The Economic Burden of Comorbid Serious Mental Illness and Chronic Non-communicable Disease in Working Age Adults in the United States

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Dedication

for those of us who live at the shoreline
standing upon the constant edges of decision
crucial and alone
for those of us who cannot indulge
the passing dreams of choice
---Audre Lorde (a litany for survival)

This dissertation is dedicated to Lula, Felsie, Josephine, James-Claude, and Laila-Jade
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Abstract

Despite increasing national healthcare expenditures, the U.S. consistently ranks among the lowest performers in health outcomes among advanced national economies. While there is debate over the origins of the problem, consensus exists that inefficient healthcare delivery and persistent population health inequities contribute to market failure of healthcare as a commodity. Persons with serious mental illnesses (SMI) represent a group for whom health inequities have long persisted. According to the National Institute of Mental Health, SMI are those psychological disorders (excluding substance abuse and developmental disorders) which cause functional impairment and interfere substantially with major life activities. SMI affect four percent of the U.S. population and constitute a leading cause of disability worldwide. Persons with SMI experience a disproportionate burden of chronic disease such as diabetes and cardiovascular disease in the U.S. which manifests as elevated prevalence and mortality rates compared to the general population. Disproportionate chronic disease burden among persons with SMI in the U.S. is a form of health inequity for which significant costs are incurred by individuals and society. Using Grossman’s model of health demand, this study investigated the relationship between comorbid SMI and chronic disease and national healthcare costs.

1 SMI – Serious mental illness
1 Background and Significance

High prevalence of chronic mental illness and physical diseases in the United States is a recognized public health problem that contributes greatly to national healthcare costs. According to the World Health Organization, globally, mental illnesses represent the leading cause of disability-adjusted life years associated with non-communicable diseases. Mental illnesses are classified according to the severity of functional impairment they may cause. Among the most severe mental illnesses are those which are defined as “serious mental illness.” The Centers for Disease Control and Prevention characterized serious mental illness (SMI) as the collection of diagnosable mental disorders characterized by continual, abnormal functioning of mood, thought, and/or behavior that triggers distress and functional limitation. Persons with SMI are particularly vulnerable to the detrimental consequences of chronic physical disease due to their impaired mental function which may substantially diminish self-care capacity, appropriate healthcare consumption, and compliance with chronic disease management regime.

In a recent report published by the National Institute of Mental Health, estimated overall SMI prevalence among U.S. adults was 4.6. A CDC statistics brief of findings from the National Health Interview Survey (NHIS) conducted in 2007 indicated that 1.7% of respondents reported
having been diagnosed with bipolar disorder and 0.6% reported having been diagnosed with schizophrenia during their lifetime (CDC, 2011). In 2012, the National Institute of Mental Health reported a 1.1% 12-month prevalence rate of schizophrenia and 2.2% 12-month prevalence of severe mood disorder in US adults (National Institute Mental Health, 2012). An estimated 5.8 million people are served each year by the public mental health system in the US and mental illness is the leading cause of disability in developed countries.9

Some studies have suggested a possible bio-psychosocial feedback loop between SMI and chronic disease. 1,5,10 According to Sokal and colleagues, development of physical health problems may exacerbate psychiatric symptoms which can trigger mental decompensation in persons with SMI.5 This process is believed to initiate a detrimental cycle of increased social withdrawal, poor adherence to mental health pharmacotherapy, and avoidance of treatment for both mental health and physical problems. 11–13

1.1. *Serious Mental Illness Defined*
The definition of serious mental illness has been shaped by the evolution of mental health policy and clinical practice in the U.S. Mental health care experts characterize mental illness by level of severity and duration of symptom exacerbation. 14 *Serious mental illness*, according to Goldman and Grob, is a term used in federal regulation and health policy to define
the proportion of the adult US population that has mental illness that interferes with at least one area of social functioning. ³

A current definition of SMI that is used in mental health policy is:

“...persons aged 18 or older who currently or at any time during the past year have had a diagnosable mental, behavioral, or emotional disorder of sufficient duration to meet diagnostic criteria specified within the third revised edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-III-R) that has resulted in serious functional impairment that substantially interferes with or limits one or more major life activities.” ¹⁴,¹⁵

SMI includes several different conditions. According to the National Alliance on Mental Illness (NAMI) the following conditions constitute SMI:

- Major depression
- Schizophrenia
- Bipolar disorder
- Obsessive Compulsive Disorder (OCD)
- Panic Disorder
- Post-Traumatic Stress Disorder
- Borderline Personality Disorder

SAMHSA’s recent National Survey on Drug Use and Health (November 2013) reported SMI prevalence of 3.7 percent (9 million adults) in the

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² It is important to note that since this definition was published, the Diagnostic and Statistical Manual of Mental Disorders has been updated; the most recent manual is the fifth edition published in 2014.
When stratified by gender, 4.9 percent of females and 3.2 percent of males had a SMI condition (Figure 1.1).

Figure 1.1 SMI National Prevalence Rates (SAMHSA, 2013).

1.2. Chronic Disease Prevalence and Consequences

When considered in the context of current trends in chronic disease risk factors, aging of the population, and rising health care costs, the disproportionate burden of chronic non-communicable physical disease poses a significant challenge to the national health system. Metabolic syndrome, obesity, type 2 diabetes mellitus (T2DM), cardiovascular disease (CVD), HIV, and chronic pulmonary illness (COPD) are some of the physical illnesses for which persons with SMI are estimated to have significantly greater risk and poorer related outcomes. Since the introduction of second-generation anti-psychotic medications to the U.S. market in the early 2000s, rates of metabolic dysregulation and associated diseases have been identified in persons with SMI who take these medications. The relative effectiveness of
these medications in controlling psychotic symptoms has placed the medical community in a precarious position of trying to balance the benefits against the costs of treating the mental health and physical problems of patients with SMI.

In addition to high chronic physical disease prevalence in persons with SMI, excess mortality has been demonstrated by elevated standardized mortality ratios in this group compared to the general population.\textsuperscript{24–26} The mean YPLL (years of productive life loss) estimates range from 20–32 years and a significant number of patients die relatively shortly after their last hospitalization.\textsuperscript{27,28} An estimated 87\% of YPLL in persons with SMI is attributable to medical conditions, many of which are preventable.\textsuperscript{29} Among Medicaid beneficiaries with SMI in the state of Maryland, the mean age of mortality was 51.8 years and the standardized mortality ratio (SMR) was 3.7 when compared with the control group of non-SMI beneficiaries.\textsuperscript{24}

\textit{1.3. Economic Costs}

Indirect costs resulting from high rates of physical complications associated with SMI represent a growing and unrecognized economic burden.\textsuperscript{27} High rates of emergency department utilization and hospitalizations for ambulatory care sensitive conditions (ACSC), lost earnings, and disability payments by government are some of the
contributors to a growing cost burden \cite{27,30,31}. The total economic burden of SMI, excluding comorbid physical conditions and premature death, doubled during the period 1992-2002, increasing from US$156 billion to US$317.6 billion. If we consider the costs implications of excess chronic disease in this population and the system-level barriers that result in inadequate treatment and care, in the context of an aging US population, the health economic burden of comorbid mental disorders and physical illness is grossly under-estimated.

System-level factors that contribute to disproportionate chronic disease burden in persons with SMI include: geographic (lack of integrated medical and mental health services within same facility), financial (separate funding streams for mental and medical care services), and organizational (difficulty sharing information)\cite{5,25,29,32,33}. Over-use of emergency medicine services, under-use of preventative services, and higher rates of medical errors and other adverse events during hospitalization for physical health problems have been identified as sources of poor quality healthcare delivery in this population\cite{27–29,34}.

2 Literature Review

Over the past 15 years, a substantial literature has evolved that explores the increased vulnerability to chronic physical disease in persons with SMI in the U.S. Despite variations in methodologic approaches, general
The consensus is that the interaction between SMI and chronic physical disease is multi-factorial. Cognitive impairment that interferes with self-management, poor social conditions, and side effects of anti-psychotic pharmacotherapy have all been cited as sources of increased risk for metabolic dysregulation and related physical illnesses. Many of the same lifestyle factors associated with obesity, diabetes, and cardiovascular disease in the general population have been noted in persons with chronic mental disorders. SMI renders individuals especially vulnerable to these conditions and the complex nature of their healthcare needs is further exacerbated by inefficient healthcare delivery. While national healthcare expenditures in the U.S. are the highest among advanced economies, persistent inequities in health production in vulnerable populations perpetuate a system of inefficiency. If we begin to disaggregate health indicators by evaluating the costs associated with differential disease risk profiles in high-risk population groups, perhaps the mismatch in healthcare expenditure and health outcomes could be addressed in a meaningful manner.

2.1. Metabolic Syndrome
Metabolic dysregulation related to atypical anti-psychotic medications and lifestyle behaviors is widely recognized as a primary contributor to elevated chronic disease risk in persons with SMI. Several authors examined association between metabolic syndrome (MetS) risk factors and
SMI conditions. Bell et al., (2009) found that among 819 schizophrenia patients, 90% had at least one risk factor for metabolic syndrome with obesity and dyslipidemia being the most prevalent. Other studies identified a variety of risk factors for MetS including sedentary lifestyle, high waist-to-hip ratio, depressive symptoms, elevated fasting glucose and duration of mental illness in persons with SMI. Estimated prevalence of MetS was 32.5% - 52%. Clozapine was the atypical anti-psychotic most frequently associated with higher rates of MetS. In their systematic review, Vancampfort, et al., found that overall MetS rate was 37.3% (CI:36.1-39.0) based on standardized metabolic syndrome criteria. Bipolar disorder patients had higher MetS rates (OR: 1.98; 95% CI: 1.74-2.25) than the general population. MetS was associated with current treatment with antipsychotic medications (45.3% [CI: 39.6-50.9]) when compared to patients who were naïve to such medications (32.4% [CI: 27.5-37.4]; OR: 1.72 [CI: 1.24-2.38]).

2.2. Diabetes
As a precursor to T2DM and CVD, elevated prevalence of MetS has implications for other chronic disease prevalence rates. In separate systematic reviews of the literature deHert and Leucht identified multiple reports of elevated T2DM prevalence in SMI populations. T2DM

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3 T2DM: Type II Diabetes Mellitus, CVD: Cardiovascular Disease
prevalence was 11.5% in the sample of schizophrenia patients described by Argo, et al., and (2011). Kilbourne, et al., reported that among a national sample of VA patients with bipolar disorder (BPD), 19% had T2DM.\textsuperscript{43,44} Among VA patients with BPD, 25% were found to have diabetes.\textsuperscript{37} In a sample of schizophrenia patients the adjusted odds ratios (OR) for T2DM was 2.11 (CI: 1.36-3.28).\textsuperscript{7} In their analysis of mental health patients in Ohio, Miller and colleagues found a T2DM prevalence rate of 12%.\textsuperscript{11}

Osborne reported elevated relative risk (RR) of T2DM in all SMI patients and schizophrenia patients which were 1.7 (1.21-2.37) and 1.87 (1.68-2.09) respectively.\textsuperscript{38} Among schizophrenia patients in South Carolina, cumulative prevalence of T2DM was 23%.\textsuperscript{21} Clozapine was noted to be the atypical anti-psychotic most associated with T2DM with a hazard ratio (HR) of 7.0 (CI: 1.7-28.9).\textsuperscript{21} In a sample of Maryland Medicaid beneficiaries with SMI, T2DM was the primary cause of death in 5% of decedents.\textsuperscript{24} Consistent with reports of chronic disease prevalence in the general population, in a comprehensive literature review, Carliner and colleagues found implications of race and ethnicity differences in T2DM prevalence in persons with SMI.\textsuperscript{45} African-American and Hispanic persons with SMI were reported to have increased risk for obesity and T2DM compared to non-Hispanic white counterparts.\textsuperscript{45}
2.3. *Cardiovascular Disease*

Persons with SMI have higher risk for and prevalence of CVD\(^6,17,18,46,47\) Carliner, et al., reported possible gender disparity in CVD risk with sex emerging as a potential risk modifier and women having higher CVD risk among all racial/ethnic subgroups.\(^45\) Jin (2012) and Kilbourne (2007) reported elevated CVD risk in persons with SMI.\(^48,49\) In a cohort of SMI patients \(\geq 40\) years old, Jin found that Framingham 10-year coronary heart disease (CHD) risk\(^4\) was increased by 79% in schizophrenia, 72% in post-traumatic stress disorder, and 61% in mood disorder with psychosis, compared to risk in the general population from the Framingham Health Study.\(^48\) In a large cohort of VA patients with SMI, Kilbourne found after adjusting for race, age, and tobacco consumption, that persons with BPD\(^5\) were 44% more likely to have coronary artery disease (adjusted OR: 1.44; \(p<0.01\)) compared to patients with schizophrenia; this difference persisted when the authors compared any CVD-related condition between BPD and schizophrenia patients (adjusted OR: 1.24; \(p<0.001\)).\(^49\) In a sample of VA patients with \(\geq 1\) CVD risk factor, Slomka found an elevated 10-year risk of developing CVD in 19%.\(^50\) In patients with clinically significant depressive symptoms, the adjusted OR of having a Framingham score of > 20% was a 6-fold difference (OR = 6.1, \(p = 0.03\)). Mortality due to CVD in persons with SMI was studied by Daumit and Miller.\(^11,33\) Daumit found

\(^4\) The Framingham 10-year coronary heart disease risk is a score developed in the Framingham Heart Study that has been shown to be valid and reliable.\(^138\)

\(^5\) BPD: Bipolar Disorder
that in the state of Maryland, CVD was one of the leading causes of death, affecting 24% of decedents with SMI. Miller reported similar findings in an Ohio cohort in which one of the leading causes of death was CVD in 21% of decedents with SMI.

2.4. Other Chronic Physical Conditions
In addition to elevated risk for and prevalence of T2DM and CVD, persons with SMI also have higher rates of other chronic physical conditions. Six articles reported rates for multiple chronic diseases in persons with SMI. deHert and colleagues considered multiple classes of physical diseases in their literature review and found multiple reports of disproportionate chronic disease associated with SMI. Leucht’s systematic review and meta-analysis produced similar findings of higher prevalence rates of HIV infection, hepatitis, osteoporosis, altered pain sensitivity, sexual dysfunction, obstetric complications, and dental problems, in persons with schizophrenia compared to the general population.

In a cohort of veterans with BPD or schizophrenia, Fuller and colleagues found there were elevated prevalence rates of chronic liver dysfunction among schizophrenia patients (n=6521) compared to the general population: liver disease [22.4% versus 3.2%; OR: 8.73]; hepatitis C infection (16.5% versus 1.9%; OR: 10.21); and alcohol-related cirrhosis (1.6% versus 0.4%; OR: 4.09). BPD patients (n=5319) also had higher prevalence of chronic liver dysfunction: disease (21.5% versus 3.5%; OR: 7.58); hepatitis C infection (15.5% versus 2.1%; OR: 8.60); and alcohol-
related cirrhosis (1.6% versus 0.4%; OR=3.82) than matched controls. Schizophrenia and BPD were independent predictors of liver disease in the sample, OR: 2.74 and OR: 2.27, respectively. In a sample of geriatric Medicare beneficiaries, Lin found elevated adjusted risk for 14 of the 15 selected chronic physical conditions in persons with mental disorder or substance use disorder (SUD). Co-occurring SUDs and mental illness were associated with the highest adjusted risk for 11 of the chronic conditions. Community-dwelling elderly with mental illness were more likely to have ≥5 chronic physical conditions compared to individuals without mental illness or SUD for whom the average was 2.5 (P<0.01). Related to substance use is tobacco consumption. Respiratory illnesses such as asthma and chronic obstructive pulmonary disease (which includes bronchitis and emphysema) are associated with smoking in the general population. Several studies reported higher rates of tobacco consumption in persons with SMI. Consequently, smoking-related illnesses appear to be highly prevalent in this population. Carney, Jones, and Sokal reported higher rates of respiratory illness, e.g., COPD, asthma, bronchitis, etc., in persons with SMI compared to the general population. Carney found an 88% increased odds of COPD [OR: 1.88 (1.51-2.32)] in schizophrenia patients compared to the general population. Jones found COPD to be

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8 Physical conditions include: hypertension, ischemic heart disease, atrial fibrillation, congestive heart failure, COPD or asthma, diabetes, chronic kidney disease, osteoporosis, hip or pelvic fracture, dementia, cancer, Parkinson’s disease, and eye disease.
most prevalent among 14 conditions considered in a sample of SMI
patients; prevalence was 31% 6. Sokal found that chronic bronchitis and
asthma were among the most prevalent physical comorbidities in a
sample of SMI patients5. Among schizophrenia patients, OR for asthma
was 2.43 (CI: 1.37-4.32), chronic bronchitis OR was 3.69 (CI: 2.0-6.8), and
emphysema OR was 9.1 (CI: 41-20.3) compared to the general
population.5

2.5. Mortality
In addition to elevated rates of chronic physical conditions, persons with
SMI have been reported to suffer from premature mortality related to
under-treatment of these conditions.24,25,52 Much of the premature and
excess mortality has been attributed to chronic disease.24,35 According to
Daumit, et al., the mean age of death in persons with SMI was 51.8 years
(SD: 11.1); the standard mortality ratio (SMR) compared to the general
population was 3.7 (95% CI: 3.6 -3.7), and leading causes of death included
CVD 24%, malignant neoplasm 15%, T2DM 5%, CVA 4%, and chronic
lung disease 4%.24 Comorbid substance abuse and SMI yielded a SMR of
5.4 and age-adjusted ratio of deaths for African-American men with SMI
was 1.38 compared to White men with SMI.24 The SMR for deaths
attributable to CVD in SMI was 1.8 (CI: 1.7 -1.9) in schizophrenia patients
and 3.1 (CI: 3.0-3.2) in BPD patients.24
Miller and colleagues examined mortality and resultant productivity losses in persons with SMI in Ohio. Similar to Daumit, et al.’s findings, the authors report that leading causes of death included CVD (21%) and suicides (18%). Lost productivity related to premature death was 32.0 years (SD =12.6 years) of productive life lost (YPLL) on average. The aggregated SMR from all causes of death was 3.2 (417 excess deaths: p<.001) compared to the general population. Morden, et al., examined mortality in a large sample of VA patients with SMI and found that annual mortality was stable over time for persons with schizophrenia (3.1%) and non-SMI persons (2.6%). However, annual mean YPLL increased from 12.8 to 15.4 in schizophrenia patients and from 11.8 to 14.0 for non-SMI groups over an eight year period (1999-2007) suggesting that individuals are dying prematurely, particularly among those with chronic mental disorders.

