IMPACT OF MENTAL HEALTH DIAGNOSIS AND TREATMENT ON ASTHMA RELATED SERVICES IN MEDICAID YOUTH WITH ASTHMA

By

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To ewe, spam man, football fan and that guy

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LIST OF ABBREVIATIONS

AHCA	Agency for Health Care Administration
ADHD	Attention deficit hyperactivity disorder
CPT	Current Procedural Terminology
DSM	Diagnostic and Statistical Manual of Mental Disorders
DSM IV	Diagnostic and Statistical Manual of Mental Disorders, 4th edition
ED	Emergency department
ER	Emergency room
FE	Fixed effect
FFS	Fee for Service
HLM	Hierarchical Linear Model
HEDIS	Healthcare Effectiveness Data and Information Set
ICD-9	International Classifications of Diseases, ninth version-
ICS	Inhaled corticosteroids
IRR	Incidence Rate Ratio
LABA	Long acting beta-adrenergic agonist
NAEPP	National Asthma Education and Prevention Program
NCQA	National Committee for Quality Assurance
NDC	National Drug Code
OCS	Oral corticosteroids
OCD	Obsessive-Compulsive Disorder
ODD	Oppositional Defiant Disorder
OR	Odds Ratio
PDD	Pervasive developmental disorders
SABA	Short acting beta-adrenergic agonist

SE	Standard error
TCC	Therapeutic Class Code

Abstract of Dissertation Presented to the Graduate School
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The most common chronic condition among children and adolescents in the United States is asthma. An association between asthma and mental health has been reported by a multitude of studies. However, characterizing, specifying and quantifying the relationships between mental health comorbidities with the delivery of asthma related services have not been accomplished. This study examines asthma related health services in youth with asthma, including assessment of specific factors which may impact asthma-related utilization. Specifically, this study investigates the impact of depression, anxiety and attention deficit hyperactivity disorder (ADHD) and the treatment of these conditions on asthma-related expenditures and health service use using a statewide sample of 8,241 youth with asthma between age 6 years and 16 years continuously enrolled in Florida Medicaid over 36 months from January 2002 through December 2004.

The current research methodology improves upon prior studies by using individual mental health diagnoses, a larger sample size, and longitudinal data. Four models are used to address the delivery of health services. The first model seeks to explain the effect of ADHD, anxiety, and depression on asthma related use and expenditures. The

second model examines the length of mental health diagnosis on asthma-related use and expenditures. The third and fourth models assess the effect of mental health treatment on asthma-related use and expenditures.

General findings suggest asthma care for those with anxiety is costly with high utilization across all asthma-related outcomes, indicative of poor coordination. Comorbid depression was associated with greater inpatient service use, but generally less asthma medication fills, suggesting poor asthma adherence and coordination. Comorbid ADHD was associated with lower inpatient use and expenditures, and higher asthma related medication fills and medical claims suggesting better coordination and adherence to medication regimen and coordination of asthma management. Generally, mental health treatment tended to mediate the inpatient utilization for those with mental health conditions towards similar utilization to those without the condition. Depression treatment suggested better adherence, whereas anxiety treatment suggested more inpatient care. Better coordination of asthma management is indicated for those with comorbid anxiety and depression, as pediatricians tend to refer these patients to psychiatric services.

CHAPTER 1
INTRODUCTION

Overview

Asthma is the most common chronic condition affecting the U.S. population under age 18 years. While prevalence of pediatric asthma has more than doubled during the last 30 years, the costs associated with pediatric asthma treatment are substantial. Asthma in youth has been associated with significant morbidity and functional impairment leading to youth with asthma having greater health care utilization and costs than children without asthma (Wang, Zhong, & Wheeler, 2005; Blackman & Gurka, 2007; Ortega, Huertas, Canino, Ramirez, & Rubio-Stipec, 2002; Sapra, Nielsen, & Martin, 2005). Additionally, a number of studies have suggested that pediatric asthma is associated with having mental health comorbidities (Katon et al., 2007; Sapra et al., 2005; Ortega et al.,2002; Craske, Poulton, Tsao, & Plotkin, 2001; Goodwin, Fergusson, & Horwood, 2004; Feldman, Ortega, McQuaid, & Canino, 2006; Bussing, Burket, & Kelleher, 1996; Blackman & Gurka, 2007; McQuaid, Kopel, & Nassau, 2001; Vila, Nollet-Clemencon, de Blic, Mouren-Simeoni, & Scheinmann et al., 2000).

