Effects of Physical Activity and Psychological Distress between Medical Comorbidity and HRQOL among People with Mental Illness: A Moderated Mediation Analysis

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I dedicate this work to my lovely wife, Chorong Lee, who makes my life meaningful and make me not give the shoe in any case. And to my parents who always support me through happy and difficult times alike.

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Abstract

Effects of Physical Activity and Psychological Distress between Medical Comorbidity and HRQOL among People with Mental Illness: A Moderated Mediation Analysis

More than 68% of adults with people with mental illness reported at least one medical disorder (Druss & Walker, 2011). Due to the combination of medical conditions and symptoms of mental illness, poor health-related quality of life (HRQOL) is common for people with mental illness (Barnes et al., 2012; Folsom et al., 2009). Lower levels of physical activity and severe psychological distress among people with mental illness are also the important contributing factors to decreased HRQOL. The purposes of this study were: 1) exploring differences in the co-occurrence of health-related factors such as presence of comorbidity, severity of psychological distress, and levels of physical activity between people with mental illness and the general population; 2) delineating the roles of physical activity and psychological distress when medical comorbidity affects HRQOL of people with mental illness.

A total of 3,797 individuals with mental illness and 32,621 individuals without mental illness were selected from the 2013 Behavioral Risk Factor Surveillance System (CDC, 2017). The criteria of mental illness in this study was having a depressive disorder, and taking medicine or receiving treatment for mental health problems at the time of contact. For the first research purpose, bivariate analyses were conducted to compare the key factors of interest between people with mental illness and without mental illness. Next, hierarchical regressions and structural equation modeling were conducted to examine mediation, moderation, and moderated mediation effects of physical activity and psychological distress using 3,797 individuals with mental illness.
People with mental illness have higher rates of comorbidity and psychological distress than people without mental illness, whereas general health, levels of physical activity and HRQOL of people with mental illness were lower than those without mental illness. Another key finding is a moderated mediation effect that levels of physical activity diminished the impact of comorbidity on psychological distress, which in turn makes the negative impact of comorbidity less likely to affect HRQOL among people with mental illness. The results indicate that increased physical activity might be linked with decreasing psychological distress and increasing HRQOL of people with mental illness when they have comorbid medical health problems.
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CHAPTER 1. INTRODUCTION

Problem Statement

In 2016, the National Survey on Drug Use and Health reported that an estimated 44.7 million individuals aged 18 or older in the US had some form of mental illness, which is defined as having experienced any mental, behavioral, or emotional disorders in the past year that met the criteria of the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; National Institute of Mental Health, 2014). An individual with mental illness who reports serious impairment in one or more life activities could be designated as having serious mental illness (Substance Abuse and Mental Health Services Administration, 2017). An estimated 10.4 million (4.2% of all adults in the US and 23.2% of adults with mental illness) people were considered to have serious mental illness (Substance Abuse and Mental Health Services Administration, 2017).

According to a global burden study by the World Health Organization, mental illnesses are the largest single source of disability-adjusted life years (DALY), which is thought of as one lost year of healthy life, worldwide among people ages 15 to 44 years (IsHak et al., 2012; Rössler, Salize, van Os, & Riecher-Rössler, 2005). Mental illness is a major cause of other physical health risks (Duckworth, 2013; US Burden of Disease Collaborators, 2013); conversely, physical illnesses can contribute to developing mental health conditions (Miyoshi, 2001). Therefore, there has been ongoing research on comorbid health conditions among people with mental illness.

Individuals with mental illness are more likely to be diagnosed with various chronic medical diseases such as obesity-related disease, cardiovascular disease, coronary heart disease, diabetes, and asthma (de Wit et al., 2010; Druss & Walker, 2011; Scott & Happell,
A systematic review and meta-analysis by Walker et al. (2015) found that the life expectancy of people with mental illness is shortened by 10 years (the median years of potential life lost in 24 studies). More precisely, mortality rates among people with schizophrenia (2 to 2.5 times) and bipolar (2 times), and depression (1.8 times) are higher than the general population (World Health Organization, 2013). About 60% of this excess mortality among people with severe mental illness is due to chronic medical health problems (De Hert et al., 2011). Moreover, their chronic medical health problems are associated with increased risks of suicide attempts, high rates of psychiatric hospitalization, high levels of psychotic symptoms, and poor quality of life (Lee, Wong, & Rothbard, 2014).

Recent studies have highlighted the negative relationships between medical comorbidity in people with mental illness and their health-related quality of life (HRQOL), which indicates the impact of disease-related or health-related factors on individuals’ perceived quality of life (Barnes, Murphy, Fowler, & Rempfer, 2012; Fenn et al., 2005). HRQOL is defined as a health-focused quality of life concept that reflects individuals’ subjective health condition, including aspects of health that influence quality of life (Miyamoto, Koichi, Akiyama, & Takamura, 2014). For example, in people with bipolar disorder, a combination of medical co-mobidity and characteristics of mental illness such as mood fluctuations, sleep disturbance, impaired interpersonal relationships, and cognitive impairment contribute to poor HRQOL (IsHak et al., 2012). Therefore, deterioration in mental health, physical health, and social functioning, which are key components of HRQOL, are commonly found in people with mental illness (Folsom et al., 2009).

Improving HRQOL in people with mental illness is an key outcome goal because HRQOL is a significant indicator of current physical, psychological, and social functioning.
(Abraham, Miller, Birgenheir, Lai, & Kilbourne, 2014). For this reason, recent research has focused on integrated mental and physical health services, particularly for people with mental illness who are most likely to suffer from mental and physical comorbidities (Barnes et al., 2012; Druss & Walker, 2011). One of the effective services is providing support for physical activity due to its mental and physical health benefits (Okoro, 2011). Incorporating physical activity interventions into mental health services has been considered in the mental health field (Richardson et al., 2005). It is becoming increasingly difficult to ignore the power of moderate and vigorous physical activity, which can reduce the risks of chronic medical problems such as cardiovascular diseases, diabetes, and cancer (Oeland, Laessoe, Olesen, & Munk-Jørgensen, 2010), as well as decrease psychological distress (Perales, Pozo-Cruz, & Pozo-Cruz, 2014). Besides improving physical health conditions and decreasing psychological distress (van Berkel et al., 2013), regular physical activity is associated with improvement in social functioning of people with serious mental illness (Pelletier, Nguyen, Bradley, Johnsen, & McKay, 2005; Van Citters et al., 2010). In the same vein, people with higher levels of physical activity reported better HRQOL than those with lower levels of physical activity (Anokye, Trueman, Green, Pavey, & Taylor, 2012).

Despite its benefits, recent research has found that people with mental illness tend to engage in less physical activity compared to the general population (Bradshaw & Pedley, 2012). Lower levels of physical activity in people with mental illness partially contributes to their premature mortality and excessive medical comorbidity (Vancampfort et al. 2012; Stanton and Happell, 2014). However, physical activity levels in people with mental illness are not well studied, and a lack of tailored physical activity interventions may cause low physical activity levels in this cohort (Jerome et al., 2009).
Significance of the Study

According to the 2016 National Survey on Drug Use and Health (NSDUH), mental illnesses are common, present in an estimated 44.7 million adults in the US (19.1% anxiety disorders, 6.7% depression, 2.8% bipolar disorder and 0.3% schizophrenia). The criteria of mental illness defined by the National Institute of Mental Health (NIMH) are as follows: diagnosis of a mental, behavioral, or emotional disorder; diagnosable currently or within the past year, and sufficient duration to meet diagnosis in DSM-5 (Center for Behavioral Health Statistics and Quality, 2015). When an individual with mental illness has significant functional impairment in one or more major life activities due to his or her mental illness, it is considered to be serious mental illness. The legal definition of serious mental illness is more flexible than those used for clinical purposes or epidemiological purposes, sometimes varying by state and excluding the necessity of functional impairment. Like the criteria of mental illness used by NIMH, the legal definition only requires a diagnosis of major mental illness, such as schizophrenia, schizoaffective disorder, psychotic disorders, major depressive disorders, bipolar disorders, anxiety disorders, and borderline personality disorder (National Alliance on Mental Illness, 2009). According to NIMH criteria, in 2015, 4.0% of adults (approximately 9.8 million) over 18 years old in the US were diagnosed with severe mental illness, meeting diagnostic criteria described in the DSM-5 (U.S. Department of Health and Human Services, 2016).

One of the most crucial factors contributing to incremental burden among people with serious mental illness is associated with their comorbid health conditions (Lee, Rothbard, & Choi, 2016). According to National Comorbidity Survey Replication, 34 million adults in the US (17%) reported co-occurring mental and physical health problems within a 12-month
period (Druss & Walker, 2011). Their report also indicates that 68% of people with mental illness had a status of comorbidity, which is the co-occurrence of physical and mental illnesses in the same person, regardless of either its chronical order or the causal relationship between them. In another research study, over 80% of people with bipolar disorders had at least one active physical illness, and 35-40% had three or more comorbid physical illnesses (Munoli, Praharaj, & Sharma, 2014). The prevalence rates for chronic medical conditions, such as diabetes, cardiovascular disease, respiratory diseases, chronic obstructive pulmonary disease, hypertension, arthritis, asthma, hepatitis, epilepsy and dyslipidemia are 2 to 3 times higher in people with mental illness (Bhattacharya, Shen, & Sambamoorthi, 2014; Rao, Raney, & Xiong, 2015).

Clearly, the economic cost of the comorbidity of mental and physical illnesses is substantial and constitutes a challenge for healthcare providers and the healthcare system (Sharma, 2016). For instance, Fitch, Iwasaki, and Villa (2014) indicate that people with schizophrenia spend an average of $1,806 per month, including paid amount by the insurer and cost sharing, as compared to $419 for people without schizophrenia, even when demographically adjusted (i.e., matched for age and gender). According to the 2011 Medical Expenditure Panel Survey, “total healthcare expenditures among individuals with mental illness were approximately 3.3 times greater than expenditures by individuals without mental illness ($11,339 vs. $3,449, respectively)” (Lee, Rothbard, & Choi, 2016, p.291). People with mental illness are more likely to have comorbid physical illnesses, which in turn leads to increased total healthcare costs.

In spite of excessive expenditures on healthcare, the quality of care and the cost effects related to comorbidity among people with mental illness are still problematic due to,
“the high prevalence of comorbidity, the complex causal connection linking mental and physical illnesses, and system fragmentation” (Druss & Walker, 2011, p. 1). In other words, the cost-effectiveness for people with mental illness having additional health problems is smaller than the general population, and they tend not to receive an adequate quality of care for their physical comorbidities. Reducing health disparities for people with mental illness is an ongoing agenda in the mental health field, yet these individuals experience numerous barriers to access and use of health care services due to treatable medical conditions that remain unaddressed (Brekke et al., 2013). Therefore, it is not surprising that the mortality gap between people with mental illness and the general population is approximately 10-25 years (Hayes, Miles, Walters, King, & Osborn, 2015) and it has changed little over time (25 years’ difference in 1996 vs. 22.5 years in 2006; Tiihonen et al., 2009).

These facts are pivotal to policy makers and medical and mental health service providers, who are often tasked with achieving contradictory goals, including improving quality of care for mental and physical comorbidities and reducing the costs of healthcare in people with mental illness (Goodell, Druss, & Walker, 2011). After all, better coordination between medical and mental healthcare providers and the development of effective interventions are needed for cost effectiveness and better quality of care in mental health settings (Lee, Rothbard, & Choi, 2016).

**The Impact of Comorbidity**

There is a growing body of research on the effect of comorbidity of mental and physical illnesses on disability and functional impairments (Kessler, Ormel, Demler, & Stang, 2003; Scott et al., 2009; Warner, 2006). The probability of severe disability and functional impairment increases when there are joint effects of mental and physical health conditions.
(Scott et al., 2009). According to Druss et al., (2009), the main areas of impairment could differ depending if they arise due to mental illnesses (i.e., social functioning and close relationships) or medical health problems (i.e., activities of daily living, work functioning and home functioning). Among people with mental illness, functional impairments in daily activities, social functioning, and basic life activities are common, which in turn contribute to decreased quality of life (Trompenaars, Masthoff, Van Heck, de Vries, & Hodiamont, 2007). Therefore, it should be noted that, in addition to symptoms of mental illness, comorbid medical conditions could be an important contributing factor to one of the pivotal criteria of serious mental illness, “serious functional impairments, which substantially interfere with or limit one or more major life activities” (National Institute of Mental Health, 2014).

With regard to the ongoing efforts to shift psychiatric treatment from incarcerating people with mental illness to promoting quality of life in the community, impairments in social and emotional functioning and activity limitations are major impediments for success in psychiatric treatment and recovery (Sánchez, Rosenthal, Tansey, Frain, & Bezyak, 2016). Due to the impairments related to medical comorbidity, reduced quality of life and low overall life satisfaction are commonly found among people with mental illness (Barnes et al., 2012). Conversely, people with mental illness can experience improved quality of life if they receive appropriate interventions to address the functional impairments related to their mental and medical comorbidities.

Cranwell et al. (2016b) argued that healthcare and mental health providers should focus on prevention, early and appropriate detection, and provision of effective treatment for people with mental illness who suffer from medical comorbidity. Prevention attempts include lifestyle interventions utilizing behavioral techniques to improve dietary habits and increase
physical activity to prevent the adverse effects of chronic health problems, which in turn improves the well-being of people with mental illness (Cabassa, Ezell, & Lewis-Fernández, 2010). Provision of effective treatments and timely detection of comorbidity can be achieved by removing barriers to medical care, such as lack of medical insurance coverage, medical providers’ discomfort with symptoms of mental illness, and noncompliance with medical treatment (Rao et al., 2015). However, in spite of the high prevalence of comorbidity in people with mental illness, they frequently experience problems accessing and receiving appropriate treatment from public healthcare settings (Cranwell et al., 2016b). Therefore, further research should focus on finding effective treatment that either prevents or reduces the barriers to medical care to reduce the effect of comorbidity among people with mental illness.

Health-Related Quality of Life

To date, quality of life among people with mental illness has been a common and important outcome measure, but examining the impact of disease-related or health-related factors on an individual’s quality of life could also be appropriate for this population due to their comorbidity rates (Barnes et al., 2012). Recent studies have highlighted the negative relationship between medical comorbidity in people with mental illness and their HRQOL (Barnes et al., 2012; Fenn et al., 2005). The concept of HRQOL was initially developed to capture the effects of health, illness, and treatment on quality of life. Thus, HRQOL is a useful term to refer to overall quality of life, reflecting general health perceptions, symptoms, and functional status of people with chronic disease (Ferrans, Zerwic, Wilbur, & Larson, 2005). According to Bamm, Rosenbaum, and Wilkins (2013), the terms quality of life and HRQOL are often used interchangeably, but HRQOL places more emphasis on subjective perceptions of the impact of health status, including physical, mental, emotional, and social
functioning. In other words, HRQOL is the portion of an individual’s quality of life that is the direct consequence of their mental and physical health (Telford, 2014). Bamm et al. (2013) defined HRQOL as the subjective perception of the impact of both mental and physical health status. For these reasons, HRQOL is a specific outcome indicator that incorporates physical and mental health and its impact on life satisfaction among people with mental illness, given their elevated mortality rates and high medical comorbidity (Barnes et al., 2012).

Compared to those without mental illness, people with mental illness showed lower levels of HRQOL (Arnold, Witzeman, Swank, McElroy, & Keck Jr, 2000; Vancampfort, Probst, Scheewe, et al., 2011). For example, Cook and Harman (2008) used a “healthy days” measure to assess HRQOL and found that people with mental illness had over twice the number of unhealthy days (17.2 days) compared to the general population (7.9 days). It should be noted that the combined effect of mental and physical illness on HRQOL is larger than the sum of their separate effects among people with major depressive disorder and anxiety (Nigatu, Reijneveld, de Jonge, van Rossum, & Bültmann, 2016).

The high prevalence of comorbidity among people with mental illness contributes to decreased HRQOL (Sim et al., 2006). In addition, the distinct characteristics of mental illness, such as mood fluctuations, sleep disturbance, and cognitive impairment, decrease HRQOL among people with mental illness (IsHak et al., 2012). In the same vein, mental and physical impairments (key components of HRQOL) are commonly found in people with mental illness who have poor HRQOL (Folsom et al., 2009). HRQOL is also influenced by demographic and environmental status (i.e., age, employment status, education level, and health care access; Ferrans et al., 2005).

**Psychological Distress**
A number of factors may contribute to HRQOL among people with mental illness. Aside from comorbidity, psychological distress also decreases HRQOL (Nordin, Pählman, Larsson, Sundberg-Hjelm, & Lööf, 2002; Shih & Simon, 2008). Among people with mental illness, psychological distress is pervasive and persistent (Wong, 2002). For instance, in the 2007 Behavioral Risk Factor Surveillance System (BRFSS), 37.7% of individuals endorsing serious psychological distress had received mental health services in the preceding year (Center for Disease Control and Prevention, 2013). According to SAMHSA (2012), psychological distress does not necessarily equate to a mental health diagnosis, but it reflects the presence and severity of mental health symptoms and the ability to participate in family, school, community, and social life. In research, psychological distress refers to a state of depression (e.g., hopelessness, depression, loss of interest) and anxiety (e.g., restlessness, tension) that may be associated with increased symptoms of mental illness as well as levels of medical comorbidity (Drapeau, Marchand, & Beaulieu-Prévost, 2011; Swartz & Jantz, 2014). Recent research found that psychological distress is associated with severity and the existence of comorbid conditions including asthma, cancer, and cardiovascular diseases (Hamer, Molloy, & Stamatakis, 2008; Singh, Singh, Singh, & Kaur, 2015; Van Lieshout & Macqueen, 2012).

Loeb and Jonas (2015) demonstrated that when serious psychological distress and other health problems coexist, an individual is more likely to have complex activity limitations in areas such as activities of daily living and social and work functioning. This is because the adverse effect of medical comorbidity and associated psychological distress can significantly contribute to declines in physical and mental functioning as well as HRQOL (Keles et al., 2007; Nordin et al., 2002). Shih and Simon (2008) found that greater
comorbidity was linked to higher levels of psychological distress and that additional severe psychological distress also contributes to decreased HRQOL.

**Physical Activity**

In the healthcare system, the role of physical activity has been highlighted, as “insufficient physical activity ranks high among 67 risk factors for burden of disease and injuries” (Vuori, Lavie, & Blair, 2013, p. 1446). Recently, researchers and mental health service providers have also focused on the need for physical activity interventions for people with mental illness because of its benefits in reducing the impact of medical comorbidity and increasing HRQOL (Cullen & McCann, 2015; Rosenbaum, Tiedemann, Sherrington, Curtis, & Ward, 2014). According to the World Health Organization, physical activity is defined as “any bodily movement produced by skeletal muscles that require energy expenditure—excluding activities undertaken while working, playing, carrying out household chores, traveling, and engaging in recreational pursuits” (Kingston, 2014, p. 39). The 2008 physical activity guidelines for Americans suggested that adults should engage in a minimum of 150 minutes of moderate-intensity, 75 minutes of vigorous-intensity aerobic physical activity, or an equivalent mix of moderate and vigorous intensity aerobic activity per week. In addition to aerobic physical activity, the guidelines call for two or more days per week of moderate or high-intensity muscle-strengthening activities that involve every muscle group (Office of Disease Prevention and Health Promotion, 2008). Moreover, adults with disabilities, such as those living with stroke, spinal cord injury, multiple sclerosis, Parkinson’s disease, muscular dystrophy, cerebral palsy, traumatic brain injury, limb amputations, dementia, intellectual disability, and mental illness are strongly encouraged to avoid inactivity and meet the same guidelines. Meeting the recommended physical activity guidelines helps reduce the risk of
adverse health outcomes and death (Shiroma & Lee, 2010).

Despite the benefits of physical activity, people with serious mental illness tend to engage in less physical activity compared to the general population (Bradshaw & Pedley, 2012). The majority of people with mental illness reported a sedentary lifestyle (Lindamer et al., 2008) and reduced functional exercise capacity compared with healthy controls (Vancampfort, Probst, Sweers, et al., 2011). For people with mental illness, a lack of physical activity during leisure time among is related to their physical HRQOL (Vancampfort, Probst, Scheewe, et al., 2011). Stanton and Happell (2014) found that low levels of physical activity partially contributed to the excess mortality rates and medical comorbidity in the cohort of people with mental illness.