2.6. Healthcare Utilization
The role of healthcare utilization in elevated chronic physical disease in persons with SMI has been evaluated by several authors. Areas of inquiry have included comparative utilization rates between persons with SMI and the general population, quality of care, unmet need, and ambulatory care sensitive conditions (ACSC). Two studies by Li (2008) and Shen considered economic costs related to utilization.
2.6.1 Hospitalization

Examples of differences in hospital utilization in persons with SMI include higher admission rates, longer length of stay, both of which contribute to higher costs (Chwastiak et al., 2014; Leung, et al., 2011; Sayers et al., 2007; Zolnierek, 2009). Zolnierek’s 2009 systematic review of non-psychiatric hospitalization of persons with SMI reported that elevated resource utilization in the form of laboratory testing, specialist consultations, and hospital charges have been noted in this population. The Agency for Healthcare Research and Quality (AHRQ) identified hospitalizations and emergency department (ED) visits as sources of high-cost encounters within the national healthcare system. Excessive resource utilization (waste) is a primary example of inefficiency in healthcare delivery. Of growing concern among health policy experts, public and private health insurance payers, and organizational leaders is the frequency of hospitalizations due to ambulatory care-sensitive condition (ACSC). ACSCs, according to Yoon, et al., are those for which high-quality ambulatory care could reduce the greatest number of adverse outcomes by controlling chronic abnormalities and preventing complications associated with poor control. ACSCs include chronic physical conditions which disproportionately affect persons with SMI, including hypertension, diabetes, pulmonary disease, and congestive heart failure, etc.; these conditions contribute greatly to hospital resource utilization. Among persons with SMI, there is greater risk of
inappropriate care due to communication barriers that may emerge during attempts to interact with the healthcare delivery system.\textsuperscript{7,28,62–65} ACSC rates serve as a widely used indicator of healthcare access and quality.\textsuperscript{31,66}

Bhattacharya, et al., found that Medicare beneficiaries with depression had higher rates of hospitalizations for ambulatory-care sensitive conditions (H-ACSC) compared to patients without depressive symptoms (13.6\% vs. 7.7\%).\textsuperscript{67} Cahoon and colleagues examined national hospital discharge data and found that schizophrenia was associated with greater odds of hospitalization for both acute ACSCs (OR: 1.34; CI: 1.31-1.38) and chronic ACSCs characterized by short-term exacerbations.\textsuperscript{32} Li, et al., (2008) evaluated state-level hospital discharge data and found that patients with SMI who were discharged from the hospital were twice as likely as non-SMI patients to have ACS hospital admissions [adjusted OR: 2.30; CI: 2.17-2.43] relative to marker\textsuperscript{7} condition admissions.\textsuperscript{54} Major depression, psychosis, combined substance abuse and psychiatric disorders were responsible for higher ACS admission rates.\textsuperscript{54} Yoon and colleagues reported that among VA patients with mental illness visiting primary care facilities, the 12-month rate of ACSC admissions was 31.7 admissions per 1,000 patients with mental health diagnoses compared

\textsuperscript{7} “Marker” conditions are those which are more urgent and not preventable with ambulatory care before hospitalization, e.g., acute appendicitis, acute cardiac events, etc. \textsuperscript{31}. 
with 21.0 admissions per 1000 patients without mental illness; ACSC-associated ED visit rate was also significantly higher.\textsuperscript{31} In adjusted analyses controlling for demographics, chronic disease, illness severity, and prior ambulatory care, those with depression had higher odds of receiving ACSC-related acute care (OR: 1.10; CI: 1.03-1.17).\textsuperscript{31}

2.6.2 Emergency Department Visits
High rates of ED utilization by persons with SMI has been identified as an indicator of poor healthcare access.\textsuperscript{28,68} Despite the presence of multiple comorbid conditions, persons with SMI have been found to interact with the healthcare system only when their condition becomes urgent, requiring emergency care.\textsuperscript{28,33,68} Similar to other vulnerable populations, excessive use of EDs, as opposed to periodic primary care, among persons with SMI has been recognized as a potential contributing factor to the disproportionate burden of chronic disease in this population.\textsuperscript{65,69,69} In a national multi-year cross-section of Medicaid beneficiaries with schizophrenia and comorbid physical conditions, Hansen and colleagues found that the combination of non-adherence to anti-psychotic medications and cardio-metabolic treatment was associated with higher ED visits.\textsuperscript{70} Like Hansen, Heaton evaluated the relationship between medication adherence for chronic physical conditions and ED visits in a multi-year national sample of adults.\textsuperscript{71} Of an estimated 450,000 medication non-adherence-related ED visits during the period 2004-2008, 29% were due to mental health disorders.\textsuperscript{71} Classes of conditions
associated with ED visits for medication non-adherence included mental illness (OR: 22.74; CI: 14.68-34.20), T2DM (OR: 15.80; CI: 5.20-48.06), non-dependent drug abuse (OR: 11.85; 3.83-36.65), and hypertension (OR: 11.06; CI: 3.99-30.61). A significant proportion of these ED visits resulted in hospital admissions.\(^7\)

Hendrie investigated ED visit frequency in geriatric patients with chronic physical conditions and compared ED utilization between persons with and without SMI.\(^7\). Geriatric patients with SMI had significantly higher rates of medical ED visits and significantly longer lengths of medical hospitalizations compared to the non-SMI geriatric group.\(^7\). In a national study of individuals with comorbid obesity and chronic physical conditions and SMI having a SMI diagnosis was a significant predictor of higher utilization. Adjusted utilization rates for patients with mental illness were higher for emergency services outpatient care and pharmaceuticals.\(^5\) In a cross-section of homeless persons, Chwastiak found that lack of insurance was the main significant predictor of use of the ED as a regular source of medical care and that SMI was not an independent predictor.\(^7\). However, the authors noted that mental illness diagnosis was self-reported and this was a possible limitation of their study that potentially underestimated the effects of SMI on ED utilization in this population.
2.6.3 Healthcare Access and Quality

According to the aforementioned AHRQ report, inadequate access to care is costly to individuals and society.\textsuperscript{60} Inappropriate use of the ED and higher hospitalization rates in persons with SMI have been attributed to poor access to care and poor quality at the healthcare delivery facility level.\textsuperscript{32,34,74} Despite evidence of high rates of chronic physical conditions requiring routine follow-up, several studies have found that persons with SMI may experience inadequate access to both primary and acute care.\textsuperscript{75,76} In a large sample of VA psychiatric patients, those with SMI, had fewer medical visits than other VA patients; persons with comorbid SMI and T2DM and/or HTN, had significantly fewer visits than non-SMI patients.\textsuperscript{77} Diagnosis of a substance use disorder, depressive, bipolar, or anxiety disorders or post-traumatic stress disorders were significant predictors of lower likelihood to receive medical care in patients $\geq$ 50 years old.\textsuperscript{77} This was after controlling for patient characteristics.

In their evaluation of healthcare access in community mental health patients, Dickerson and colleagues found that persons with SMI were more likely to report receiving some medical care services in the past year than were individuals in the general population.\textsuperscript{65} Despite this finding, persons with SMI were three times more likely to report perceived barriers to healthcare than the comparison group.\textsuperscript{65} Drapalski and colleagues reported similar findings in their evaluation of a cohort of VA
patients with SMI who reported substantial perceived barriers to care.\textsuperscript{78} Two-thirds of the patients reported perceived barriers to accessing mental health care and 60\% reported perceived barriers to medical care.\textsuperscript{78} Having active, uncontrolled psychiatric symptoms and medical conditions were identified as additional reasons for having unmet medical care needs.\textsuperscript{78}

In a national sample of Medicare beneficiaries who were hospitalized due to acute cardiac events, those patients with mental illness had lower likelihood of admission to a hospital with capacity to perform invasive cardiac procedures (OR:0.81, p < .001).\textsuperscript{76} This persisted for patients with dual diagnosis of SUD and SMI, after adjustment for patient characteristics. The authors found that admission to hospitals with capacity to perform invasive cardiac procedures improved 30-days re-admission and mortality rates. Consequently, those patients (including persons with an SMI diagnosis) who were admitted to lower quality facilities had significantly higher mortality rates.\textsuperscript{76} Miller and Rosenheck reported that elderly patients with SMI were more likely to be admitted to nursing homes.\textsuperscript{26} The odds of nursing home admission in patients with schizophrenia was 1.26, other psychosis 1.15, and bipolar disorder 1.28.\textsuperscript{26} A more recent study of the efficacy of the medical home model in persons with comorbid mental illness and chronic physical conditions in North Carolina reported that among adults, there was no difference in medical
home participation (enrollment) and utilization (regular visits) between persons with SMI and non-SMI persons.\(^7^9\) Having psychosis was associated with lower rates of medical home participation among adults (8.2%; \(P<0.01\)) and lower utilization (0.92, \(P<0.01\)).\(^7^9\)

In a large sample of Medicare claims, Cai and Li (2013) found in a comparison of persons with SMI and those without that mental illness predicted a higher likelihood of admission to low-quality hospitals (2.9% vs. 2.0%; adjusted OR:1.25; CI: 1.17-1.34, \(p<0.01\)), and an equal likelihood to high-quality hospitals (unadjusted rate 9.8% vs. 10.3%; adjusted OR 0.97, 95% CI 0.93-1.01, \(p=0.11\)).\(^6^4\) Lower hospital quality and mental illness were predictors of worse outcomes including higher rates of 30-day readmission, 30-day mortality, and 1-year mortality.\(^6^4\) In a large sample of Medicare beneficiaries in North Carolina, exploration of access to preventive healthcare services revealed that schizophrenia patients had lower screening rates for colorectal and breast cancers, compared to persons without schizophrenia.\(^8^0\) Depression was associated with lower medication adherence and diabetes screening and poorer cardiovascular outcomes.\(^8^0\) In a community sample of geriatric patients with multiple chronic physical conditions, older patients with schizophrenia had similar levels of physical disorders and rates of health visits compared to geriatric
patients without schizophrenia but the schizophrenia patients received less adequate treatment for T2DM, HTN, gastric ulcers, and CVD.81

2.7. Health System Quality and Barriers to Care
Several studies investigated different aspects of healthcare quality among persons with comorbid SMI and chronic physical conditions to: 1) determine if health system factors may contribute to disease burden, 2) if differences in quality results in different outcomes, and 3) estimate costs. Daumit and colleagues examined the prevalence of adverse events in medical and surgical hospitalizations of persons with schizophrenia compared to the general population and the effects of prevalence on several patient safety quality indicator.34 Schizophrenia patients who were hospitalized had higher relative odds of having adverse safety events while hospitalized compared to the general population.34 These events included: medical care related infections (OR, 2.49; CI: 1.28-4.88); post-operative respiratory failure (OR, 2.08; CI, 1.41-3.06); post-operative deep venous thrombosis (OR 1.96 :CI: 1.18-3.26); and postoperative sepsis (OR: 2.29; CI: 1.49-3.51).34 Schizophrenia patients experienced twice the adjusted odds for intensive care unit admission and death if they were diagnosed with respiratory illness or sepsis.34

A primary aim of the AHRQ health system quality framework is promotion of timely delivery of preventive services for chronic physical conditions. Timely preventive care reduces the costly impact of ACSC
hospitalizations. Given the substantial evidence around metabolic
dysregulation induced by atypical anti-psychotic medications, Mittal and
colleagues evaluated the clinical practice of monitoring metabolic side
effects of these medications in a national cohort of VA psychiatric
patients. The authors found there was a significant discrepancy in
monitoring of MetS risk factors according to evidence-based guidelines.
In a systematic review and meta-analysis, Mitchell and colleagues aimed
to quantify potential differences in pharmacotherapeutic management of
medical conditions in persons with SMI compared to the general
population (Mitchell, et al., 2012). In 61 comparative analyses from 23
publications about pharmacotherapeutic management of chronic physical
conditions --cardiovascular health, T2DM, cancer, arthritis, osteoporosis
and HIV (total sample n = 1,931,509---in persons with SMI, the adjusted
OR for an equitable prescription was 0.74 (CI: 0.63-0.86). Of particular
concern was the lower than expected prescriptions for cardiovascular
medications including angiotensin-converting enzyme inhibitors or
angiotensin II receptor blockers (ACE/ARBs), beta-blockers and statins.

In their comparative analysis of studies on the receipt of preventive
screening and medical care among persons with SMI, Lord and colleagues
concluded there is strong evidence that the quality of preventive services
for this population are often inferior (and rarely superior) despite
increased vulnerability attributable to comorbid mental and physical illness. In their qualitative literature review on comorbid bipolar disorder and metabolic syndrome, McElroy and Keck found that metabolic dysregulation was highly prevalent and undertreated in patients with bipolar disorder; inadequate management of metabolic syndrome was attributed to poor access to preventive screening and care. Leung, et al., found that persons with SMI receive lower-quality T2DM care. In a study of veterans with SMI, Kilbourne and colleagues found that co-location of mental health and medical services improved likelihood of all cardiometabolic tests according to existing guidelines (OR: 1.26; CI: 1.18-1.35).

2.7.1 Health Status and Disease Severity Indicators
Differences in health outcomes between persons with SMI and the general population have been noted alongside differences in incidence and prevalence of chronic physical conditions. According to AHRQ, health outcomes research provides evidence about “benefits, risks, and results of treatments.” Alternatively, health outcomes data informs us of the inadequacy of treatment, from a national health system perspective, when there are persistent differences in outcomes for certain populations. Brown, et al., found that among patients with T2DM, independent predictors of mortality for both groups (patients with SMI and non-SMI patients) were age, duration of T2DM, T2DM-related hospitalization, and current smoking. However, patients with SMI had 8% greater odds of
death per year of age at baseline, >6% mortality odds per year duration of T2DM at baseline, three times greater odds of mortality if hospitalized due to T2DM, and two times greater mortality risk if a current smoker.\textsuperscript{12} African-American race was significantly associated with mortality after covariate adjustment (OR: 2.19, CI: 1.07-4.48).\textsuperscript{52} Druss, et al., found that persons with SMI died an average of 8.2 years younger than the rest of the population: SMI was associated with a significant risk of excess mortality, (hazard ratio: 2.06, CI:1.71-2.40); ≥90% deaths were attributable to medical problems and health system factors such as general health insurance, mental health insurance, and number of medical visits improved the relationship between SMI and mortality.\textsuperscript{10} Plomondon reported no significant association between SMI and mortality in acute cardiac VA patients.\textsuperscript{89}

The relationship between risks for chronic physical conditions, particularly CVD, has been established. However, apart from mortality, a long-term outcome of CVD is “vascular aging.” Vascular aging is the structural and functional changes that occur with aging\textsuperscript{90}. It is a predictor of CVD mortality.\textsuperscript{91} In a sample of patients with bipolar disorder, the authors concluded that vascular disease risk may be acquired over the long-term course of mental illness and seems to reflect
maladaptive health behaviors, which may be amenable to targeted intervention.\textsuperscript{91}

The capacity to engage in the self-care and management\textsuperscript{8} required for chronic physical disease control depends greatly on an individual’s cognitive function. This can potentially become a source of increased vulnerability in the context of SMI which negatively affects behavior. After controlling for SMI symptom severity, Depp and colleagues found that obesity and hypertension were associated with greater cognitive impairment in patients with bipolar disorder.\textsuperscript{92} The direction of the relationship was not clear from the study, i.e., it was not clear whether cognitive impairment was caused by poorer physical health outcomes or vice versa. In a study of the relationship between SMI and cognition measures reflective of decision-making capacity, Dickerson found that educational level was independently associated with a composite measure of health behaviors.\textsuperscript{35} No relationship between mental function and health-related quality of life (HRQOL) was noted in SMI with comorbid T2DM despite there being a relationship between HRQOL and physical functioning.\textsuperscript{35} In a report of the baseline characteristics of a sample of bipolar disorder patients enrolled in an intervention to improve CVD risk, Goodrich, et al., found that mean mental and physical HRQOL scores were 1.5 SD below the general population.\textsuperscript{93} Friedman, et al., examined

\textsuperscript{8} Examples of self-care and management would include adherence with daily medication schedules and self-monitoring of physiologic indicators such as blood glucose levels to determine the amount of medication to take.
cognitive function in a sample of schizophrenia patients in New York City and found that hypertension was associated with worse memory impairment compared to the control group that did not have schizophrenia.94

2.7.2 Interventions to Improve Self-Management of Chronic Disease

The extent to which persons with SMI are able to engage in self-management of chronic physical disease and provide reliable reports of daily activities such as glucose and blood pressure monitoring at home, are valid concerns for clinicians and others who would design interventions to improve outcomes in this population. Goldberg reported that persons with SMI are able to recall accurately their use of health services.95 Several authors reported different approaches to improving self-management of chronic physical conditions among persons with SMI living in the community. In a pilot test of a behavior-based weight loss intervention tailored to persons with SMI, Daumit and colleagues reported process outcomes of their program.16 Average attendance across all weight management sessions was 70% (87% on days participants attended the center) and 59% for physical activity classes (74% on days participants attended the center); on average, participants lost 1.9% of body weight, mean waist circumference change was 3.1cm (SD= 5.6) and physical activity improved.16

Among SMI with a comorbid physical condition, Goldberg, et al., tested the feasibility of a self-management program developed by the Centers for
The authors found that participants indicated self-reported improvements in self-efficacy, illness self-management, emotional and physical well-being and general health functioning; facilitation of the intervention by a mental health professional and patient peer showed significant improvement in self-management behaviors among participants compared to facilitation by two peers. The authors also reported an effect of their program on health service utilization patterns among study participants—the intervention was associated with decreased ED visits.

In an intervention consisting of self-management education, care coordination, and guideline implementation with mental health providers for VA patients with bipolar disorder, Kilbourne and colleagues concluded that participation in the program has the potential to slow decline in physical functioning in persons with bipolar disorder. Pirraglia, et al., reported that participation in their program was associated with significantly more primary care visits and improved goal attainment for MetS risk factors; attendance of primary care visits on the same day as mental health services increased to 86% from 49% after program enrollment. Pratt and colleagues’ feasibility evaluation of an automated tele-health program supported by a nurse care manager found that the majority of enrollees (n = 62; 89%) participated in at least 70% of the tele-health sessions; participation was associated with improvements in self-
efficacy for managing depression and diastolic blood pressure.\textsuperscript{97} Most participants reported improved understanding of their medical condition after the program; among those with T2DM, fasting blood glucose decreased and among those with T2DM and major depression or bipolar disorder, there were reductions in urgent care and primary care visits. \textsuperscript{97}

2.8. \textit{Economic Outcomes}
Disproportionate disease burden, poor access to care, inappropriate utilization of health services, and differences in healthcare outcomes among persons with SMI would be expected to have significant economic implications for the national healthcare delivery system. Jerrell et al., found that among patients with SMI, mean medical costs for the first year of diagnosis of a cardiometabolic incident were higher when compared to patients without the medical condition; however, these costs declined over time.\textsuperscript{21}

Medication adherence for both SMI and physical conditions appeared to have an effect on utilization of healthcare services and subsequent costs in the study conducted by Hansen and colleagues.\textsuperscript{36} They found that non-adherence with either anti-psychotic or cardiometabolic medication classes was associated with higher emergency and inpatient care expenditures; the highest expenditures were for patients who were non-adherent to both medication classes (Hansen et al., 2012).
In the aforementioned study of ACS hospitalizations by Li, et al., the authors reported that average incremental cost during ACS hospitalization among SMI patients was $556 (CI: $340-$778), which was significantly higher than the general population.54

In a cross-sectional analysis of the Medical Expenditure Panel Survey (MEPS), Shen, et al., found among adults with obesity, 25% also had a mental illness diagnosis: average total expenditures for obese adults with physical and mental illness were $9,897 compared to average expenditures among adults with only physical illness were $6,584.55 Patients with mental illness had higher pharmacy expenditures than those without mental illness, $3,343 and $1,756, respectively.55 In a systematic review of the cost-effectiveness of interventions to improve physical health outcomes in persons with SMI, Park and colleagues concluded that most programs purport economic value and that measures of program fidelity, uptake and adherence should be included in future cost analyses.98 Yoon found that costs for ACSC ED visits and hospitalizations were not affected by SMI in a sample of VA patients.31 Daumit determined the cost effects of poor healthcare quality in persons with schizophrenia resulted in median hospital charges that were elevated by at least $20,000 for infections due to medical care, respiratory failure, deep venous thrombosis, and sepsis (Daumit et al., 2006).
2.9. Literature Review Conclusion

There is substantial evidence of a disproportionate chronic physical disease burden and related poor outcomes, including excessive mortality, among persons with SMI in the United States. Patterns of health services utilization seem to mediate the relationship between chronic disease prevalence, poor health outcomes, and related economic costs in this population. Three areas that have received substantial attention are metabolic syndrome, diabetes, and cardiovascular disease due to their physiologic relationship and the increased risk that results in the presence of atypical anti-psychotic medications. Other chronic physical conditions that seem to have a disproportionate effect on persons with SMI include respiratory illnesses and liver disease. Respiratory illnesses have been associated with elevated rates of smoking in persons with SMI. Unfortunately, while there have been multiple reports of self-management interventions for other health behaviors (e.g., weight loss, glucose monitoring, etc.), there were no identified reports of smoking cessation interventions. It is plausible that Daumit’s findings of higher risk for adverse safety events such as respiratory failure and deep venous thromboembolism in schizophrenia patients hospitalized in medical and surgical settings and associated consequences are associated, to some degree, with smoking.34 Like the general population, persons with SMI are burdened by health problems that are related to lifestyle factors. It is encouraging that interventions to address this and tailor self-
management programs to the needs of the mentally impaired are being
developed, evaluated, and reported in the literature.

There have been numerous reports of elevated mortality rates and more
recently, efforts to explain some of the excess mortality. Mortality as an
indicator of health system quality indicator highlights the severity of the
issues of unmet healthcare need in persons with SMI. When asked
directly about access to care challenges, persons with SMI consistently
report perceived barriers that are either system-related (e.g., difficulty
making appointments for healthcare services) or the result of illness
factors (e.g., depressive and/or psychotic symptoms). This is indicative of
the need for more integrated healthcare delivery for this population
consistent with the patient-centered behavioral health home model
evaluated by Bartels, et al., (2013). Efforts to improve access to primary
care and deliver it in a way that meets the mental and physical health
needs is essential to improving healthcare delivery efficiency for this
population. Several studies revealed trends toward high rates of
ambulatory care sensitive condition (ACSC) hospitalizations which
resulted in significantly excessive length of stay and associated costs. This
was evident particularly in the poor outcomes related to preventive
screening and pharmacotherapeutic management of chronic diseases.

