristics, our findings suggest that older adults with physical disorders [T2DM] may tend to seek information or assistance in managing their conditions as compared to those with mental disorders [MCI].

Perceived Understanding in Physical Disorder [T2DM] and Mental Disorder [MCI]

Our participants with MCI had significantly lower coherence perception as compared to those with T2DM, indicating that MCI participants endorsed the view that their cognitive or memory difficulties do not make sense to them or, are not easily understandable, so that such a lack of coherence may lead to poor treatment compliance. Although prior studies of individuals' coherence perception have been focused on either mental (Hussain et al., 2017; Lingler et al., 2016) or physical (Kristoffersen, Lundqvist, & Russell, 2019; Nie et al., 2018; Stallings, 2016) conditions, our finding does support previous research that persons with mental disorders were more likely than those with physical disorders to have lower levels of perceived understanding about their conditions. The mood and anxiety disorder groups reported the lowest scores on the coherence item among the dimensions of illness perceptions in a study by Subramanian et al. (2018), whereas persons with hypertension had a higher perceived understanding about their condition (Stallings, 2016). Such discrepancy may reflect differences in disease characteristics, for example, the diagnostic process or monitoring of disease progression of mental disorders differentiates it from physical health disorders with the definitive indicators (e.g., blood tests, urine test, and imaging tests).

Concerns about patients' uncertainty about their own mental disorders have also surfaced in research on the MCI population. The findings of a metasynthesis of 17 MCI qualitative interviews (Gomersall et al., 2015) were similar to our findings that persons with MCI were confused about their cognitive decline, indicating that the unclear course of the disease and the lack of secondary prevention strategies for AD may be related to less understanding about the disease in persons with MCI. In a study by Lin et al. (2012) also reported that, one third of participants believed MCI would convert to dementia, but most participants with MCI were not

sure the prognosis of their memory problems, which provides context for the current finding of lower perception of illness coherence in older adults with MCI as compared to those with T2DM. Our analysis of coherence perception in persons with T2DM is also consistent with previous research. For example, cross-sectional studies have revealed persons with T2DM to clearly understand their health conditions (Al-Amer et al., 2016; Nie et al., 2018), and in a qualitative interview (Tanenbaum et al., 2015), data revealed an understanding about the course of, and management of the condition among persons with T2DM. Tanenbaum et al. (2015) also highlighted that the level of understanding about T2DM is a key factor for subsequent self-management behaviors. Considering that higher perception of illness coherence has been significantly associated with problem-focused coping strategies (e.g., asking for assistance and seeking out information) and well-being in persons with chronic disorders (Hagger et al., 2017), persons with physical disorders such as T2DM may be more likely than those with mental disorders such as MCI to engage in obtaining helpful information on available support systems.

Interestingly, persons with T2DM had more negative feelings (e.g., anger and anxiety) about their condition as compared to those with MCI which was not expected. One potential reason for this finding is that persons with T2DM may be overwhelmed by negative feelings because T2DM needs a life-long, careful management including checking blood glucose levels, following the healthy meal plans, or taking medications if prescribed (Aljuaid, Almutairi, Assiri, Almalki, & Alswat, 2018). In contrast to T2DM, persons with MCI may remain stable or return to a cognitively intact state (Petersen et al., 2018), suggesting that persons with MCI may have less negative feelings than those with T2DM because the diagnosis does not necessarily mean an AD diagnosis. Other factors impact on negative feelings among older adults with chronic disorders should be investigated.

Given differences in illness perceptions between older adults with T2DM and those with MCI, clinicians and public health experts should not only focus on individuals' disease characteristics (physical vs. mental), but also take into account individuals' unique perceptions about the health conditions when discussing and planning self-management behaviors. Future studies are needed to investigate the association between illness perceptions and self-management behaviors in older adults with chronic disorders, depending on the disease characteristics, either physical or mental disorder.