Recent research has demonstrated several benefits of regular physical activity for people with mental illness. First, Oeland et al. (2010) reported that regular moderate physical activity can decrease the risk of developing medical disorders such as cardiovascular disease, diabetes, and cancer. Second, moderate to vigorous physical activity has been shown to decrease psychological distress and psychiatric symptoms of mental illness such as major depression, panic disorder, social phobia, and agoraphobia (Perales et al., 2014; van Berkel et al., 2013; Weyerer & Kupfer, 1994; Zschucke, Gaudlitz, & Ströhle, 2013). Third, physical activity also contributes to increased satisfaction with fitness and elevated HRQOL among people with mental illness (Pelletier et al., 2005; Van Citters et al., 2010). Physical activity contributes to improvement in quality of life through social interaction, meaningful use of time, and empowerment of people with mental illness (Alexandratos, Barnett, & Thomas, 2012). In the same vein, people with higher levels of physical activity reported better HRQOL than those with lower levels of physical activity (Anokye et al., 2012). For people
with mental illness, therefore, physical activity can be used as a supplemental treatment in reducing psychological distress and chronic diseases while increasing HRQOL (Oeland et al., 2010).

Given the benefits of physical activity, some mental health service providers have designed interventions to promote it. For example, the In SHAPE program (Van Citters et al., 2010) and the Clubhouse Model Structured Exercise program (Moon, 2016; Pelletier et al., 2005) have been led by community-based mental health service providers. Studies of these programs found that people with mental illness gain health and psychosocial benefits from these physical activity interventions, including weight loss, decreased psychotic symptoms, improved diet, and improved HRQOL during the intervention (Kalarchian et al., 2005; Pelletier et al., 2005; Van Citters et al., 2010).

In spite of its physical and psychological benefits, the importance of physical activity intervention in mental health care has been neglected by mainstream mental health services (Callaghan, 2004; Pearsall, Hughes, Geddes, & Pelosi, 2014) because the roles and responsibilities of mental health service providers in regard to physical health interventions have been uncertain (Collins, Tranter, & Irvine, 2012). In the US, primary care physicians have the greatest influence in promoting lifestyle behaviors, including physical activity (Manley, 1996; Oberg & Frank, 2009). In the 1980s and 1990s, only 49% of primary care physicians believed that regular daily physical activity was very important (Wechsler, Levine, & Idelson, 1996); furthermore, the counseling they provided often lasted less than 2 minutes (Wells, Lewis, Leake, & Ware, 1984). Similarly, 49% of U.S. physicians “always” and 45% “sometimes” provide specific physical activity guidelines for people with chronic disease, while 30% (always) and 56% (sometimes) of them provide specific physical activity
guidelines for people without chronic disease (Vuori et al., 2013). In the same study, physicians in Canada (70%), Catalan (84%), and Scotland (62%) reported more frequent provision of physical activity guidelines, including verbal counseling or written prescriptions. Due to the lack of counseling for physical activity by physicians, Richardson et al. (2005) insisted that physical activity intervention should be integrated into psychiatric services because people with mental illness have frequent contact with their mental health service providers; thus, barriers to mental illness can be more appropriately addressed by mental health services.

In short, current empirical evidence indicates that comorbidity and psychological distress further impair HRQOL (Keles et al., 2007) and that levels of physical activity are correlated with the presence of comorbidity, decreased psychological distress, and increased HRQOL (Brown et al., 2003). So far, however, little is known about how these factors influence HRQOL among people with mental illness. Therefore, this dissertation explores relationships among comorbidity, psychological distress, physical activity, and HRQOL. It then examines the influence of physical activity on comorbidity, psychological distress, and HRQOL among people with mental illness in order to evaluate physical activity as an intervention for people with mental illness.
CHAPTER 2. CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

This chapter presents the conceptual framework and literature review that supports this research. The proposed conceptual framework has been developed by adapting and modifying three health-related theories along with a statistical approach that is able to describe an overview of the theoretical underpinnings: (a) biopsychosocial model of health and illness; (b) Wilson and Cleary’s health-related quality of life (HRQOL); (c) buffering effect of physical activity; and (d) a moderated mediation approach.

First, the biopsychosocial (BPS) model, which integrates biological components of illness with behavioral, psychological, and social components, informed the selection of the key factors (i.e., comorbidity, psychological distress and physical activity) of this dissertation. This holistic model considers being ill as not simply the presence of illness itself, but rather the integrated impacts of multiple components on wellness and quality of life (Okoro, 2011). Other models were considered for the theoretical underpinning of this study, such as that of Wilson and Cleary (1995) and the buffering effect of physical activity. The Wilson and Cleary (1995) model provided the organizing conceptual framework for this dissertation as it encompasses the important key factors of this study. Wilson and Cleary’s HRQOL model is useful in conceptualizing the determinants of HRQOL described in the process flow (Ferrans et al., 2005). Thus, by modifying this model, the proposed dissertation can examine causal paths from comorbidity through psychological distress and physical activity to HRQOL.

The next section of this chapter introduces the buffering effect of physical activity, which explains the role of physical activity (moderation) in the conceptual framework developed from the Wilson and Cleary (1995) model. In the remainder of this chapter,
moderated mediation process is introduced, as the purpose of this study was to examine both
the direct and indirect relationships of key factors and delineating paths of the conceptual
framework.

Biopsychosocial (BPS) Model of Health and Illness

In 1977, Dr. George Engle criticized the biomedical model that prevailed at that
time, stating that its framework had no room for the biological, psychological, and social
components of illness (Engel, 2012). Engle then introduced the biopsychosocial (BPS) model
that considers biological, psychological, behavioral, and social factors and their complex
interactions in health and illness (see Figure 1; Engel, 2012). The BPS model provides a
holistic and humanistic approach to a person’s illness status that attends to neglected areas
(Engel, 1980). This model expects healthcare providers to consider behavioral,
psychological, and social aspects when designing appropriate interventions for an individual
influence the prevention, causes, presentation, management and outcome of the disease”
(p.12). These factors are interrelated, and they compose the unique state that is known as
illness.

The BPS model can explain individual differences in a similar illness status (i.e., a
biological component) because psychosocial and behavioral factors (i.e., self-reported
disease activities) are important predictors of disability and HRQOL (Nicassio et al., 2011).
In rehabilitation settings, the BPS model of patient care is more beneficial for persons with
disabilities than models that consider only the person’s biological characteristics of a
disability or illness itself. As the BPS model indicates, people with mental illness do not
suffer from only their mental illness, but also from increased psychological, social, and
physical disability (Cummings & Cassie, 2008).

Figure 1. The Biopsychosocial Model of Health and Illness (Lakhan, 2006, August 3).

Kinderman (2005) argued that the role of psychological process in mental disorders requires further attention because disruption or dysfunction in psychological process is a final common pathway in the development of mental disorders. For that reason, the role of psychological distress is of great importance in understanding people with mental illness. Matalon, Yaphe, Nahmani, Portuguez-Chitrit, and Maoz (2009) indicated that a BPS intervention for heavy users of medical care increases their levels of physical activity, emotional health, social function, daily activity and general health status. Their study supports the use of the BPS model to guide this dissertation in considering multiple factors (i.e., biological, psychological, and sociological) that influence health and illness among people with mental illness.

Recently, it has been argued that there is a need to apply the BPS model for people with comorbid mental illness and physical health problems (Habtewold, Islam, Radie, &
Tegegne, 2016; Ramezani, McCarron, Lashai, & Lenaerts, 2015). Chronic physical illnesses are often accompanied by comorbid mental health problems, therefore demanding shift to “more heuristic and comprehensive BPS model, which emphasizes the unique interactions among biological, psychological, and social factors” (Gatchel, 2004. p. 802). The BPS model could be used to treat comorbid mental-physical interactions, as it has been well-studied for a number of prevalent physical illnesses, such as diabetes mellitus, hypertension and other cardiovascular disorders, asthma, and gastrointestinal disorder (Gatchel, 2004). The utilization of the BPS perspective has allowed researchers to evaluate the comorbidity of mental and physical health problems in multiple aspects, not only in a biological one. As a result, the BPS model led to the development of the most heuristic approach to dealing with the increased risks of mental illnesses, maladaptive cognitions, functional impairments, and physical deconditioning (Gatchel, Peng, Peters, Fuchs, & Turk. 2007).

The pathways leading to comorbidity of mental and physical illnesses are complex and bidirectional. As mentioned previously, mental illnesses may cause medical health problems, but it could also be possible that chronic medical health problems can place an individual at risk for mental illnesses (Druss & Walker, 2011). Consequently, both mental and physical illnesses may share common risk factors. An extensive study found that people with mental illness often also have chronic health conditions such as rheumatoid arthritis, cancer, heart diseases, and multiple sclerosis (De Hert et al., 2011). However, these chronic physical health conditions (i.e., rheumatoid arthritis, COPD, diabetes, hypertension, and cardiovascular disease) may also lead to serious mental conditions such as depression and anxiety disorder (Nicassio, 2010). For example, patients with rheumatoid arthritis are at high risk of depression due to their disease status, physical functioning, and other psychosocial
factors; therefore, the holistic BPS approach was recommended for this group to help focus on both pain and depression (Tali, 2014). In the same vein, treatments for people with mental illness who suffer from medical comorbidity need to consider biopsychosocial factors including genetics, medical conditions, symptoms of mental illness, physical functioning, personality, behaviors, and socioeconomic status (Gunzler et al., 2016).

In the rehabilitation stage, people with mental illness experience increased complex BPS challenges due to a dearth of appropriate community-based services (Cummings & Cassie, 2008). Historically, without adequate services for people with mental illness, these individuals can experience persistent poverty, massive homelessness, widespread incarceration, premature death, and lack of healthcare access (Nasrallah, 2015). People with mental illness tend to live without the benefits of psychosocial treatment components; unacceptable health disparities also exist (Nasrallah, 2015). Therefore, interventions for people with mental illness who suffer from medical comorbidity need to be evaluated based on the BPS model of healthcare instead of emphasizing only the biological perspective on illness.

**Wilson and Cleary’s Model of HRQOL**

Recent research has emphasized that HRQOL is related to multiple factors, such as chronic diseases, psychological distress, and functional impairments, which are commonly found in people with mental illness (Arnold et al., 2000; IsHak et al., 2012; Michelson, Bolund, & Brandberg, 2000; Nordin et al., 2002; Zhao, Li, Li, & Balluz, 2013). Awad and Voruganti (2012) pointed out in their review assessing HRQOL that there is a paucity of appropriate conceptual models based on symptoms and characteristics of people with mental illness. However, a conceptual model of HRQOL was developed by Wilson and Cleary in
1995 that shows the determinants of HRQOL and linear chains from biological variables through to overall quality of life (Ferrans et al., 2005). This model has been tested and widely used to facilitate and understand associations among clinical outcomes and subjective patient experiences in the presence of comorbidities (Shiu, Choi, Lee, Yu, & Man Ng, 2014). Wilson and Cleary’s model provides a framework for understanding the main concepts of HRQOL. However, the model is well-suited for physical illnesses, but not for psychiatric ones (Revicki, Kleinman, & Cella, 2014). In this respect, it will be beneficial to review Wilson and Cleary’s model and examine the conceptual framework that includes the effects of comorbidity of chronic physical health conditions and psychological distress on HRQOL in people with mental illness.

**Comorbidity and Health-Related Quality of Life (HRQOL)**

Wilson and Cleary’s model for HRQOL introduced five main contributing factors to HRQOL: biological function, symptoms, functional status, general health perceptions, and overall quality of life. The model shows causal paths of five contributing factors from left to right (Figure 2; Wilson & Cleary, 1995). It is a useful model that provides a theoretical approach to conceptualizing a multidimensional construct of HRQOL and guides the development of new theories (Sousa & Kwok, 2006). In their model, the five contributing factors have causal flows, and the last four contributing factors, except biological functions, can be improved or declined by characteristics of the individual and the environment (Rizzo & Kintner, 2013). In this process, individual and environmental characteristics, including age, gender, working status, physical activity levels, and psychological distress play important roles (Shiu et al., 2014).

The first level of Wilson and Cleary’s HRQOL model begins with biological and
physiological variables (Wilson & Cleary, 1995). Biological and physiological variables include molecular, cellular, and genetic components that influence an individual’s biological vulnerability and resilience (Ferrans et al., 2005). Thus, changes in biological and physiological variables can directly or indirectly affect perceptions of health, symptoms, functional status, and overall quality of life. In the second level, symptom status refers to an individual’s perception of an abnormal physical, emotional, and cognitive state, while the third level, functional status, encompasses physical, psychological, social, and role function. Functional status can be determined by multiple factors, including personal choice, values, and motivation to perform everyday activities, which can be assessed by the levels of physical activity (Ferrans et al., 2005). The fourth level, general health perception, refers to a subjective rating of an individual’s own health status and integrates all of the preceding components (Ferrans, 2005). In other words, general health perceptions include all of the health components previously reviewed, such as functioning and symptoms. Lastly, the fifth level, overall quality of life, refers to the general assessment of well-being related to how

Figure 2. Revised Wilson and Cleary model of HRQOL.
happy or satisfied an individual is with his or her life.

HRQOL is a multidimensional construct that shows how an individual’s health condition influences one’s own health perception and quality of life (Sousa & Kwok, 2006). Wilson and Cleary’s model places these concepts in a context of general health, but this model has limitations in accounting for psychiatric components. As Revicki et al. (2014) highlighted, psychiatric components need to be included, particularly to reflect characteristics of people with mental illness in the model in order to explain the impact of psychiatric symptoms on HRQOL. Thus, a HRQOL model should include comorbidity of mental and physical components and its impact on psychological distress that reflects health perceptions among people with mental illness.

A growing body of research indicates that comorbid chronic physical and mental health conditions have a significant impact on HRQOL (Arnold et al., 2000; Bayliss et al., 2012). Wilson and Cleary’s HRQOL model illustrates how biological and physiological variables, which are the first contributing factors in the causal paths of HRQOL, include the concept of chronic diseases (Rizzo & Kintner, 2013). This conceptual model, however, is limited in that it does not fully explain how an individual’s symptoms of both mental illness and physical illness, and the associated functional status, influence general health perception and overall quality of life among people with mental illness.

Psychological distress is an important predictor of HRQOL (Keles et al., 2007), but it could be underestimated by Wilson and Cleary’s model. For example, Shiu et al. (2014) analyzed Wilson and Cleary’s model using structural equation modeling (SEM) to find possible determinants of HRQOL. In their findings, psychological distress is a direct determinant of HRQOL, while factors such as symptom status and functional status have
indirect effects on HRQOL through general health perceptions, as in the original model. It is worth attending to psychological distress that explains the direct/indirect effects of the relationships between their biological components (i.e., chronic diseases) and HRQOL among people with mental illness. Therefore, this research intended to understand the role of psychological distress on HRQOL. For the baseline assumption, this study simplified Wilson and Cleary’s HRQOL concepts to intuitively show the direct relationship between chronic diseases and HRQOL (Figure 3).

![Figure 3. The Direct Relationship between Comorbidity and HRQOL.](image)

**Associations between Psychological Distress, Comorbidity and HRQOL**

Psychological distress is directly or indirectly related to emotional suffering from symptoms of depression and anxiety as well as physical health problems. According to the stress-distress model, however, psychological distress is distinguished from mental disorders because it is a natural response to stressful social situations (Horwitz, 2007). Thus, psychological distress increases when an individual is exposed to stressful events and has insufficient coping skills to manage them. Among people with mental illness, it is worthwhile to clarify the role of psychological distress as it is strongly associated with common characteristics of people with mental illness, including difficulty coping with comorbid physical health problems and symptoms of mental illness (Shih & Simon, 2008). In that context, Shih and Simon (2008) found that serious psychological distress is associated with poor HRQOL and the presence of chronic physical illness. Their findings were parallel with
the concepts of Wilson and Cleary (1995)’s HRQOL model, but they also stressed the unique role of psychological distress in linking physical illness and HRQOL.

![Diagram]

*Figure 4. Role of Psychological Distress between Comorbidity and HRQOL.*

Rizzo and Kintner (2013) tested Wilson and Cleary’s HRQOL model in a similar manner, showing causal paths from the impact of biological and physiological factors (i.e., age and chronic disease) through to HRQOL. They posited that symptom distress, including stress/anxiety levels, mental health status, lack of energy, days impacted by pain, and inability to rest, mediates chronic disease and HRQOL. Using Rizzo and Kintner’s findings, I highlighted psychological distress, which people with mental illness are more likely to experience, to examine its mediating role between comorbidity and HRQOL. Therefore, the causal paths could be developed as follows: influences from comorbidity to psychological distress and from psychological distress to HRQOL (Figure 4). This study hypothesized that psychological distress of people with mental illness mediates the impact of the relationship between comorbidity and HRQOL.

**Buffering Effect of Physical Activity**

The level of physical activity is a possible contributing factor that can strengthen or reduce the impact of chronic health conditions on HRQOL (Anokye et al., 2012; Demont-
Researchers have focused on the buffering effect of physical activity in reducing the negative effect of stress (Burton, Hoobler, & Scheuer, 2012). Puterman et al. (2010) also argued that physical activity mitigates the detrimental effect of psychological distress on physical health. Physical activity has a direct effect of reducing depressive symptoms and mediates the effect of stress on depression (Craike, Coleman, & MacMahon, 2010). This effect is supported by the evidence that individuals with moderate levels of physical activity reported decreased psychological distress and better HRQOL (Abell, Hootman, Zack, Moriarty, & Helmick, 2005; Tetlie, Eik-Nes, Palmstierna, Callaghan, & Nøttestad, 2008).

Figure 5. Buffering Effect of Physical Activity on Psychological Distress or/and HRQOL.

Physical activity could be an important factor in reducing psychological distress.
and increasing HRQOL. For example, the path model of HRQOL for Chinese people with diabetes, which is a modified version of Wilson and Cleary’s model, found that physical activity is one of the important environmental characteristics influencing HRQOL (Shiu et al., 2014). Drawing upon these findings, the proposed research assumes that level of physical activity could be an important characteristic of individuals with mental illness, which affects the pathways of the Wilson and Cleary model. In the proposed model, therefore, I could hypothesize as follows: (a) levels of physical activity would buffer the impact of comorbidity on psychological distress, (b) levels of physical activity would buffer the impact of comorbidity on HRQOL, and (c) physical activity levels would buffer the impact of psychological distress on HRQOL among people with mental illness (Figure 5; Casagrande et al., 2010; Vancampfort, Probst, Scheewe, et al., 2011).

**Interactions of Comorbidity and Physical Activity, Psychological Distress, and HRQOL**

A growing body of literature has noted direct relationships among health-related factors that influence HRQOL (Schwarzer, Lippke, & Luszczynska, 2011; Strine, Chapman, Balluz, & Mokdad, 2008). For example, comorbidity, psychological distress, and physical activity have been shown to have the most effect on HRQOL (Achat et al., 1998; Kosma, Ellis, Cardinal, Bauer, & McCubbin, 2009; Miyamoto et al., 2014). In addition to investigating the direct relationship between one factor and HRQOL, Keles et al. (2007) focused on how comorbidity and its associated psychological distress impairs HRQOL. Also, a moderate level of physical activity has been found to be associated with increased HRQOL (Anokye et al., 2012), as well as with decreased psychological distress (Oeland et al., 2010; Tetlie et al., 2008). The findings from previous research point to the possibility of indirect effects (not easily observed, but surely exits) among the factors mentioned above. There are
many parallels between these findings and Wilson and Cleary’s HRQOL model (1995), but as Revicki et al. (2014) proposed, an HRQOL model for people with mental illness should be modified to reflect their physical and mental health issues. Synthesizing all of these findings leads to the hypothesis that the impact of comorbidity on HRQOL is mediated by psychological distress. In the proposed model, the strength of the mediation effect of psychological distress depends on the level of physical activity among people with mental illness (Figure 6).

![Model of Relationships between Comorbidity and HRQOL with Psychological Distress and Physical Activity](image)

*Figure 6. Model of Relationships between Comorbidity and HRQOL with Psychological Distress and Physical Activity.*

The proposed research will clarify the role of psychological distress in the paths from comorbidity through to HRQOL and highlight the importance of providing effective physical activity interventions, including the concept of buffering the negative effect of comorbidity and psychological distress for improved HRQOL among people with mental illness (see Figure 6). Based on the conceptual framework derived from a combination of the BPS model, Wilson and Cleary’s HRQOL, and the buffering effect of physical activity, this study examines the moderated mediation effect of key factors; that is, whether psychological distress (mediator variable) mediates the effect of comorbidity (independent variable) on
HRQOL (dependent variable) via the level of physical activity (moderator variable).