Given that CVD is the leading cause of death in persons with SMI and
that they experience premature mortality and loss of physical function as a result, interventions to improve healthcare quality and adjustments of performance measures for this population are needed.
3 Theoretical Perspective

Grossman’s health economics model of the demand for health framed “good health” as a commodity or durable capital stock that individuals both produce and consume throughout their lifespan. Medical care is one of several inputs which individuals “invest” in their health. Other inputs include education, nutrition, and personal behaviors (e.g. physical activity, refraining from harmful activities, etc.). Of particular importance in Grossman’s model was the assertion that health, unlike other forms of human capital, determines a person’s capacity for producing other commodities, including income. Smith and Kington (1997) asserted that an individual’s health stock is an important input to the health production function because individuals with better health are likely to be more equipped to leverage other commodities for greater health investments.

As a commodity, health depreciates over time. When considered in the context of serious mental illness (SMI), one would expect health production to be lower in individuals affected by such conditions due to a diminished health stock derived from cognitive impairment. Add to this the increased vulnerability to chronic physical conditions among persons with SMI and we can use Grossman’s model to evaluate the economic implications of premature mortality and excessive disability in this
population. Hypothetically, persons with comorbid SMI and chronic physical disease would be expected to experience more rapid depreciation in health stock when compared to the general population. This rapid depreciation would suggest an increased demand for quantity of medical services. Increased demand for medical services has significant implications for health policy and healthcare finance due to documented reports of inappropriate utilization of healthcare resources. Inappropriate utilization contributes to increased expenditures; increased expenditures in the presence of rapidly depreciating health stock ultimately contribute to the cost-outcome mismatch that has persisted in the U.S. with respect to national healthcare spending.

Smith and Kington’s (1997) initial formulation of the Grossman model was as follows:

\[ H_t = f(H_{t-1}, G_0, B_t, MC_t, ED) \]

Health in the period \( t \) \((H_t)\) is a function of the individual’s stock of health in the period \( t-1 \), family background and genetic characteristics \((G_0)\), adoption of favorable health behaviors such as physical exercise and the avoidance detrimental behaviors such as smoking \((B_t)\), individual investment in health \((I_{t-1})\), and what the authors call a “vector of family education levels” \((ED)\). Each component of this theoretical model
represents an array of market goods and conditions specific to an individual’s lifespan.

For the purposes of this research, “health demand” is applied to an analysis of the interaction between SMI and chronic physical disease, the impact this interaction has on the depreciation of health stock and demand for medical services over time, and the indirect implications of these factors on the national economy in the form of excessive healthcare expenditures. The modified Grossman-type model that I will employ in this study is as follows:

\[ H_t = f(H_{t-1}, B_t, I_{t-1}, x_t) \]

Health in the period \( t \) \( (H_t) \) is hypothesized to be diminished in persons with SMI due to increased vulnerability to chronic physical disease and premature mortality. Because SMI conditions are organic in nature, they require continuous medical and psychiatric management throughout the course of an individual’s lifespan which would impact the variable \( H_{t-1} \).

Both health promoting and health depleting behaviors influence SMI (i.e., control or decompensation of psychotic symptoms) and have an impact on an individual’s health stock.

Since Grossman’s initial proposal in 1972, several authors have offered refinements to the model that incorporate socioeconomic variables including, household characteristics, education level of family members and other close contacts, and marital status. Theoretically, these
refinements are included in the framing of this research with the variable $I_{t-1}$. I believe there are several additional variables that would have a notable impact on an individual’s health stock, factors that might be specific to the life experience of persons with SMI, e.g., interaction with the criminal justice system, housing instability, co-occurring mental disorders, etc., but were not captured in the original framework because it was conceived for the general population. Finally, I used the aforementioned modified version of Grossman’s health capital model to frame this investigation with a set of research questions designed to evaluate my overarching hypothesis that persons with SMI have diminished health stock that manifests as elevated chronic physical disease risk, differences in medical services utilization, and consequently, differences in healthcare costs related to chronic physical disease. Instead of actually regressing the theorized independent variables on the outcome “health capital,” I aim to explore them in the context of SMI to offer an illustration of the unique needs of this population. This approach is particularly relevant for continued planning and implementation of healthcare delivery programs designed to address population health inequities and to improve the efficiency of national healthcare spending.
4 Research Questions and Hypotheses

This study aimed to evaluate the chronic disease burden and its consequences in working age adults (18 – 64 years) with a history of serious mental illness (SMI) in the U.S. Findings from the literature review (Chapter 2) guided the development of the following research questions and associated hypotheses.

4.1. Epidemiologic Analyses

Research Question
What is the association between SMI and chronic disease burden in working age adults (18-64 years) in the U.S.?

Hypotheses

$H_0$: There is no difference in chronic disease burden between persons with SMI and the general population of working age adults (18-64 years).

$H_1$: Working age adults (18-64 years) with a history of SMI have greater chronic disease burden than the general population.

4.2. Medical Care Utilization

Research Question
What is the association between medical service utilization and comorbid SMI and chronic physical disease in the U.S.?
**Hypotheses**

$H_0$: There is no difference in utilization of medical services between persons with SMI and the general population among adults (18-64 years) with chronic conditions in the U.S.

$H_1$: Utilization of medical services is higher in persons with SMI among adults with chronic conditions (18-64 years) in the U.S.

4.3. **Cost Analysis**

**Research Question**

Among working age adults (18-64 years) in the U.S., what are the costs differences associated with medical care utilization in individuals with comorbid SMI and chronic physical conditions versus individuals with chronic physical conditions but no history of SMI?
5 National Health Interview Survey

The data used for statistical analysis in this study came from the 2007 National Health Interview Survey (NHIS). This chapter provides an overview of the data used for this study. It includes the following:

- Overview of the survey
- Description of the survey design and sampling frame
- Brief discussion of the sampling weights employed in the survey
- Variable definitions for variables that were used in the statistical analyses

5.1. Overview of NHIS

The data for this study was derived from the NHIS for the year 2007. The NHIS is a publicly available de-identified dataset located on the Centers for Disease Control and Prevention National Center for Health Statistics website. The NHIS was established after enactment of the National Health Survey Act of 1956 which mandated initiation of a national continuing survey to collect data that would provide statistical information on the prevalence and consequences of illnesses and disability and utilization of related medical services in the U.S. population. The survey is conducted annually by the National Center for Health Statistics (NCHS). It is a national probability survey that collects household-level data on the non-institutionalized U.S. adult civilian population. The survey includes questions on a variety of health topics and provides data to track individual health status, healthcare access, and national progress.
towards achieving health policy goals. The NHIS data provides insight into epidemiologic and policy issues, e.g., identifying barriers to healthcare, Federal health program evaluation, and characterizing disease burden in the larger U.S. population. Major health topics included in the survey include:

- Physical and mental health status
- Chronic conditions, including asthma and diabetes
- Access to and use of healthcare services
- Health insurance coverage
- Health-related behaviors including smoking, alcohol use, and physical activity
- Injuries
- Immunizations

5.2. **NHIS Design & Sampling Frame**

The NHIS data collection is governed by a multi-stage area probability sample design. One of the key features of the sample design is oversampling of population subgroups who are typically underrepresented in the general population. Racial/ethnic minorities are over-sampled annually. The sampling plan utilized in the 2007 data collection was implemented in 2006 following development of a new sampling design aimed at improving operational efficiency. The sampling design applied to the 2007 data collection covers the period
The process of implementing the sampling design was described as follows:

1. The U.S. population is divided into primary sampling units (PSUs) which consists of single counties, groups of adjacent counties, or metropolitan areas. This process is determined by population distribution in the PSUs.

2. Due to variation in population size of the PSUs, they are divided further into up to 21 sub-strata of census blocks (defined by the U.S. Census Bureau) based on the concentration of black, Asian, and Hispanic individuals in a given area. The sub-strata division is based on the 2000 Decennial Census demographic estimations of racial/ethnic minorities.

3. Within the PSU sub-strata, dwelling units are clustered to form secondary sampling units (SSUs).

4. A sample of SSUs is systematically selected to represent each sub-stratum. The process by which this is done has not been fully described in the NHIs documentation.

5. Before conducting interviews, a portion of the sample is selected for screening to confirm that the household contains at least one black, Hispanic, or Asian person in residence.

6. In the remainder of the sample that is not screened, from each family, one adult is randomly selected to respond to the sample
adult interview questionnaire. Additional information is collected on randomly selected adults in the dwelling unit.

7. In the current sample design, any black, Hispanic, Asian or person ≥65 years is given twice the chance of being selected as the sample adult to represent a family as any other adult in the household.

5.3. Sampling Weight
The NHIS sampling process described above allows the survey administrator to employ a process by which household- and person-level base weights are generated. These base weights are the product of the inverse probability of selection at each sampling stage. The National Center for Health Statistics defines the base weight as the number of population units represented by a sampling unit. The base weights are adjusted for non-response and the final person-level weights are derived from population estimates generated by the U.S. Census Bureau.

5.4. NHIS Questionnaire Structure
The survey questionnaire consists of four components --- household, family, adult, and child. For each household selected for the survey, limited demographic information on all residents within the household is collected; this is done in an effort to maintain individual privacy. The family component of the survey yields information on health status, functional limitations, healthcare access, and financial status of the household residents as a collective. Within each family, one sample adult and, when possible, one sample child are randomly selected to generate
data for the Sample Adult Core and Sample Child core questionnaires respectively. All data is self-reported from respondents.
6 Methodology

This chapter describes the methodologic approach to the study. The purpose of the study was to evaluate the relationship that SMI has with: 1) chronic physical disease burden, 2) medical service utilization, and 3) healthcare costs. The NHIS household, family, and adult files for 2007 were used to construct the study analytic sample (described below). The NHIS public release micro-data files correspond to the survey questionnaires of which there are nine. The survey questionnaires are organized into multiple components including household, family, adult and child. The household component of the survey collects basic demographic data on all household members. The family component of the survey yields information on health status, functional limitations, healthcare access, and financial status for each adult family member. Within each family, one sample adult and, when possible, one sample child are randomly selected to generate data for the Sample Adult Core and Sample Child core questionnaires respectively. The Sample Adult and Sample Child questionnaires collect data on health status, healthcare utilization, and health behaviors. The 2007 version of the survey included a supplemental component on mental health in which respondents were asked whether they had ever been diagnosed with any of three serious mental illness, including schizophrenia, bipolar disorder, and mania/psychosis. Respondents were
also asked if they had experienced chronic depression and/or anxiety over the past twelve months. Included in this chapter are the following:

- Study Design
- Study Sample Construction
- Statistical Software
- Data Cleaning
- Variable Definitions

6.1. Study Design
The study was a retrospective, cross-sectional, secondary analysis of the NHIS 2007 dataset.

6.2. Study Sample Construction
The NHIS 2007 dataset is publicly available de-identified data located on the Centers for Disease Control and Prevention National Health Statistics website. The survey is a continuous cross-sectional household survey of the U.S. non-institutionalized civilian population.

6.2.1 Obtaining the Data
The public release NHIS microdata was downloaded from the Centers for Disease Control and Prevention website. The original microdata is divided into multiple self-extracting compressed data files that correspond to different components of the survey. The data codebook for the 2007 NHIS was reviewed to determine which files contained demographic, health status, health behavior, and medical care utilization variables. The sample adult microdata file from the Sample Adult Core questionnaire
and person microdata files from the Family Questionnaire were downloaded and read into Stata, the statistical software package used for analyses in this study. Both of the downloaded files comprised person-level microdata or data from individual adults. The original person-level microdata had been sorted by combining serial numbers for household, family, and person that were assigned prior to the public data release. This combination of serial numbers created unique identifiers for each adult in the dataset such that each adult was considered one unique observation. After merging the files, they were checked to confirm that each observation corresponded to an individual respondent.

6.2.2 Analytic Sample Development
The only criteria for inclusion in the study was that a respondent had to be an adult and 18 – 64 years old. As noted in the literature view (Chapter 2), several studies reported a significant association between SMI and premature mortality.10,11,24 The premature mortality has been attributed to chronic physical diseases.10 Druss et al., reported that persons with SMI died on average 8.2 years earlier than the general population and more than 95% of the deaths were attributable to medical problems.10

In another study that estimated lost productivity due to comorbid SMI and chronic physical conditions, persons with SMI were reported to have a mean years of productive life loss (YPLL) of 32.0 years (±12.6).11 Due to previous reports of premature and excessive mortality and substantial
productivity losses attributable to medical problems, the study sample was limited to focus on working age adults. Furthermore, focusing on working age adults minimized potential bias related to aging, such as greater risk for chronic physical diseases and differences in health insurance coverage options that could influence medical care utilization.

The final analytic sample (n=17,787) was based on the inclusion criteria and exclusion of cases with implausible responses to key variables. Implausible responses were identified during the data cleaning process which is described below (section 6.2.3). Figure 6.1 describes the process for developing the final analytic sample. The merged sample adult and person microdata files were merged as noted in the previous section. This created a dataset consisting of all adults (18-85 years) who participated in the 2007 NHIS (n=23,393). From this group, individuals with age >64 years old (n=4,583) were excluded from the sample which left only working age adults (n=18,810). After data cleaning, cases with implausible responses or who refused to respond to key questions (n=1,023) were removed from the dataset which yielded a final analytic sample (n=17,787). Of this final analytic sample, the SMI sub-sample was identified (n=788); the SMI subsample consisted of individuals who reported having been diagnosed with at least one of the SMI conditions considered in the study (bipolar disorder, schizophrenia, mania/psychosis, chronic depression and anxiety).
6.2.3 Data Cleaning

To examine the data for out-of-range values, descriptive statistics were computed. Cases with implausible data for key variables were deleted from the dataset (n = 1,023). To evaluate the dataset for potential bias...
created by systematic deletion of cases with missing data, chi-square tests for categorical variables and t-test for continuous variables were computed to compare data from the deleted cases and complete cases. There was no statistically significant difference between the deleted cases and complete cases. After excluding respondents >64 years of age and deleting cases with missing data, the final analytic sample consisted of 17,787 cases of which 788 (4.4%) reported a history of SMI.

6.3. Statistical Software
The Stata statistical analysis software package (Stata, Version 12.1 2014) was used for all statistical analysis included in the study. The NHIS 2007 data files described above (were downloaded into Stata and subsequently merged to create one analytic dataset. Microsoft EXCEL ® 2013 was used for the economic analyses (see Chapter 9).

6.4. Variable Definitions
This section describes the general structure of the variables used to address the research questions and test the hypotheses noted in Chapter 4 above.

6.4.1 Demographic and Socioeconomic Status Variables
To characterize the study sample’s demographics and socioeconomic status, variables for age, gender, race/ethnicity, marital status, education, employment, public financial assistance and were included in the final dataset. Gender was recoded to create a dummy variable called “female” for which female was coded “1” and male was coded “0.” A dummy variable
called “non-white” was created from the race/ethnicity variable such that non-Hispanic black, Hispanic, Asian, and Native American/Alaskan Native were all coded “1” and white was coded “0.” A dummy variable called “high school” was created such that respondents who reported receiving a high school diploma or more education were coded “1” and those who reported less than a high school diploma were coded “0.” A dummy variable called “married” was created from the marital status variable such that individuals who reported being currently married or living with a partner were coded “1” and those who reported being single, separated, divorced, or widowed were coded “0.” A dummy variable called “employed” was created from the employment variable for which respondents reported whether they had worked full-time for pay in the past 12 months: employed was coded “1” for “yes” and “0” for “no.” For the dummy variable “public financial assistance” a respondent was coded “1” for a yes response to questions about receipt of food stamps and/or social security disability benefits in the past year; respondents were coded “0” if they denied receipt of any of these items.

6.4.2 Epidemiologic Variables
To evaluate the relationship between serious mental illness (SMI) and chronic disease burden in working age (18-64 years) adults in the U.S., dummy variables for each of 12 chronic physical conditions were created. Analysis and results will be discussed below (Chapter 7). The dummy variables were coded “0” for “no” responses and “1” for “yes” responses to
questions about history of diagnosis with a given chronic physical condition. The chronic physical condition dummy variables were derived from survey questions that asked respondents if they had ever been told by a physician that they had a given condition.

6.4.2.1 Chronic Disease Burden in Persons with SMI

In this study, a fundamental aim was to evaluate the relationship between SMI and chronic physical disease burden in a national sample to determine if the problem is indeed universal. The 12 chronic physical conditions selected for this analysis were consistent with those referenced in the literature review (Chapter 2) and included:

1. Hypertension
2. Cardiovascular disease
3. Stroke
4. Asthma
5. Hyperlipidemia
6. Peripheral vascular disease
7. Diabetes
8. COPD
9. Kidney Disease
10. Liver Disease
11. Hepatitis
12. Obesity

The obesity variable was derived from the body mass index (BMI) variable in the dataset. In the survey BMI was based on each respondent’s self-reported body weight and height at the time of the survey. If BMI was \( \geq 30 \), the obesity dummy variable was coded “1” and if BMI was coded <30, the obesity dummy variable was coded “0.” A count variable called “conditions” was created that summed the total number of chronic physical conditions out of the 12 listed above that an individual reported.
6.4.2.2 Self-Rated Health Status

In addition to the chronic physical conditions, a dummy variable for self-reported health status was created. The variable was derived from the question, “In general, would you say your health is excellent, very good, good, fair, or poor?” Self-rated health has been shown to be a valid predictor of mortality and is included in numerous national longitudinal health surveys including the National Health Interview Survey (NHIS) and the National Health and Nutrition Survey (NHANES)\textsuperscript{108,109}. Idler and colleagues reported in their 1990 study that self-rated health was associated with mortality during a 12-year follow-up of middle-age adult male respondents in the NHANES.\textsuperscript{108} In addition to mortality prediction, single-item assessments of self-rated health also predict future health expenditures, allowing for identification of individuals who are more likely to incur higher medical costs.\textsuperscript{109} DeSalvo and colleagues reported that a single-item assessment of self-rated health was predictive of total healthcare expenditures.\textsuperscript{109} A dummy variable for self-rated health (0=good/1=poor) called “poor health” was created. Responses of “fair” and “poor” were collapsed and coded “1” and excellent, very good, and good were collapsed and coded “0.”

6.4.2.3 Health Behaviors

The excessive chronic disease burden found in persons with SMI has been attributed, at least in part, to health behaviors such as smoking,
sedentary living, and poor diet. Dummy variables were created for smoking and obesity to include as covariates in statistical analyses. Like the chronic disease and self-reported health variables described above, the smoking dummy variable was derived from individuals’ responses to questions about current or lifetime smoking, current body weight, and height. The smoking dummy variable was coded “1” if the respondent endorsed current or previous tobacco use and “0” if they denied ever smoking.

6.4.3 Medical Care Utilization Variables
One of the hypothesized explanations for excessive chronic disease burden in persons with SMI is inappropriate utilization of medical care services, e.g., excessive ED visits versus preventive and routine primary care. Medical care utilization is one of the focal areas in the NHIS (Chapter 5). To evaluate the relationship between medical care utilization and comorbid SMI and chronic physical conditions, variables were created for the following:

- Health Insurance Status
- Delayed care due to personal financial constraints
- Physician Office Visits
- Emergency Department (ED) visits
- Hospitalizations
- >10 Medical care encounters
Each of the variables were derived from questions respondents were asked about their health service utilization behavior in the past 12 months.

### 6.4.3.1 Health Insurance Status
A dummy variable called “insured” for health insurance status was derived from a variable in the survey that captured whether a respondent had health insurance coverage of any kind in the past 12 months. The dummy variable “insured” was coded “1” for yes and “0” for no.

### 6.4.3.2 Delayed Care
A dummy variable for delayed care was created and coded “1” if a respondent reported delaying care due to cost, despite perceived need, in the past 12 months and “0” if they denied doing so. Respondents were not asked how many times they delayed care.