5.0 Summary of Dissertation Findings

This dissertation project is comprised of three complementary studies to address gaps in knowledge on illness perceptions and self-management in late-life chronic disorders. Findings are documented in the following three manuscripts:

Manuscript 1. Illness Perceptions and Self-management among Older Adults with Mild Cognitive Impairment

Manuscript 2. Illness Perceptions, Self-efficacy, and Medication Adherence among Older Adults with Type 2 Diabetes

Manuscript 3. Illness Perceptions in Type 2 Diabetes and Mild Cognitive Impairment

Although each manuscript described a study with a unique purpose, the findings together advance understanding of illness perceptions and self-management among older adults with chronic disorders by highlighting the influence of disease characteristics, specifically whether the condition represents a physical [T2DM] or mental [MCI] disorder. I adapted Leventhal's (1984, 2003) *Common Sense Model (CSM) of Self-Regulation* as a conceptual framework for this set of studies. The rationale for selecting this framework is that, unlike other models, the CSM framework places illness perceptions into the center of the process around the performance of health behaviors. Below is a summary of the key messages embedded within this framework.

First, illness perceptions can independently, or through their interactions with sociodemographic characteristics/comorbid conditions, be associated with either self-efficacy or self-management among older adults with chronic disorders. For example, in our sample of persons with MCI, a trend in the association between illness perceptions and self-management was only observed when considering sociodemographic characteristics or the number of comorbid conditions (manuscript 1). Illness perceptions were associated with both self-efficacy

and medication adherence among older adults with T2DM, which suggests that beliefs about T2DM may play an important role in managing T2DM (manuscript 2). Taken together, these findings confirm previous research that not only illness perceptions, but sociodemographics and comorbid conditions may also affect self-management practices to prevent or delay disease progression among older adults with chronic disorders. This finding holds true regardless of one's disease characteristics. A recent meta-analysis suggests that certain dimensions of illness perceptions, such as perceived controllability and illness coherence, are associated with either coping strategies or well-being among persons with chronic disorders (Hagger et al., 2017). Indeed, nurses and other health care professionals who are counseling older adults with chronic disorders should consider patients' perceptions about their health conditions together with sociodemographic characteristics and comorbid conditions.

Another core message from this dissertation project is that patients' disease characteristics (physical [T2DM] or mental [MCI]) play a critical role in how older adults formulate perceptions about health conditions affecting them. Specifically, our tests of effect of disease characteristics (T2DM or MCI) revealed significant differences in illness perceptions between T2DM and MCI participants after controlling for covariates (manuscript 3). Although both T2DM and MCI participants believed that their conditions will be long-lasting, our participants with T2DM were more likely than those with MCI to view their condition as being controllable and understandable. This may reflect distinct differences in disease characteristics between late-life physical and mental disorders. For example, stigma associated with late-life cognitive changes and the fact that there is no curative treatment for MCI may contribute to lower levels of perceived controls over and understanding of a health condition among our participants with MCI. While illness perceptions may affect subsequent self-management behaviors in chronic

disorders (Leventhal et al., 2016), other factors such as sociodemographics and comorbid conditions may also serve as facilitators or barriers to self-management in chronic disorders (Schulman-Green, Jaser, Park, & Whittemore, 2016). Therefore, understanding patients' unique illness perceptions based on their disease characteristics (physical or mental) as well as other factors (sociodemographics and comorbid conditions) is a first step to improve self-management in late-life chronic disorders.

In sum, this dissertation advances the current state of scientific knowledge with regard to illness perceptions and self-management as well as self-efficacy within the context of late-life physical [T2DM] and mental [MCI] disorders. Knowledge obtained from this dissertation project suggests direction of future research including:

1) Longitudinal investigations exploring the causal relationship between illness perceptions and self-management in late-life chronic disorders.
2) Identifying a mediating role of self-efficacy in the relationship between illness perceptions and self-management.
3) Testing a full CSM process in which associations between illness perceptions, self-management, and health outcomes are considered.
4) Validating and extending findings in samples comprised of persons experiencing other late-life physical and mental disorders.