**Moderated Mediation Approach**

The existing literature consistently suggests statistically significant direct and indirect influences of comorbidity, psychological distress and levels of physical activity on HRQOL among people with mental illness. However, no one has clarified the role of psychological distress and importance of physical activity in moderating comorbidity and HRQOL among people with mental illness. According to Fairchild and MacKinnon (2009), relationships between a predictor variable and an outcome variable are complex, often mediated or explained by the addition of a third variable, including suppressors, confounders, covariates, mediators, and moderators. By examining mediators and moderators, we can suggest possible causal mechanisms for how the variables under investigation interrelate (Shrout & Bolger, 2002).

A mediation model seeks to provide an explanation for why or how two variables are related (Fairchild & MacKinnon, 2009). The term mediator refers to an intervening causal variable that is necessary to complete a cause-effect pathway between a predictor variable and an outcome variable (Lewis, Marcus, Pate, & Dunn, 2002). In this regard, this researcher hypothesizes that a predictor variable (comorbidity) would influence a mediator variable (psychological distress), which in turn would influence the outcome variable (HRQOL). Testing this hypothesis can clarify the direct effect of chronic diseases on HRQOL and the indirect effect of comorbidity on HRQOL via psychological distress.

Additionally, the moderation model examines whether the relationship between two variables (comorbidity and psychological distress, chronic diseases and HRQOL, or psychological distress and HRQOL) depends on the level of the third variable (physical
activity; Fairchild & MacKinnon, 2009). A moderator influences the direction and/or strength of the relationship between predictor and outcome variables (Baron & Kenny, 1986; Kraemer, Kiernan, Essex, & Kupfer, 2008). In other words, a mediation effect can be found when the positive relationship between an independent variable and an outcome variable is attenuated by a statistically controlled mediator, and a moderation effect can be found when a moderator affects the direction and/or strength of the relationship between an independent variable and an outcome variable (Baron & Kenny, 1986).

Furthermore, moderation and mediation effects can occur together when the indirect effect of a mediator between two variables changes depending on the value of the moderator (i.e., conditional indirect effect; Preacher, Rucker, & Hayes, 2007). Wegener and Fabrigar (2000) also explained a moderated mediation effect that occurs, “when a moderator interacts with an IV to affect a DV, but the moderator has its effect via some mediating variable” (Little, Card, Bovaird, Preacher, & Crandall, 2007, p. 222). A moderated mediation effect can be implied three ways: (a) the effect of an independent variable on an mediator variable depends on the level of the moderator variable; (b) the indirect effect of a mediator depends on the level of the moderator variable; or (c) both (Muller, Judd, & Yzerbyt, 2005).

Therefore, based on the findings from the reviewed literature, this current research hypothesizes that the indirect effect of psychological distress between comorbidity and HRQOL depends on the level of physical activity.

**Other Environmental and Individual Factors of HRQOL**

This dissertation study also included a variety of influential predictors of HRQOL from previous studies. These factors were individual factors such as race, gender, and age as well as environmental factors such as healthcare access, employment status, and education
level (Ferrans et al., 2005). According to Kintner (2010), an individual’s symptoms are not directly associated with their biological and physiological variables because they are usually filtered through individual values; rather, symptoms are affected by complex interactions with both individual factors and environmental factors. In order to control the multiple layers of influence on HRQOL at different levels, this dissertation study included other possible environmental and individual factors as covariates.

Receiving appropriate healthcare services is a significant predictor of HRQOL among people with mental illness. Inadequate access to and use of quality healthcare among people with mental illness were reported (Morden, Mistler, Weeks, & Bartels, 2009). Lawrence and Kisely (2010b) also argued that there have been inequalities in healthcare provision for people with mental illness and this contributes to the poor physical health of this population. In the Kintner (2010) study of Wilson and Cleary’s model, healthcare access was used as a environmental risk factor that affects an individual’s biological and physiological state in Wilson and Cleary’s HRQOL model (Kintner, 2010). According to Kilbourne et al. (2006), people with mental illness were more likely to report difficulty in seeing a specialist and finding the care they need. Thus, healthcare access was taken into account in this dissertation as a covariate that represents environmental risk factors.

In several existing studies conducted with a variety of populations, the impact on specific HRQOL domains varied by age, and many researchers found a non-linear relationship between age and HRQOL (Browall, Ahlberg, Persson, Karlsson, & Danielson, 2008; Gordon et al., 2014; Quinten et al., 2015). Barnes et al. (2012) also found no significant differences among people with mental illness in terms of age. However, there are marked differences in mortality rate between age groups among people with mental illness.
(Taggart & Bailey, 2015), and the prevalence of poor social functioning and lower quality of life among older people with mental illness is remarkable (Bartels & Pratt, 2009). Thus, it is reasonable to include the age gap among people with mental illness as a covariate in this dissertation study.

Employment status is another indicator of HRQOL. Research has demonstrated that employment status is associated with physical and mental HRQOL in vulnerable populations, such as morbidly obese subjects (Lund et al., 2011) and liver transplant patients (Åberg et al., 2009). Similarly, Marwaha et al. (2009) found that the employment status of people with mental illness is positively correlated with their social functioning, quality of life, self-esteem, and decreased symptoms of their mental illness. Generally speaking, unemployment rates of people with mental illness are high due to factors linked to living with mental illness (e.g., symptoms, treatment setting, age at onset, duration, and alcohol and substance abuse; Bouwmans, De Sonneville, Mulder, & Hakkaart-van Roijen, 2015). The same study also found a positive association between employment and HRQOL among people with mental illness.

Similarly, education level could be another predictor of HRQOL. A study by Abraham et al. (2014) included education as a covariate in assessing a relationship between self-efficacy and HRQOL. In their study, education level was significantly associated with HRQOL in a multiple linear regression analysis. Including lower levels of education was important for this dissertation because education is one of the essential elements of recovery for people with mental illness (CMHA & CAMH, 2010). Furthermore, Rizzo and Kintner (2013) included education level as one of their observed variables for environmental characteristics (a latent variable), and it had a statistically significant impact on biological
factors, symptoms distress, and HRQOL. Thus, education level should be taken into account as a covariate when predicting HRQOL among people with mental illness.

It has been well known that the coexistence of serious psychological distress and other chronic health problems causes complex activity limitations in activities of daily living as well as social and work functioning (Loeb & Jonas, 2015). This occurs because everyday functioning can be largely affected by both mental illness (Hayes et al., 2012) and common chronic physical illnesses (Rozzini et al., 1997). According to a report by the Centers for Disease Control and Prevention (CDC; 1998), HRQOL was poorer for people who reported activity limitations due to health problems, including arthritis, difficulty walking, lung or breathing problems, hearing problems, vision problems, stroke, hypertension, diabetes, depression, anxiety, and other emotional issues. This statement is congruent with the Wilson and Cleary HRQOL Model, which emphasizes the influence of functional status on HRQOL. Moreover, activity limitation also mediates the effect of physical activity on levels of disability (Miller, Rejeski, Reboussin, Have, & Ettinger, 2000). Since activity limitation is also highly correlated with quality of life among people with mental illness (Sánchez et al. 2016), in this study, activity limitation was included in the model as a covariate to control its effect on comorbidity, physical activity and HRQOL.

**Summary and Research Aims**

In summary, the existing research indicates that comorbidity, physical activity, and psychological distress are strongly associated with HRQOL. There have been many previously developed conceptual frameworks of HRQOL, but there is a lack of conceptual models that reflect the individual and environmental characteristics of people with mental illness who are at high risk of comorbid physical health problems. In particular, no previous
studies have focused on investigating the direct and indirect contributions of comorbidity on HRQOL via changes in important individual characteristics of this dissertation (i.e., psychological distress and physical activity). Most of the previous research on HRQOL has focused exclusively on direct relationships between HRQOL and other single factors. Thus, this dissertation was designed to investigate theoretical conceptualization of the construct, illustrating the mechanism of the impact of comorbidity on HRQOL through important contributing factors among people with mental illness.

This dissertation was designed to emphasize the role of physical activity by describing how it moderates the effect of comorbidity on HRQOL through alleviation of psychological distress among people with MI. The conceptual model (see Figure 6) derives from a combination of the BPS model of health and illness, Wilson and Cleary’s model for HRQOL, and the buffering effect of physical activity. More specifically, this dissertation has modified Wilson and Cleary’s model to address the role of physical activity levels as a moderator. The buffering effect of physical activity provides a basis for including levels of physical activity in the proposed study. Moreover, by adding discussions about the mediation effect of psychological distress (the most critical result from both mental and physical illnesses) in the model, this dissertation tests the association between comorbidity and HRQOL among people who suffer from mental illness.

Despite the serious impact of comorbidity on the HRQOL of people with mental illness, there has been little discussion about how HRQOL is affected by comorbidity or the roles of independent factors that may affect the impact of comorbidity on HRQOL, such as physical activity and psychological distress. Therefore, it is worthwhile to investigate the relationships among comorbidity, psychological distress, physical activity, and HRQOL of
people with mental illness. These findings will highlight the importance of providing integrated physical and mental health services for people with mental illness in order to reduce the effect of comorbidity on HRQOL. To this end, this dissertation had four research aims:

Aim 1: To explore differences in health-related factors such as health status, presence of comorbidity, psychological distress, levels of physical activity, and HRQOL between people with mental illness and people without mental illness.

Aim 2: To describe the relationships between key factors of interest (i.e., comorbidity, psychological distress, physical activity) and HRQOL for individuals with mental illness.

Aim 3: To investigate the role of psychological distress in the relationship between comorbidity and HRQOL for people with mental illness.

Aim 4: To determine the impact of physical activity level on the relationships between comorbidity, psychological distress, and HRQOL for people with mental illness.
CHAPTER 3. METHODS

To address the aims of this dissertation, a cross-sectional study using secondary data from the 2013 Behavioral Risk Fact Surveillance System (BRFSS) was employed. This chapter offers an overview of the BRFSS, data collection, sample design, description of the 2013 BRFSS, the study sample, measures, variables of interest, and analyses.

Overview of BRFSS

The Behavioral Risk Factor Surveillance System (BRFSS) is a state-based annual telephone survey of adults regarding their health-related behaviors, use of preventive services, chronic conditions, and health status. It was established in 1984 by the Centers for Disease Control (CDC). Since then, the BRFSS has been used to collect uniform, state-specific data on preventive health practices and risk behaviors that are correlated with chronic illnesses, injuries, and preventable infectious diseases. Annually, the BRFSS completes over 400,000 interviews with adults, making it the largest health survey collection in the world (Centers for Disease Control and Prevention, 2017). The target population of the BRFSS is non-institutionalized citizens who are over 18 years of age.

The telephone survey consists of three parts: (a) Core component: all of the states collect core questions related to health behaviors and health status; (b) Optional BRFSS modules: each state collects a number of optional modules depending on the needs of each state; (c) State-added questions: individual states add questions that the CDC neither edits nor evaluates (Center for Disease Control and Prevention, 2014a). In the core component, demographic characteristics and health-related information are collected in 16 sections. These are: demographics, health status, HRQOL (healthy days), health care access, sleep, tobacco use, HIV/AIDS knowledge and prevention, exercise, immunization, cholesterol awareness, chronic health conditions, alcohol consumption, fruit and vegetable
consumption, arthritis burden, seatbelt use, and hypertension awareness. The optional module contains items assessing pre-diabetes, diabetes, symptoms (healthy days), healthcare access, sugary drink consumption, adult asthma history, cardiovascular health, arthritis management, influenza, HIV, breast and cervical cancer screening, sodium or salt-related behavior, cancer screenings, social context, mental illness and stigma, and social context.

**Data Collection**

Because each state collects and submits data to the CDC monthly, BRFSS data processing is routinely performed on an ongoing basis. New versions of the BRFSS are made available each year for the next data collection cycle (Center for Disease Control and Prevention, 2014a). For the BRFSS data collection, computer-assisted telephone interview (CATI) systems were used. The CDC supports CATI with the Ci3 WinCATI software package for programming the core and module questions. Under the administration of the CDC, the surveys have been conducted by the State Department of Health.

Responses to core questions are always collected from calls to both landline telephones and cellular telephones, but optional module data are collected by a variety of methods: landline telephone only or combined landline telephone and cellular telephone in 2013. Depending on the modules, states determined their samples and used different versions of the surveys. The average time to complete the core questions is about 18 minutes, with approximately five to ten additional minutes depending on the number of state-added module questions. The state coordinators or interviewer supervisors provide continuing education to the BRFSS interviewers, and the rate of interviewer retention is high. The response rates for landline telephone were 49.6% and for cellular telephone were 37.8% in 2013 (CDC, 2014c).
For this study, data from both landline telephone and cellular telephone surveys were utilized.

**Sample Design**

The BRFSS encourages using appropriately weighted data that complies with the following assumptions: (a) each record has equal probabilities of being selected, and (b) noncoverage and nonresponse are equal among all parts of the population (CDC, 2013). In the BRFSS, appropriately weighting each record helps researchers avoid these assumption violations through a blanket adjustment for noncoverage and nonresponse and application of the total number of cases to equal population estimates for the geographic region (CDC, 2013). Even though the BRFSS used state sample designs, applying the final weight to the data is required in analyses in order to be able to make generalizations from samples to the general population.

The 2013 BRFSS data also used a post-stratification method to weigh survey data to reflect the probability of participation and differences in gender, age, race, and ethnicity (Rothman, Sullivan, Keyes, & Boehmer, 2012). The stratum weight differentiates the probability of selection among strata (subsets of area code/prefix combination). The purpose of weight trimming in the 2013 BRFSS was to reduce errors in the outcome estimates caused by unusually high or low weights in some categories. Therefore, a complex survey analysis was applied to the data to provide population estimates using the following syntax command in Stata: `svyset _psu[pweight=_llcpwt], singleunit(centered) strata(_ststr).

**Description of the 2013 BRFSS**

For this study, the 2013 BRFSS was selected because the 2013 BRFSS contains a Mental Illness & Stigma module. The 2014 and 2015 BRFSS did not include the Mental Illness & Stigma module. This module provides essential information that allows
identification of respondents with mental illness and measurement of psychological distress, which is an important individual factor in HRQOL. In 2013, 50 states, the District of Columbia, Guam, and Puerto Rico participated in the BRFSS. A total of 491,773 surveys were collected (40.93% male; 59.07% female). Out of 50 states plus the District of Columbia, Guam, and Puerto Rico, only four states (Minnesota, Nevada, Tennessee, and Washington) were selected for this study. These four states had collected information via the Mental illness & Stigma module that was necessary to extract responses from people with mental illness from the dataset.

**Sample Description**

In the 2013 BRFSS, a total of 491,773 respondents participated from all 50 states plus Guam, Puerto Rico, and the District of Columbia. The target population of this study was people with mental illness. In order to select samples of people with mental illness out of the pool of all survey participants, this research used the definition of mental illness suggested by the National Institute of Mental Health (NIMH; 2014). According to NIMH (2014), mental illness is defined as a mental, behavioral, and/or emotional disorder (excluding developmental and substance use) with diagnosable symptoms either present currently or within the past year.

Four states (Minnesota, Nevada, Tennessee, and Washington) were selected for this study since they had administered the optional Mental Illness & Stigma module for the 2013 BRFSS. A total of 36,418 respondents in the four states completed the 2013 BRFSS. Information from two questions was used to select respondents with mental illness. The first was, “Has a doctor, nurse, or other health professional ever told you that you have a depressive disorder, including depression, major depression, dysthymia, or minor
depression?” A total of 7,591 (20.84%) of respondents answered “yes” for the question, indicating that they had ever been diagnosed with depressive disorder. The second question was, “Are you now taking medicine or receiving treatment from a doctor or other health professional for any type of mental health condition or emotional problem?” A total of 3,797 respondents (54.03%) answered “yes” to this question. Out of 36,418 study participants in the four states, a total of 3,797 (11.46%) individuals who answered “yes” in both questions were designated as having mental illness. To address research Aim 1, all remaining respondents from the 2013 BRFSS data set that included the Mental Illness & Stigma Optional Module were included, for a total of 3,797 individuals with mental illness and 32,621 individuals without mental illness. For Aims 2, 3, and 4, this study focused on the 3,797 individuals with mental illness.

**Research Questions and Hypotheses**

Four research aims and corresponding research questions were examined in this study in order to understand the direct and indirect impact of comorbidity, psychological distress, and levels of physical activity, controlling for the effects of other environmental and individual factors on HRQOL. Given the research aims and the conceptual framework, the following research questions and hypotheses were particularly salient:

Q1: Do people with mental illness have poorer health as measured by their perceived health status, presence of comorbidity, psychological distress, physical activity levels and HRQOL than people without mental illness?

H1a: People with mental illness will have higher rates of comorbidity (i.e., heart attack, angina/coronary heart disease, stroke, asthma, skin cancer, any cancer, COPD/emphysema/bronchitis, arthritis, kidney disease and
diabetes) than people without a diagnosis of mental illness. Ultimately, people with mental illness will have greater numbers of comorbid conditions than people without mental illness.

H1b: Psychological distress will be higher among people with mental illness than among people without mental illness.

H1c: Levels of physical activity will be lower among people with mental illness than among people without mental illness.

H1d: HRQOL will be lower among people with mental illness than those without mental illness.

Q2: Are key factors of interest (comorbidity, psychological distress, and physical activity) among people with mental illness significantly associated with their HRQOL after controlling for other covariates?

H2a: Greater comorbidity (the number of chronic diseases) and higher psychological distress will decrease HRQOL among people with mental illness after controlling for other covariates.

H2b: Higher levels of physical activity will increase HRQOL among people with mental illness after controlling for other covariate factors.

Q3: Does psychological distress of people with mental illness mediate the effect of comorbidity upon HRQOL after controlling for other covariates?

H3: Among people with mental illness, comorbidity will indirectly affect HRQOL via psychological distress after controlling for covariates. (i.e., decreasing psychological distress will mitigate the negative effect of comorbid health conditions on HRQOL.)
Q4: Do levels of physical activity make a difference in the impact of comorbidity on psychological distress and/or HRQOL among people with mental illness after controlling for other covariates? Further, do levels of physical activity make a difference in the impact of psychological distress on HRQOL among people with mental illness after controlling for other covariates? Ultimately, does the indirect effect of psychological distress on comorbidity and HRQOL among people with mental illness conditionally differ due to their level of physical activity?

H4a: Levels of physical activity will buffer the impact of comorbidity on psychological distress.

H4b: Levels of physical activity will reduce the effect of comorbidity on HRQOL.

H4c: Levels of physical activity will mitigate the influence of psychological distress on HRQOL.

H4d: There will be a differential indirect effect of comorbidity on HRQOL through psychological distress, dependent on physical activity level (i.e., levels of physical activity will moderate the indirect relationship between comorbidity and HRQOL through psychological distress).

Measures

To answer the research questions, one dependent variable (HRQOL) and three independent variables that could affect HRQOL (comorbidity, psychological distress, and levels of physical activity) were selected based on the conceptual framework developed in the previous section. Out of the three independent variables, psychological distress was defined as a mediating variable between the dependent and the independent variables, and level of
physical activity was selected as a moderating variable, which affects the strength of the relationship between the dependent and independent variables (see Figure 7). In addition to these key factors of interest, other environmental and individual factors were included as covariates.

Figure 7. A Conceptual Model Reflecting Research Aims.

Health Related Quality of Life: Dependent Variable

The measures of HRQOL were assessed using the questions in the Healthy Days and General Health sections in the core component of the BRFSS. Therefore, the following four questions were asked to assess the HRQOL of an individual: (a) Would you say that in general your health is excellent, very good, good, fair, or poor?; (b) Now thinking about your physical health, which includes physical illness and injury, for how many days during the past 30 days was your physical health not good?; (c) Now thinking about your mental health,
which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?; (d) During the past 30 days, for about how many days did poor physical or mental health keep you from doing your usual activities, such as self-care, work, or recreation?

A validity study of the BRFSS HRQOL measures, which compared them to other HRQOL measures such as the 36-item Short Form Health Survey (SF-36), indicated acceptable construct, criterion, and known groups validities for the BRFSS core questions (self-rated health, physical and mental health days, and limited functioning days) (Newschaffer, 1998). The BRFSS HRQOL measures also showed acceptable test-retest reliability and strong internal validity (Moriarty, Zack, & Kobau, 2003). These measures were used in this study and provide the most insight into physical and mental HRQOL. Based on scientific literature and perspectives of its public health partners, the CDC defined HRQOL as, “an individual’s or group’s perceived physical and mental health over time” (p. 8), and this definition is reflected in the BRFSS survey (CDC, 2000).