### 6.4.3.3 Physician Visits
The original variable for physician office visits was a categorical variable derived from the respondents’ report of the number of times they were seen in a physician’s office in the past 12 months. In the NHIS dataset the variable was coded as follows:

- 0 = 0
- 1 = 1
- 2 = 2–3
- 3 = 4–5
- 4 = 6–7
- 5 = 8–9
- 6 = 10–12
- 7 = 13–15
- 8 = ≥16
6.4.3.4 Emergency Department Visits

The original variable for ED visits was a count variable derived from the number of times a respondent reported being seen in the ED in the past 12 months. In the NHIS dataset the variable was coded as follows:

- 0 = 0
- 1 = 1
- 2 = 2-3
- 3 = 4-5
- 4 = 6-7
- 5 = 8-9
- 6 = 10-12
- 7 = 13-15
- 8 = ≥16

From the original variable a dummy variable was created to evaluate access to the ED and coded “1” if the respondent reported ≥1 ED visit in the past 12 months and “0” if they had no ED visits.

6.4.3.5 Hospitalizations

There were two variables for hospitalization in the NHIS dataset. The first variable for hospitalization was based on the question: “Were you hospitalized overnight during the past 12 months?” From the original variable a dummy variable was created to evaluate any hospitalization over the past year. It was coded “1” for ≥1 hospitalization in the past 12 months and “0” if the respondent had not been hospitalized.

A second hospitalization variable measured the number of nights hospitalized in the previous 12 months. The variable was a discrete count variable that took the form of a non-negative integer with possible range of 0-365.
6.4.4 Multiple Medical Encounters
The survey included an imputed variable “medical care 10” derived from the sum of medical encounters (i.e. physician office visits, ED visits, and hospitalizations) in the previous 12 months for each respondent. From the imputed variable a dummy variable was created and coded “1” if the sum of visits was ≥10 and “0” if it was <10.

6.4.5 Economic Variables
Cost data were obtained from published reports of average national healthcare expenditures generated from the Medical Expenditure Panel Survey (MEPS). For physician office visits, ED visits, and hospitalizations, the average national cost per service type for the year 2008 was recorded in an EXCEL spreadsheet. Annual per capita prescription drug costs were also recorded in the EXCEL spreadsheet. Results of, total per capita costs, sensitivity and scenario analyses are discussed below (Chapter 9). All costs were adjusted to 2014 US dollars.

6.5 Proposed Methodology
In this section, the methodologic approach to each of the research questions will be discussed.

6.5.1 Study Sample Characteristics
First, univariate analyses were computed to generate basic descriptive statistics for the entire study sample. This was followed by bivariate analyses to evaluate differences between the SMI sub-sample and the remaining study sample which was the reference group for this study. The
SMI and non-SMI groups were split by age according to the age cutoffs applied to the published cost estimates.\textsuperscript{113–116} Chi-square tests were computed to determine if there were statistically significant differences in categorical variables, e.g., gender, education, etc. T-tests were computed to estimate differences in continuous variables.

6.5.2 SMI Chronic Physical Disease Burden

To evaluate the relationship between SMI and chronic physical disease burden in working age (18-64 years) adults in the U.S., several analyses were conducted. Univariate analyses were computed to generate basic descriptive statistics to identify proportions of the study sample who reported having each of the 12 chronic physical conditions (section 6.5.2.1) considered in this study and to identify proportions of each group who reported poor self-rated health in the past 12 months. This was followed by bivariate analyses to evaluate differences in proportions of the chronic physical conditions and poor self-rated health between the SMI sub-sample and reference sample. Chi-square tests were computed to determine if there were statistically significant group differences in chronic physical conditions and poor self-rated health. T-tests were computed to test differences in the average number of conditions between the SMI sub-sample and the remaining study sample.

Multivariate analyses consisted of logistic regression models and negative binomial regression models. Logistic regression is typically used to model
the relationship between a binary outcome variable and a set of predictors or covariates.\textsuperscript{117} In public health and health economics research it can be used to model the presence versus the absence of a disease or event. For this section of the study, logistic regression models were constructed to estimate the relationship between SMI (independent variable) and specific chronic physical conditions (outcome variables). The logistic model is expressed as:

\[ y_i = \pi(x_i) + \varepsilon_i \]

In this equation, \( y_i \) is the binary outcome variable, e.g., heart disease; \( \pi(x_i) \) is the conditional probability of the outcome occurring given a set of predictor variables, e.g., SMI, age, race, gender, etc.; \( \varepsilon_i \) is the binomial random error term. Logistic regression assumes that the data included in the model has come from a random sample of the population.

To check the fit of the model to the data, one of the widely used tests of goodness-of-fit of a logistic model is the Hosmer-Lemeshow test.\textsuperscript{117,118} The Hosmer-Lemeshow test is based on the expectation that the observed frequency and the predicted frequency of the outcome should be very similar.\textsuperscript{118} The test is conducted by grouping the observations in the dataset into deciles of risk. These deciles are split into \( g=10 \) equal-sized groups based on their ordered estimated probability of having the outcome of interest. A chi-square test is calculated on the risk deciles to determine if there are statistically significant differences between the observed
frequencies and the predicted frequencies. If the chi-square test is statistically significant (p<0.05), the observed and predicted frequencies are different, indicating poor model fit to the data. Consequently, after estimating a logistic regression model, the Hosmer-Lemeshow test is conducted and if it is not statistically significant, this is an indication that the estimated logistic regression model is a good fit to the data because the observed and predicted frequencies of the outcome are similar.118

6.5.3 SMI and Medical Care Utilization

To evaluate the relationship between SMI and medical care utilization in working age (18-64 years) adults in the U.S., univariate, bivariate and multivariate analyses were conducted. The univariate analyses were computed to generate basic descriptive statistics of the medical care utilization variables described above (section 6.53). Bivariate analyses were computed to test differences in proportions of the outcome variables—delayed care, physician office visits, emergency department visits, hospitalizations and ≥10 medical care encounters in the previous year, between the SMI sub-sample and larger reference sample.

Logistic regression models were estimated to evaluate the relationship between medical care utilization variables and SMI. Previous reports in the published literature have shown age, gender, race/ethnicity, previous diagnosis with chronic physical conditions, smoking, marital status,
having a usual source of care, and insurance status. to be significant factors associated with medical care utilization in persons with SMI.\textsuperscript{54,65} Preliminary analysis consisted of backward stepwise regression models that were estimated for each of the medical care utilization variables to identify which covariates would be statistically significant. Covariates included in the logistic regression models for each of the medical care utilization outcomes were: age, gender, race/ethnicity, having chronic physical conditions, smoking, and insurance status. Model fit was assessed with the aforementioned Hosmer-Lemeshow goodness-of-fit tests.

6.5.4 Costs of Medical Care Utilization in the SMI Population
A cost model was constructed to estimate: 1) the annual costs of medical care utilization in individuals with comorbid SMI and chronic physical conditions versus non-SMI individuals with chronic physical conditions 2) the differences in annual costs attributable to both groups. Cost model construction followed the U.S. Government Accountability Office (GAO) cost estimation guidance described in detail in Chapter 9.\textsuperscript{119} The cost model was constructed with inputs from the medical care utilization analyses (Chapter 8) and national estimates of unit costs of those services. The annual mean utilization rates for physician office visits, ED visits, hospitalizations and prescription drugs were computed for four groups derived from the study sample:

- SMI – 18·44 years
- SMI – 45·64 years
Prescription drug utilization estimates were derived from physician office visit estimates under the assumption that only individuals who had physician office visits would have annual prescription drug costs. The annual weighted average utilization rates for physician office visits, ED visits, hospitalizations and prescription drugs were multiplied by national unit cost estimates to generate annual average per capita costs for each medical care utilization variable. These costs were summed to generate the annual average per capita medical care costs for SMI and non-SMI by age.

Sensitivity and scenario analyses were conducted to assess the impact of altering key model inputs on per capita costs in the four groups. Sensitivity analyses were conducted on physician office visit unit costs and prescription drug costs because there was uncertainty in the two variables as they were applied to the cost model. Scenario analysis is an analytic tool that is very similar to sensitivity analysis. According to the World Bank, scenario analysis is a practical tool that can be used to facilitate decision making and risk assessment for large-scale projects that must consider future population and structural changes. Scenario analyses were conducted on ED and hospital utilization rates to
investigate the potential impact of incremental percentage changes on annual per capita medical care costs.

The cost analysis in this study was conducted from the payer perspective, with a one-year time horizon, and with the aim of providing a framework for future economic evaluations of programs designed to reduce healthcare costs in complex patient populations, particularly those with comorbid SMI and chronic physical conditions.
7 Epidemiologic Analysis and Results

This section addresses the research question and hypotheses listed in Table 7.1.

Table 7.1 Chronic Disease Burden: research question & hypotheses

<table>
<thead>
<tr>
<th>Research Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the association between SMI and chronic disease burden in working age adults in the U.S.?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hypotheses</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₀: There is no difference in chronic disease burden between persons with SMI and the general population of working age adults.</td>
</tr>
<tr>
<td>H₁: Working age adults with a history of SMI have greater chronic disease burden than the general population.</td>
</tr>
</tbody>
</table>

Included in this chapter are the following:

- Overview
- Definition and discussion of chronic disease burden
- Description of variables (dependent, independent, covariates)
- Univariate analyses and results
- Bivariate analyses and results
- Multivariate analyses and results

7.1. Overview

In this section, the methodologic approach to the research question noted in Table 7.1 will be presented. The statistical analyses to address the hypotheses will be discussed; all statistical analyses considered an alpha level of 0.05 as statistically significant.
7.2. Estimating Chronic Disease Burden

Disease burden is a measure of the impact a health problem has on individuals and society in terms of morbidity, disability, mortality, economic costs and functional status.2 Chronic disease burden in persons with SMI has been evaluated in numerous studies.6,7,10,35,121 Persons with SMI have been shown to have higher rates of morbidity and associated disability and mortality attributable to chronic physical conditions.4,7,10,35,122

This study aimed to address two major limitations in the published literature. First, comorbid SMI and chronic disease burden at the national level was considered while most published studies have only evaluated the problem at the local level, e.g., clinic-based cohorts, state Medicaid databases. Second, contrary to recent reports that have considered comorbid SMI and chronic disease, this study evaluated the chronic disease burden in multiple SMI diagnostic sub-groups including persons with bipolar disorder, schizophrenia, mania/psychosis, and depression and anxiety. Recent studies have focused on one SMI diagnostic subgroup, e.g., schizophrenia, bipolar disorder, etc. or the manifestations of a particular chronic physical disease in persons with SMI.121,123,124 The analytic approach presented here is consistent with the national health policy and legal operational definition of SMI discussed above in Chapter 1.15 Moreover, it considers a variety of chronic physical
diseases that have been reported to contribute to excess burden in persons with SMI in the literature over the past 15 years.\textsuperscript{6,7,35} By evaluating overall chronic disease burden in multiple SMI diagnostic sub-groups, this study was able to compare risk for specific chronic diseases between groups, thereby offering more insight into the problem.

7.3. Variables
As discussed in Chapter 6 (6.5.2.1), this study aimed to estimate the relationship between SMI and chronic physical disease burden. Chronic physical disease burden was estimated with several outcome variables described below. SMI was treated as an independent variable. Covariates were included to control for individual characteristics.

7.3.1 Outcome Variables
The association between SMI and each of the 12 chronic physical conditions selected for this study was estimated. The chronic physical conditions included in the analyses for this study were selected from published reports that examined chronic disease prevalence and related mortality in persons with SMI.\textsuperscript{5–7,52,122} For each chronic physical condition, a dummy variable was created based on individuals’ responses to questions about previous diagnosis with a given condition during their lifetime. Chronic physical diseases included:

1. Hypertension
2. Cardiovascular disease
3. Stroke
4. Asthma
5. Hyperlipidemia
6. Peripheral vascular disease
7. Diabetes
To evaluate chronic disease burden a variable called “conditions” was created that summed the total number of chronic physical conditions out of the 12 selected for this study. This was followed by creation of a dummy variable for having chronic physical conditions; it was coded “1” for having ≥1 chronic physical condition and “0” for having no chronic physical conditions.

In addition to the chronic disease burden outcome variable, self-rated health was an outcome variable as described above (Chapter 5). Self-rated health was transformed to create a dummy variable for poor health; it was coded “1” for having poor health and “0” for not having poor health. The poor health variable was used to test the relationship between SMI and self-reported poor health while controlling for other key variables.

7.3.2 Independent variables
A dummy variable for SMI was created and used to identify the sub-sample of individuals who reported history of being diagnosed with psychiatric disorders included in the NHIS 2007 mental health module. For each of the psychiatric disorders or SMI sub-groups, a dummy variable was created and used to evaluate the relationship between SMI sub-group and each of the specific chronic conditions as well as SMI sub-group and overall burden of chronic conditions. An individual was
considered as having SMI if they reported having any one of the conditions or subgroups. This approach yielded five independent variables:

- SMI
- bipolar disorder
- schizophrenia
- mania/psychosis
- depression/anxiety

7.3.3 Covariates

To control for individual characteristics that would be expected to influence chronic physical disease risk, as reported in the literature, several covariates were included in the multivariate analyses described below. Covariates included:

- Gender (female/male)
- Race/ethnicity (white/nonwhite)
- Age (18-64 years)
- Smoking status (current or previous vs. never)

7.4. Univariate Analyses & Results

First, univariate analyses on the entire study sample were conducted for the demographic characteristics discussed above (6.5.1). Frequencies and percentages were computed for categorical variables. Means and standard deviations were computed for continuous variables. Mean age was 42.1 years (±12.8) for the SMI sub-sample and 40.6 years (±12.9) for individuals without SMI (p=0.002). Results for categorical descriptive variables are presented below in Table 7.2. Next univariate analyses for the outcome variables was conducted for the entire study sample. Results
are presented below in Table 7.2. Univariate analyses for the independent variables (SMI and psychiatric sub-groups) were conducted and the results are presented below in Table 7.3.

7.5. Bivariate Analyses & Results
This section consists of descriptions of the bivariate analyses conducted on study sample characteristics, outcome variables and independent variables.

7.5.1 Chi-square Analysis
Differences in proportions between persons with SMI and those without a history of psychiatric disorders were tested with Pearson Chi-square tests for the following:

- Study Sample Demographic and Health Behavior Variables (Table 7.2)
- Outcome Variables (Chronic Physical Disease, Self-Rated Health) (Table 7.3)
- Independent Variables (SMI and SMI diagnostic sub-groups) (Table 7.4)

7.5.2 T-test Analysis
Differences in means between persons with SMI and those without a history of psychiatric disorders were tested with t-tests for the following:

- Age
- Body Mass Index (BMI)
Results, including statistical significance, are reported below in Table 7.2.
Table 7.2 Characteristics of study sample and weighted population for SMI and non-SMI in the U.S.

<table>
<thead>
<tr>
<th>Descriptive Variables</th>
<th>SMI</th>
<th></th>
<th></th>
<th></th>
<th>Non-SMI</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sample n</td>
<td>%</td>
<td>Weighted N</td>
<td>%</td>
<td>Sample n</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>(n=788)</td>
<td></td>
<td></td>
<td></td>
<td>(n = 16,999)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>498</td>
<td>63.2</td>
<td>4,399,058</td>
<td>59.7</td>
<td>7,934</td>
<td>46.7</td>
</tr>
<tr>
<td>Non-white</td>
<td>260</td>
<td>33.0</td>
<td>1,693,223</td>
<td>23.0</td>
<td>7,358</td>
<td>43.3</td>
</tr>
<tr>
<td>High School Education</td>
<td>538</td>
<td>68.3</td>
<td>5,200,659</td>
<td>70.6</td>
<td>13,803</td>
<td>81.2</td>
</tr>
<tr>
<td>Marital Status</td>
<td>208</td>
<td>26.4</td>
<td>2,632,056</td>
<td>35.7</td>
<td>8,195</td>
<td>48.2</td>
</tr>
<tr>
<td>No Health Insurance b</td>
<td>154</td>
<td>19.5</td>
<td>1,497,670</td>
<td>20.3</td>
<td>3,697</td>
<td>21.7</td>
</tr>
<tr>
<td>Smoking</td>
<td>352</td>
<td>44.7</td>
<td>3,481,113</td>
<td>47.3</td>
<td>3,495</td>
<td>20.6</td>
</tr>
<tr>
<td>Alcohol Consumption</td>
<td>451</td>
<td>57.2</td>
<td>4,309,598</td>
<td>58.5</td>
<td>10,814</td>
<td>63.6</td>
</tr>
<tr>
<td>Unemployed</td>
<td>408</td>
<td>51.8</td>
<td>3,672,908</td>
<td>49.9</td>
<td>3,305</td>
<td>19.4</td>
</tr>
<tr>
<td>Age in years (±SD)</td>
<td>42.1 (±12.8)</td>
<td></td>
<td>7,364,035</td>
<td></td>
<td>40.6 (±12.9)</td>
<td></td>
</tr>
<tr>
<td>BMI (±SD)</td>
<td>29.1 (±0.28)</td>
<td></td>
<td>7,364,035</td>
<td></td>
<td>27.5 (±0.5)</td>
<td></td>
</tr>
</tbody>
</table>

a. Differences between the two groups were statistically significant at p<0.05 unless otherwise noted.
b. Difference between the two groups was not statistically significant (p=0.142).

9 Person-level weights were applied to the study sample to generate the estimated total U.S. population represented by the sample. The person level weights are derived from U.S. Census Bureau population estimates.
Table 7.3 Chronic physical conditions and chronic disease burden for SMI and non-SMI (18-64 years old) in the U.S.

<table>
<thead>
<tr>
<th>Chronic Physical Conditions&lt;sup&gt;a&lt;/sup&gt;</th>
<th>SMI (n = 788)</th>
<th>Non-SMI (n = 16,999)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>%</td>
</tr>
<tr>
<td>Hypertension</td>
<td>286</td>
<td>36.3</td>
</tr>
<tr>
<td>Heart Disease</td>
<td>49</td>
<td>6.2</td>
</tr>
<tr>
<td>Stroke</td>
<td>42</td>
<td>5.3</td>
</tr>
<tr>
<td>Asthma</td>
<td>133</td>
<td>16.9</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>268</td>
<td>34.0</td>
</tr>
<tr>
<td>Peripheral Vascular Disease</td>
<td>190</td>
<td>24.1</td>
</tr>
<tr>
<td>Diabetes</td>
<td>104</td>
<td>13.2</td>
</tr>
<tr>
<td>COPD</td>
<td>119</td>
<td>15.1</td>
</tr>
<tr>
<td>Kidney Disease</td>
<td>39</td>
<td>5.0</td>
</tr>
<tr>
<td>Liver Disease</td>
<td>49</td>
<td>6.2</td>
</tr>
<tr>
<td>Hepatitis</td>
<td>64</td>
<td>8.1</td>
</tr>
<tr>
<td>Obesity</td>
<td>302</td>
<td>38.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chronic Disease Burden&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Frequency</th>
<th>%</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>285</td>
<td>36.2</td>
<td>11,250</td>
<td>66.2</td>
</tr>
<tr>
<td>1</td>
<td>206</td>
<td>26.1</td>
<td>3,625</td>
<td>21.3</td>
</tr>
<tr>
<td>2</td>
<td>128</td>
<td>16.2</td>
<td>1,256</td>
<td>7.4</td>
</tr>
<tr>
<td>3</td>
<td>69</td>
<td>8.8</td>
<td>475</td>
<td>2.8</td>
</tr>
<tr>
<td>4</td>
<td>47</td>
<td>6.0</td>
<td>224</td>
<td>1.3</td>
</tr>
<tr>
<td>≥5</td>
<td>53</td>
<td>6.7</td>
<td>169</td>
<td>1.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Self-Rated Health&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Frequency</th>
<th>%</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor self-rated health</td>
<td>351</td>
<td>44.5</td>
<td>1,748</td>
<td>10.3</td>
</tr>
</tbody>
</table>

<sup>a</sup> Group differences were statistically significant (p<0.05) for all variables unless otherwise noted.
Table 7.4 Univariate results for SMI and disorder subgroups (adults 18-64 years)

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>SMI (n = 788)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
</tr>
<tr>
<td>SMI</td>
<td>788</td>
</tr>
<tr>
<td>Bipolar Disorder</td>
<td>360</td>
</tr>
<tr>
<td>Schizophrenia</td>
<td>122</td>
</tr>
<tr>
<td>Mania/Psychosis</td>
<td>137</td>
</tr>
<tr>
<td>Chronic Depression or Anxiety</td>
<td>476</td>
</tr>
</tbody>
</table>

<sup>a</sup> Percentage of the study sample that reported having a given condition

7.6. Chronic Disease Burden

This section explains the logistic regression models that estimated the relationship between SMI and chronic physical disease burden.