Appendix A: Study Instruments and Assessments

Brief Illness Perception Questionnaire (Brief IPQ)

For the following questions, please circle the number that best corresponds to your views:

(*Note.* The term "your illness" was replaced with "diabetes" or "your memory difficulties/MCI" in the parent studies)

1.How much does <u>your illness</u> affect your life?										
0 no affect at all	1	2	3	4	5	6	7	8	9	10 severely affects my life
2.How long do you think <u>your illness</u> will continue?										
0 a very short time	1	2	3	4	5	6	7	8	9	10 forever
3.How much control do you feel you have over <u>your illness</u>?										
0 absolutely no control	1	2	3	4	5	6	7	8	9	10 extreme amount of control
4.How much do you think your treatment can help <u>your illness</u>?										
0 not at all	1	2	3	4	5	6	7	8	9	10 extremely helpful
5.How much do you experience symptoms from <u>your illness</u>?										
0 no symptoms at all	1	2	3	4	5	6	7	8	9	10 many severe symptoms
6.How concerned are you about <u>your illness</u>?										
0 no at all concerned	1	2	3	4	5	6	7	8	9	10 extremely concerned

7.How well do you feel you understand <u>your illness</u>?

0	1	2	3	4	5	6	7	8	9	10
don't understand at all										understand very clearly

8.How much does <u>your illness</u> affect you emotionally? (e.g., does it make you angry, scared, upset or depressed?)

0	1	2	3	4	5	6	7	8	9	10
no at all affected emotionally										extremely affected emotionally

9.Please list in rank-order the three most important factors that you believe caused <u>your illness</u>.

The most important causes for me:

1._____

2._____

3._____

Illness Perception Questionnaire-R (IPQ-R): Illness Coherence and Causality Subscales

Illness Coherence Subscale

The following are five statements about how you view your memory or thinking difficulties. Although these statements may seem similar, it is important I read all of them and ask you to rate how much you agree or disagree with each one.

Please indicate how much you agree or disagree with the following statements about your illness by ticking the appropriate box.

Views About Your Illness	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
The symptoms of my memory or thinking difficulties are puzzling to me	❍	❍	❍	❍	❍
My memory or thinking difficulties are a mystery to me	❍	❍	❍	❍	❍
I don't understand my memory or thinking difficulties	❍	❍	❍	❍	❍
My memory or thinking difficulties doesn't make any sense to me	❍	❍	❍	❍	❍
I have a clear picture or understanding of my memory or thinking difficulties	❍	❍	❍	❍	❍

Causality Subscale

We are interested in what you consider may have been the cause of your memory or thinking difficulties. As people are very different, there is no correct answer for this question. We are most interested in your own views about the factors that caused your memory or thinking difficulties rather than what others including doctors or other family may have suggested to you.

Please list in rank-order the three most important factors that you believe caused your memory or thinking difficulties.

The most important causes for me…

Cause 1: _____

Cause 2: _____

Cause 3: _____

Assessment of Intention to Perform Health Behaviors

(*Notes.* This questionnaire was used in the first set of MCI parent study. The data will be manually recoded to address the items assess by the REVEAL Health Behavior measure [Chao et al., 2008], which is provided on the next page.)

Interview Instructions: Introduce this assessment by informing the participant that the following set of questions focuses on his or her plans to perform health-related activities that may have been discussed at his or her last clinic visit (use Recommendation Form responses to identify action for insertion below). Instruct the participant to select the response that best describes his or her intentions.