The CDC recommended that the only scoring used in the BRFSS HRQOL measures be a summary “unhealthy days” index, which added the scores of respondents’ physically and mentally unhealthy days (Questions 2 and 3 above), for a maximum of 30 days (Moriarty et al., 2003). Newschaffer (1998) and Moum (1999) stated that, “Unhealthy days provides a simple, but comprehensive HRQOL summary measure that is a valid and responsive index of perceived physical and mental health over time” (as cited in CDC, 2000, p. 9). This summary unhealthy days index has been used in many studies because this instrument has been validated by statistically correlating the responses with measures from other more comprehensive or established HRQOL measures such as the SF-36 (Abell et al., 2005). In the
report of Booske, Kindig, Remington, Kempf, & Peppard (2006), a summary unhealthy days index was found to capture more dimensions of HRQOL than the question regarding days of activity limitation (Question 4 above). Therefore, they adopted a summary unhealthy days index to monitor HRQOL for their project “Making Wisconsin the Healthiest State.”

For these reasons, out of four core questions, Question 2 (which is a global measure of recent perceived physical health) and Question 3 (which is a global measure of recent perceived mental and emotional health) were added together to make a summary unhealthy days index for the purposes of this dissertation. There is a cut-off point of 30 unhealthy days, meaning any responses of more than 30 unhealthy days is assigned the maximum of 30 unhealthy days. HRQOL-Unhealthy Days was also reverse-coded to account for healthy days, indicating days in the past 30 days when both physical and mental health were good. In conclusion, a HRQOL-Healthy Day measure was used as a dependent variable.

Comorbidity: Independent Variable

In order to collect information on comorbid mental and physical health problems for the survey completers, the CDC included a Chronic Health Conditions module in the 2013 BRFSS data. The variable of comorbidity was assessed using 10 questions about diseases diagnosed by a doctor, nurse, or other health professional. Comorbidity included 10 types of illnesses: a heart attack; angina or coronary heart disease; stroke; asthma; skin cancer; any types of cancer; chronic obstructive pulmonary disease (COPD), emphysema or bronchitis; arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia; kidney disease; and diabetes. The question of depressive disorder was removed from comorbidity because it is one of the main sampling criteria for this study. The answer of “yes” was coded as 1, and all of the “yes” responses were combined to create an interval level variable, ranging from 0 to 10, with
higher values indicating more reported physical diseases.

**Psychological Distress: Mediator Variable**

The Kessler Psychological Distress Scale (K6) scale in the Mental Illness & Stigma module was used in order to measure non-specific psychological distress among the survey participants. The K6 was developed by Kessler and colleagues for the U.S. National Health Survey to measure individuals’ levels of non-specific psychological distress (Slade, Grove, & Burgess, 2011). In the BRFSS questionnaires, the K6 scale included these questions: How often (all of the time, most of the time, some of the time, a little of the time, or none of the time) during the past 30 days did you feel: 1) Nervous? 2) Hopeless? 3) Restless or fidgety? 4) So depressed that nothing could cheer you up? 5) That everything was an effort? 6) Worthless? Responses are made using a Likert scale ranging from 1 (none of the time) to 5 (all of the time). The negatively phrased items were reverse-coded and summed to produce the total score. The total K6 score ranges from 0 (indicating no psychological distress) to 24 (indicating severe psychological distress).

The K6 scales demonstrated excellent internal consistency reliability (Cronbach $\alpha$ = .89-.92) and criterion validity (Hootman & Cheng, 2009). The reliability of K6 questions in the sub-sample of people with mental illness in four states in the 2013 BRFSS data had a Cronbach’s alpha coefficient of .86. Kessler et al. (2002) stated, “Kessler 6 has good precision in the 90th-99th percentile range of the population distribution as well as consistent psychometric properties” (p. 959). This scale is also considered the most efficient screening tool in predicting serious mental illness in the general population (Kessler et al., 2003).

**Physical Activity: Moderator Variable**

The BRFSS physical activity questions are commonly used state-level
measurements of progress towards meeting physical activity guidelines (Yore et al., 2007). The BRFSS contains 13 physical activity questions related to occupation, leisure time, household, transportation, walking, muscle strengthening, and moderate and vigorous physical activities (Graves, 2011). Of the 13 questions regarding physical activity in the BRFSS data, three questions were used to derive a calculated variable for the physical activity levels. First, one question (“During the past month, other than your regular job, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise?”) is used to differentiate a physically inactive group from a physically active group. Next, minutes of total physical activity per week and minutes of total vigorous physical activity per week are calculated to categorize the physically active groups into three levels: insufficiently active, active, and highly active groups. Respondents in the Highly Active category do enough physical activity per week to meet the 300-minute (or vigorous equivalent) aerobic activity recommendation. Respondents who reported doing 150–300 minutes per week (or vigorous equivalent) of physical activity were labeled as “Active” respondents. Those who engaged in insufficient physical activity (11–149 minutes per week) were entered as “Insufficiently Active” for their level of physical activity, and respondents who reported doing no physical activity were termed “Inactive.” This variable was reversed-coded, with scores ranging from 1 to 4, with a higher number indicating more physical activity.

The BRFSS physical activity measurement has a fair validity and test-retest reliability that can categorize groups of adults into the levels of recommended and vigorous physical activity suggested by Health People 2010, which is a project designed to increase quality of life and to eliminate health disparity (Yore et al., 2007). The test-retest reliability
for respondents meeting the national physical activity recommendation was high, k=0.83 (.068-0.99) 93% agreement (Kimsey, Ham, Macera, Ainsworth, & Jones, 2003). Physical activity questions also had high validity (Abell et al., 2005). In conclusion, previous research suggests that the BRFSS physical activity questions can produce reliable information about meeting physical activity recommendations.

**Environmental and Individual Factors: Covariates**

This dissertation includes several covariates (healthcare satisfaction, education level, gender, age, and race) based on existing empirical evidence that may possibly affect HRQOL among people with mental illness.

**Age.** The categorical variable of age was divided into six age groups: (a) Age 18 to 24; (b) Age 25 to 34; (c) Age 35 to 44; (d) Age 45 to 54; (e) Age 55 to 64; and (f) Age 65 or older.

**Gender.** Male and female gender were coded as 1 and 2, respectively (0 = female; 1 = male).

**Race.** The race variable was composed of two categories: (0 = White; 1 = Non-White).

**Education level.** The education level in the 2013 BRFSS was categorized into six levels: (a) Never attended school or only kindergarten; (b) Grades 1 through 8 (Elementary); (c) Grades 9 through 11 (Some high school); (d) Grades 12 or GED (High school graduate); (e) College, 1 year to 3 years (Some college or technical school); and (f) College, 4 years or more (College graduate). The education level variable categories used in this dissertation were imputed by the CDC. If the respondent refused to give their education level, the value used was the average education level of the sample. Previous research found that there was
the greatest difference between those who had no high school diploma and those who had a high school diploma.

Table 1

*Variables Included in the Analysis*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>HRQOL (Dependent variable)</td>
<td>An index of individual’s perceived physical and mental health over time, ranging from 0 to 30 unhealthy days, with a higher number indicating higher number of healthy days</td>
</tr>
<tr>
<td>Comorbidity (Independent variable)</td>
<td>An index of comorbidity, ranging from 0-10, with a higher number indicating more chronic physical disease</td>
</tr>
<tr>
<td>Psychological distress (Mediator variable)</td>
<td>An index of non-specific psychological distress, ranging from 6 to 30, with a higher number indicating greater psychological distress</td>
</tr>
<tr>
<td>Physical Activity (Moderator variable)</td>
<td>A calculated variable for levels of physical activity from multiple physical activity related questions, ranging from 1 to 4, with a higher number indicating higher level of physical activity</td>
</tr>
<tr>
<td>Education level (covariate)</td>
<td>Respondent’s education level, indicating 0= those who did not graduate from high school; 1= those who either graduated from High school or attained a GED, or above</td>
</tr>
<tr>
<td>Age (Covariate)</td>
<td>Six age groups with a higher number indicating older age group</td>
</tr>
<tr>
<td>Gender (Covariate)</td>
<td>Respondent’s gender, indicating 0= female and 1= male</td>
</tr>
<tr>
<td>Race (Covariate)</td>
<td>Respondent’s racial status, indicating 0= Non-White and 1=White</td>
</tr>
<tr>
<td>Employment Status (covariate)</td>
<td>Respondent’s employment status, indicating 0= Employed for wages and Self-employed; 1= Out of work and unable to work, a homemaker and a student and retired</td>
</tr>
<tr>
<td>Healthcare access (covariate)</td>
<td>Respondent’s health insurance, indicating 0= Not insured and 1= Insured</td>
</tr>
<tr>
<td>Activity limitation (covariate)</td>
<td>Respondent’s activity limitation due to health problems, indicating 0= No, I am not limited in any activity and 1= Yes, I am limited in any activity due to health problems</td>
</tr>
</tbody>
</table>
high school diploma or attained a GED (Pauly, Janosky, & Sharma). In this study, therefore, education level was dummy coded (0 = those who did not graduate from high school; 1 = those who either graduated from high school or attained a GED, or above).

**Employment status.** Employment status was dummy coded from eight categories to two categories (0 = employed for wages or self-employed; 1 = out of work and unable to work, homemaker, student, or retired). Employment status indicates whether or not the respondent was employed.

**Healthcare access.** Healthcare access was a nominal variable, indicating individuals insured or not covered by any kind of health insurance such as prepaid plans, HMOs, Medicare or the Indian Health Service. Yes and no responses were coded as 0 and 1, respectively (0 = No; 1 = Yes).

**Activity limitation.** Activity limitation due to physical, mental, or emotional problems was a nominal variable. Yes and no were coded as 0 and 1, respectively (0 = No, 1 = Yes).

**Data Analysis**

The analysis consists of both a cross-sectional study that shows demographic and health-related factors of people with mental illness through comparison with people without mental illness, as well as a theoretical evaluation that examines the relationships among HRQOL, comorbidity, psychological distress, and physical activity. Therefore, this dissertation utilized two separated datasets, given that the research Aim 1 compared people with mental illness and people without mental illness and the other aims were concerned only with individuals with mental illness. For research Aim 1, participants’ socio-demographic
information (gender, income, employment status, education level, race, and marital status),
health-related factors (health status, chronic health conditions, BMI, healthcare access, and
healthcare provider) and key factors of interest (HRQOL, comorbidity, psychological
distress, and physical activity) were analyzed and compared between people with mental
illness and without mental illness. For the purposes of research Aims 2, 3 and 4, this analysis
only included data from people with mental illness.

First, basic statistical conditions, such as missing data and assumptions for
multivariate analyses and SEM, were assessed for the data of people with mental illness,
using Stata 13 (StataCorp, 2013a). To check the missingness of the data, Little’s missing
completely at random (MCAR) tests and covariate-dependent missingness (CDM) tests were
performed. Next, multivariate normality, multicollinearity, bivariate correlations tests, and
heteroscedasticity were used to determine whether the assumptions for hierarchical
regression and SEM were met.

After performing the preliminary analyses, the following steps were performed to
address the research aims of this study. First, descriptive and comparative analyses were
performed for Aim 1 using chi-square tests and t-tests. These descriptive and comparative
analyses were intended to provide better understanding of the study samples and differences
between people with mental illness and without mental illness. Second, to address research
Aim 2, a hierarchical multiple regression analysis was used to determine if key factors of
interest explained a statistically significant amount of variance in HRQOL, after controlling
for covariates. Third, a mediation test was conducted through mental illness and
bootstrapping methods in order to address research Aim 3. Before conducting a mediation
test, bivariate correlations tests, namely Pearson correlation and Kendall tau-a correlation
test, were performed to determine if there were significant associations among key factors of interest that are necessary conditions of the mediating effect (Baron & Kenny, 1986). It should be noted that the purpose of these bivariate analyses was not to determine independent variables that were included in the next step. Instead, all variables included in the final model were derived from theory or existing empirical studies. Last, SEM and bootstrapping methods were performed for research Aim 4 to examine whether physical activity levels moderate the impact of comorbidity on HRQOL through psychological distress among people with mental illness.

**Missing Data**

Out of 491,773 respondents, 433,220 (88.09%) completed the interview and 58,553 (11.91%) respondents partially completed the interview (CDC, 2014b). Data from the four states that implemented the Mental Illness and Stigma Module in 2013 had missing responses or people responded “don’t know/not sure,” and some refused to answer. In the four states, incomplete interview rates were 10.82% (n = 3,670), which is slightly less than the national population.

Missingness was checked and handled in the data of people with mental illness since missing data often cause major difficulties in the estimation of regression analysis and SEM analyses that were used for research Aims 2, 3 and 4 (Allison, 2003; Haitovsky, 1968). For people with mental illness, the incomplete interview rate was 0.82% (n = 31). This dissertation selected 25 questions for analysis. Excluding the 10 questions for a comorbidity variable, the missing rate for the rest of the 26 questions was 8.6% (n = 323). Chi-square tests and t-tests were conducted to determine if there was a difference in mean scores between cases with complete data and cases with missing values. These methods assessed whether or
not missing cases were random.

Table 2

**Missing Data**

<table>
<thead>
<tr>
<th>Endogenous Measured Variables</th>
<th>Number of Missing Cases (%)</th>
<th>How Missing Cases Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comorbidity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart attack (CVDINFR4)</td>
<td>19 (0.5%)</td>
<td>Imputation of 0</td>
</tr>
<tr>
<td>Angina or coronary heart disease (CVDCHRD4)</td>
<td>34 (0.9%)</td>
<td>Imputation of 0</td>
</tr>
<tr>
<td>Stroke (CVDSTRK3)</td>
<td>19 (0.5%)</td>
<td>Imputation of 0</td>
</tr>
<tr>
<td>Asthma (ASTHMA3)</td>
<td>13 (0.46%)</td>
<td>Imputation of 0</td>
</tr>
<tr>
<td>Skin cancer (CHCSCNCR)</td>
<td>9 (0.24%)</td>
<td>Imputation of 0</td>
</tr>
<tr>
<td>Cancer (CHCOCNCR)</td>
<td>10 (0.26%)</td>
<td>Imputation of 0</td>
</tr>
<tr>
<td>COPD (CHCCOPD1)</td>
<td>30 (0.79%)</td>
<td>Imputation of 0</td>
</tr>
<tr>
<td>Arthritis (HAVARTH3)</td>
<td>20 (0.53%)</td>
<td>Imputation of 0</td>
</tr>
<tr>
<td>Kidney disease (CHKIDNY)</td>
<td>19 (0.5%)</td>
<td>Imputation of 0</td>
</tr>
<tr>
<td>Diabetes (DIABETE3)</td>
<td>6 (0.16%)</td>
<td>Imputation of 0</td>
</tr>
<tr>
<td><strong>Physical Activity (_PACAT1)</strong></td>
<td>108 (2.84%)</td>
<td>Listwise deletion</td>
</tr>
<tr>
<td><strong>Psychological Distress (Kessler-6)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nervous (MISNERV)</td>
<td>11 (0.29%)</td>
<td>Listwise deletion</td>
</tr>
<tr>
<td>Hopelessness (MISOPLS)</td>
<td>15 (0.39%)</td>
<td>Listwise deletion</td>
</tr>
<tr>
<td>Restless (MISRSTLS)</td>
<td>22 (0.58%)</td>
<td>Listwise deletion</td>
</tr>
<tr>
<td>Depressed (MISDEPRD)</td>
<td>20 (0.53%)</td>
<td>Listwise deletion</td>
</tr>
<tr>
<td>Effort (MISEFFRT)</td>
<td>30 (0.79%)</td>
<td>Listwise deletion</td>
</tr>
<tr>
<td>Worthless (MISWTLES)</td>
<td>18 (0.48%)</td>
<td>Listwise deletion</td>
</tr>
<tr>
<td><strong>HRQOL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical health (PHYSHLTH)</td>
<td>81 (2.14%)</td>
<td>Listwise deletion</td>
</tr>
<tr>
<td>Mental health (MENTHKT)</td>
<td>85 (2.24%)</td>
<td>Listwise deletion</td>
</tr>
<tr>
<td><strong>Gender (sex)</strong></td>
<td>No Missing</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Age (_age_g)</strong></td>
<td>8 (0.21%)</td>
<td>Mean age imputation</td>
</tr>
<tr>
<td><strong>Race (_imprace)</strong></td>
<td>30 (0.79%)</td>
<td>Common race/ethnicity imputation</td>
</tr>
<tr>
<td><strong>Education (_impeduc)</strong></td>
<td>4 (0.11%)</td>
<td>Common level of education imputation</td>
</tr>
<tr>
<td><strong>Healthcare access (hlthpln1)</strong></td>
<td>10 (0.26%)</td>
<td>Listwise deletion</td>
</tr>
<tr>
<td><strong>Employment status (employ1)</strong></td>
<td>4 (0.11%)</td>
<td>Listwise deletion</td>
</tr>
<tr>
<td><strong>Activity limitation (qkactlm2)</strong></td>
<td>26 (0.68%)</td>
<td>Listwise deletion</td>
</tr>
</tbody>
</table>

In applied research, the existence of missing values is a pervasive problem. Missing
data causes some loss of information, reduced power, and bias in estimates (Bartlett, 2012). Researchers have been compensating for missing data in a variety of ways. For example, in many statistical packages and research, the standard analysis is restricted to use for subjects with no missing values, otherwise it could yield biased estimates (Raghunathan, 2004). In this regard, Little and Rubin (1987) suggested checking missing data mechanisms in order to treat missing values in an appropriate way. There are three types of missing data mechanisms or so-called assumptions: (a) Missing completely at random (MCAR), (b) Missing at random (MAR) and (c) Not missing at random (NMAR). MCAR is the strongest assumption that missingness of an observed variable is independent from all other variables (Allison, 2002). In order to meet the conditions of MCAR, the result of the independent $t$-test or chi-square test of each variable between data with missing values and data without missing values should not be statistically different. When this assumption is violated, we presume the missing value mechanism of data could be considered either MAR or NMAR. Despite its strength, the assumption of MCAR is rarely satisfied in practical applications, and a weaker assumption, MAR, is more appropriate in most cases (Raghunathan, 2004). The assumption of MAR is that the variable’s pattern of missingness depends on several other variables in the dataset. In practical application, the MAR is the most common pattern of missingness (Little & Rubin, 1987). If the MCAR and MAR assumptions are violated, the data are considered to be NMAR. The NMAR assumes that the pattern of missing values can be explained only by the variable itself or by very closely related variables. When the missing value is NMAR, the missing data mechanism cannot be ignored, and a special treatment such as Heckman’s (1979) method for selection bias is required (Allison, 2002). Even when missingness of the data is less than 10%, checking missing value patterns is necessary.
As suggested by Li (2013), the Little’s MCAR test and the covariate-dependent missingness (CDM) were conducted to test the missing mechanism of this data. The result of Little’s MCAR test for key factors of interest (HRQOL, comorbidity, psychological distress, and physical activity levels) gave a $\chi^2$ distance of 49.82 ($df = 16; p < .001$). The test provided evidence that the missing data in the four key factors of interest were not MCAR at a significance level of $p \geq .001$.

The CDM test was also conducted to investigate whether missingness in outcomes depended on covariates measured at baseline or if it depended on the outcome itself (Hossain, Diaz-Ordaz, & Bartlett, 2016). CDM is a special case of MAR and can be used to check whether the chance of seeing patterns of missing values in the key factors of interest depends on possible covariates (Li, 2013). Because the patterns of missing values of four health-related key variables violated the assumptions of MCAR, the CDM test could offer insight into missing value patterns and whether or not they depend only on observed covariates. The former can be considered NMAR, while the latter can be considered MAR. For this study, six covariates were considered: age, gender, race, healthcare access, education level, and employment status. The result of the CDM test including seven covariates produced a $\chi^2$ distance of 143.59 ($df = 128; p = 0.16$). This result was highly nonsignificant, which implies that although key factors of interest (HRQL, comorbidity, psychological distress and physical activity) were not MCAR, the missing data mechanism can be reasonably viewed as CDM (special case of MAR) given seven covariates. Therefore, the health-related factors’ missing mechanisms were considered MAR, and adjusting the effect of covariates is recommended when any analysis of the key factors of interest using completely observed samples is conducted.
As Graham (2009) suggested, this dissertation considered several approaches to treating missing data, such as complete case analysis, pairwise deletion, listwise deletion, a full information maximum likelihood (FIML) estimation, and multiple imputation. In the 2013 BRFSS, demographic data such as age, race, and education level were already imputed by CDC. A mean imputation method was performed on these demographic data, meaning that the common value of data replaced the missing value (CDC, 2014b). A conservative “0” replacement was performed for composite variables comprising the comorbidity.