7.5.3 Specific Chronic Conditions

To evaluate the relationship between SMI and specific chronic diseases, the following logistic regression model was estimated for each of the conditions listed above in Table 7.3.

\[
\text{logit}(\text{medical condition}) = \alpha + \beta_1 \text{SMI} + \beta_2 \text{Age} + \beta_3 \text{Gender} + \\
+ \beta_4 \text{Race} + \beta_5 \text{Smoking}
\]

To control for individual characteristics and health behaviors that might contribute to chronic physical disease risk, the logistic regression model included age and the dummy variables for gender, race, and smoking.
7.6.1 Having Chronic Conditions

To evaluate the relationship between having at least one chronic conditions and SMI, the following logistic regression was estimated with the dummy variable for having chronic physical conditions as the outcome.

\[
\text{logit(burden)} = \alpha + \beta_1 \text{SMI} + \beta_2 \text{Age} + \beta_3 \text{Gender} \\
+ \beta_4 \text{Race} + \beta_5 \text{Smoking}
\]

7.6.2 Chronic Conditions and SMI Diagnostic Groups

To evaluate the relationship between specific SMI diagnostic sub-groups (Table 7.4) and specific chronic physical conditions, the following logistic regression model was estimated.

\[
\text{logit(} \text{medical condition}) = \alpha + \beta_1 \text{SMI} + \beta_2 \text{Age} \\
+ \beta_3 \text{Gender} + \beta_4 \text{Race} \\
+ \beta_5 \text{Smoking}
\]

Estimation of separate models for each of the SMI diagnostic subgroups attempted to control for their etiologic differences. Bipolar disorder, schizophrenia, and mania/psychosis are psychiatric disorders caused by physiologic abnormalities in brain function. Chronic depression and anxiety are sometimes considered “organic” mental disorders because sometimes they derive from physical illness such as heart disease or other related functional limitations. Despite differences in etiology, all four conditions are classified as SMI due to their effects on individual functioning and requirements for ongoing treatment. Results of the logistic regression models are presented below in Table 7.5.
7.7. Self-Rated Health

The relationship between SMI and self-rated health was evaluated with the poor health outcome variable described above (7.3.1). Separate logistic regression models were estimated for each of the SMI diagnostic subgroups. The following logistic regression models were estimated:

\[
\text{logit(} \text{poor health}\text{)} = \alpha + \beta_1 \text{SMI} + \beta_2 \text{Age} + \beta_3 \text{Gender} + \beta_4 \text{Race} + \beta_5 \text{Smoking}
\]

\[
\text{logit(} \text{poor health}\text{)} = \alpha + \beta_1 \text{SMI Diagnosis} + \beta_2 \text{Age} + \beta_3 \text{Gender} + \beta_4 \text{Race} + \beta_5 \text{Smoking}
\]

Results of the logistic regression models are presented below in Table 7.5.
Table 7.5 Relationship between Serious Mental Illnesses, Chronic Conditions, and Self-Rated Health

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>SMI$^{a, d}$ (n = 788) Adjusted OR$^{b}$ (95% CI)</th>
<th>Bipolar Disorder (n = 373) Adjusted OR$^{b}$ (95% CI)</th>
<th>Schizophrenia (n = 136) Adjusted OR$^{b}$ (95% CI)</th>
<th>Mania/Psychosis (n = 145) Adjusted OR$^{b}$ (95% CI)</th>
<th>Chronic Depression/Anxiety (n = 486) Adjusted OR$^{b}$ (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>1.85 (1.6 - 2.7)</td>
<td>2.02 (1.6 - 2.7)</td>
<td>1.48 (.97 - 2.3)</td>
<td>1.91 (1.3 - 2.8)</td>
<td>1.91 (1.5 - 2.4)</td>
</tr>
<tr>
<td>Heart Disease</td>
<td>2.68 (1.9 - 3.7)</td>
<td>3.02 (1.9 - 4.8)</td>
<td>0.89 (0.3 - 2.5)$^{c}$</td>
<td>2.16 (0.98 - 4.6)$^{c}$</td>
<td>2.65 (1.8 - 3.9)</td>
</tr>
<tr>
<td>Stroke</td>
<td>3.43 (2.4 - 4.8)</td>
<td>2.97 (1.7 - 5.1)</td>
<td>2.92 (1.3 - 6.3)</td>
<td>2.97 (1.3 - 6.6)</td>
<td>3.73 (2.5 - 5.6)</td>
</tr>
<tr>
<td>Asthma</td>
<td>2.23 (1.8 - 2.7)</td>
<td>2.23 (1.7 - 3.0)</td>
<td>2.18 (1.3 - 3.7)</td>
<td>2.46 (1.6 - 3.9)</td>
<td>2.27 (1.8 - 2.9)</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>2.13 (1.8 - 2.5)</td>
<td>1.75 (1.4 - 2.3)</td>
<td>0.82 (0.52 - 1.3)$^{c}$</td>
<td>1.92 (1.3 - 2.8)</td>
<td>2.28 (1.8 - 2.8)</td>
</tr>
<tr>
<td>Peripheral Vascular Disease</td>
<td>3.74 (3.1 - 4.5)</td>
<td>3.71 (2.8 - 4.9)</td>
<td>3.09 (2.0 - 4.9)</td>
<td>4.23 (2.8 - 6.3)</td>
<td>3.78 (3.0 - 4.8)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>2.03 (1.6 - 2.6)</td>
<td>2.01 (1.2 - 2.6)</td>
<td>2.40 (1.1 - 3.5)</td>
<td>1.67 (0.92 - 3.0)$^{c}$</td>
<td>2.19 (1.6 - 2.9)</td>
</tr>
<tr>
<td>COPD</td>
<td>3.56 (2.8 - 4.5)</td>
<td>3.76 (2.8 - 5.1)</td>
<td>4.18 (2.6 - 6.8)</td>
<td>3.24 (2.0 - 5.2)</td>
<td>3.11 (2.4 - 4.1)</td>
</tr>
<tr>
<td>Kidney Disease</td>
<td>4.10 (2.8 - 5.9)</td>
<td>5.55 (3.4 - 8.7)</td>
<td>2.51 (1.0 - 6.4)</td>
<td>2.66 (1.1 - 6.6)</td>
<td>3.59 (2.3 - 5.7)</td>
</tr>
<tr>
<td>Liver Disease</td>
<td>4.95 (3.5 - 6.9)</td>
<td>5.56 (3.6 - 8.6)</td>
<td>5.38 (2.8 - 10.4)</td>
<td>3.59 (1.7 - 7.5)</td>
<td>3.79 (2.5 - 5.8)</td>
</tr>
<tr>
<td>Hepatitis</td>
<td>2.54 (1.9 - 3.4)</td>
<td>2.99 (2.0 - 4.4)</td>
<td>4.17 (2.5 - 6.9)</td>
<td>3.41 (2.0 - 5.9)</td>
<td>2.10 (1.5 - 3.0)</td>
</tr>
<tr>
<td>Obesity</td>
<td>1.68 (1.5 - 1.9)</td>
<td>1.68 (1.4 - 2.1)</td>
<td>0.91 (0.7 - 1.4)$^{c}$</td>
<td>1.82 (1.3 - 2.6)</td>
<td>1.87 (1.5 - 2.3)</td>
</tr>
<tr>
<td>Chronic Conditions</td>
<td>3.58 (3.0 - 4.2)</td>
<td>3.81 (3.0 - 4.8)</td>
<td>4.00 (2.6 - 6.1)</td>
<td>4.99 (3.3 - 7.5)</td>
<td>3.86 (3.1 - 4.8)</td>
</tr>
<tr>
<td>Poor Health</td>
<td>6.49 (5.5 - 7.7)</td>
<td>5.27 (4.1 - 6.7)</td>
<td>7.59 (5.1 - 11.3)</td>
<td>6.44 (4.5 - 9.3)</td>
<td>7.11 (5.8 - 8.7)</td>
</tr>
</tbody>
</table>

$^{a}$ All values statistically significant at p<0.01 level unless otherwise noted.

$^{b}$ Adjusted for age, gender, race and smoking status

$^{c}$ Not statistically significant (p>0.05)

$^{d}$ SMI refers to any of the following serious mental illnesses (bipolar disorder, schizophrenia, mania/psychosis, and chronic depression and anxiety.)
7.8. Summary of Results: Chronic Disease Burden
Consistent with previous reports in the scientific literature, the SMI group had significantly greater reported diagnoses of selected chronic physical conditions and greater overall chronic disease burden.

Approximately 60% of the SMI sub-group reported having two or more of the physical conditions considered in this study compared to approximately 10% of the non-SMI group (p<0.001) Table 7.5). Results of bivariate analysis suggested that persons with SMI have a much greater chronic physical disease burden (Table 7.3). More than 40% of the SMI sub-sample rated their health in the past 12 months as poor compared to approximately 10% in the non-SMI group.

7.8.1 SMI and Chronic Physical Conditions
Multivariate logistic regression models were estimated to assess the relationship between SMI and a) chronic physical disease burden and b) self-rated poor health (Table 7.5). The models adjusted for age, gender, race/ethnicity, and smoking. Separate estimations were completed for SMI as the independent variable and for each of the SMI diagnostic categories, e.g., bipolar disorder, schizophrenia, mania/psychosis, and chronic depression and anxiety.

SMI was associated with statistically significantly (p<0.01) greater odds of having each of the specific chronic physical conditions considered in this study. Among the individual chronic physical conditions, stroke,
peripheral vascular disease, COPD, kidney disease and liver disease had adjusted odds ratios (ORs) indicating at least three-fold greater risk. SMI was also associated with threefold (OR: 3.58, CI: 3.0-4.2, p<0.01) greater odds of having a chronic condition and six-fold (OR: 6.49, CI: 5.5-7.7) p<0.01) greater odds of poor self-rated health (Table 7.5).

7.8.2 SMI Diagnostic Categories and Chronic Physical Conditions

When the SMI diagnostic subgroups were considered as independent variables, the results were as follow:

- **Bipolar Disorder** was associated with statistically significant greater odds of reporting each of the specific chronic physical conditions, having at least one of the chronic conditions, and self-rated poor health.
  - Obesity (OR: 1.68, CI: 1.4-2.1, p<0.01) and hypercholesterolemia (OR: 1.75, CI: 1.4-2.3, p<0.01) were associated with almost two fold greater odds.
  - The odds associated with the remaining conditions were 2-5 times greater if an individual reported a history of bipolar disorder

- **Schizophrenia** was associated with statistically significant greater odds of reporting eight of the 12 chronic physical conditions, having at least one of the chronic conditions, and self-rated poor health.
Hypertension, heart disease, hypercholesterolemia, and obesity were not statistically significant.

The odds of having the remaining chronic physical conditions was associated with 2.5 fold greater odds.

The odds associated with having chronic physical conditions was four-fold (OR: 4.0, p<0.01)

The odds associated with having poor self-rated health was five-fold (OR: 5.27, p<0.01)

- Mania/psychosis was associated with statistically significant greater odds of having 10 of the chronic physical conditions, having at least one chronic physical condition, and poor self-rated health.
  - The odds of having heart disease and diabetes were not statistically significant.
  - Hypertension (OR: 1.91, CI: 1.3-2.8, p<0.01), hypercholesterolemia (OR: 1.92, p<0.01), diabetes (OR: 1.67, p<0.01), and obesity (OR: 1.82, CI: 1.3-2.6, p<0.01) were associated with almost twofold greater odds.
  - The remaining chronic physical conditions were associated with 2.4 greater odds.
  - The odds of having at least one chronic condition was four-fold (OR: 4.00, CI: 2.6-6.1, p<0.01).
The odds of having poor self-rated health was six-fold (OR: 6.44, CI: 4.5-9.3, p<0.01)

- Chronic depression/anxiety was associated with statistically significant greater odds of having each of the chronic physical conditions, having at least one chronic physical condition, and reporting poor self-rated health.
  - The odds of having hypertension (OR: 1.91, CI: 1.5-2.4, p<0.01) and obesity (OR: 1.87, CI: 1.5-2.3, p<0.01) were almost twofold.
  - The remaining chronic physical conditions were associated with 2-4 greater odds.
  - Having at least one chronic physical condition was associated with almost four times greater odds (OR: 3.86, CI: 3.1-4.8, p<0.01).
  - The odds of having poor self-rated health was seven-fold (OR: 7.11, CI: 5.8-8.7, p<0.01).

7.8.3 Comparison of Chronic Physical Disease Burden across SMI Categories

SMI and each of the four SMI categories were associated with greater odds of having a given chronic disease. Hypertension was approximately two times as probable in all groups and highest in individuals reporting a history of bipolar disorder (OR: 2.02, CI: 1.6-2.7, p<0.01). Heart disease was 2·3 times as likely in all groups, excluding schizophrenia which did
not achieve statistical significance (OR: 0.89, CI: 0.3-2.5, p=0.754); heart
disease was most probable in individuals reporting a history of bipolar
disorder. Stroke was 2-4 times as likely in all groups, with greater
probability in persons reporting history of chronic depression/anxiety (OR:
3.7, CI: 2.5-5.6, p<0.01). Peripheral vascular disease was associated with
3-4 greater odds, and highest if an individual reported a history of
mania/psychosis (OR: 4.23, CI: 2.8-6.3, p<0.01). The odds of having
diabetes was greater than twofold in all groups, excluding
mania/psychosis, which did not achieve statistical significance; the odds of
having diabetes was greatest in individuals reporting a history of
schizophrenia (OR: 2.4, CI: 1.1-3.5, p<0.01). COPD was more than three
times probable in all SMI categories; among individuals reporting a
history of schizophrenia the odds of having COPD was greatest (OR: 4.2,
CI: 2.8-6.2, p<0.01). Having kidney disease was 2-4 times more probable
across all SMI categories and highest if an individual reported a history of
bipolar disorder (OR: 5.55, CI: 3.4-8.7, p<0.01). Liver disease was 3-6
times more probable in all groups and highest in individuals reporting a
history of bipolar disorder (OR: 5.56, CI: 3.6-8.6, p<0.01). Hepatitis had a
2-4 times greater odds across all SMI categories and was highest in
individuals with a history of schizophrenia (OR: 4.17, CI: 2.5-6.9, p<0.01).
the odds of having obesity was almost twofold in all SMI categories
excluding individuals reporting a history of schizophrenia which did not
achieve statistical significance; the odds of having obesity was highest in individuals reporting a history of chronic depression and anxiety (OR: 1.87, CI: 1.5-2.3, p<0.01).
8 Medical Care Utilization: Analysis and Results

This chapter addresses the research question and hypotheses listed in Table 8.1.

<table>
<thead>
<tr>
<th>Research Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the association between medical service utilization and comorbid SMI and</td>
</tr>
<tr>
<td>chronic physical disease in the U.S.?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hypotheses</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₀: There is no difference in utilization of medical services between</td>
</tr>
<tr>
<td>persons with SMI and the general population among adults (18-64 years)</td>
</tr>
<tr>
<td>with chronic conditions in the U.S.</td>
</tr>
<tr>
<td>H₁: Utilization of medical services is higher in persons with SMI</td>
</tr>
<tr>
<td>among adults with chronic conditions (18-64 years) in the U.S.</td>
</tr>
</tbody>
</table>

Included in this chapter are the following:

- Overview
  - Description of medical care utilization as it is measured by NHIS
  - Description of variables (dependent, independent, covariates)
  - Univariate and bivariate analyses and results
  - Multivariate analyses and results

8.1. Overview

In this section, the methodologic approach to the research question noted in Table 8.1 will be presented. The statistical analyses to address the hypotheses will be discussed; all statistical analyses considered an alpha level of 0.05 or less as significant.
8.2. Medical Care Utilization in the NHIS

Medical care access and utilization are two of the major content areas of the NHIS. The NHIS 2007 included questions about frequency of utilization of outpatient physician office visits, emergency department (ED) visits, and hospitalization in the past year. The survey also included questions about perceived barriers to and motivations for seeking medical care.

Previous studies have demonstrated that individuals with serious mental illness (SMI) were less likely to receive primary and preventive care and more likely to utilize the ED when ill compared to the general population. These ED visits are more likely to result in hospital admissions when compared to the general population. Bradford and colleagues evaluated medical care access in individuals with SMI using the 1994 and 1995 NHIS datasets. The authors found that individuals with psychiatric disorders reported significantly lower likelihood of having access to primary care and greater likelihood of barriers to care such as delayed care due to cost and inability to obtain medication prescriptions when needed.

This study estimated differences in medical care utilization in working age adults (18-64 years) with comorbid chronic physical conditions and SMI versus individuals with chronic physical conditions and no history of SMI. Previous studies have shown that history of SMI is associated with
premature mortality and excessive use of high-quality medical care services such as ED visits and hospitalizations.\textsuperscript{30,65} To investigate the potential link between chronic disease burden and medical care utilization, the study addressed two persistent deficiencies in the published literature, 1) characterization of the problem and its magnitude at the national level and 2) evaluation of its economic consequences. This approach potentially provides a framework for contemporary health policy and economic evaluations focused on improving health of vulnerable population and reducing per capita healthcare costs.\textsuperscript{126}

The study sample for this analysis consisted of individuals 18-64 years old who reported a history of chronic disease (SMI: n = 503, non-SMI: n = 5,748).

8.3. Variables
To evaluate the relationship between medical care utilization and comorbid SMI and chronic physical disease burden, SMI was treated as an independent variable (Section 6.5.3). Covariates were included to control for individual characteristics that might influence medical care utilization. According to Andersen and Newman, individual characteristics include demographic, attitudinal-belief, and social-structural factors.\textsuperscript{127} The NHIS 2007 dataset included demographic characteristics and health behavior information. As noted in Chapter 6, preliminary backward stepwise regression analysis identified covariates
that had statistically significant associations with the utilization variables. As such, age, gender, race, insurance status and smoking status were included as covariates in all of the regression models described below.

8.3.1 Outcome Variables

The association between medical care utilization and comorbid SMI and chronic physical disease was estimated. The following outcome variables were created:

- **Delayed care (section 6.5.3.2)** was a binary variable that captured whether an individual had foregone seeking medical care due to personal financial constraints despite perceived need. It was coded “0” if an individual denied delaying care and was coded “1” if the respondent reported delaying care in the past 12 months.

- The original variable for **physician office visits** was coded as a categorical variable (section 6.5.3.3) in the NHIS dataset.
  - To evaluate utilization of any physician office visits, a dummy variable was created and coded “1” for having ≥1 physician office visits in the past 12 months and was coded “0” for having no physician office visits in the past 12 months.

- The original variable for **ED visits** was coded as a categorical variable (section 6.5.3.4).
To evaluate ED utilization, a dummy variable was created and coded “1” for having \( \geq 1 \) ED visits in the past 12 months and was coded “0” for having no ED visits in the past 12 months.

- The original variable for hospitalizations was a categorical variable (section 6.5.3.5) that captured whether an individual had been hospitalized during the past 12 months.

- To evaluate hospitalization, a dummy variable was created that was coded “1” for having \( \geq 1 \) hospitalization in and was coded “0” for having no hospitalizations in the past 12 months.

- As a follow-up to the original hospitalization question, a second question in the survey captured the *number of nights hospitalized* in the past 12 months. This variable took the form of a count variable with non-negative integer (range 0–365) responses.

- Having \( \geq 10 \) medical care encounters in the past 12 months was a categorical variable (section 6.5.3.6) derived from the sum of physician office visits, ED visits, and hospitalizations in the past year reported by each respondent. A dummy variable was created and was coded “1” if the sum of visits was \( \geq 10 \) and “0” if the sum of visits was <10.
8.3.2 Independent variables
Consistent with the analyses in Chapter 7, SMI was the independent variable. It was a dummy variable used to identify the sub-sample of individuals who reported history of being diagnosed with psychiatric disorders included in the NHIS 2007 mental health module.