Section A:

1. How likely are you to within the next six months?

Very likely **Somewhat likely** **Not sure** **Somewhat unlikely** **Very unlikely**

2. How likely are you to within the next six months?

Very likely **Somewhat likely** **Not sure** **Somewhat unlikely** **Very unlikely**

3. How likely are you to within the next six months?

Very likely **Somewhat likely** **Not sure** **Somewhat unlikely** **Very unlikely**

4. How likely are you to within the next six months?

Very likely **Somewhat likely** **Not sure** **Somewhat unlikely** **Very unlikely**

5. How likely are you to within the next six months?

Very likely **Somewhat likely** **Not sure** **Somewhat unlikely** **Very unlikely**

6. How likely are you to within the next six months?

Very likely **Somewhat likely** **Not sure** **Somewhat unlikely** **Very unlikely**

Section B:

What, if any, other changes will you make as a result of being diagnosed with mild cognitive impairment?

_____

Health Behavior Assessment

Are you currently taking any steps to help prevent further memory problems or the onset of Alzheimer's disease?

Yes _____ No _____

This lists some categories of health or behavior changes that apply to some people.
As we run down this list, let me know which categories apply to the changes you have made, and then specifically what change was made.
What types of preventative measure are you taking? Since your diagnosis, have you made any…

Preventative Measures		
	Yes	**Please Specify**
1. **Dietary changes**	○	
2. Physical activities	○	
3. Medications	○	
4. Vitamins	○	
5. Herbal Supplements	○	
6. Activities to reduce stress	○	
7. Mental activities (e.g., crossword puzzles, luminosity)	○	
8. Other life style changes (e.g., alcohol consumption, driving routine, etc.)	○	

Self-Efficacy for Managing Chronic Disease (SEMCD)

We would like to know how confident you are in doing certain activities. For each of the following questions, please choose the number that corresponds to your confidence that you can do the tasks regularly at the present time.

1. How confident are you that you can keep the fatigue caused by your diabetes from interfering with the things you want to do?

Not at all confident									**Totally confident**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

2. How confident are you that you can keep the physical discomfort or pain of your diabetes from interfering with the things you want to do?

Not at all confident									**Totally confident**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

3. How confident are you that you can keep the emotional distress caused by your diabetes from interfering with the things you want to do?

Not at all confident									**Totally confident**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

4. How confident are you that you can keep any other symptoms or your diabetes you have from interfering with the things you want to do?

Not at all confident									**Totally confident**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

5. How confident are you that you can do the different tasks and activities needed to manage your diabetes so as to reduce you need to see a doctor?

Not at all confident									**Totally confident**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

6. How confident are you that you can do things other than just taking medication to reduce how much your diabetes affects your everyday life?

Not at all confident									**Totally confident**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

4-item Morisky Medication Adherence Scale (MMAS- 4)

1. Do you ever forget to take your medication?
   Yes _____ No _____

2. Are you careless at times about taking your medicine?
   Yes _____ No _____

3. Sometimes if you feel worse when you take the medicine, do you stop taking it?
   Yes _____ No _____

4. When you feel better do you sometimes stop taking your medicine?
   Yes _____ No _____

Appendix B: Human Subjects Training Modules Certificates

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)

COMPLETION REPORT - PART 1 OF 2
COURSEWORK REQUIREMENTS*

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

- **Name:** Hyejin Kim (ID: 5501175)
- **Institution Affiliation:** University of Pittsburgh (ID: 2074)

- **Curriculum Group:** Social and Behavioral Science Human Subjects
- **Course Learner Group:** Social-Behavioral-Educational Course
- **Stage:** Stage 1 - Basic Course
- **Description:** Choose this group to satisfy CITI training requirements for investigators and staff involved primarily in Social/Behavioral Research with human subjects.

- **Record ID:** 24569738
- **Completion Date:** 06-Feb-2018
- **Expiration Date:** 05-Feb-2022
- **Minimum Passing:** 80
- **Reported Score*:** 85

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
History and Ethical Principles - SBE (ID: 490)	06-Feb-2018	3/5 (60%)
Defining Research with Human Subjects - SBE (ID: 491)	06-Feb-2018	4/5 (80%)
The Federal Regulations - SBE (ID: 502)	06-Feb-2018	4/5 (80%)
Assessing Risk - SBE (ID: 503)	06-Feb-2018	5/5 (100%)
Informed Consent - SBE (ID: 504)	06-Feb-2018	5/5 (100%)
Privacy and Confidentiality - SBE (ID: 505)	06-Feb-2018	5/5 (100%)
Gender and Sexuality Diversity (GSD) in Human Research (ID: 16556)	06-Feb-2018	4/5 (80%)
Introduction to Community-Based Participatory Research (CBPR) (ID: 16995)	06-Feb-2018	4/5 (80%)

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid independent Learner.