This dissertation utilized FIML, which has been shown to produce unbiased parameter estimates and standard errors under MAR or MCAR (Acock, 2013). Through an adjusted likelihood function, incomplete observations can be used in estimation (Medeiros, 2013). Ad hoc techniques for treatment of missing values, such as listwise and pairwise deletion, are more likely to have bias for parameter estimates under MAR, but not under missing completely at random (MCAR). Therefore, FIML is an effective method for this study, producing unbiased parameter estimates even under MAR (McDonald & Ho, 2002). An FIML parameter estimator generates less bias and less sampling variability than the three ad hoc methods: listwise deletion, pairwise deletion, and imputation (Enders, 2001b). Unlike other imputation methods in which missing values were replaced or imputed, the FIML method handles missing data within the analysis model that produces population parameter estimates from the sample data (Collins, Schafer, & Kam, 2001). In the final model, therefore, this study included 3,455 cases in the regression analysis and SEM using a FIML estimation to handle missing data.

Assumptions for Hierarchical Multiple Regression and SEM Using FIML Estimation

FIML in SEM requires the following assumptions: (a) reasonable sample size; (b)
multivariate normality; (c) multicollinearity; and (d) heteroscedasticity.

**Reasonable sample size.** The 2013 BRFSS dataset contains a total of 491,773 cases for all 50 states, with 3,797 cases of mental illness and 36,418 cases of no mental illness in four states (Minnesota, Nevada, Tennessee, and Washington). Large samples (at least 200 plus) are required in order to conduct SEM (Kline, 2015). The samples in this research were adequately large for performing SEM.

**Multivariate normality.** Multiple regression assumes normality before conducting analyses (Osborne & Waters, 2002). The normality assumption can be evaluated by calculating the marginal distribution of each variable or the skewness and kurtosis coefficients (McDonald & Ho, 2002). Each continuous variable (HRQOL, comorbidity, and psychological distress) was checked for its normality. According to George (2011), values for skewness and kurtosis between -2 and +2 are considered acceptable in order to prove normal distribution. All of the continuous variables in this study indicated acceptable values of skewness (between -2 and +2), but an independent variable, comorbidity, did not satisfy the kurtosis cut-off point (4.39).

One step beyond the assumption of regression analysis, SEM with ML estimation requires multivariate normality, which assumes joint normality among variables (Ullman, 2006). Multivariate distribution, the method used to check normality and multivariate outliers, can be measured by Mardia’s coefficient. Applying Mardia’s test of normality to the four key factors of interest (HRQOL, comorbidity, psychological distress, and physical activity) revealed that the assumption of joint normality was violated because the results showed skewness of data ($\chi^2 = 1468.510, p < .001$). On the other hand, Mardia’s kurtosis results showed normality ($\chi^2 = 0.962, p = 0.3267$).
Generally, FIML estimation, which is a default estimation technique for SEM using the variance-covariance matrix of the estimators and listwise deletion, is used for medium (over 120) to large samples to prevent the potential risks of nonnormal distribution (Acock, 2013; Ullman, 2006). Enders (2001a) also claimed that FIML parameter estimates are not influenced by the distribution shape in MAR data. Even with a nonnormal distribution curve, FIML parameter estimates involved less bias and were more efficient than other ad hoc techniques. Assumption of multivariate normality (full joint-normality) of all the variables can be relaxed in SEM when using FIML. Because of these advantages, I selected FIML for this analysis (Enders, 2001a).

Table 3

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. HRQOL</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Comorbidity</td>
<td></td>
<td>-.31*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(-.19)*</td>
<td></td>
</tr>
<tr>
<td>3. Psychological distress</td>
<td></td>
<td>-.60*</td>
<td>.23*</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(-.46)*</td>
<td>(.14)*</td>
</tr>
<tr>
<td>4. Physical activity</td>
<td></td>
<td>.21*</td>
<td>-.18*</td>
<td>-.19*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(.13)*</td>
<td>(-.12)*</td>
</tr>
</tbody>
</table>

Note: Numbers with a star indicate statistical significance at the .05 level; Values in the parentheses are Kendall’s tau-a correlation coefficient

**Multicollinearity.** Multicollinearity requires an assumption that independent variables should not be highly correlated with one another. The correlation matrix (see Table 3) is a useful method to detect high correlations between key factors of interest. The correlation coefficient lies between -1 and +1. The closer the correlation coefficient is to +/-1, the closer the relationship is to being perfectly linear. Values above 0.7 and below -0.7
indicate the presence of an association between variables. In Table 3, there is no value above 0.7 or below -0.7, indicating no multicollinearity.

Table 4

Multicollinearity Test

<table>
<thead>
<tr>
<th>Model</th>
<th>Collinearity Statistics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VIF</td>
<td>Tolerance</td>
</tr>
<tr>
<td>Comorbidity</td>
<td>1.37</td>
<td>0.73</td>
</tr>
<tr>
<td>Psychological distress</td>
<td>1.39</td>
<td>0.72</td>
</tr>
<tr>
<td>Physical activity</td>
<td>1.07</td>
<td>0.93</td>
</tr>
<tr>
<td>Gender</td>
<td>1.00</td>
<td>1.0</td>
</tr>
<tr>
<td>Age</td>
<td>1.33</td>
<td>0.75</td>
</tr>
<tr>
<td>Education level</td>
<td>1.08</td>
<td>0.92</td>
</tr>
<tr>
<td>Employment Status</td>
<td>1.33</td>
<td>0.75</td>
</tr>
<tr>
<td>Race</td>
<td>1.04</td>
<td>0.96</td>
</tr>
<tr>
<td>Healthcare access</td>
<td>1.04</td>
<td>0.96</td>
</tr>
<tr>
<td>Activity limitation</td>
<td>1.42</td>
<td>0.70</td>
</tr>
</tbody>
</table>

*Note: Dependent Variable: HRQOL*

Because a categorical variable is not appropriate for the correlation matrix, the variance inflation factor (VIF) and tolerance statistics were also provided. A VIF value greater than 10 or a tolerance value less than 0.1 indicates that variables have a multicollinearity problem (Acock, 2012). The results in Table 4 show no VIF value higher than 10 and no tolerance value less than 0.1. Therefore, there is no multicollinearity found between the independent and dependent variables.

**Heteroscedasticity.** A linear regression analysis has another assumption called homoscedasticity, indicating that the variance of error term is constant (Field, 2009). When this assumption is violated, it is called heteroscedasticity. Heteroscedasticity refers to the circumstance in which the variability of a variable is not equally distributed across the range
of values of a second variable. In other words, the residual values of a variable are “not equally likely to be above or below the predicted value for a particular value” of a second variable (Acock, 2012, p. 279). This heteroscedasticity may cause a serious distortion, such as biased standard errors, which in turn leads to bias in test statistics and confidence intervals (R. Williams, 2012). Robinson (1997) insisted that regression methods for variance estimation, used in this dissertation, can avoid this problem by changing some function of the residuals on an appropriate variance function. This dissertation employed a complex survey data analysis that included variance estimation methods used by the Stata’s complex survey estimation commands (StataCorp). As a result, the variance estimation method for complex survey data adjusts heteroscedasticity, and this dissertation was not affected by this assumption.

**Descriptive and Comparative Analyses (Research Aim 1)**

To address research Aim 1, chi-square and t-tests were performed for descriptive results and to identify differences between people with mental illness and without mental illness. Participants’ socio-demographic information (gender, income, employment status, education level, race, and marital status), health-related factors (health status, chronic health conditions, BMI, healthcare access and healthcare provider, HRQOL, comorbidity, psychological distress, and physical activity) were analyzed and compared between people with mental illness and without mental illness. Since socio-demographic information and health-related factors were categorical variables, chi-square tests were performed to compare differences between the two groups. For key factors of interest, t-tests were performed to assess whether the means of the group with mental illness and the group without mental illness were statistically different from each other.

**Hierarchical Multiple Regression (Research Aim 2)**
In order to examine research Aim 2, a two-step hierarchical multiple regression was conducted with HRQOL as the dependent variable and other key factors of interest (comorbidity, psychological distress, and physical activity levels) as the independent variables. Other environmental and individual factors, such as age, gender, education levels, employment status, and healthcare access, were included in the hierarchical multiple regression as covariates. In the first step, covariates were entered into the regression to control for possible environmental and individual characteristics that could affect the HRQOL of people with mental illness. In the next step, key factors of interest were entered to examine the influence of each variable on HRQOL, after controlling for other environmental and individual characteristics (Petrocelli, 2003).

**Mediation Analyses (Research Aim 3)**

The moderated mediation analysis followed the three-step method of Preacher et al. (2007), as well as using bootstrapping for the moderated mediation analysis. In the first step, a mediation analysis was conducted to find the indirect effect of psychological distress (M) between comorbidity (X) and HRQOL (Y). In the traditional approach to mediation (see Figure 8), there is a series of steps for evaluating a mediation model, known as a three variable (X, Y, and M) model: (1) regressing y on x, beta for c; (2) regressing m on x, beta for a; (3) regressing y on both x and m, beta for b and c’ (Acock, 2013). In this model, all three variables should be significantly correlated for a mediation effect. The aim of this approach is evaluating whether c’ is small and insignificant (full mediation) or significant, but smaller than c (partial mediation). This dissertation omitted these traditional steps of a mediating analysis since a maximum likelihood estimate using structural equation modeling (SEM), which is a second-generation multivariate analysis technique, allows researchers to conduct
an analysis of mediation models in one step. Using SEM, direct, indirect, and total effects for each predictor were estimated. In each step, Preacher et al. (2007) also suggested using bootstrap tests. Bootstrapping is not a normal distribution-based estimation because a normal theory-based method cannot reflect the sampling destitution of the indirect effect (most usually skewed and kurtotic), thus bootstrapping estimates the biased corrected and percentile confidence intervals (Bruin, 2006). Therefore, bootstrapping was conducted to obtain standard errors and confidence intervals.

$$Y_i = \beta_1 + \epsilon_1$$

$$M = \beta_2 + aX + \epsilon_2$$

$$Y = \beta_3 + c'X + bM + \epsilon_3$$

**Figure 8. A Statistical Diagram of Mediation model.** This figure illustrates direct variable and indirect paths.

Source: Acock, A. C. (2013)

**Moderation Analyses (Research Aim 4)**

In the second step, the moderation effects of physical activity (X), which represent the interactions with comorbidity (X*W) and psychological distress (M*W), were tested to determine whether the interactions have a statistically significant impact on psychological
distress (M) and HRQOL (Y).

\[ Y = \beta_{40} + \beta_{41}X + \beta_{42}W + \beta_{43}XW + \varepsilon_4 \]  \hspace{1cm} (4)
\[ M = \beta_{50} + \beta_{51}X + \beta_{52}W + \beta_{53}XW + \varepsilon_5 \]  \hspace{1cm} (5)
\[ Y = \beta_{60} + \beta_{61}X + \beta_{62}W + \beta_{63}MW + \varepsilon_6 \]  \hspace{1cm} (6)

Figure 9. A Statistical Diagram of Moderation Model. This figure illustrates interaction effects of \( XW \) and \( MW \) on \( M \) and \( Y \).

As described in Figure 9, the moderation analysis tests whether the estimate of a dependent variable (Y) from an independent variable (X) differs across levels of a moderator variable (W; Fairchild & MacKinnon, 2009). For moderation analysis, this study performed Baron and Kenny (1986)’s method using SEM as well as bootstrapping. First, mean-
centering was applied for an independent variable and a moderator, in order to reduce multicollinearity, which could be a serious problem in moderation analysis (Gatignon & Vosgerau, 2006). Second, the interaction term of X and W was created and included in the moderation model. Next, three different values (mean -1 SD; mean; mean +1 SD) of the moderator variable (physical activity) were examined through SEM (Aiken, West, & Reno, 1991). To delineate the interaction effect of physical activity and comorbidity on psychological distress and HRQOL, I also plotted the effect of comorbidity on psychological distress at low and high values of physical activity. Doing so created three simple slopes reflecting three levels of physical activity (mean -1 SD; mean; mean +1 SD) and visualized these interactions (X*W) to compare the effects of physical activity. Therefore, two-way interaction effect plots visualized the moderation effect of physical activity on interactions among comorbidity (IV), psychological distress (MV), and HRQOL (DV).

**Moderated Mediation Analysis (Research Aim 4)**

For the final model, moderated mediation analysis was also performed. Figure 10 depicts a moderated mediation model and its equation. If both $\beta_{53}$ in Equation 5 and $\beta_{73}$ in Equation 7 are significant, then there exists a moderation effect between the independent variable (comorbid health condition) and mediation variable (psychological distress). Also, if both $\beta_{53}$ in Equation 5 and $\beta_{75}$ in Equation 7 are significant, there is a moderation effect between the mediation variable (psychological distress) and dependent variable (HRQOL). Either one of the conditions above should be met for the moderated mediation effect of physical activity (Bae, 2015). The results of the moderation analysis in Equations 4, 5, and 6, determined which interaction effect ($XW$ or $MW$) was to be included in the final model. As a result, the conditional indirect effect of physical activity on comorbidity and HRQOL though
psychological distress was tested through moderated mediation analysis using SEM and bootstrapping.

\[
Y = \beta_{70} + \beta_{71}X + \beta_{72}W + \beta_{73}XW + \beta_{74}M + \beta_{75}MW + \epsilon
\]

(7)

\[
M = \beta_{80} + \beta_{81}X + \beta_{82}W + \beta_{73}XW
\]

(8)

*Figure 10* A Statistical Diagram of Moderated Mediation Model. This figure illustrates a conditional indirect effect.


As the above moderation effect model shows, the conditional indirect effects were computed by multiplying coefficients along with three different values of the moderator variable (mean -1 SD = low moderator; mean = medium moderator; mean +1 SD = high moderator). These three values were used for a normal based approach that computes the conditional indirect effects and their standard errors. Therefore, bootstrapping was also conducted to obtain standard errors and confidence intervals.

In each step of the moderated mediation analysis, SEM was used to examine the interactions of all key factors of interest among people with mental illness. SEM is superior to traditional regression analysis for analyzing complex relationships between variables (Schumacker & Lomax, 2008). Alavifar, Kariminalayer, and Anuar (2012) also have stated that SEM is much more powerful than the first generation methods such as multiple
regression because SEM, “enables researchers in measurement of direct and indirect effects and performing test models with multiple dependent variables and also using of several regression equations simultaneously” (p. 326). After conducting SEM, some post-estimation procedures are recommended for testing the model’s goodness-of-fit (Hooper, Coughlan, & Mullen, 2008). According to StataCorp (2013b), some post-estimation and model goodness-of-fit procedures can be inappropriate for use with survey estimation results because a sample likelihood value is not provided. It is controversial to utilize conventional model fit measures such as RMSEA, CFI, SRMR, or chi-square for the complex survey design because the fit indices above are not reliable for complex sampling (Bollen, Tueller, & Oberski, 2013; Wu & Kwok, 2012). Instead of using conventional model fit measures such as RMSEA, chi-Square test and CFI, this study calculated fit indices that were valid for complex survey data to determine how well the model of this dissertation fit the sample data, depending on residuals: standardized root-mean-squared residual (SRMR) and coefficient of determination (CD; Acock, 2013). The following values are recommended for fit indices. A recommended value for SRMR is less than 0.08, and CD ranges from 0 to 1, indicating prediction of the independent variable on the outcome variable. (i.e., 1 means 100 %; Acock, 2013; Hooper et al., 2008).
CHAPTER 4. RESULTS

This chapter is divided into three parts based on the study aims: (a) descriptive results and differences between people with mental illness and without mental illness (Aim 1); (b) the effects of key factors of interest predicting HRQOL (Aim 2); and (c) the results of moderated mediating tests (Aims 3 and 4) among people with mental illness. For the first part, the total sample is separated into two groups (people with mental illness and without mental illness) to compare differences in descriptive information and health-related factors. For the second and third parts of the result section, only data from the group with mental illness were used to describe the relationships between key factors of interest among people with mental illness.

The section of results follows this order. First, descriptive analyses for demographic, health-related factors, and key factors of interest are presented, and results from the chi-square tests and t-tests are also offered to compare people with mental illness and people without mental illness. Second, the hierarchical multiple regression analysis results are examined to determine if key factors of interest explain a statistically significant amount of variance in HRQOL, after controlling for covariates. Third, SEM and bootstrapping methods provide the results of mediation analysis, moderation analysis, and moderated mediation analysis after controlling for covariates.

Descriptive Results and Differences between People with Mental Illness and Without Mental Illness

The results of socio-demographic and health-related factors for people both with and without mental illness are provided in this section. Table 5 contains socio-demographic information of the study sample. Furthermore, the results of chi-square tests are provided to determine whether the presence of mental illness creates a difference between people with
## Table 5

**Chi-square Test Results for Socio-Demographic Factors in Comparison between People with Mental Illness (MI) and without Mental Illness (MI)**

<table>
<thead>
<tr>
<th>Item</th>
<th>With MI</th>
<th>Without MI</th>
<th>χ²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>990</td>
<td>26.1</td>
<td>14,241</td>
</tr>
<tr>
<td>Female</td>
<td>2,807</td>
<td>73.9</td>
<td>18,380</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-24</td>
<td>107</td>
<td>2.8</td>
<td>1,818</td>
</tr>
<tr>
<td>25-35</td>
<td>283</td>
<td>7.5</td>
<td>3,469</td>
</tr>
<tr>
<td>35-44</td>
<td>498</td>
<td>13.1</td>
<td>4,146</td>
</tr>
<tr>
<td>45-54</td>
<td>822</td>
<td>21.7</td>
<td>5,460</td>
</tr>
<tr>
<td>55-64</td>
<td>1,140</td>
<td>30.0</td>
<td>7,262</td>
</tr>
<tr>
<td>65 and older</td>
<td>947</td>
<td>24.9</td>
<td>10,466</td>
</tr>
<tr>
<td><strong>Race</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>3,384</td>
<td>89.1</td>
<td>27,555</td>
</tr>
<tr>
<td>Non-White</td>
<td>413</td>
<td>10.9</td>
<td>5,066</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not graduate from high school</td>
<td>249</td>
<td>6.6</td>
<td>1,992</td>
</tr>
<tr>
<td>Graduate from high school</td>
<td>877</td>
<td>23.1</td>
<td>8,519</td>
</tr>
<tr>
<td>Attended college</td>
<td>1,296</td>
<td>34.2</td>
<td>9,661</td>
</tr>
<tr>
<td>Graduated from college</td>
<td>1,371</td>
<td>36.2</td>
<td>12,289</td>
</tr>
<tr>
<td><strong>Employment</strong></td>
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</tr>
<tr>
<td>Employed for wage</td>
<td>1,233</td>
<td>32.5</td>
<td>14,612</td>
</tr>
<tr>
<td>Self-employed</td>
<td>219</td>
<td>5.8</td>
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<tr>
<td>Unemployed 1 year=&lt;</td>
<td>178</td>
<td>4.7</td>
<td>841</td>
</tr>
<tr>
<td>Unemployed 1 year &gt;</td>
<td>104</td>
<td>2.7</td>
<td>816</td>
</tr>
<tr>
<td>A homemaker</td>
<td>208</td>
<td>5.5</td>
<td>1,833</td>
</tr>
<tr>
<td>A student</td>
<td>88</td>
<td>2.3</td>
<td>792</td>
</tr>
<tr>
<td>Retired</td>
<td>892</td>
<td>23.5</td>
<td>9,374</td>
</tr>
<tr>
<td>Unable to work</td>
<td>871</td>
<td>23.0</td>
<td>1,574</td>
</tr>
<tr>
<td><strong>Marital Status</strong></td>
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</tr>
<tr>
<td>Married</td>
<td>1,630</td>
<td>43.1</td>
<td>17,410</td>
</tr>
<tr>
<td>Divorced</td>
<td>848</td>
<td>22.4</td>
<td>4,590</td>
</tr>
<tr>
<td>Widowed</td>
<td>410</td>
<td>10.9</td>
<td>3,963</td>
</tr>
<tr>
<td>Separated</td>
<td>126</td>
<td>3.3</td>
<td>535</td>
</tr>
<tr>
<td>Never married</td>
<td>635</td>
<td>16.8</td>
<td>4,995</td>
</tr>
<tr>
<td>A member of an unmarried couple</td>
<td>130</td>
<td>3.4</td>
<td>865</td>
</tr>
<tr>
<td><strong>Income</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Less than $15,000</td>
<td>661</td>
<td>19.5</td>
<td>2,424</td>
</tr>
<tr>
<td>$15,000 to $24,999</td>
<td>636</td>
<td>18.8</td>
<td>4,439</td>
</tr>
<tr>
<td>$25,000 to $34,999</td>
<td>321</td>
<td>9.5</td>
<td>3,136</td>
</tr>
<tr>
<td>$35,000 to $49,999</td>
<td>518</td>
<td>15.3</td>
<td>4,092</td>
</tr>
<tr>
<td>$50,000 or more</td>
<td>1,246</td>
<td>36.8</td>
<td>13,295</td>
</tr>
</tbody>
</table>

*Note. *p*<0.05, **p*<0.01, and ***p*<0.001*
mental illness and without mental illness. Therefore, the frequency of the presence of mental illness was compared with different values of other variables (see Table 5 & Table 6). According to the complex survey sample design of the data, using weighted proportions (not shown in the tables) of the sample was recommended for the results of cross-tabulation between mental illness and no mental illness. These tables are separated into two groups (people with mental illness and people without mental illness) and display descriptive information of the study samples and comparative information.