8.3.3 Covariates
To control for individual characteristics that would be expected to influence medical care utilization, the following covariates were included in the multivariate analyses described below. Covariates included:

- Gender (female/male)
- Race/ethnicity (white/nonwhite)
- Age (18-64 years)
- Smoking status (current or previous vs. never)
- Insurance status (yes/no)

8.4 Bivariate Analyses & Results
This section consists of descriptions of the bivariate analyses conducted on medical care utilization variables. Differences in proportions between persons with SMI and those without a history of psychiatric disorders were tested with Chi-square tests for each of the outcomes variables listed above in Table 8.2. T-tests were conducted for the count outcome for hospitalizations. Results, including statistical significance, are reported below in Table 8.3
Table 8.2 Differences in medical care utilization for SMI vs. non-SMI among working age adults (18-64 years) with chronic physical conditions in the U.S.

<table>
<thead>
<tr>
<th>Medical Care Utilization Variables</th>
<th>SMI (n = 503)</th>
<th>Non-SMI (n = 5,748)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>%</td>
</tr>
<tr>
<td>Insurance Status b</td>
<td>421</td>
<td>83.7</td>
</tr>
<tr>
<td>Delayed Care</td>
<td>170</td>
<td>33.8</td>
</tr>
<tr>
<td>Physician Office Visits</td>
<td>464</td>
<td>92.3</td>
</tr>
<tr>
<td>ED Visits</td>
<td>150</td>
<td>29.8</td>
</tr>
<tr>
<td>Hospitalization</td>
<td>127</td>
<td>25.3</td>
</tr>
<tr>
<td>≥ 10 Medical Care Visits</td>
<td>250</td>
<td>49.7</td>
</tr>
</tbody>
</table>

Chronic Conditions a

| Diabetes                          | 104           | 20.7                 | 982           | 17.1                 |
| COPD                              | 119           | 23.7                 | 557           | 9.7                  |
| Hypertension                      | 286           | 56.9                 | 3,596         | 62.6                 |

* a. Statistically significant (p<0.05) unless otherwise noted.
* b. Statistically non-significant (p>0.05)
* c. Each sub-group was limited to individuals with chronic physical conditions.

Table 8.3 Differences in Hospital Nights for SMI vs. non-SMI among working age adults (18-64 years) with chronic physical conditions in the U.S.

<table>
<thead>
<tr>
<th>Hospital Nights</th>
<th>Range</th>
<th>Mean a</th>
<th>SD</th>
<th>Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMI (n=503)</td>
<td>0-120</td>
<td>3.14</td>
<td>6.7</td>
<td>2.17 – 4.10</td>
</tr>
<tr>
<td>Non-SMI (n=5,748)</td>
<td>0-235</td>
<td>1.02</td>
<td>10.9</td>
<td>.844 – 1.19</td>
</tr>
</tbody>
</table>

* a. Statistically significant (p<0.05).

8.5. Delayed Care

To evaluate the relationship between SMI and delayed care (defined in section 8.3.1), the following logistic regression model was estimated. The outcome was the binary variable for having delayed care, due to cost and despite perceived need, in the past 12 months.

\[
delayed \text{ care} = \alpha + \beta_1 SMI + \beta_2 \text{Age} + \beta_3 \text{Gender} + \beta_4 \text{Race} + \beta_5 \text{Smoking} + \beta_9 \text{Insurance} + \varepsilon
\]
Results of the logistic regression model are presented below in Table 8.4.

8.6. *Physician Office Visits*

This section describes the logistic regression analyses for physician office visits. To evaluate the relationship between SMI and physician office visits (section 8.3.1), the following logistic regression model was estimated. The outcome was the binary variable for having at least one physician office visit in the past 12 months.

\[
\text{physician office visit} \geq 1 = \alpha + \beta_1 SMI + \beta_2 \text{Age} + \beta_3 \text{Gender} + \beta_4 \text{Race} + \beta_5 \text{Smoking} + \beta_6 \text{Insurance} + \epsilon
\]

Results of the logistic regression model are presented below in Table 8.4.

8.7. *Emergency Department Visits*

This section describes the logistic regression analyses for emergency department (ED) visits. To evaluate the relationship between SMI and ED visits (section 8.3.1), the following logistic regression model was estimated. The outcome was the binary variable for having at least one ED visit in the past 12 months.

\[
ED \text{ visit} \geq 1 = \alpha + \beta_1 SMI + \beta_2 \text{Age} + \beta_3 \text{Gender} + \beta_4 \text{Race} + \beta_5 \text{Smoking} + \beta_6 \text{Insurance} + \epsilon
\]

Results of the logistic regression model are presented below in
Table 8.4.

8.8. SMI and Hospitalizations

This section describes the logistic regression analyses for hospitalizations. As noted above (section 8.3.1), two outcome variables were created to estimate 1) the relationship between SMI and hospitalization in the past 12 months and 2) the relationship between SMI and number of nights hospitalized in the past 12 months.

8.8.1 SMI and Hospitalization

To evaluate the relationship between SMI and hospitalization (section 8.3.1), the following logistic regression model was estimated. The outcome was the binary variable for having at least one hospitalization in the past 12 months.

\[
Hospitalization \geq 1 = \alpha + \beta_1 SMI + \beta_2 Age + \beta_3 Gender + \beta_4 Race + \beta_5 Smoking + \beta_6 Insurance
\]

Results of the logistic regression model are presented below in Table 8.4.

8.8.2 SMI and Hospital Nights

To evaluate the relationship between SMI and number of nights hospitalized (section 8.3.1), the following negative binomial regression model was estimated. The outcome was the discrete variable for the number of nights hospitalized in the past 12 months. Due to the
distribution of the variable (excess “0” responses), a negative binomial model was estimated.

\[
\text{Hospital Nights} = \alpha + \beta_1 \text{SMI} + \beta_2 \text{Age} + \beta_3 \text{Gender} \\
+ \beta_4 \text{Race} + \beta_5 \text{Smoking} + \beta_6 \text{Insurance} + \varepsilon
\]

Results for the negative binomial regression model are presented below in Table 8.5.

8.9. More than Ten Medical Encounters
This section describes the logistic regression analyses for ≥10 medical care encounters (including total physician office visits, ED visits, and hospitalizations) in the past 12 months (defined in section 8.3.1). To evaluate the relationship between SMI and ≥10 medical encounters, the following logistic regression model was estimated. The outcome was the binary variable for having ≥10 medical encounters in the past 12 months.

\[
\geq 10 \text{ Medical Care Visits} = \alpha + \beta_1 \text{SMI} + \beta_2 \text{Age} + \beta_3 \text{Gender} \\
+ \beta_4 \text{Race} + \beta_5 \text{Smoking} + \beta_6 \text{Insurance} + \varepsilon
\]

Results of the logistic regression model are presented below in Table 8.4.

8.10. Medical Care Utilization and Comorbid SMI and Chronic Physical Conditions
To evaluate the relationship between SMI and particular chronic physical condition associated with high ED and hospital utilization rates attributable to ambulatory care sensitive conditions (ACSC), the
previously described regression analyses were estimated in individuals who reported a history of diabetes, chronic lung disease, and hypertension. Results of the regression analyses are presented below in Table 8.6 thru Table 8.11.

Table 8.4 Logistic regression estimates of relationship between SMI and medical care utilization in working age adults (18-64 years) with chronic physical conditions in the U.S.

<table>
<thead>
<tr>
<th>Medical Care Utilization Variables</th>
<th>Adjusted OR\textsuperscript{a, b}</th>
<th>P</th>
<th>Hosmer-Lemeshow chi\textsuperscript{-2} (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delayed Care</td>
<td>2.75</td>
<td>&lt;0.001</td>
<td>0.027\textsuperscript{c}</td>
</tr>
<tr>
<td>Physician Office Visit</td>
<td>1.84</td>
<td>0.001</td>
<td>0.928</td>
</tr>
<tr>
<td>ED Visits</td>
<td>3.17</td>
<td>&lt;0.001</td>
<td>0.406</td>
</tr>
<tr>
<td>Hospitalization</td>
<td>2.20</td>
<td>&lt;0.001</td>
<td>0.063</td>
</tr>
<tr>
<td>(\geq 10) Medical Care Visits</td>
<td>4.00</td>
<td>&lt;0.001</td>
<td>0.442</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Dependent variables. Logistic regression model adjusted for age, gender, race/ethnicity, having chronic physical conditions, smoking and insurance status.

\textsuperscript{b} Independent variable was SMI.

\textsuperscript{c} Hosmer-Lemeshow goodness-of-fit p-value <0.05 indicates model doesn’t fit data well.

Table 8.5 Negative binomial regression estimate of relationship between SMI and time in hospital in the past year for working age adults (18-64 years) with chronic physical conditions in the U.S.

<table>
<thead>
<tr>
<th>Medical Care Utilization Variable</th>
<th>Incidence Rate Ratio\textsuperscript{a}</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital Nights</td>
<td>3.10</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Adjusted for age, gender, race/ethnicity, smoking and insurance status.
Table 8.6 Logistic regression estimates of relationship between SMI and medical care utilization in working age adults (18-64 years) with diabetes in the U.S.

<table>
<thead>
<tr>
<th>Medical Care Utilization Variables</th>
<th>Adjusted OR&lt;sup&gt;a&lt;/sup&gt;</th>
<th>P</th>
<th>Hosmer-Lemeshow chi-2 (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delayed Care</td>
<td>2.22</td>
<td>0.001</td>
<td>0.200</td>
</tr>
<tr>
<td>Physician Office Visits</td>
<td>1.27</td>
<td>0.606</td>
<td>0.048&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>ED Visits</td>
<td>2.62</td>
<td>&lt;0.001</td>
<td>0.858</td>
</tr>
<tr>
<td>Hospitalization</td>
<td>1.57</td>
<td>0.070</td>
<td>0.612</td>
</tr>
<tr>
<td>≥ 10 Medical Care Visits</td>
<td>4.19</td>
<td>&lt;0.001</td>
<td>0.912</td>
</tr>
</tbody>
</table>

<sup>a</sup> Adjusted for age, gender, race/ethnicity, smoking and insurance status.

<sup>b</sup> Hosmer-Lemeshow goodness-of-fit p-value < 0.05 indicates model doesn’t fit data well.

Table 8.7 Negative binomial regression estimate of relationship between SMI and time in hospital in working age adults (18-64 years) with diabetes in the U.S.

<table>
<thead>
<tr>
<th>Medical Care Utilization Variable</th>
<th>Incidence Rate Ratio&lt;sup&gt;a&lt;/sup&gt;</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital Nights</td>
<td>2.45</td>
<td>0.047</td>
</tr>
</tbody>
</table>
Table 8.8 Logistic regression estimates of relationship between SMI and medical care utilization in working age adults (18-64 years) with **COPD** in the U.S.

<table>
<thead>
<tr>
<th>Medical Care Utilization Variables</th>
<th>Adjusted OR(^a)</th>
<th>(P)</th>
<th>Hosmer-Lemeshow chi-2 (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delayed Care</td>
<td>1.77</td>
<td>0.014</td>
<td>0.626</td>
</tr>
<tr>
<td>Physician Office Visit</td>
<td>1.22</td>
<td>0.596(^b)</td>
<td>0.431</td>
</tr>
<tr>
<td>ED Visits</td>
<td>2.04</td>
<td>0.01</td>
<td>0.673</td>
</tr>
<tr>
<td>Hospitalization</td>
<td>1.79</td>
<td>0.02</td>
<td>0.590</td>
</tr>
<tr>
<td>≥ 10 Medical Care Visits</td>
<td>3.71</td>
<td>0.00</td>
<td>0.67</td>
</tr>
</tbody>
</table>

\(^a\) Adjusted for age, gender, race/ethnicity, smoking and insurance status.

\(^b\) Not statistically significant (p>0.05)

Table 8.9 Negative binomial regression estimate of relationship between SMI and time in hospital in working age adults (18-64 years) with **COPD** in the U.S.

<table>
<thead>
<tr>
<th>Medical Care Utilization Variable</th>
<th>Incidence Rate Ratio</th>
<th>(P) (^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital Nights (^a)</td>
<td>1.85</td>
<td>0.141</td>
</tr>
</tbody>
</table>

\(^a\) Not statistically significant (p>0.05)

Table 8.10 Logistic regression estimates of relationship between SMI and medical care utilization in working age adults (18-64 years) with **hypertension** in the U.S.

<table>
<thead>
<tr>
<th>Medical Care Utilization Variables (^a)</th>
<th>Adjusted OR(^a)</th>
<th>(P)</th>
<th>Hosmer-Lemeshow chi-2 (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delayed Care</td>
<td>2.87</td>
<td>0.000</td>
<td>0.064</td>
</tr>
<tr>
<td>Physician Office Visit</td>
<td>1.88</td>
<td>0.014</td>
<td>0.346</td>
</tr>
<tr>
<td>ED Visits</td>
<td>2.78</td>
<td>0.000</td>
<td>0.652</td>
</tr>
<tr>
<td>Hospitalization</td>
<td>1.95</td>
<td>0.000</td>
<td>0.795</td>
</tr>
<tr>
<td>≥ 10 Medical Care Visits</td>
<td>4.49</td>
<td>0.000</td>
<td>0.688</td>
</tr>
</tbody>
</table>

\(^a\) Adjusted for age, gender, race/ethnicity, smoking and insurance status.
Table 8.11 Negative binomial regression estimate of relationship between SMI and hospital LOS in working age adults (18-64 years) with hypertension in the U.S.

<table>
<thead>
<tr>
<th>Medical Care Utilization Variable</th>
<th>Incidence Rate Ratio&lt;sup&gt;a&lt;/sup&gt;</th>
<th>P&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital Nights</td>
<td>2.67</td>
<td>0.001</td>
</tr>
</tbody>
</table>

8.11. **Summary of Results: Medical Care Utilization**

Univariate and bivariate analyses were conducted on each of the medical care utilization variables (section 8.3). The analyses were limited to individuals who reported having been diagnosed with one of the 12 chronic physical conditions analyzed in Chapter 7. Logistic regression (categorical outcome variables) and negative binomial regression (continuous outcome variable with excessive “0” responses) analyses were conducted to evaluate the relationship between SMI and different forms of medical care utilization in working age adults (18-64 years) in the U.S. The analyses were conducted on the NHIS 2007 dataset.

8.11.1 Delayed Care

Univariate analysis (Table 8.2) showed that 33.8% of the SMI group versus 16.4% of the non-SMI group reported having delayed medical care due to cost, despite perceived need, in the past 12 months. In bivariate analyses (Table 8.2), the chi-square test was statistically significant (p<0.001) indicating that persons with SMI were more likely to delay care. Logistic regression analysis (}
Table 8.4) was conducted on the binary outcome variable “delayed care” with SMI as the independent variable, while controlling for the covariates listed above (section 8.6). The adjusted odds ratio (OR) was statistically significant and indicated that during the year prior to the survey, individuals with SMI had 2.75 (CI: 2.22-3.41, p<0.001) greater odds of delaying care due to personal financial constraints, despite perceived need, when compared with the reference sample of individuals with chronic physical conditions but no history of SMI.

8.11.2 Physician Office Visits
For physician office visit ≥ 1 (Table 8.2), 92.3% of the SMI group versus 86.9% of the non-SMI group had at least one physician office visit during the past 12 months. The difference was statistically significant (p<0.001) indicating that persons with SMI were more likely to have at least one physician office visit. Logistic regression analysis (Table 8.4) estimated the adjusted odds ratio (OR) and indicated that during the year prior to the survey, individuals with SMI had 1.84 (CI: 1.30-2.61, p<0.001) greater odds of having at least one physician office visit when compared with individuals with no history of SMI. The logistic regression model was tested for goodness-of-fit using the Hosmer-Lemeshow test (section 6.6.2). The Hosmer-Lemeshow test indicated the model was a good fit to the data (chi-square: 8.12, p-value = 0.93).
8.11.3 Emergency Department Visits
For emergency department (ED) visits (Table 8.2), univariate analysis showed that 29.8% of the SMI group versus 10.4% of the non-SMI group had at least one ED visit during the past 12 months. The difference was statistically significant (p<0.001) indicating that persons with SMI were more likely to have at least one ED visit during the past 12 months. Logistic regression analysis (Table 8.4) estimated the adjusted odds ratio (OR) and indicated that during the year prior to the survey, individuals with SMI had 3.17 (CI: 2.56-3.94, p<0.001) greater odds of having at least one physician office visit when compared with individuals with no history of SMI. The logistic regression model was tested for goodness-of-fit using the Hosmer-Lemeshow test (section 6.6.2). The Hosmer-Lemeshow test indicated the model was a good fit to the data (chi-square: 11.78, p-value = 0.41).

8.11.4 Hospitalizations
For hospitalization ≥ 1, univariate analysis showed that 25.3% of the SMI group versus 12.6% of the non-SMI group had at least one hospitalization during the past 12 months. The difference was statistically significant (p<0.001) indicating that persons with SMI were more likely to have at least one hospitalization during the past 12 months. Logistic regression analysis (Table 8.4) estimated the adjusted odds ratio (OR) and indicated that during the year prior to the survey, individuals with SMI had 2.20 (CI: 1.76-2.74, p<0.001) greater odds of having at least one hospitalization
when compared with individuals with no history of SMI. The logistic regression model was tested for goodness-of-fit using the Hosmer-Lemeshow test (section 6.6.2). The Hosmer-Lemeshow test indicated the model was a good fit to the data (chi-square: 14.8, p-value = 0.06). For the second outcome, number of nights hospitalized, on average, individuals with SMI reported 3.14 nights in the year prior to the survey, compared to the non-SMI group that reported 1.02 days. Due to the zero-inflated distribution of the variable, a negative binomial regression model was estimated to evaluate the relationship between SMI and number of nights hospitalized during the previous year. The incidence rate ratio (IRR) indicated that during the year prior to the survey, individuals with SMI had 3.10 (CI: 2.00-4.81, p<0.001) greater nights in the hospital compared to non-SMI individuals.

8.11.5 ≥ 10 Medical Care Visits

Univariate analysis (Table 8.2) showed that 49.7% of the SMI group versus 19.6% of the non-SMI group reported having ≥ 10 medical care visits in the past 12 months. The difference was statistically significant (p<0.001) indicating that persons with SMI were more likely to have ≥ 10 medical care visits in the past 12 months. Logistic regression analysis (Table 8.4) estimated the adjusted odds ratio (OR) and indicated that during the year prior to the survey, individuals with SMI had 4.00 (CI: 3.30-4.85, p<0.001) greater odds of having have ≥ 10 medical care visits
when compared with individuals with no history of SMI. The logistic regression model was tested for goodness-of-fit using the Hosmer-Lemeshow test (section 6.6.2). The Hosmer-Lemeshow test indicated the model was a good fit to the data (chi-square: 7.91, p-value = 0.442).

8.11.6 SMI and Comorbid Chronic Physical Conditions

Logistic regression models were estimated for all the medical care utilization variables with SMI as the independent variable in disease groups that correspond with high ambulatory care sensitive conditions (diabetes, COPD, and hypertension) that result in ED visits and hospitalizations. The purpose of these analyses was to identify specific chronic physical conditions, which, when comorbid with SMI contribute to higher utilization rates.

In individuals with diabetes, SMI was associated with greater likelihood to delay care (OR: 2.22, CI: 1.37-3.60, p<0.001), to have at least one ED visit (OR: 2.62, CI: 1.72-3.98, p<0.001), and to have ≥10 medical care visits in the past year (OR: 4.19, CI: 2.71-6.48, p<0.001); it was not associated with greater probability of hospitalization (OR: 1.57, CI:.963-2.54, p=0.070).

In individuals with COPD, SMI was associated with greater likelihood to
delay care (OR: 1.77, CI: 1.12-2.81, p=0.014), to have at least one ED visit (OR: 2.04, CI: 1.35-3.07, p=0.01), to have been hospitalized (OR: 1.79, CI: 1.11-2.90, p=0.02), and to have ≥10 medical care visits in the past year (OR: 3.71, CI: 2.71-6.48, p<0.001); there was no association between comorbid SMI and COPD and the number of nights hospitalized in the past year (OR: 1.84, CI: .817-4.17, p=0.141).

In individuals with hypertension, SMI was associated with greater likelihood to delay care (OR: 2.87, CI: 2.17-3.79, p<0.001), to have at least one physician office visit (OR: 1.88, CI: 1.14-3.11, p=0.014), to have at least one ED visit (OR: 2.78, CI: 2.08-3.71, p<0.001), to have been hospitalized (OR: 1.95, CI: 1.46-2.61, p<0.001), and to have ≥10 medical care visits in the past year (OR: 4.49, CI: 3.48-5.78, p<0.001); comorbid HTN and SMI was associated with 2.67 (p=0.001) times greater nights in the hospital compared to individuals with COPD but no history of SMI.
9 Economic Assessment

This chapter addresses the research question noted in Table 9.1.