Verify at: www.citiprogram.org/verify/?k97077a68-ab4a-4f72-a4bd-709ddf5d2a20-24569738

Collaborative Institutional Training Initiative (CITI Program)
Email: support@citiprogram.org
Phone: 888-529-5929
Web: https://www.citiprogram.org

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)

COMPLETION REPORT - PART 2 OF 2

COURSEWORK TRANSCRIPT**

** NOTE: Scores on this Transcript Report reflect the most current quiz completions, including quizzes on optional (supplemental) elements of the course. See list below for details. See separate Requirements Report for the reported scores at the time all requirements for the course were met.

- **Name:** Hyejin Kim (ID: 5501175)
- **Institution Affiliation:** University of Pittsburgh (ID: 2074)

- **Curriculum Group:** Social and Behavioral Science Human Subjects
- **Course Learner Group:** Social-Behavioral-Educational Course
- **Stage:** Stage 1 - Basic Course
- **Description:** Choose this group to satisfy CITI training requirements for investigators and staff involved primarily in Social/Behavioral Research with human subjects.

- **Record ID:** 24569738
- **Report Date:** 06-Feb-2018
- **Current Score**:** 87

REQUIRED, ELECTIVE, AND SUPPLEMENTAL MODULES	MOST RECENT	SCORE
History and Ethical Principles - SBE (ID: 490)	06-Feb-2018	3/5 (60%)
Defining Research with Human Subjects - SBE (ID: 491)	06-Feb-2018	4/5 (80%)
The Federal Regulations - SBE (ID: 502)	06-Feb-2018	4/5 (80%)
Assessing Risk - SBE (ID: 503)	06-Feb-2018	5/5 (100%)
Informed Consent - SBE (ID: 504)	06-Feb-2018	5/5 (100%)
Privacy and Confidentiality - SBE (ID: 505)	06-Feb-2018	5/5 (100%)
Cultural Competence in Research (ID: 15166)	30-Oct-2015	5/5 (100%)
Gender and Sexuality Diversity (GSD) in Human Research (ID: 16556)	06-Feb-2018	4/5 (80%)
Introduction to Community-Based Participatory Research (CBPR) (ID: 16995)	06-Feb-2018	4/5 (80%)

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid independent Learner.

Verify at: www.citiprogram.org/verify/?k97077a68-ab4a-4f72-a4bd-709ddf5d2a20-24569738

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Appendix C: IRB Approval

Manuscript 1.

University of Pittsburgh
Institutional Review Board

Human Research Protection Office
3500 Fifth Avenue, Suite 106
Pittsburgh, PA 15213
Tel (412) 383-1480
www.hrpo@pitt.edu

APPROVAL OF SUBMISSION (Exempt)

IRB:	STUDY18120135
PI:	Hyejin Kim
Title:	Illness Perceptions and Health Behaviors among Persons with Mild Cognitive Impairment
Funding:	None
Date:	January 17, 2019

On 1/17/2019, the Institutional Review Board reviewed and approved the above referenced application through the administrative review process. The study may begin as outlined in the University of Pittsburgh approved application and documents.

Approval Documentation

Review type:	Initial Study
Approval Date:	January 17, 2019

Exempt Category:	(4) Data, documents, or specimens
Determinations:	
Approved Documents:	• Measurements_Hyejin Kim • MCIPP consent form.doc • Consent form_Result Study.docx • Exemption form_Hyejin Kim

As the Principal Investigator, you are responsible for the conduct of the research and to ensure accurate documentation, protocol compliance, reporting of possibly study-related adverse events and unanticipated problems involving risk to participants or others. The HRPO Reportable Events policy, Chapter 17, is available at http://www.hrpo.pitt.edu/.