In regard to gender, our sample of people with mental illness had a greater gender gap (73.9% female versus 26.7% male) than the group without mental illness (56.3% female versus 43.7% male). Gender was statistically significantly different between the groups based on the presence of mental illness. In addition, age was categorized into six groups, ranging from 18 to 65 or above with a mean of 46.9 (not shown in tables). For age, a statistically significant gap existed between people with and without mental illness. Most people without mental illness were 65 or older, but the age group 55 to 64 was the largest in people with mental illness. The percentage of the elderly with mental illness (24.9%) was noticeably smaller than the percentage of the elderly without mental illness (32.1%). Turning to race, the dominant racial/ethnic group in the sample was White (84.3% without mental illness and 89.1% with mental illness) followed by Black (5.1% without mental illness and 3.4% with mental illness), Hispanic (4.5% without mental illness and 4.5% with mental illness), American Indian or Alaskan Native (1 % without mental illness and 1.1 % with mental illness), and Asian (2.3% without mental illness and 0.6% with mental illness). In the table, race is separated into two categories: White and Non-White, and there are statistically significant differences in race depending on the presence of mental illness. Similarly,
education level is statistically significantly different based on the presence of mental illness. The majority group for education level is college graduates (36.9% without mental illness and 37.9% with mental illness). The largest group by education level in the total sample was “graduate from college or a technical school” (37.7%). There was disparity between people with mental illness and people without mental illness in terms of education level. A higher percentage of people in the mental illness group indicated attending college compared to the group of people without mental illness (34.2% versus 29.8%). However, the percentage of individuals having graduated from college between the two groups was similar. This result indicated that people without mental illness had a higher level of education.

In terms of employment, employment status differed greatly between the two groups ($\chi^2 = 252.57, p < .001$). While only 38.3% of people with mental illness were employed, 53% of people without mental illness were employed. Furthermore, the percentage of those “unable to work” was overwhelmingly greater in people with mental illness than people without mental illness (23% versus 4.9%). For marital status, the proportions of marital status are different based on the presence of mental illness. Over half (53.8%) of the respondents without mental illness were married, while 43.1% of the samples with mental illness were married. The proportion of married individuals was higher in the group without mental illness (22.4% versus 14.2%), but the divorce rate (22.4% versus 14.2%) was higher in the mental illness group. With respect to annual income, the largest income group earned more than $50,000 per year. However, the percentage of people with mental illness in the high income groups was relatively smaller than the percentage of people without mental illness (36.8% with mental illness versus 48.6%-without mental illness). Moreover, 19.5% of people with mental illness earned less than $15,000 per year, more than double the percentage of people.
## Table 6

**Chi-square Test Results for Health-Related Factors in Comparison between People with Mental Illness (MI) and without Mental Illness (MI)**

<table>
<thead>
<tr>
<th>Item</th>
<th>With MI</th>
<th>Without MI</th>
<th>$\chi^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Health Status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excellent</td>
<td>3,779</td>
<td>32,521</td>
<td>344.1***</td>
</tr>
<tr>
<td>Excellent</td>
<td>291</td>
<td>6,351</td>
<td></td>
</tr>
<tr>
<td>Very good</td>
<td>1,026</td>
<td>11,676</td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>1,156</td>
<td>9,623</td>
<td></td>
</tr>
<tr>
<td>Fair</td>
<td>754</td>
<td>3,474</td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>552</td>
<td>1,397</td>
<td></td>
</tr>
<tr>
<td><strong>Overweight (BMI)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI &lt;25.00</td>
<td>3,653</td>
<td>30,674</td>
<td>33.6***</td>
</tr>
<tr>
<td>BMI =&gt;25.00</td>
<td>1,049</td>
<td>11,328</td>
<td></td>
</tr>
<tr>
<td><strong>Chronic Disease</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart Attack (myocardial infarction)</td>
<td>267</td>
<td>1,768</td>
<td>8.6***</td>
</tr>
<tr>
<td>Angina/ Coronary Heart disease</td>
<td>302</td>
<td>1,710</td>
<td>21.5*</td>
</tr>
<tr>
<td>Stroke</td>
<td>242</td>
<td>1,150</td>
<td>27.6***</td>
</tr>
<tr>
<td>Asthma</td>
<td>652</td>
<td>2,537</td>
<td>104.9***</td>
</tr>
<tr>
<td>Skin cancer</td>
<td>359</td>
<td>2,929</td>
<td>11.6***</td>
</tr>
<tr>
<td>Any cancer</td>
<td>484</td>
<td>3,115</td>
<td>20.4***</td>
</tr>
<tr>
<td>COPD, emphysema or chronic bronchitis</td>
<td>552</td>
<td>2,163</td>
<td>72.3***</td>
</tr>
<tr>
<td>Arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia</td>
<td>1,843</td>
<td>9,351</td>
<td>231.1***</td>
</tr>
<tr>
<td>Kidney disease</td>
<td>250</td>
<td>924</td>
<td>27.8***</td>
</tr>
<tr>
<td>Diabetes</td>
<td>656</td>
<td>3,459</td>
<td>49.3***</td>
</tr>
<tr>
<td><strong>Activity Limitation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1,966</td>
<td>6,782</td>
<td>428.2***</td>
</tr>
<tr>
<td>No</td>
<td>1,805</td>
<td>24,972</td>
<td></td>
</tr>
<tr>
<td><strong>Healthcare Access (Insured)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>3,505</td>
<td>29,002</td>
<td>20.9***</td>
</tr>
<tr>
<td>No</td>
<td>282</td>
<td>3,519</td>
<td></td>
</tr>
<tr>
<td><strong>Healthcare Provider</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Only one</td>
<td>3,214</td>
<td>23,812</td>
<td>262.5***</td>
</tr>
<tr>
<td>More than one</td>
<td>3,214</td>
<td>1,811</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>296</td>
<td>6,888</td>
<td></td>
</tr>
</tbody>
</table>

*Note. *$p<0.05$, **$p<0.01$, and ***$p<0.001$*
without mental illness who earned less than $15,000 (8.9%). This result indicated that the annual income of people with mental illness was lower than that of people without mental illness.

Table 6 provides health-related information and chi-square results between people with mental illness and people without mental illness. In terms of perceived general health conditions, 14.6% of people with mental illness indicated their health condition to be poor, compared to 4.3% of people without mental illness. On the other hand, 7.7% of people with mental illness and 19.5% of people without mental illness perceived their health to be excellent. The result of the chi-square test indicate that the presence of mental illness is statistically significantly associated with health status.

Body mass index (BMI), calculated from the height and weight of the sample, indicated that the percentage of overweight people with mental illness is about 8.2% higher than the percentage of overweight people without mental illness (71.3% versus 63.1%). People with mental illness were more likely to be overweight. In terms of chronic health conditions, the percentages of all of the studied diseases in people with mental illness were overwhelmingly higher than the percentage in people without mental illness. With the exception of the prevalence of angina/coronary heart disease ($\chi^2 = 21.51, p < .05$), chi-square results between the presence of mental illness and all of the diseases indicated statistically significant relationships at a significance level of .001.

As many previous research have indicated, the 2013 BRFSS data also demonstrated that people with mental illness were more likely to have all 10 chronic diseases, compared to the prevalence of chronic diseases among people without mental illness. Out of the 10 chronic diseases included in the survey, the prevalence of arthritis was noticeably high.
(48.5%) in the sample of people with mental illness. The proportions of people with mental illness with health insurance and access to healthcare providers were higher than for people without mental illness. According to the 2013 BRFSS, 10.8% of people without mental illness were uninsured, while 7.5% of people with mental illness were uninsured in four states (Nevada, Minnesota, Tennessee, and Washington). Moreover, 21.2% of people without mental illness had no healthcare provider, while only 7.8% of people with mental illness had no healthcare provider.

Table 7

The Results of -Test for Key Factors of Interest Included in the Analysis between People with Mental Illness and without Mental Illness

<table>
<thead>
<tr>
<th>Item</th>
<th>With Mental Illness Mean(SD)</th>
<th>Without Mental Illness Mean(SD)</th>
<th>t-value</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td>HRQOL</td>
<td>14.27 (12.49)</td>
<td>24.58 (9.42)</td>
<td>29.41***</td>
<td>35,154</td>
</tr>
<tr>
<td>Physically unhealthy days</td>
<td>9.29 (11.82)</td>
<td>3.45 (7.91)</td>
<td>17.63***</td>
<td>35,565</td>
</tr>
<tr>
<td>Mentally unhealthy days</td>
<td>11.89 (11.98)</td>
<td>2.75 (6.80)</td>
<td>26.57***</td>
<td>35,754</td>
</tr>
<tr>
<td># of Comorbid Health Conditions</td>
<td>1.42 (1.41)</td>
<td>.742 (1.11)</td>
<td>-18.37***</td>
<td>36,290</td>
</tr>
<tr>
<td>Psychological Distress</td>
<td>8.00 (.17)</td>
<td>2.66 (3.48)</td>
<td>-29.85***</td>
<td>31,385</td>
</tr>
<tr>
<td>Physical Activity</td>
<td>2.25 (1.18)</td>
<td>2.52 (1.18)</td>
<td>8.00</td>
<td>32,637</td>
</tr>
</tbody>
</table>

Note. *p<0.05, **p<0.01, and ***p<0.001

The mean scores and standard deviation of key factors of interest for people with and without mental illness are presented in Table 7. Independent-sample t-tests were also performed to answer Research Question 1: Do people with mental illness have poorer health in terms of perceived health status, number of chronic diseases, psychological distress, levels
of physical activity, and HRQOL than people without mental illness? To assess this question, t-tests were used to compare key factors of interest between people with mental illness and people without mental illness. The key factors of interest were: HRQOL, physically unhealthy days, mentally unhealthy days, levels of physical activity, psychological distress, and comorbidity.

In terms of HRQOL, there was a significant difference in the mean of HRQOL for people with mental illness ($M = 14.27$, $SD = 12.49$) and people without mental illness ($M = 24.58$, $SD = 9.42$). This indicated that people with mental illness have decreased HRQOL. Also, the means of physically unhealthy days and mentally unhealthy days among people with mental illness were substantially greater than for people without mental illness. Overall, people with mental illness had more unhealthy days than did people without mental illness (14.27 unhealthy days versus 5.42 unhealthy days). It is also noted that, among people without mental illness, the mean number of physically unhealthy days was higher than the mean of mentally unhealthy days, whereas people with mental illness had more mentally unhealthy days than physically unhealthy days.

The number of comorbid conditions in people with mental illness ($M = 1.42$, $SD = 1.41$) and people without mental illness ($M = .742$, $SD = 1.11$) were statistically significantly different. On average, people with mental illness had more than one co-occurring physical health problem. Specifically, the results indicate that people with mental illness are more likely to have comorbid physical health problems. On average, people with mental illness reported higher psychological distress. For physical activity, there was no statistically significant difference between people with mental illness ($M = 2.25$, $SD = 1.18$) and people without mental illness ($M = 2.52$, $SD = 1.18$). However, people with mental illness tended to
be less physically active compared to people without mental illness.

In conclusion, the hypotheses of this dissertation were answered. First, the number of comorbid health conditions and levels of psychological distress of people with mental illness were greater than for those without mental illness. Second, HRQOL and levels of physical activity were higher among people with no mental illness diagnosis than among people with mental illness.

**Predicting HRQOL from Comorbidity, Psychological Distress, and Physical Activity**

To understand the effect of key factors of interest on HRQOL among people with mental illness, only samples (n=3,797) who met the criteria of mental illness were utilized: having mental illness and currently taking medication, or receiving treatment for a mental health condition or emotional problem. In this section, the results of hierarchical multiple regression are presented as preliminary to the next section for mediating, moderating and moderated mediating analysis. Table 8 displays the results of a hierarchical regression analysis that examined whether each health-related factor of interest explains a statistically significant amount of variance in HRQOL after controlling for covariates.

A two-step hierarchical multiple regression was conducted with HRQOL as the dependent variable. Age, gender, race, education level, healthcare access, employment status, and activity limitation were entered at Step 1 of the regression to control for the influence of covariates on HRQOL. The key factors of interest (i.e., number of comorbid conditions, psychological distress, and physical activity levels) were entered at step 2. The hierarchical multiple regression revealed that at Step 1, the following variables contributed significantly to the regression model, $F(7, 3496) = 103.65, p < .001$ with $R^2$ of .32; age ($p < .001$); education level: high school diploma or above ($p < .001$); employment: not employed
### Table 8

**Summary of Hierarchical Regression Analysis for Variables Predicting HRQOL**

<table>
<thead>
<tr>
<th>Variable</th>
<th>β</th>
<th>SE</th>
<th>t</th>
<th>( R^2 )</th>
<th>( \Delta R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>1.15</td>
<td>.25</td>
<td>4.56***</td>
<td></td>
<td>.32</td>
</tr>
<tr>
<td>Gender(male)</td>
<td>-.23</td>
<td>.63</td>
<td>-0.37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Race (White)</td>
<td>1.22</td>
<td>.85</td>
<td>1.43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education level (high school diploma or above)</td>
<td>3.59</td>
<td>1.00</td>
<td>3.58***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Healthcare access (insured)</td>
<td>1.63</td>
<td>1.04</td>
<td>1.57</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employment status (not employed)</td>
<td>-4.16</td>
<td>.69</td>
<td>-5.99***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activity limitation</td>
<td>-10.97</td>
<td>.68</td>
<td>16.13***</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.46</td>
</tr>
<tr>
<td>Age</td>
<td>.73</td>
<td>.25</td>
<td>2.92**</td>
<td></td>
<td>.46</td>
</tr>
<tr>
<td>Gender(male)</td>
<td>.43</td>
<td>.58</td>
<td>0.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Race (White)</td>
<td>.75</td>
<td>.78</td>
<td>0.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education level (high school diploma or above)</td>
<td>.47</td>
<td>.97</td>
<td>.48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Healthcare access (insured)</td>
<td>.69</td>
<td>1.01</td>
<td>.68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employment status (not employed)</td>
<td>-1.62</td>
<td>.63</td>
<td>-2.57**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activity limitation</td>
<td>-6.61</td>
<td>.71</td>
<td>9.37***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comorbidity</td>
<td>-1.04</td>
<td>.19</td>
<td>-5.40***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychological distress</td>
<td>-.81</td>
<td>.06</td>
<td>-14.22***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical Activity</td>
<td>.70</td>
<td>.25</td>
<td>2.83**</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. *\( p<0.05 \), **\( p<0.01 \), and ***\( p<0.001 \)*
and activity limitation due to health problems \((p < .001)\); and activity limitation due to health problems \((p < .001)\). Gender, race, White, and healthcare access: insured did not show statistical significance with HRQOL at Stage One. At this step, the result of the hierarchical multiple regression accounted for 32\% of the variation in HRQOL among people with mental illness.

In the step 2, the addition of key factors of interest to the regression model explained an additional 14\% of the variation in HRQOL, with \(R^2\) significant, \(F (10, 3333) = 158.83, p < .001\). \(R^2\) reported in the step 1 and 2 showed substantial values for the model to achieve a minimum level of explanatory power, which should be equal to or greater than 0.10 (Falk & Miller, 1992). An \(R^2\) of 0.25 is recommended for good amount of explanatory power (Nau, 2017). When all key factors of interest (comorbidity, psychological distress, and physical activity) were included in Step 2 of the regression model, they were all significant predictors of HRQOL. However, education level became statistically insignificant in Step 2.

This dissertation study found that comorbidity significantly predicted HRQOL, as did psychological distress and physical activity levels. There was a decrease of 1.04 days in HRQOL (healthy days) for each additional chronic disease amongst people with mental illness, after controlling for covariates and other key factors of interest.

Examination of psychological distress revealed that for every one point (ranging 6-30) increase in psychological distress, HRQOL was decreased by 0.8 days, whereas going up one level of physical activity was associated with an increase of 0.7 healthy days of HRQOL among people with mental illness, after controlling for other environmental and individual factors and key factors of interest.

Among environmental and individual factors, age and employment status (not employed) were significant predictors of HRQOL, even after controlling for other factors.
Each increase in age category, or getting older, led to an increase of 0.72 days in HRQOL amongst people with mental illness. People with mental illness who were not employed had an average of 1.62 fewer healthy days than people with mental illness who were employed. One of the strongest predictors of HRQOL is activity limitation. People with activity limitation due to health problems had fewer healthy days (6.61 days) than people who were not limited in any activities. As a result, comorbidity, psychological distress, and physical activity levels are important predictors of HRQOL, even after controlling for covariates. As Hypothesis 2a predicted, greater comorbidity and higher psychological distress were associated with lower HRQOL among people with mental illness after controlling for other covariates. Hypothesis H2b was also supported; higher levels of physical activity were associated with higher HRQOL among people with mental illness after controlling for other covariate factors. The results of hierarchical multiple regression support that testing the role of key factors of interest in HRQOL using mediation, moderation and moderated mediation analyses was reasonable, as discussed in the conceptual framework of this study.

Results of Mediation, Moderation and Moderated Mediation Tests

To delineate the roles of key factors of interest, several steps were conducted: (a) mediation analysis, (b) moderation analysis, and (c) moderated mediation analysis. First, a mediating analysis was performed to explain the role of psychological distress in mediating between comorbid health conditions and HRQOL, since psychological distress is the most powerful predictor of HRQOL. Second, moderating analyses were conducted to find whether physical activity amplifies or buffers the effect of key factors of interest (comorbidity and psychological distress) on HRQOL. Finally, a moderated mediation analysis, which is a combined method of mediation and moderation analyses, was performed to decide whether
the pattern of the mediation role of psychological distress between comorbidity and HRQOL varies as a function of the physical activity.

**Mediating Effect**

Aim 3 of this study was to investigate the role of psychological distress in the relationship between comorbidity and HRQOL for people with mental illness. It was hypothesized that psychological distress would mediate the relationship of comorbidity to HRQOL. In other words, through decreasing psychological distress, the negative effect of comorbidity on HRQOL would be reduced.

Prior to conducting the mediation test, the results from bivariate analyses using Pearson correlation and Kendal’s tau-a correlation, as well as hierarchical regression, were considered because significant associations amongst variables are an indispensable condition of mediating effects (Baron & Kenny, 1986). The results indicate that there are statistically significant associations among comorbidity, psychological distress, and HRQOL. These results can be extended to the assumptions that depict the causal chain of a mediation model: (a) two causal paths from the independent variable and the mediator into the outcome variable; (b) one path from the independent variable to the mediator (Baron & Kenny, 1986).

For the mediation analysis, SEM was conducted to calculate the direct effect of comorbidity and psychological distress on HRQOL, the indirect effect of comorbidity on HRQOL via psychological distress, and the total effect that is equal to the sum of direct effect and indirect effect (see Table 9). In the model, the direct effect of comorbidity on HRQOL (path c’ in Figure 11) is estimated to be -1.11 ($t = -75.74, p < .001$), after controlling the mediator. The direct effect of comorbidity on psychological distress is also statistically significant ($B = .58, t = 5.2, p < .001$).
As hierarchical regression analysis indicated, both comorbidity and psychological distress of people with mental illness predict their HRQOL, after controlling for the mediator.