<table>
<thead>
<tr>
<th>Research Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Among working age adults (18-64 years) in the U.S., what are the costs differences associated with medical care utilization in individuals with comorbid SMI and chronic physical conditions versus individuals with chronic physical conditions but no history of SMI?</td>
</tr>
</tbody>
</table>

Included in this chapter are the following:

- Cost Analysis Overview
- Cost Model Framework
- Cost Estimation Initiation and Research
- Cost Estimation Assessment
- Cost Model Analysis
- Sensitivity and Scenario Analyses

9.1. Cost Analysis Overview

In this section, the methodologic approach to the research question in Table 9.1 will be presented. A cost model was constructed to address the research question. Results of the cost analyses are presented below.

Sensitivity and scenario analyses evaluating the impact of altering key model assumptions and model inputs are presented after the cost model.

9.2. Cost Model Framework

According to the United States Government Accountability Office (GAO), cost analysis has three distinct functions:119

- Development, analysis, and documentation of cost estimates with analytical procedures
- Analysis, interpretation, and estimation of incremental and total resources required to support past, present, and future programs
- Evaluation of resource requirements for strategic decision-making

The GAO estimation process for conducting a high-quality cost analysis is presented below in Figure 9.1. It includes four stages: 1) initiation and research, 2) assessment, 3) analysis, and 4) presentation. Within each stage are specific tasks or steps that must be undertaken in order to move to the next stage. The process is intended for development and presentation of cost estimates for government funded initiatives. This process has been moderately adapted for this study; the first three stages are presented here.

![Figure 9.1 GAO cost estimation process](image)

**9.3. Cost Estimation Initiation and Research**

The first stage of the GAO cost estimation process is “initiation and research.” In this stage, the purpose of the estimation and the plan for its undertaking are completed. Results presented in previous chapters of this
study (Chapters 7 and 8) provided empirical evidence to support the
development of the model. The results were consistent with findings
reported in the recent literature and indicated that working age adults
with SMI were more likely to have a significant chronic disease burden,
poor self-rated health, were more likely to delay care and more likely to
utilize medical care services including physician office visits, emergency
department (ED) visits, and hospitalizations compared to individuals with
no history of SMI. Prescription drug utilization data was not included in
the National Health Interview Survey (NHIS).\textsuperscript{103}

\subsection{9.3.1 Medical Care Utilization Cost Estimation Purpose}
While there have been numerous reports of higher medical care utilization
and related expenditures among individuals with SMI, a considerable
limitation of the published literature is that most studies focused on one
SMI diagnostic group, such as schizophrenia patients, or, the studies
focused on differences in utilization costs attributable to a specific chronic
condition between individuals with SMI and individuals with no history of
psychiatric disorder. For example, Bhattacharya, et al., evaluated the
relationship between depression and hospitalization for ambulatory care
sensitive conditions (ACSCs); the authors found that patients with
depression had higher rates of hospitalization for ACSCs and concluded
that quality measures may need to include depression as a risk
adjustment variable.\textsuperscript{67} Cahoon and colleagues investigated the issue of
hospitalization for ACSCs in a sample of schizophrenia patients and found
that such patients had greater odds of hospitalization for ACSCs characterized by periodic exacerbations, such as COPD or diabetes complications when compared to the general population.32

According to Hansen, non-adherence to antipsychotic medications was associated with higher ED and hospital utilization due to cardiometabolic conditions in a sample of schizophrenia patients.128 Hospitalization for ACSC, longer length of stay (LOS), and higher hospitalization costs were associated with mental illness in Li’s 2008 study.54 In a study of the cost consequences of obesity and physical illness in a national sample of Medicare beneficiaries, Shen found that average total expenditures for obese adults with comorbid physical and mental illness were $9897 compared to average total expenditures of $6,584 among obese adults with only physical illness.55 Patients with mental illness had higher pharmacy expenditures than those without mental illness, $3,343 and $1,756, respectively.55 The higher average total expenditures were attributed to higher adjusted utilization rates of ED outpatient care and pharmaceuticals.55

All of these examples from the published literature estimated the impact of SMI on medical care utilization costs. However, to date, there have been no reports of annual per capita medical care utilization costs for working age adults with SMI in the U.S. The purpose of the cost analysis presented in this study was to estimate the direct cost to the U.S.
healthcare system of medical care utilization by working age adults with SMI versus working age adults with no history of SMI. This cost analysis also calculated the average cost differential attributable to SMI among working age adults.

9.3.2 Medical Care Utilization Cost Model Estimation Approach

The cost model was derived from empirical evidence of medical care utilization in working age adults in the U.S. (Chapter 8). It was designed to generate the per capita costs of medical care utilization by age, among persons with self-reported chronic physical conditions, for the two groups--- SMI and non-SMI in the U.S. The per capita costs of medical care utilization by age were generated by first estimating the mean utilization rates (average number of encounters per year) by age for SMI and non-SMI for three types of medical care encounters --- physician office visits, emergency department (ED) visits, and hospitalizations. These estimates were limited to individuals who self-reported a history of chronic physical conditions. Next the mean utilization rates were multiplied by average cost per encounter estimates for each type of encounter by age for SMI and non-SMI. Prescription drugs were included in the cost model but were estimated differently due to absence of data in the original dataset. The approach is described below with model assumptions.
9.4. Cost Estimation Model Assessment

The second stage of cost estimation, according to the GAO framework, is assessment. This stage consists of the following processes:

- Definition of cost estimation model
- Data acquisition
- Determination of estimating structure
- Identification of assumptions
- Development of model estimates for comparison to existing estimates

Each of these processes is described below.

9.4.1 Cost Estimation Model Definition

As noted above, this cost estimation model was constructed to estimate the magnitude of difference in per capita medical care utilization costs for working age adults with SMI versus working age adults with no history of SMI in the U.S. The intensity of medical care utilization in the past year were calculated from self-reported frequencies for physician office visits, ED visits, and hospitalizations. Cost differences were generated for each type of encounter and for total annual per capita cost estimates for SMI and non-SMI groups by age. The model adopted generic payer and local health system perspectives with a one-year time horizon.

9.4.2 Cost Estimation Model Data

Data was extracted from two sources. First, medical care utilization data were obtained from the NHIS 2007 dataset used for the analyses in Chapters 7 and 8. Second, Cost estimates were obtained from the Agency for Healthcare Research and Quality (AHRQ) Medical Expenditure Panel
Survey (MEPS) internet-based query tool.\textsuperscript{113–116} The MEPS 2008 summary data included annual mean per encounter estimates for physician office visits, ED visits, and hospitalizations and annual mean per capita prescription drug cost estimates by age for the U.S. population.

9.4.3 Cost Estimation Structure
The cost model constructed for this study was designed according to the GAO guidelines. The main components of the cost model included:

- Base Case Utilization Estimates
- Base Case Unit Costs
- Cost Model Outputs

The base case provides a structure of the primary components of the model, their relationships to one another, and estimated values against which outcomes can be tested.\textsuperscript{129} It is the fundamental framework for testing uncertainty and development of estimates.\textsuperscript{130} For this study, the base case included the weighted population medical care utilization frequencies for physician office visits, emergency department (ED) visits, and hospitalizations for the U.S. working age (18-64 years) adult population that self-reported a history of chronic physical conditions.

Annual prescription drug cost estimates were included in the model. One of the main model assumptions was that prescription drugs were utilized only by individuals who had physician office visits. The prescription drug model input was an estimate of the proportion of the population that would be expected to have annual prescription drug costs.

The population was split into the following four study groups:
- Persons with SMI, age 18-44 years
- Persons with SMI, age 45-64 years
- Persons without SMI, age 18-44 years
- Persons without SMI, age 45-64 years

These four groups were created to be able to compare cost differences between SMI and non-SMI. The age cut-offs for the two groups corresponded with the cost data described below. The cost data was reported by age for adults 18-44 years and 45-64 years.

Base case unit costs consisted of national per capita cost estimates for the four types of medical care utilization included in the base case. Cost model outputs are the results to be generated by analysis of the base case. The outputs generated by the cost model presented here included:

- Mean costs per capita per medical utilization variable for SMI and non-SMI by age
- Total costs per capita per medical utilization variable for SMI and non-SMI by age
- Per capita cost differences and potential cost savings for SMI and non-SMI by age

9.4.4 Cost Model Assumptions

When constructing a cost model, initial assumptions determine the insights and conclusions that can be obtained from it. Due to limitations in data availability, it is often necessary to bound model construction with assumptions that facilitate cost estimation. Assumptions are defined as a set of judgments about past, present, and future conditions postulated to be true in the absence of confirmatory proof. Medical care utilization data for the cost model was derived from a national survey—the NHIS (Chapter 5) in which respondents reported their health status and health
care utilization over the past year. The following assumptions were applied to the cost model:

1. Self-reported medical care utilization in the NHIS was accurate
2. Unit costs for medical care utilization encounters (e.g. physician office visit, ED visits and hospitalizations) were the same for SMI and non-SMI
3. Annual prescription drug utilization was equal to the proportion of the population that reported having physician office visits in the past year

The assumptions were subjected to sensitivity analyses for which results are presented below in Section 9.6.

9.4.5 Calculation of Point Estimate for Comparison to National Average

According to the GAO cost estimation guidelines, an initial model estimate should be calculated and compared to existing estimates. This enables validation of the best approximation of the final output (cost estimate), given the available data. Calculation of the initial model estimate consists of the following steps:

- Estimation of each component of the model
- Establishment of model assumptions
- Calculation of costs in constant-dollar years, i.e., determine the common reference year for which all monetary values will be adjusted to facilitate comparison
- Summation of the estimated model components to generate the model estimate

The study sample utilization proportions were the initial point estimates.

For each of the types of medical utilization services, the proportion of the sample that reported any utilization in the past 12 months was
calculated. The point estimates were compared to independent estimates. The utilization proportions by age for the four study groups derived from the NHIS 2007 were the point estimates. The utilization proportions by age for the 2007 U.S. population reported in the MEPS cost data summary was the independent estimate. The point estimate and independent estimate results are presented in Table 9.2.

10 Prescription drugs were excluded because such data was not included in the 2007 NHIS dataset.
Table 9.2 National utilization proportions by age for the U.S. population (2007) and derived utilization proportions by age for SMI and non-SMI by age (NHIS 2007)

<table>
<thead>
<tr>
<th>Type of medical care resource</th>
<th>National Average Utilization (Population in thousands)(^a)</th>
<th>NHIS Study Sample by Age for non-SMI and SMI(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>U.S. Adults(^{18-44})</td>
<td>U.S. Adults(^{45-64})</td>
</tr>
<tr>
<td>Physician office visits</td>
<td>61.5</td>
<td>78.0</td>
</tr>
<tr>
<td>ED visits</td>
<td>11.4</td>
<td>11.6</td>
</tr>
<tr>
<td>Hospitalizations</td>
<td>6.2</td>
<td>6.8</td>
</tr>
</tbody>
</table>

\(^a\) Obtained from MEPS 2008 data.\(^{113-115}\)

\(^b\) Derived from NHIS 2007 dataset.
Table 9.2 presents comparison of the proportions of the NHIS study sample who reported utilization of a given medical service in the past year against existing national average medical care resource utilization, by age, in the U.S. Comparison of the non-SMI groups in the NHIS 2007 study sample to the national average were fairly similar; differences ranged from 0.2% to 6.2%. Similarities between the initial model estimates of medical care utilization in the non-SMI sub-groups and the national average of medical care utilization for the general U.S. population supported development of a full cost model. Validation of the non-SMI sub-groups against the general U.S. population estimates provided confidence that the cost model would be able to yield reliable estimates of differences in utilization rates and annual per capita costs between SMI and non-SMI, by age.

In individuals 18-44 years old, 61.5% of the U.S. population versus 66.2% of the NHIS study sample reported having physician office visits in the past year. Among individuals 45-64 years old, 78% of the U.S. population versus 72.6% of the NHIS study sample reported having physician office visits in the past year. There was a 6.2% difference in self-reported ED utilization between the U.S. population and the NHIS 2007 study sample. This was likely due to attributable to sampling techniques employed by the NHIS. Hospitalization rates were similar for both age groups in the general population and the study sample with <1% differences.
9.5. Cost Model Analysis

The third stage of cost estimation, according to the GAO framework, is analysis. This stage consists of the following:

- Calculation of base case utilization rates
- Calculation of base case per capita costs for each type of medical care resource utilization for SMI and non-SMI by age
- Sensitivity analysis
- Documentation of the estimate

9.5.1 Base Case Utilization Rate Calculations

The weighted average medical care utilization rates for physician office visits, ED visits, and hospitalizations were calculated for SMI and non-SMI, by age. Table 9.3 displays the average medical encounters experienced by each group in the past year.

Table 9.3 Average medical care utilization rates for SMI and non-SMI with self-reported chronic physical conditions, by age.

<table>
<thead>
<tr>
<th>Type of Medical Care Encounter</th>
<th>Utilization Rates by Agea</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SMI_{18-44}</td>
</tr>
<tr>
<td>Physician office visits</td>
<td>8.51</td>
</tr>
<tr>
<td>ED visits</td>
<td>1.77</td>
</tr>
<tr>
<td>Hospitalizations</td>
<td>0.42</td>
</tr>
</tbody>
</table>

a. Estimates were derived from (total average utilization) x (weighted population)

b. Prescription drug utilization estimate excluded because relevant data was not included in NHIS dataset.

Table 9.3 shows that overall, SMI had considerably higher utilization rates for each types of medical care when compared to non-SMI by age. On average, older SMI (45-64 years old) had the highest mean utilization rates for physician office visits (9.24 per year) and hospitalizations (0.68
per year) compared to the other groups. The younger SMI group (18-44 years) had the highest mean ED visit rate (1.77 per year) compared to the other groups. Generally POVs and hospitalizations increased with age and ED visits decreased with age.

9.5.2 Base Case Per Capita Cost Calculations

To generate base case per capita calculations, annual national costs per type of medical care encounter was obtained for physician office visits, ED visits, and hospitalizations from the MEPS data summary. Table 9.4 displays national mean unit costs per medical care utilization variable, by age, derived from the MEPS data summary.

<table>
<thead>
<tr>
<th>Medical Care Resource</th>
<th>General Population 18-44$</th>
<th>General Population 45-64$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physician Office Visit</td>
<td>$329</td>
<td>$593</td>
</tr>
<tr>
<td>ED Visit</td>
<td>$1,155</td>
<td>$1,681</td>
</tr>
<tr>
<td>Hospitalization</td>
<td>$10,570</td>
<td>$18,928</td>
</tr>
<tr>
<td>Annual Prescription Drug Costs $^b</td>
<td>$742</td>
<td>$1,760</td>
</tr>
</tbody>
</table>

$^a$. Obtained from MEPS 2008 per person (by age) national mean cost estimates, in U.S. dollars.
$^b$. Annual mean per capita prescription drug expenditures

Consistent with previous reports for the general population, annual healthcare costs increase with age for all medical care services. As noted above (Section 9.4.4), one of the main assumptions applied to this cost analysis was that unit costs would be the same for SMI and non-SMI persons. Most recent studies have suggested that SMI is associated with higher medical care utilization and thus, higher expenditures due...
to higher costs incurred during a given encounter and higher frequencies of encounters.\textsuperscript{27,55,123}

The base case unit costs for each medical care utilization variable were estimated for SMI and non-SMI persons, by age (section 9.3.2), according to the age distribution of the NHIS 2007 dataset. The age cutoffs were selected to match the age cutoffs used in the MEPS cost data.\textsuperscript{113} Costs were adjusted to 2014 US dollars using the Consumer Price Index inflation calculator.\textsuperscript{133}

First, for each of the SMI and non-SMI age groups, the average utilization rate for a given type of medical care service was multiplied by annual cost estimates.\textsuperscript{11} The formula for annual medical care service utilization cost calculation was:

\[
\text{Annual medical care service utilization cost} = (\text{Average utilization rate per group}) \times (\text{National annual cost per encounter})
\]

Next, annual mean per capita prescription drug costs were obtained from the MEPS data summary for each age group.\textsuperscript{116} For each of the SMI and non-SMI groups, the proportion of the study sample that had physician office visits was multiplied by the national annual per capita costs for prescription drugs. The formula for annual per capita prescription drug costs was:

\[
\text{Annual per capita prescription drug costs} = (\text{Proportion of study sample with physician office visits}) \times (\text{National annual per capita cost for prescription drugs})
\]

\textsuperscript{11} Annual cost estimates for physician office visits, ED visits, and hospitalizations were calculated on a per encounter basis.
Summing the estimated mean cost per capita for all medical care utilization variables and prescription drug cost estimates generated the total annual per capita costs for SMI and non-SMI by age (Table 9.5).

Table 9.5 Estimated per capita medical utilization costs (adjusted to 2014 US$) for working age SMI and non-SMI adults in the U.S.

<table>
<thead>
<tr>
<th>Medical Care Resources</th>
<th>Estimated per capita cost, SMI &amp; non-SMI (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SMI_{18-44}</td>
</tr>
<tr>
<td>Physician office visits</td>
<td>3,050</td>
</tr>
<tr>
<td>ED visits</td>
<td>2,225</td>
</tr>
<tr>
<td>Hospitalizations</td>
<td>4,795</td>
</tr>
<tr>
<td>Prescriptions</td>
<td>707</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$10,777</strong></td>
</tr>
</tbody>
</table>

For each type of service, individuals with SMI had higher rates of medical care utilization and consequently, higher estimated per capita costs when compared to non-SMI individuals, in both age groups. Total estimated annual costs were more than twice as high in individuals with SMI compared to non-SMI individuals. Table 9.6 reflects the differences in costs between SMI and non-SMI populations by age.
Table 9.6 Medical Care Utilization Cost Differences between SMI and non-SMI (adjusted to 2014 US$)

<table>
<thead>
<tr>
<th>Medical Care Resources</th>
<th>Estimated Annual Cost Difference between SMI vs. non-SMI by Age (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Age 18-44</td>
</tr>
<tr>
<td>Physician office visits</td>
<td>1,276</td>
</tr>
<tr>
<td>ED visits</td>
<td>1,422</td>
</tr>
<tr>
<td>Hospitalizations</td>
<td>2,639</td>
</tr>
<tr>
<td>Prescriptions</td>
<td>28</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$5,365</strong></td>
</tr>
<tr>
<td><strong>Percentage Difference</strong></td>
<td>199%</td>
</tr>
</tbody>
</table>

Among individuals 18-44 years old, those with comorbid SMI and chronic physical conditions incurred annual medical care costs that were >$5,000 more than individuals with chronic physical conditions but no history of SMI.

This cost difference more than doubled among individuals 45-64 years old for whom estimated annual medical care costs were >$11,000.
Figure 9.2 presents a distribution of annual medical care costs for SMI and non-SMI by age and the relative difference for the two age groups. In the younger age group, annual per capita medical care costs were 50.2% higher in individuals with SMI compared to non-SMI; in the older age group (45-64 years), annual per capita costs were 53.7% higher in individuals with SMI compared to non-SMI.

9.6. Sensitivity and Scenario Analyses
To evaluate the impact of changing model inputs on cost results, sensitivity analyses were conducted. Specifically, the sensitivity analyses tested base case model assumptions that were used to specify some of the model inputs for which there was uncertainty associated with the data.
Two sets of analyses were completed:

- Variation of the annual per capita prescription drug costs for both SMI groups
- Variation of the annual per capita physician office visit costs for SMI and non-SMI groups

In addition to the sensitivity analyses, scenario or “what if” analyses were conducted to estimate potential cost savings associated with reducing utilization of higher cost medical care resources among individuals with SMI. Two sets of analyses were completed:

- Incremental reduction in annual per capita ED utilization rates
- Incremental reduction in annual per capita hospitalization rates

9.6.1 Sensitivity Analysis – 1
The first sensitivity analysis tested the base case assumption that annual prescription drug costs were the same in SMI and non-SMI populations. In the base case, prescription drug model inputs were derived from national annual unit cost estimates for the general U.S. population by age (Table 9.4). This was a conservative estimate because several reports in the literature indicate that persons with comorbid SMI and chronic physical conditions have significantly greater demand for and utilization of prescription drugs.\(^{55,70,123}\) Hansen and colleagues estimated that among schizophrenia patients and comorbid diabetes, hypertension, and/or hyperlipidemia, annual prescription drug costs ranged from US$ 4,000 – 11,000 depending on adherence to anti-psychotic and cardiometabolic medications.\(^{70}\) Desai reported that among schizophrenia patients, annual prescription costs were US$1,916 for the “low cost” group and US$6,339
for the “high-cost” group. Due to these findings, the base case prescription drug unit costs were subjected to sensitivity analyses.