Research being conducted in an UPMC facility cannot begin until fiscal approval is received from the UPMC Office of Sponsored Programs and Research Support (OSPARS). Contact OSPARS@upmc.edu with questions.

If you have any questions, please contact the University of Pittsburgh IRB Coordinator, Amy Fuhrman.

Please take a moment to complete our Satisfaction Survey as we appreciate your feedback.

Manuscript 2.

University of Pittsburgh
Institutional Review Board

3500 Fifth Avenue
Pittsburgh, PA 15213
(412) 383-1480
(412) 383-1508 (fax)
http://www.irb.pitt.edu

Memorandum

To: Hyejin Kim
From: IRB Office
Date: 6/6/2018
IRB#: PRO18050218
Subject: Illness Perceptions, Self-efficacy, and Medication Adherence Among Persons with Type 2 Diabetes

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The above-referenced project has been reviewed by the Institutional Review Board. Based on the information provided, this project meets all the necessary criteria for an exemption, and is hereby designated as "exempt" under section

45 CFR 46.101(b)(4)

Please note the following information:

- Investigators should consult with the IRB whenever questions arise about whether planned changes to an exempt study might alter the exempt status. Use the **"Send Comments to IRB Staff"** link displayed on study workspace to request a review to ensure it continues to meet the exempt category.
- It is important to close your study when finished by using the **"Study Completed"** link displayed on the study workspace.
- Exempt studies will be archived after 3 years unless you choose to extend the study. If your study is archived, you can continue conducting research activities as the IRB has made the determination that your project met one of the required exempt categories. The only caveat is that no changes can be made to the application. If a change is needed, you will need to submit a NEW Exempt application.

Please be advised that your research study may be audited periodically by the University of Pittsburgh Research Conduct and Compliance Office.

Manuscript 3.

University of Pittsburgh
Institutional Review Board

Human Research Protection Office
3500 Fifth Avenue, Suite 106
Pittsburgh, PA 15213
Tel (412) 383-1480
www.hrpo@pitt.edu

APPROVAL OF SUBMISSION (Exempt)

IRB:	STUDY18120121
PI:	Hyejin Kim
Title:	Comparing Illness Perceptions Between Older Adults with Mild Cognitive Impairment and Those with Type 2 Diabetes
Funding:	None
Date:	January 10, 2019

On 1/10/2019, the Institutional Review Board reviewed and approved the above referenced application through the administrative review process. The study may begin as outlined in the University of Pittsburgh approved application and documents.

Approval Documentation

Review type:	Initial Study
Approval Date:	1/10/2019

Exempt Category:	(4) Data, documents, or specimens
Determinations:	
Approved Documents:	• Exemption_ExistingData Version_M3 revised.docx • Original consent form of Habit Study (T2DM sample) • BIPQ • Original consent form of Result Study (MCI sample)

As the Principal Investigator, you are responsible for the conduct of the research and to ensure accurate documentation, protocol compliance, reporting of possibly study-related adverse events and unanticipated problems involving risk to participants or others. The HRPO Reportable Events policy, Chapter 17, is available at http://www.hrpo.pitt.edu/.

If this trial meets the definition of a clinical trial, accrual cannot begin until it has been registered at clinicaltrials.gov and a National Clinical Trial number (NCT) provided. Contact ctgov@pitt.edu with questions.

Research being conducted in an UPMC facility cannot begin until fiscal approval is received from the UPMC Office of Sponsored Programs and Research Support (OSPARS). Contact OSPARS@upmc.edu with questions.

If you have any questions, please contact the University of Pittsburgh IRB Coordinator, Amy Fuhrman at fuhrman@pitt.edu.

Please take a moment to complete our Satisfaction Survey *as we appreciate your feedback.*

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