Table 9

Mediation Analysis of Comorbidity on HRQOL via Psychological Distress

<table>
<thead>
<tr>
<th>Outcome</th>
<th>B</th>
<th>SE</th>
<th>z</th>
<th>Bootstrapping Bias-corrected 95% CI Lower</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Effect</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Path c’ (Comorbidity ➔ HRQOL)</td>
<td>-1.11</td>
<td>.19</td>
<td>-5.74***</td>
<td>-1.52</td>
<td>-.78</td>
</tr>
<tr>
<td>Path a (Comorbidity ➔ Psychological distress)</td>
<td>.58</td>
<td>.11</td>
<td>5.20***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Path b (Psychological distress ➔ HRQOL)</td>
<td>-.83</td>
<td>.05</td>
<td>-15.29***</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Indirect Effect via psychological distress

Path c-c’ or a*b (Comorbidity ➔ HRQOL) ➔ -.70 -30

Total Effect

Path c (Comorbidity ➔ HRQOL) ➔ -2.00 -1.20

Note. CI = confidence interval. * = p<0.05, ** = p<0.01, and *** = p<0.001.

and other covariates. The results of mediating analysis suggest that the indirect effect is significant (B = -.83, t = -15.29, p < .001), meaning that there exists a mediation effect of psychological distress in the model. The total effect of comorbidity on HRQOL is calculated by summing the direct effect and indirect effect of comorbidity on HRQOL (B = -1.59, t = -7.92, p < .001). The total effect represents Path c in Figure 11 that indicates the effect of the independent variable on the dependent variable, excluding the effect of the mediator. In our model, the indirect effect was statistically significant, indicating that there is a mediating effect of psychological distress, a*b, in our model. However, the direct effect, c’, was also statistically significant. Thus, this is the case of partial mediation as the relationship between the independent variable and the dependent variable is partially accounted for by the mediator.
(MacKinnon, 2011). Moreover, it is important to note that the direct effect of comorbidity on HRQOL is smaller than the total effect (c’ > c). This means that the role of psychological distress has a suppression effect, which, “increases the predictive validity of another variable by its inclusion in a model” (Rucker, Preacher, Tormala, & Petty, 2011, p. 366).

![Mediation Analysis Diagram]

**Figure 11.** Mediation Analysis of Comorbidity on HRQOL via Psychological distress.

This study computed ratios and proportions of effects in order to interpret the mediation effect. For the standardized results, the total effect of comorbidity on HRQOL is -.17. The direct component of this total effect is -.12; therefore, -.12 / -.17 = .70, or 70% of the effect of comorbidity on HRQOL is direct after controlling for psychological distress and covariates. By contrast, the proportion of the total effect mediated by psychological distress is -.05 / -.17 = .294. There is a smaller percentage (29.4%) of the indirect effect than the direct effect in the model. Thus, even after controlling for psychological distress and other covariates, the majority of the effect of comorbidity on HRQOL is a direct one. However, this is a respectable amount. The total effect is about 1.4 times the direct effect, and the ratio of the indirect effect to the direct effect is about .41.

Finally, bootstrap tests were performed for the mediation analysis. Bootstrapping is
more powerful than the usual tests of Baron and Kenny (1986) or Sobel (1982) as it is used to treat non-normal sampling distribution and compensate for the weakness of the usual tests of indirect effect, which lack statistical power (Shrout & Bolger, 2002). As Shrout and Bolger (2002) suggested, bias-corrected bootstrap confidence intervals, which produce accurate confidence intervals, were tested with 1,000 samples (see Table 9). Bootstrapping bias-corrected confidence intervals (CI; between lower CI and upper CI) do not include 0 in the indirect effect ($B = -.49$, $p < .001$, 95% CI = -.70 ~ -.30). These results support the meditational hypothesis. In conclusion, the results can be interpreted as follows: the number of comorbid conditions was associated with approximately 0.49 fewer healthy days (HRQOL) as mediated by psychological distress. It was found that psychological distress partially mediated (29.4%) the relationship between comorbidity and HRQOL among people with mental illness after controlling for covariates.

The postestimation tests were conducted by Stata statistical software to assess goodness-of-fit. The standardized root mean squared residual (SRMR) was less than 0.08, which is a recommended value. This indicates that the mediation model substantially reproduced each correlation and was considered a good fit (Acock, 2013). A measure of the global fit of the model like $R^2$, coefficient of determination (CD), indicates the proportion of the variance of predictability of the independent variables on the dependent variables. The coefficient of determination of the model is 0.438, which is not considered a perfect fit.

**Moderating Effect**

The first hypothesis of Aim 4 was that levels of physical activity would diminish the strength of comorbidity on psychological distress and/or HRQOL, and that levels of physical activity would diminish the effect of psychological distress on HRQOL. Before conducting
Table 10

*Moderation Analysis of Physical Activity on the Relationships between Comorbidity, Psychological Distress and HRQOL*

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B</th>
<th>SE</th>
<th>β</th>
<th>t</th>
<th>Bootstrapping Bias-corrected 95% CI Lower</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Model 1 (X W XW→ M)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R^2$ = .35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comorbidity</td>
<td>.51</td>
<td>.10</td>
<td>.12</td>
<td>4.89***</td>
<td>.31</td>
<td>.73</td>
</tr>
<tr>
<td>Physical activity</td>
<td>-.38</td>
<td>.11</td>
<td>-.08</td>
<td>-3.40***</td>
<td>-.60</td>
<td>-.17</td>
</tr>
<tr>
<td>Comorbidity* Physical Activity</td>
<td>-.25</td>
<td>.07</td>
<td>-.07</td>
<td>-3.45***</td>
<td>-.39</td>
<td>-.11</td>
</tr>
<tr>
<td><strong>Model 2 (X W XW→ Y)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R^2$ = .35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comorbidity</td>
<td>-1.50</td>
<td>.21</td>
<td>-.17</td>
<td>-7.16***</td>
<td>-1.79</td>
<td>-.96</td>
</tr>
<tr>
<td>Physical activity</td>
<td>.98</td>
<td>.25</td>
<td>.09</td>
<td>3.97***</td>
<td>.38</td>
<td>1.36</td>
</tr>
<tr>
<td>Comorbidity* Physical Activity</td>
<td>.18</td>
<td>.14</td>
<td>.02</td>
<td>1.29</td>
<td>-.02</td>
<td>.48</td>
</tr>
<tr>
<td><strong>Model 3 (M W MW→ Y)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R^2$ = .45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comorbidity</td>
<td>-.41</td>
<td>.06</td>
<td>-.52</td>
<td>-13.61***</td>
<td>-.91</td>
<td>-.67</td>
</tr>
<tr>
<td>Physical activity</td>
<td>.08</td>
<td>.25</td>
<td>.10</td>
<td>3.33***</td>
<td>.28</td>
<td>1.20</td>
</tr>
<tr>
<td>Psychological distress* Physical activity</td>
<td>-.02</td>
<td>.05</td>
<td>-.03</td>
<td>-.51</td>
<td>-.11</td>
<td>.10</td>
</tr>
</tbody>
</table>

*Note.* CI = confidence interval. Table presents both standardized (β) and unstandardized (B) regression coefficients. Continuous variables (HRQOL, comorbidity, psychological distress, physical activity and age) were mean-centered. *$p<0.05$, **$p<0.01$, and ***$p<0.001$.

SEM for moderation analyses, the variables were centered (mean-centering) to avoid potentially problematic high multicollinearity with the interaction term (Aiken et al., 1991).

In order to examine the effect of physical activity combined with comorbidity and psychological distress, two interaction terms were created: Comorbidity*Physical activity and Psychological distress*Physical activity Therefore, three models were tested to
determine the statically significant moderation effect of physical activity levels on relationships between comorbidity, psychological distress, and HRQOL (see Table 10).

Model 1 in Table 10 demonstrates that there is a statistically significant interaction effect between the levels of physical activity and comorbidity on psychological distress ($R^2 = .35, B = -.25, t = -3.45, p < .001, CI = -.39 \sim -.11$). Figure 12 depicts Statistical Model 1. This significant interaction indicates that the effect of comorbidity differs depending on the level of physical activity. According to postestimation tests of Moderation Model 1, the coefficient of determination indicates that the model is not a perfect fit ($CD = 0.269$), but SRMR is 0.000, which is a recommended value.

![Figure 12. Moderation Analysis for Interactions between Comorbid Health Conditions and Psychological Distress by Physical Activity.](image)

In Model 2, the interaction effect of physical activity with comorbidity on HRQOL was tested, but the result did not show a statistically significant effect on HRQOL ($R^2 = .35, B = .18, t = .129, p > .05, CI = -.02 \sim .48$). Model 3 was also tested to investigate the interaction effect of physical activity with psychological distress on HRQOL. In Model 3, the interaction term between physical activity and psychological distress had no statistically significant effect on HRQOL ($R^2 = .45, B = -.02, t = -.51, p > .05, CI = -.11 \sim .10$).

In sum, Models 2 and 3 have no moderation effect. On the contrary, examination of
the interaction plot of Model 1 (see Figure 13) shows a buffering effect in that as levels of physical activity increase, the impact of comorbidity on psychological distress decreases. The graph in Figure 13 indicates that the effect of comorbidity is greater for physically inactive individuals with mental illness. The steeper the slope of the physical activity, the greater the magnitude of the impact of comorbidity on psychological distress; the slope of low physical activity is steeper than the slope of high physical activity. Since the interaction was significant, the impact of comorbidity on psychological distress is less severe for the physically active individuals with mental illness than it is for the physically inactive individuals with mental illness.

Figure 13. Graph on Interaction Effect between Physical Activity and Comorbid Health Problems on Psychological Distress.

As a result, H4a, which stated that levels of physical activity will diminish the impact of comorbidity on psychological distress, was supported, but H4b (Levels of physical activity will diminish the effect of comorbidity on HRQOL) and H4c (Levels of physical activity will diminish the effect of comorbidity on HRQOL)
activity will diminish the effect of psychological distress on HRQL) were not supported. Therefore, levels of physical activity buffers the effect of comorbidity on psychological distress, but not on HRQOL.

**Moderated Mediating Effect**

Table 11

*Results of Moderated Mediation Analyses*

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Path</th>
<th>B</th>
<th>SE</th>
<th>t</th>
<th>Path</th>
<th>B</th>
<th>SE</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>a1</td>
<td>1.06</td>
<td>.20</td>
<td>5.20***</td>
<td>C1'</td>
<td>-.93</td>
<td>.34</td>
<td>-2.74**</td>
</tr>
<tr>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>b1</td>
<td>-.81</td>
<td>.06</td>
<td>-14.33***</td>
</tr>
<tr>
<td>W</td>
<td>a2</td>
<td>-.01</td>
<td>.16</td>
<td>-.04</td>
<td>C2'</td>
<td>.78</td>
<td>.34</td>
<td>2.32*</td>
</tr>
<tr>
<td>XW</td>
<td>a3</td>
<td>-.20</td>
<td>.07</td>
<td>-3.24**</td>
<td>C3'</td>
<td>-.05</td>
<td>.13</td>
<td>-.41</td>
</tr>
<tr>
<td>Constant</td>
<td>a0</td>
<td>11.92</td>
<td>.87</td>
<td>13.66***</td>
<td>b0</td>
<td>20.33</td>
<td>2.07</td>
<td>9.84***</td>
</tr>
</tbody>
</table>

Conditional Indirect Effect of X on Y at Levels of W (mean-1SD, mean, and mean+1SD)

<table>
<thead>
<tr>
<th>Levels of Physical Activity</th>
<th>Bootstrap</th>
<th>Bootstrapping Bias-corrected</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>SE</td>
</tr>
<tr>
<td>Mean-1</td>
<td>-1.11</td>
<td>.15</td>
</tr>
<tr>
<td>Mean</td>
<td>-.88</td>
<td>.12</td>
</tr>
<tr>
<td>Mean+1</td>
<td>-.64</td>
<td>.15</td>
</tr>
</tbody>
</table>

Note. CI = confidence interval. Table presents and unstandardized (B) regression coefficients. *p<0.05, **p<0.01, and ***p<0.001.

To test the moderated mediating effect, a moderated path analysis was conducted, and bootstrapping was used to compute bias-corrected confidence intervals. As seen in Table 11,
statistically significant interaction ($a_3 = -.20$, $t = -3.24$, $p = 0.001$) between comorbidity and physical activity levels is found in the model for M (psychological distress). In the model for Y (HRQOL), Path $b_1$ (psychological distress through HRQOL) shows statistical significance ($b_1 = -.81$, $t = -14.33$, $p < 0.001$), which is the strongest direct effect in the model. The moderated mediation analysis of this study indicates that the indirect effect of comorbidity on HRQOL through psychological distress is moderated by the levels of physical activity.

The results of the bootstrapping method show statistical significance across the levels of physical activity (see Table 11). In Table 11, the conditional indirect effect of comorbidity on HRQOL slowly decreases via psychological distress (a mediator variable) as the levels of physical activity increase (a moderator variable). In the model predicting HRQOL, levels of physical activity moderated the indirect path from comorbidity through psychological distress to HRQOL.

Formulas: $m = a_0 + a_1x + a_2w + a_3xw$

$y = b_0 + b_1m + c_1'x + c_2'w + c_3'xw$

Conditional indirect effect $= b_1 (a_1 + a_3w)$

*Figure 14. Moderated Mediation Analysis for Conditional Indirect Effect of Physical Activity via Psychological Distress on Comorbidity and HRQOL.*
Hypothesis H4d predicted that levels of physical activity would moderate the indirect relationships of comorbidity to HRQOL through psychological distress. This hypothesis was supported by the results of the study. In the path analysis, the coefficient of determination indicates that the model is not a perfect fit (CD = 0.335), but SRMR is 0.000, which is a recommended value for goodness-of-fit (see Figure 14).

**Summary of Results**

The following four research questions were tested in this dissertation study. First, differences between people with mental illness and people without mental illness in regard to health-related factors, namely perceived health status, presence of comorbidity, psychological distress, levels of physical activity, obesity rate, and HRQOL, were investigated. Direct comparison between people with mental illness and people without mental illness revealed that people with mental illness were more likely to have higher numbers of comorbid conditions and levels of psychological distress than people without mental illness. However, perceived general health conditions, levels of physical activity, and HRQOL of people with mental illness were significantly lower than people without mental illness. Second, the effects of key factors of interest (comorbidity, psychological distress, and physical activity) on HRQOL among people with mental illness were tested through hierarchical regression. Hypothesis H2a predicted the key factors of interest would be significant predictors of HRQOL among people with mental illness. As Hypothesis 2a predicted, greater comorbidity and higher psychological distress were associated with lower HRQOL among people with mental illness after controlling for other covariates. Since higher levels of physical activity were associated with higher HRQOL among people with mental illness after controlling for other covariate factors, Hypothesis H2b was also supported. Third, Research Question 3 of
this dissertation investigated the role of psychological distress on the relationship between comorbidity and HRQOL for people with mental illness. This research question was tested through mediation analysis using SEM and a bootstrapping method. The results of the mediation analysis supported H3, indicating that the indirect effect of comorbidity on HRQOL via psychological distress was statistically significant after controlling for other environmental and individual factors. Fourth, this dissertation study tested whether level of physical activity was a moderator in the indirect relationships of comorbidity to HRQOL via psychological distress after controlling for other environmental and individual factors. SEM and a bootstrapping method were also conducted to examine moderation effects and moderated effects. Hypothesis H4a was supported since levels of physical activity diminished the strength of comorbidity on psychological distress. However, levels of physical activity could not diminish the effect of comorbidity or psychological distress on HRQOL. Finally, Hypothesis H4d predicted a conditional indirect effect. The results indicate that levels of physical activity moderated the indirect effect of comorbidity on HRQOL via psychological distress. Therefore, H4d was also supported. In conclusion, an indirect effect of psychological distress between comorbidity and HRQOL was found, and indirect effect through psychological distress may be conditional on the interaction effect of physical activity with comorbidity among people with mental illness as hypothesized.
CHAPTER 5. CONCLUSIONS AND IMPLICATIONS

The purpose of this dissertation was threefold: to explore differences in health-related factors between people with mental illness and those without a diagnosis of mental illness; to examine the influence of key factors of interest on HRQOL among people with mental illness; and to investigate the relationships between comorbidity, psychological distress, physical activity, and HRQOL for people with mental illness. Through direct comparison, this study has explored differences in health-related factors between people with mental illness and people without mental illness. Moreover, using a conceptual framework developed from Wilson and Cleary’s model (Wilson & Cleary, 1995) and research on the buffering effect of physical activity (Puterman et al., 2010), this study has described the relationships among comorbidity, psychological distress, physical activity, and HRQOL for people with mental illness. This chapter will interpret and discuss the study findings, present limitations and strengths of this study, and explore the implications of the findings for social work policy, practice, and research.

Discussion

Differences of Health-Related Factors between People with Mental Illness and People without Mental Illness

The results indicate that there are statistically significant differences in demographic and health-related factors between people with mental illness and people without mental illness. Some aspects of the demographic information are interesting. First, it is notable that the proportion of elderly individuals with mental illness was less than the proportion of elderly individuals without mental illness. This could suggest a high premature mortality rate in people with mental illness. People with mental illness are dying about 25 years earlier than the general population (Parks, Svendsen, Singer, Foti, & Mauer, 2006). Second, the
proportion of females in the mental illness group was outstandingly high, while the group without mental illness showed no gender differences. This greater gender gap in the group with mental illness may have been caused by our sample criteria requiring a diagnosis of a depressive disorder. This result reflects the equivalent estimates of female preponderance in depression from the findings of other research (Mirowsky, 1996; Wang et al., 2016). Third, the prevalence of each chronic disease (heart attack, angina/coronary heart disease, stroke, asthma, skin cancer, any cancer, COPD, arthritis, kidney disease, and diabetes) is higher among people with mental illness than for those without mental illness. These results are consistent with previous research by De Hert et al. (2011) and Robson and Gray (2007). Even though the prevalence of all 10 of the common physical diseases included in this dissertation study were high among people with mental illness, rates of arthritis-related disease were significantly high (48.5%). As indicated in previous studies, the presence of mental illness is highly correlated with the development of physical health problems that result from mental illness itself and as a consequence of treatment (Leucht, Burkard, Henderson, Maj, & Sartorius, 2007). However, it may be the case that arthritis leads to increase risk of health problems. For example, Wells et al. reported the results of a NIMH catchment area study, “showing that persons with arthritis had a lifetime prevalence rate of psychiatric disorders of 63.6 percent and a 6-month prevalence rate of 42.8 percent” (as cited in Nicassio, 2010, p. 183). The high prevalence of arthritic disease in the sample of this dissertation could be related to the selection criteria because this study only encompasses people who reported a depressive disorder and received treatment or took medication for mental and emotional health conditions. A growing body of evidence has proposed that there is a bidirectional link between mood disorders and many physical illnesses (Evans et al., 2005). Therefore, the
sample of this study may have had a heightened probability of having both depressive disorders and physical health problems, especially arthritis-related diseases.

The results supported the hypotheses of the first research question. First, people with mental illness showed higher rates of heart attack, angina/coronary heart disease, stroke, asthma, skin cancer, any cancer, COPD/emphysema/bronchitis, arthritis, kidney disease and diabetes than the general public. This finding is consistent with previous studies by Benton, Staab, and Evans (2007) and De Hert et al. (2011). Munoli et al. (2014) found that over 80% of people with bipolar disorder had at least one active medical disease, while 19%-23% had two medical diseases and 35%-40% had three or more. The findings of this study were similar: 72.5% of respondents with mental illness had at least one physical health problem, while 20.75% had two such conditions and 21.15% of people with mental illness had three or more physical health problems. In contrast, only 51.49% of people without mental illness reported at least one physical health problem. The results of independent t-tests and chi-square tests indicated a statistically significant difference between people with mental illness and people without mental illness in terms of the number of comorbid conditions and the prevalence of chronic diseases. Therefore, the hypothesis that comorbidity is higher in people with mental illness than in people without a diagnosis of mental illness was supported by the findings.