First, the annual prescription drug cost estimates for both SMI age groups were increased to reflect the aforementioned findings reported in the published literature. To generate new estimates of annual prescription drug costs for the SMI groups by age, the following process was undertaken:

- The estimate for the low-cost group in Desai’s study (US$1,916) was applied to the SMI18-44 group.
- For the SMI 45-64 group, the US$1,916 value was multiplied by a factor of 2.37 to reflect the difference between annual prescription drug costs by age in the general population; the final estimate was US$ 4,541.

All other variables were held constant. The aim of this sensitivity analysis was to determine the effect that incremental percentage changes in the annual prescription drug costs for the SMI groups would have on annual prescription drug costs and annual medical care utilization costs.

The prescription drug costs for the SMI groups were subjected to incremental percentage increases while holding all other variables constant in the model. The costs were increased by increments of 25% to 200%. The impact of incremental percentage increases in prescription

---

12 The sample was divided into low-cost (≤$16,000) and high-cost (≥$16,000) subgroups based on the distribution of their mean annual healthcare costs. The authors used MEPS panel data which includes detailed insurance claims data. Costs were expressed in 2008 US dollars ($).
drug costs for the SMI groups was considered against per capita prescription drug costs (Figure 9.3) and per capita medical care utilization costs (Figure 9.4). Similarly, in the older age group (45-64 years old), the cost differential between individuals with comorbid SMI and chronic physical conditions compared to non-SMI individuals with chronic physical conditions would increase from $11,237 to $21,333.

Similarly, in the older age group (45-64 years old), the cost differential between individuals with comorbid SMI and chronic physical conditions compared to non-SMI individuals with chronic physical conditions would increase from $11,237 to $21,133.

Figure 9.4 Sensitivity Analysis: Incremental Increases in Prescription Drug Costs and Annual Per Capita Healthcare Costs in SMI
Figure 9.3 Sensitivity Analysis - I: Impact of Changes in Prescription Drug Costs on Annual Per Capita Prescription Drug Costs in SMI by Age in the U.S.

Figure 9.3 shows that for the SMI_{18-44} group, incremental changes in prescription drug costs would yield annual per capita prescription drug costs in the range of approximately $2,000 to $6,000. Among the SMI_{45-64} group, incremental changes in prescription drug costs would yield annual per capita prescription drug costs in the range of $4,000 to approximately $14,000.

Consequently, the difference in total annual per capita medical care utilization costs (Table 9.6) between SMI and non-SMI would increase substantially as indicated in Figure 9.3.
Figure 9.4 The cost differential between individuals 18-44 years old with comorbid SMI and chronic physical conditions versus non-SMI individuals with chronic physical conditions, would increase from $5,365 to $10,917. Similarly, in the older age group (45-64 years old), the cost differential between individuals with comorbid SMI and chronic physical conditions compared to non-SMI individuals with chronic physical conditions would increase from $11,237 to $21,133.
9.6.2 Sensitivity Analysis – 2

Physician office visits constitute the most frequently used medical care resource for all age groups in the U.S. as noted above in Table 9.3. The NHIS 2007 survey from which the medical care utilization data was derived did not specify how physician office visits were defined. A review of the published literature revealed that physician office visits can be defined as general/primary care, specialty care, and/or procedures; all of these services would have different cost distributions. According to Davis et al., the overall average expense for physician office visits in the U.S.
was $218 in 2009. However, when considered by specialty, the range of average expenditures per visit was between $145 for primary care and $340 for cardiology care. These estimates were not broken down by age.

The base case input for physician office visit costs (Table 9.4) applied to this study were based on national median unit cost estimates reported in the MEPS 2008 report. The estimated median unit cost estimate for the general population was $329 for individuals 18-44 years old and $593 for individuals 45-64 years old.

This sensitivity analysis aimed to evaluate the impact of varying the physician office visit unit cost estimates on annual per capita medical care utilization costs. The base case unit costs for physician office visits were changed to reflect the estimates for primary care visits reported by Davis et al. All other variables in the cost model were held constant. The original assumption that cost estimates for SMI and non-SMI were equal was held.

To generate new estimates of physician office visits for the SMI and non-SMI groups by age, the following process was undertaken:

- The average unit cost estimate for primary care physician office visits reported by Davis et al., ($145) was applied to the SMI\textsubscript{18-44} group
- For the SMI \textsubscript{45-64} group, the $145 value was multiplied by a factor of 1.8 to reflect the difference between annual physician office visit costs by age in the general population; the final estimate was $261.
Figure 9.5 shows that for all groups the annual per capita costs for physician office visits declined by at least 50% with the greatest reduction occurring in the SMI\textsubscript{45-64} group. Total annual per capita medical care utilization costs decreased for all groups, with the greatest reduction in the SMI\textsubscript{45-64} group. In the younger age group (18-44 years), the estimated annual per capita medical care cost differential between SMI and non-SMI would decline from $5,365 to $5,016; among individuals 45-64 years old, the annual per capita medical care cost differential between SMI and non-SMI would decline from $11,237 to $9,627.

9.6.3 Scenario Analysis – 1

In the base case model, the ED utilization cost differences between SMI and non-SMI, by age, were US$1,201 and US$1,675 respectively (Table
Both SMI groups had higher ED utilization rates than the non-SMI groups. The first scenario tested the potential impact of reducing ED utilization rates of individuals with SMI on the following cost model outputs:

- Annual per capita ED utilization costs
- Differences in annual total per capita medical care costs between SMI and non-SMI
- Potential cost savings in annual medical care costs

To generate the cost model outputs for this scenario, the mean ED utilization rates were reduced by increments of 10 percentage points, from 10% to 50%, in both SMI groups. All other variables in the model were held constant. The 50% reduction in ED utilization yielded substantial annual per capita decline in ED utilization costs for both SMI groups (Figure 9.6). In the SMI\textsubscript{18-44} group the decline was $2,225 to $1,112; in the SMI\textsubscript{45-64} group, the costs declined from $2,477 to $1,238.
The impact of reducing annual ED utilization rates for SMI was considered against the differences in per capita annual medical care costs between SMI and non-SMI that were presented in Table 9.6. Below in Figure 9.7, the change in annual cost differences show that for individuals 18-44 years old, reduction in ED utilization rates among SMI would yield a decline in annual per capita medical care cost difference from $5,365 to $4,253 compared to non-SMI. Among individuals 45-64 years old, reduction in ED utilization rates among SMI would yield a decline in annual per capita cost differences from $11,237 to $9,999.
The potential total annual per capita costs savings (Figure 9.8) associated with the aforementioned cost reductions were substantial. In the SMI\textsubscript{18-44} group, potential annual per capita cost savings ranged from $222 to $1,112; for the SMI\textsubscript{45-64} group potential annual per capita cost savings ranged from $248 to $1,238.
9.6.4 Scenario Analysis - 2

In the base case model, the mean hospital utilization cost for the SMI groups, by age, were $4,795 and $14,044 respectively (Table 9.5). The cost differences relative to the non-SMI groups, by age, were $2,639 and $7,008, respectively (Table 9.6). Both SMI groups had relatively higher mean hospital utilization costs which were attributable to disproportionately higher hospitalization rates (Table 9.3). This scenario tested the potential impact of reducing hospitalization rates of individuals with SMI on the following cost model outputs:

- Annual per capita hospitalization costs
- Differences in annual total per capita medical care costs between SMI and non-SMI
- Potential cost savings in annual medical care costs

To generate the cost model outputs, the mean hospitalization rates were reduced by increments of 10 percentage points, from 10% to 50%, in both
SMI groups. All other variables in the model were held constant. The 50% reduction in hospitalization resulted in substantial annual per capita decline in hospitalization costs for both SMI groups (Figure 9.9). In the SMI\textsubscript{18-44} group the decline was $4,795 to $2,398; in the SMI\textsubscript{45-64} group, the costs declined from $14,044 to $7,022.

![Impact of Decline in Hospitalization Rate on Annual Per Capita Hospital costs in SMI](image)

**Figure 9.9 Scenario 2: Impact of Incremental Percentage Reduction in Hospitalization on Per Capita Hospital Costs in SMI**

The impact of reducing annual hospitalization rates for SMI was considered against differences in per capita annual medical care costs between SMI and non-SMI that were presented in Table 9.6. Below in Figure 9.10, the change in annual cost differences show that for individuals 18-44 years old, reduction in hospitalization rates among SMI would yield a decline in annual per capita medical care cost difference from $5,365 to $2,968 compared to non-SMI. Among individuals 45-64
years old, reduction in hospitalization rates among SMI would yield a
decline in annual per capita cost differences from $11,237 to $4,216.

The potential total annual per capita cost savings (Figure 9.11) associated
with changes in hospitalization rates were substantial. In the SMI_{18-44} group,
potential annual per capita cost savings ranged from $480 to $2,398; for the
SMI_{45-64} group potential annual per capita cost savings ranged from $1,404 to
$7,022.
9.7. Summary of Results: Cost Analysis

A cost analysis model was constructed to estimate the difference in annual medical care costs between individuals with comorbid SMI and chronic physical conditions and individuals with chronic physical conditions but no history of SMI. The cost model was constructed according to the GAO cost estimation guidelines (Figure 9.1). A base case model was constructed consisting of weighted average utilization rates and national average per capita costs. The weighted average utilization rates for physician office visits, ED visits, and hospitalizations were calculated for SMI and non-SMI by age with data from the NHIS 2007 dataset (Table 9.2).

Prescription drug utilization rates were derived from physician office visit utilization due to the absence of detailed data for prescription drugs in the NHIS 2007 dataset. The four sets of medical care utilization rates were
then multiplied by national average estimates from the MEPS 2008 data reports. Age cutoffs for the SMI and non-SMI sub-groups were structured according to the MEPS reports and according to the age distribution in the NHIS 2007 dataset. From these calculations, the national per capita medical care cost was calculated for each of the four sub-groups. On average, the annual per capita medical care costs (Table 9.5) for individuals with comorbid SMI and chronic physical conditions ($10,777) were ~50% higher than non-SMI individuals with chronic physical conditions ($5,412) among adults age 18-44 years old. The difference was substantial in the 45-64 years old group in which individuals with comorbid SMI and chronic physical conditions were estimated to incur costs of $24,284 versus non-SMI with chronic physical conditions who incurred estimated costs of $13,047.

Sensitivity analyses were conducted to evaluate uncertainties in the base case model --- prescription drug costs and physician office visit costs. Among individuals age 18-44 years, variation of the prescription drug costs would yield an increase in the annual per capita cost differential between SMI and non-SMI from $5,365 to $10,917; among individuals 45-64 years, the cost differential would increase from $11,237 to $21,333. Scenario analyses considered the potential impact of reducing high-cost utilization rates (ED visits and hospitalizations) in individuals with SMI.
on annual cost differences between this group and individuals with no
history of SMI. Incremental reductions in utilization rates were done to
the point of convergence with the rates for the non-SMI population, or
approximately 50%. Also, potential per capita cost savings were calculated
to determine potential financial impact of reducing ED visits and
hospitalizations in individuals with SMI. Overall, comorbid SMI and
chronic physical conditions contribute to substantial differences in annual
per capita medical care costs due to disproportionate utilization of all
services.
10 Discussion, Conclusion, & Recommendations

The burden of chronic non-communicable physical disease in persons with a history of SMI is significantly greater compared to the general population. Persons with SMI have higher rates of chronic diseases and related premature mortality. One manifestation of this increased chronic disease burden is the elevated utilization of acute healthcare services. With data from the National Health Interview Survey (NHIS) and Medical Expenditure and Panel Survey (MEPS), this study aimed to evaluate the health economic implications of comorbid SMI and chronic physical disease in adults in the U.S.

10.1 Epidemiologic Implications

This study offers two relevant contributions to existing knowledge. First, this study was able to consider the problem of disproportionate chronic disease burden in individuals with SMI on a national scale. Most of the reported literature to date has examined the issue at the local level. Second, the study considered multiple types of SMI including bipolar disorder, schizophrenia, mania/psychosis, and chronic depression and anxiety. Many studies have examined the problem of elevated chronic disease burden in single SMI diagnosis study samples such as comorbid schizophrenia and diabetes.
This study identified some chronic physical conditions for which risk is potentially higher in a given SMI diagnostic sub-group, e.g., BPD was associated with 5.5 greater odds of kidney disease which was considerable greater than the other groups (Table 7.5). Having at least one SMI condition gave an individual the greatest odds of having liver disease (OR: 4.95, CI: 3.5-6.9, p<0.001), followed by kidney disease (OR: 4.10, CI: 2.8-5.9, p<0.001), and peripheral vascular disease (OR: 3.74, CI: 3.1-4.5, p<0.001). This trend persisted for respondents with history of BPD. However, among persons with schizophrenia, odds of having a history of hepatitis was highest among all SMI diagnostic sub-groups (OR: 4.17, CI: 2.5-6.9, p<0.001). Mania/psychosis was most significantly associated with peripheral vascular disease (OR: 4.23, CI: 2.8-6.3, p<0.001). Chronic depression or anxiety was most significantly associated with a history of stroke (OR: 3.73, CI: 2.5-5.6, p<0.001).

Analysis of self-reported health aimed to capture the influence of multiple mental health and physical conditions on an individual’s personal sense of well-being. Having an SMI was associated with more than six times greater odds of reporting poor perceived health status (OR: 6.49, CI: 5.5-7.7, p<0.001). Among SMI diagnostic sub-groups, schizophrenia (OR: 7.59, CI: 5.1-11.3, p<0.001) and chronic depression and anxiety (OR: 7.11, CI: 5.8-8.7, p<0.001) were associated with greatest odds of poor self-reported
health status, followed by mania/psychosis (OR: 6.44, CI: 4.5-9.3, p<0.001) and bipolar disorder (OR: 5.27, CI: 4.1-6.7, p<0.001).

When considered in the context of Grossman’s theory of health capital, the findings reported in this study provide empirical evidence of diminished health production among persons with comorbid SMI and chronic physical disease.

### 10.2. Medical Care Utilization

After considering the epidemiologic implications of comorbid SMI and chronic physical conditions, the study investigated the relationship between SMI and medical care utilization in individuals with chronic physical conditions. Physician office visits, ED visits, and hospitalizations were considered. Another medical care utilization outcome was having 10 or more medical care visits in the past 12 months. SMI was associated with significantly greater odds for each of the outcomes; the adjusted OR for ED visits was 3.17 (p<0.001), hospitalizations (2.20, p<0.001), and ≥ 10 medical care visits was 4.00 (p<0.001).

The decision to delay seeking healthcare when needed due to personal financial constraints was significantly associated with SMI in individuals with chronic physical conditions (OR: 2.75, p<0.01). The relationships between SMI and medical care utilization in individuals with specific chronic physical conditions were considered. In the separate models for
diabetes, COPD, and hypertension, SMI was significantly associated with ED visits, hospitalizations and having ≥ 10 medical care visits.

10.3. **Health Economic Implications**

After considering the epidemiologic and medical care utilization implications of comorbid SMI and chronic physical disease in working age adults in the U.S., a cost analysis was conducted to estimate the national per capita costs of medical care delivery in this population. Annual mean ED visits were highest in younger (age 18-44) individuals with SMI; annual mean hospitalization rates were highest in older (age 45-64) individuals with SMI. This was a substantial finding given that ED visits and hospitalizations are high-cost encounters. Annual per capita costs for individuals with comorbid SMI and chronic physical disease were approximately 200% greater when compared to individuals with chronic disease and no history of SMI.

10.4. **Limitations**

The primary limitation of this study was reliance on secondary cross-sectional data that included only non-institutionalized household residents during one year (2007). Unfortunately, given some of the psychosocial consequences of chronic psychiatric disorders, opportunities to interview and conduct research with such patients on a national longitudinal basis have been lacking. The respondents with history of SMI who participated in the NHIS 2007 survey likely did not represent the entirety of the SMI population in the U.S. Many such individuals have
unstable housing and/or they are regularly institutionalized vis a vis the criminal justice system or periodic stays in psychiatric institutions.135

Lack of available data sources that report detailed healthcare utilization behavior and associated expenditures in working age individuals with SMI is another major limitation. Consequently, the cost analyses would serve more as scenario planning tools than concrete estimators in the real world. While there is an abundance of data that reports utilization patterns and medical histories of SMI patients in the Veterans Administration system, this does not extend to the general population and has inherent bias due to the disproportionate number of men who constitute those patient groups.

The data used for the epidemiologic and utilization analyses presented here relied on self-reported medical histories. The cognitive limitations associated with chronic psychiatric disorder call into question the reliability and validity of such self-reports. There have been some small-scale studies that examined this issue and suggested that persons with SMI are able to provide reliable survey responses about their health status and health behavior. 95,136 However, given the complexity of chronic disease self-management, clinical management and treatment requirements, it would be ideal to be able to validate our data with actual clinical records.
Due to bi-directional interactions between SMI and chronic physical disease, efforts to specify associations between some variables presented a challenge when constructing regression models of the chronic physical disease and medical care utilization outcomes. For example, socioeconomic factors such as an individual’s educational background, employment history, and marital status would be considered potential confounding factors in the general population and would be controlled for in statistical analyses. Individuals with SMI have lower rates of education, employment, housing stability, and social support networks, often due to their mental illness, when compared to the general population. As such the aforementioned confounding factors were not included in the statistical analyses.

In constructing the cost estimation model included in Chapter 9, several assumptions were made. One of those assumptions was that unit cost estimates for medical services were equivalent for individuals with SMI and the general population. Several studies have indicated that SMI is associated with more hospital admissions from the ED and longer hospital length of stay, both of which would contribute to higher unit costs. While the assumption was necessary for constructing the model, it yielded a conservative estimate of the annual per capita medical care costs for individuals with SMI and consequently, a conservative estimate of the
cost differential between individuals with SMI and the general population.

10.5. Conclusions
In the U.S. individuals with SMI a disproportionate burden of chronic physical disease. SMI is associated with 2-6 fold greater odds of many chronic conditions. This comorbidity has a significant relationship with utilization of acute healthcare services and delayed healthcare seeking in non-elderly adults. Diabetes, COPD and hypertension are potential drivers of acute healthcare utilization patterns in persons with SMI. The economic consequences appear to be substantial and help to illustrate the patient-level impact in the form of premature mortality.

10.6. Recommendations
Comorbid SMI and chronic physical disease burden is an area that merits further investigation with particular emphasis placed on the economic consequences associated with low perceived health status, diminished productivity, and utilization of acute healthcare services. National healthcare quality metrics and chronic disease treatment guidelines would benefit from consideration of the potential influence that SMI has on a patient’s life and experience with the healthcare system.

One of the leading contemporary health policy issues is that of “high-need/high-cost” patients.¹³⁷ The analyses and findings presented in this study provide empirical support for the development of targeted care coordination programs that would be designed to address the need for
integrated care delivery for individuals with SMI in the U.S. Due to historic healthcare financing structures that have divided delivery and payment for mental healthcare and medical care, individuals who have comorbid vulnerabilities are often faced with the challenge of navigating a fragmented healthcare delivery system. Targeted care coordination could contribute substantially to increasing communication between mental healthcare providers, primary care providers, and specialists, especially as individuals age and their healthcare needs increase. Such communication and sharing of patient health information has the potential to reduce utilization of high-cost services such as emergency departments and hospitalizations and potentially improve adherence to complex self-care regimes.

This recommendation could be especially meaningful in an accountable care organization context (ACO) in which healthcare delivery organizations have agreed to absorb the financial risk of improving patient outcomes and reducing healthcare costs. ACO executives would be expected to provide an upfront financial investment for the development, implementation, and evaluation of targeted care coordination programs that include SMI as one of the “high risk” eligibility criteria for participation. However, as demonstrated in the scenario analyses in Chapter 9, financial metrics could be integrated into the evaluation efforts to demonstrate potential cost savings over time, and to determine the
extent to which such programs can pay for themselves with cost offsets
generated by lower ED and hospital utilization rates.
11 References


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