The results also showed that 70.93% (weighted percentage) of people with mental illness were overweight (BMI ≥ 25), while a weighted 63.19% of people without mental illness were overweight. This result is also congruent with a previous report of Parks, Radke, and Ruter (2008) that 65% of adults in the United States were either overweight or obese and that this rate could increase to 75% by 2015. Compared to the general population, obesity and
being overweight are common in people with mental illness. A high prevalence of obesity or being overweight in people with mental illness were also found in four national studies conducted in Australia, North America, and continental Europe. The results of these four studies indicated that a high prevalence of obesity and overweight may be associated with metabolic disturbance such as diabetes and cardiovascular disease (Bradshaw & Mairs, 2014). Findings from this study support their statements in that the prevalence of chronic diseases related with metabolic disturbance and being overweight was high among the respondents with mental illness.

The difference in psychological distress between people with and without mental illness was statistically significant. The current findings support previous research identifying psychological distress as an independent indicator of mental illness (Kessler et al., 2003). A higher prevalence of psychological distress is common in people with mental illness. The correlation analysis of this study found a positive association between psychological distress and the number of comorbid chronic diseases. Previous research of Swartz and Jantz (2014) has also found that severe psychological distress among people with mental illness is associated with a specific set of comorbid illnesses. Psychological distress among people with mental illness intensified as the number of chronic diseases increased, which is congruent with our conceptual model.

As in previous studies, this study also found that people with mental illness are more likely to be physically inactive. For example, Nyboe and Lund (2013) reported that 48% of the healthy controls had a moderate to higher level of physical activity, while only 7% of people with mental illness had a moderate to higher physical activity level. Physical activity is beneficial for physical health, but also for mental health (Okoro et al., 2014). Their lower
levels of physical activity partially explains the higher mortality rates and physical health problems in this group. Therefore, interventions to increase physical activity to a moderate or higher level for people with mental illness have been strongly suggested by previous research.

Significantly more people with mental illness than people without described their health status as poor, and they had lower HRQOL. Previous studies have also found HRQOL impairment in people with mental illness (Barnes et al., 2012; IsHak et al., 2012; Saarni et al., 2007). In conclusion, findings from this study supported the hypotheses of the first research question that people with mental illness have poorer health (i.e., high number of comorbid chronic health problems, severe psychological distress, low levels of physical activity, being highly overweight, poor perceived general health status, and decreased HRQOL) compared to people without mental illness.

**Relationships of Comorbidity, Psychological Distress and HRQOL**

As described in the results, people with mental illness in this study showed decreased HRQOL compared to people without mental illness. These findings are unsurprising since people with mental illness in this study reported comorbid chronic health problems, severe psychological distress, and low levels of physical activity. The study confirms previous research that all of these factors are important indicators of HRQOL. For example, Bayliss et al. (2012) reported the statistically significant relationship between comorbidity (i.e., mental and physical health problems) and HRQOL, even after controlling for age and gender. The result of this study also indicated that the number of comorbid conditions were significantly associated with the magnitude of decrement in HRQOL. Respondents with mental illness who had more chronic medical diseases were more likely to have decreased HRQOL than
people with mental illness who had no or fewer chronic medical diseases. These findings suggest that interventions addressing comorbidity among people with mental illness may play an important role in increasing their HRQOL. According to Hutchinson et al. (2015), there are differences in HRQOL across the types of medical conditions and age groups. Further research is required to advance the understanding of the varied impacts of different medical condition and age-related disorders on HRQOL among people with mental illness.

The findings indicate that people with mental illness tend to have increased psychological distress and that there exists a statistically significant relationship between psychological distress and HRQOL. Previous research confirms that psychological distress is an important contributing factor of HRQOL (Ibrahim et al., 2016; Shih & Simon, 2008). Surprisingly, people with mental illness who had more psychological distress reported significantly impaired HRQOL. Beside the impact on HRQOL, it is important to note that psychological distress is associated with comorbidity. For example, individuals suffering from chronic diseases such as chronic kidney disease, heart disease, cancer, epilepsy, diabetes, or arthritis are more likely to have increased psychological distress, and thus have decreased HRQOL (ACTION Study Group, 2017; Byles et al., 2014; Co et al., 2015; Elliott, Charyton, Lu, & Moore, 2009; Ibrahim et al., 2016; Kotsis et al., 2014). In this dissertation, psychological distress and the number of comorbid conditions were positively correlated to a statistically significant degree by both Pearson correlation and Kendall’s tau-a correlation. Thus, both comorbidity and psychological distress negatively affect HRQOL, and comorbidity and psychological distress are also correlated. These results are congruent with the findings of Ekici and Ekici (2010) that the role of psychological distress is as important as comorbidity in HRQOL, and psychological distress has an additional negative influence on
the HRQOL of people with chronic health problems. These findings suggest a need for defining and explaining the role of psychological distress between comorbidity and HRQOL of people with mental illness.

Mediating Effects of Psychological Distress between Comorbidity and HRQOL

This study was guided by Wilson and Cleary’s HRQOL model (1995) that posited that HRQOL is influenced by a continuum of increasing biological and psychological complexity. Their model described a linear chain from biological variables through general health perceptions and quality of life, which fall under the broad concept of HRQOL (Revicki et al., 2014). Wilson and Cleary (1995) described HRQOL was described as a multidimensional construct that consists of a causal chain of various factors. For this reason, the conceptual model (Figure 4) of this dissertation was developed in order to account for causal paths from comorbidity to HRQOL, as well as the role of psychological distress. After controlling for covariates, the statistically significant association between comorbidity and HRQOL is mediated by psychological distress among people with mental illness. In other words, having more comorbid conditions increases the psychological distress of people with mental illness, which in turn decreases HRQOL. Previous literature also have provided clues regarding the role of psychological distress that may partially explain why and how comorbidity affects HRQOL, as it did in this dissertation. For example, the research of Shih and Simon (2008) found that psychological distress is significantly associated with having one or more comorbid illness, while serious psychological distress decreased HRQOL. Another study conducted with adults in Kirikkale, Turkey, by Keles et al. (2007) also found that comorbidity and its associated psychological distress negatively influence HRQOL. They showed that the effect of psychological distress was the most important factor in the
association between comorbidity and HRQOL.

The partial mediating role of psychological distress does not fully explain why and how comorbidity decrease HRQOL among people with mental illness. However, 29.4% of the mediating effect of psychological distress between comorbidity and HRQOL could not be ignored. The findings of this dissertation and previous studies suggest that people with mental illness need specialized care for their psychological distress besides the usual specific medical treatment for their comorbid physical health problems. In this way, people with mental illness who have comorbid medical conditions may experience dramatic improvement in HRQOL.

**Moderating Effects of Physical Activity**

As indicated above, the direct effect of physical activity on each variable was found, but the main purpose of this study was to examine physical activity as a moderator that reduces or strengthens the effect of comorbidity on psychological distress and HRQOL, or that buffers the effect of psychological distress on HRQOL among people with mental illness. The results of the first two models, the interaction effect of physical activity with comorbidity on HRQOL and the interaction effect of physical activity with psychological distress on HRQOL, were not statistically significant. These findings differ slightly from existing studies. The extant literature largely concludes that physical activity has a stress-buffering function, indicating that physical activity buffers the effect of psychological distress on mental and physical health (Craike et al., 2010; Zschucke et al., 2013). However, there exists a statistically significant interaction effect of physical activity and comorbidity on psychological distress. In other words, the level of physical activity has a moderation effect only in the relationship between comorbidity and psychological distress. The level of
physical activity buffers the negative effect of comorbidity on psychological distress; therefore, decreased psychological distress can be associated with high levels of physical activity among people with mental illness.

The results of moderation analyses propose the need for further investigation, since the main purpose of this study was to explore how physical activity moderates the negative effect of comorbidity on HRQOL among people with mental illness. To my knowledge, no existing empirical research addresses the buffering effect of physical activity between comorbidity and HRQOL. Thus, this study focused on combining the mediating effect of psychological distress and moderating effect of physical activity to determine how to reduce the impact of comorbidity on HRQOL.

**Moderated Mediating Effect of Physical Activity and Psychological Distress between Comorbidity and HRQOL**

The result of the moderated mediation analysis indicates that the negative effect of comorbidity on HRQL mediated by psychological distress differs depending on the levels of physical activity. Surprisingly, based on the findings in this study, the more physically active individuals with mental illness were, the more likely they were to indicate they had increased HRQOL despite their comorbidity after controlling for activity limitation. One possible reason is that physically active individuals with mental illness are more likely to report a decrease in the psychological distress that is partially caused by their comorbidity, and ultimately their decreased psychological distress could contribute to increasing HRQOL. The results indicate that physical activity is an important intervention to help people with mental illness who have comorbid physical health problems to increase their HRQOL. It is noteworthy that psychological distress that is reduced by the higher physical activity level plays an important role in mediating the negative effect of comorbidity on HRQOL. The
result is congruent with the definition of a moderated mediation model. Moderated mediation can occur when the effect of an independent variable on a dependent variable via a mediator variable differs across the levels of a moderator variable (Preacher et al., 2007). In conclusion, increased physical activity might be linked with decreasing psychological distress and increasing HRQOL of people with mental illness when they have comorbid medical health problems.

**Implications for Social Work**

**Practice**

Promoting health and well-being is one of the pivotal roles of social workers (Rizzo & Seidman, 2016). Recent changes in delivering integrated health and wellness services could increase the demand for social workers’ services and interventions for their clients’ health and well-being (Van Pelt, 2009). According to the National Alliance of Social Work (2017), social work is an integral component of the U.S. healthcare system, providing services to individuals and families throughout the life span. Therefore, one of social workers’ important duties is promoting the health and well-being of their clients.

Reducing health disparities between people with mental illness and the general population has been an ongoing issue in the mental health field for the last decade (Druss & Bornemann, 2010). People with mental illness are one of the most vulnerable groups in regard to health and well-being. Excessive mortality rates and comorbid physical health problems among people with mental illness affect their severely impaired HRQOL. These egregious health disparities between people with mental illness and the general population invoke the need for special services and interventions. Social workers are one of the most influential professionals in promoting HRQOL due to their pivotal role in advocating for
policies, reducing health disparities, and providing clinical assistance for better health of clients (National Alliance of Social Work, 2017).

People with mental illness have significantly higher rates of serious psychological distress and poor HRQOL of life, and their high probability of comorbidity may affect these results. Physical activity intervention is one effective model that social workers may use with their clients to reduce the risks of falls and fracture, boost mood, and improve mental health (Rizzo & Seidman, 2016). The current research findings support the literature review, in that physical activity buffers the negative impact of comorbidity and helps people with mental illness decrease psychological distress and increase HRQOL. While many individuals with mental illness are unaware of the impact of physical activity on their psychological distress and HRQOL, many social workers could help them by providing psychoeducation about the impact of physical activity on their health and well-being. In the mental health setting, social workers’ role in promoting physical activity is as pivotal as that of other mental health professionals. Furthermore, social workers can bring about different perspectives and considerations from other professionals, such as the strength approach and person-in-environment, when conducting a physical activity intervention with their clients. Social workers probably know the benefits and importance of physical activity, but many social workers may not know to use it effectively (Williams & Strean, 2006). Insufficient knowledge of how to utilize physical activity in mental health settings are an issue not only for social workers, but also for other professionals. Therefore, designing effective physical activity interventions based on collaborated care models that use a multidisciplinary team approach is needed (Goodell et al., 2011). At the practice level, team members complement one another, and a social worker might play an important role in serving people with mental
illness in their own special domain. Further research is needed to identify the role of social work in physical activity interventions within multidisciplinary teams (e.g. physical therapists, nurses, physicians, psychiatrists, occupational therapists).

Recently, several wellness initiatives have been spotlighted in the mental health field. According to SAMHSA-HRA integrated health solutions, wellness strategies for people with mental illness such as In SHAPE, Life Goals Collaborative Care, and weight management strategies for adults and youth with behavioral health conditions have been provided and found effectiveness to reduce the risk of chronic diseases, and enhance life expectancy of people with mental illness. A Wellness Recovery Action Plan (WRAP) and a clubhouse structured exercise program are also recovery oriented models that provide physical activity intervention for people with mental illness, and these programs help people with mental illness involved in physical activity (Moon, 2016; Pratt, MacGregor, Reid, & Given, 2013). A social worker can play a pivotal role to increase an organization’s awareness of the key component of wellness initiatives and to provide integrate mental and physical health support for people with mental illness when working on these interventions.

**Policy**

At the community and policy level, there are several barriers that prevent people with mental illness from maintaining healthy lifestyles (moderate physical activity levels and healthy eating habits) and HRQOL. McKibbin, Kitchen, Wykes, and Lee (2014) reported that people with mental illness often lack community-level support for healthy lifestyles such as limited access to places for physical activity, lack of financial resources, limits for supportive programs, and lack of transportation. Although the findings of this dissertation and many previous studies support increasing physical activity in order to reduce the negative impact of
comorbidity on psychological distress and improving HRQOL of people with mental illness, maintaining moderate physical activity levels is a great challenge due to these barriers.

Richardson et al. (2005) argued that effective coordination across many service providers is one of the most challenging aspects of assisting people with mental illness. In the present system, physical activity services are delivered primarily by medical health providers and are often fragmented and inadequate. Integrating physical activity interventions into routine comprehensive psychiatric care is the key to overcoming this issue. By integrating physical activity interventions across domains of interest and incorporating policy development and implementation, health promotion and well-being of people with mental illness could be achieved (Cranwell, Polacsek, & McCann, 2016a; Lawrence & Kisely, 2010a). Based on the findings of this study, growing emphasis on integrated mental and physical health services, particularly for people with mental illness who suffer from comorbidity, is necessary at the policy level. In doing so, all of the domains of interest, including social workers, psychiatric nurses, psychiatrists, psychologists, and policy makers, may be more sensitive to the need for integrated physical activity interventions based on a multidisciplinary team approach. Social workers in particular can play an important role in collaboratively identifying behavioral goals, addressing resources and environmental factors, removing barriers, and reinforcing target behaviors to increase physical activity levels and improve HRQOL among people with mental illness.

Research

It is expected that this dissertation will guide further research in this field. The sample of this study consisted of people with mental illness, particularly depressive disorders, but serious functional impairment in daily living, a key criteria for serious mental illness, was not
applied to the sample. Furthermore, individuals with other major mental illnesses, such as schizophrenia, anxiety disorder. Obsessive compulsive disorder, etc. was not included in this study. Therefore, this study has limited ability to generalize its findings to a population with other serious mental illnesses who has serious functional limitations and low HRQOL. Future research should apply the model developed in this research to a sample of adults with serious mental illness.

Second, this study includes only mentally and physically healthy days as an outcome variable for HRQOL. HRQOL is a multi-dimensional concept that includes physical, mental, psychological, and social functioning. Because this dissertation followed the suggestion of using a HRQOL- healthy days measure created by CDC, only mental and physical health were used for HRQOL. Further studies should include social functioning, which is an important dimension of HRQOL as well as one of the criteria for serious mental illness. Thus, further research should examine the impact of comorbidity, psychological distress, and physical activity on social functioning of people with mental illness.

Third, the literature review and the data from participants in this research highlight the importance of physical activity and psychological distress in supporting people with mental illness in decreasing the negative impact of comorbidity and increasing HRQOL. In order to find these results, this research study assumed causal relationships among key factors of interest. Even though this dissertation developed strong causal inference in the conceptual models based on previous literature and theories, there remains a risk of misinterpretation of effects (Fairchild & MacKinnon, 2009). In order to establish strong causal ordering, the cause must be ahead of its presumed effect, known as the creation of time order (Chambliss & Schutt, 2012). Therefore, this author recommends an experimental
design for future research.

**Limitations**

The proposed study had several limitations. One of the major limitations to this study is that the BRFSS is a telephone survey, which may have led to a non-response bias for people with mental illness since they are more likely to have no fixed address or phone number due to hospitalization or institutionalization during the data collection period. For example, people being treated for a psychiatric disorder may be particularly reluctant to participate in research, and this participation bias may lead to differential participation and dropout rates among important subgroups (Vanable, Carey, Carey, & Maisto, 2002).

Second, a sampling bias is possible because people with serious mental illness could have severe cognitive dysfunction, which in turn causes obstructions to participating in the survey. One of the major problems for individuals with mental illness (about 85%) is cognitive dysfunction that affects their performance of answering the survey (Medalia & Revheim, 2002). Therefore, people with serious mental illness are more likely to be excluded from the survey, and this study may have only included people with mental illness who had mild to moderate cognitive dysfunction. This is one of the largest shortfalls of this study because the target population of this study includes people with serious mental illness who have a great functional limitation. Due to the limitation of secondary analysis and inappropriateness of the data, this study selected mostly people with mental illness who mainly have a depressive disorder. Further research should include other common mental illnesses such as schizophrenia, bipolar disorder, schizoaffective disorders, pervasive developmental disorders, paranoia, and other psychotic disorders.

Third, the cross-sectional nature of this study makes it difficult to fully test causal
influence and prevents an analysis of how the effects of the mediator and moderator alternate over time. Even though Baron and Kenny’s moderation and mediation models have been used in many cross-sectional design studies for testing causal relations based on theoretical or conceptual models, it is difficult to discover rigorous inferences about causal relations implied by models in the cross-sectional design (Cole & Maxwell, 2003; Kraemer et al., 2008). Certainly, further studies are required to clearly identify the causal relationships among key factors of interest. Moreover, using cross-sectional data also leads to another limitation related to selecting pure samples of people who have mental illness that is completely independent from the effect of comorbid health conditions. For example, 48.5% of the respondents of this dissertation reported having arthritis-related diseases, and these physical health problems can lead to depression. This could be harmful to the validity of the study since the first criteria of this study was the presence of a depressive disorder. Due to the limitations of the cross-sectional nature of this study, it is not possible to identify which is the primary health problem that causes another secondary health issue. Future study should examine the causal links between mental illness and comorbid health conditions.

Fourth, due to the limited selection of mental illness module data, this study utilized data collected from only four states (Nevada, Minnesota, Tennessee, and Washington) and respondents with a depressive disorder. Therefore, the samples of this study may not fully represent people with mental illness residing in other states of the US. Further research is recommended to include other serious mental illnesses, and revalidate our findings by collecting data from different states.

Fifth, all of the data from BRFSS for the proposed study was self-reported; therefore, social desirability bias is possible. This tendency for respondents to respond in
socially desirable ways may cause underestimation or overestimation of the results of the proposed study.

Finally, this study did not control the influences of substance abuse. Among individuals with mental illness, the diagnosis of substance abuse and chemical dependency are high (about 59%) and it could be considered as a clinically significant comorbidity (Henwood, Padgett, Smith & Tiderlington, 2012; Laudet, 2008), and conversely, those with substance abuse are more likely to have mental illness (Kim, Leierer, Atherton, Toriello, & Sligar, 2016). People with substance abuse reported more physically and mentally unhealthy days, indicating lower HQOL (Morgen, Astone-Twerell, Gunneson, & Santangelo, 2007). Therefore, further research needs to control the influence of substance abuse or integrate substance abuse as one of the comorbidity to examine HRQOL of people with mental illness.

**Conclusions**

First, this study sought to examine the differences in health-related factors that affect HRQOL between people with mental illness and those without a diagnosis of mental illness in order to identify any health disparities. The findings from this study indicate that people with mental illness have poorer health status in terms of comorbidity, psychological distress, physical activity, and HRQOL than people without mental illness. Next, these key factors of interest were correlated with one another and contributed to the impaired HRQOL of people with mental illness. Finally, this author delineated the direct and indirect effect of key factors of interest on HRQOL among people with mental illness through mediation, moderation, and moderated mediation analyses. This study is important because relatively little existing research has examined the mediating role of psychological distress in the relationship between comorbidity and HRQOL. Also, no extant literature has described the potential
moderating role of physical activity on the relationship between comorbidity, psychological distress, and HRQOL among people with mental illness. Due to the lack of previous studies, this study is unique in the attention it pays to the importance of physical activity that reduces the negative impact of comorbidity on psychological distress and HRQOL.

Overall, the findings of this dissertation study provide additional encouragement for mental health providers to utilize physical activity as an important intervention for people with mental illness. Furthermore, the findings provide justification for the development of mental health policy that moves toward integrating physical activity into mental health services. In conclusion, mental health service providers, including social workers and policy makers, should consider the importance of physical activity when they treat people with mental illness who have other comorbid conditions and suffer from serious psychological distress. In doing so, people with mental illness will have a greater chance of experiencing increased HRQOL and well-being.


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