Recent studies are beginning to emphasize the impact of mental health comorbidities on health service use in youth with asthma (Richardson, Russo, Lozano, McCauley, & Katon, 2008; Kewalramani, Bollinger, & Postolache, 2008). Given the high cost and increasing prevalence of asthma in children and the overwhelming evidence of co-occurring mental health conditions like depression and anxiety, there remains a need to further understand how specific mental health diagnoses (e.g., attention deficit hyperactivity disorder (ADHD), depression, anxiety) impact the delivery of asthma related services. Additionally, there is the question of how treatment of each mental

health condition impacts the service delivery of asthma-related medical care. This study has implications for mental health and the role of mental health treatment in chronic disease. Therefore, understanding how mental health and its treatment is associated with asthma-related health service use and expenditures is critical to inform, develop, and facilitate appropriate cost containment strategies and highlight areas for policy intervention to improve the quality of health care.

Study Objectives

The main purpose of this study is to further understand the relationship between being diagnosed with asthma and high asthma-related service utilization and expenditures. Specifically this study is interested in how individual mental health diagnosis of ADHD, anxiety, and depression modify utilization and expenditures of asthma-related services. This study expands on an early study that reported an association between mental illness and health services use in pediatric asthma (Jamoom, 2010).

The specific objectives of this study include.

Objective 1. To measure the impact of mental health diagnosis on asthma-related utilization and expenditures.

Objective 2. To understand time-related effects of having a mental health diagnosis on asthma-related utilization and expenditures.

Objective 3. To measure the impact mental health treatment (e.g., pharmacological intervention and counseling) has on the relationship between mental health diagnosis and asthma-related utilization and expenditures.

Specific Sub Aims

The sub aims include.

Sub Aim 1. To understand the relationship of having comorbid mental health diagnoses on asthma-related utilization and expenditures in youth with pediatric asthma. The specific mental health diagnoses that will be assessed include ADHD, anxiety, and depression.

Sub Aim 2. To understand the effect of mental health treatment on asthma-related utilization and expenditures among children with asthma with a comorbid ADHD, anxiety, or depression diagnosis.

Healthy People 2010 Objectives

The study objectives are aligned with the goals described in the national plan Healthy People 2010 (USDHHS, 2010).

These objectives include:

1) To identify and ultimately increase the proportion of children with mental health problems who receive treatment (Objective 18-07)
2) To identify and ultimately reduce hospitalizations and hospital emergency department visits for asthma (Objectives 24-02 & 24-03)
3) To increase the proportion of persons with asthma who receive appropriate asthma care according to the NAEPP Guidelines(2007) (Focus on written asthma management plans from health care providers (24-7a) and patient education to recognize and respond to early signs and symptoms (24-7c)) (Objective 24-07).

Ultimately successful understanding of the major objectives of this study will further other Healthy People 2010 objectives to increase formal patient education (24-06) and track asthma outcomes and access to medical care and asthma management (24-08) (USDHHS, 2010).

CHAPTER 2
LITERATURE REVIEW

Pediatric Asthma

Asthma, an illness characterized by airway inflammation, wheezing, and chest tightness, impacts approximately 9% of the U.S. population under 18 years and represents one of the most common chronic diseases in children (Moorman et al., 2007; Blair, Breit, & Berkow, 2007; Vila, Nollet-Clemencon, de Blic, Mouren-Simeoni, & Scheinmann et al., 1998). Pediatric asthma is the leading cause of missed school days and hospitalizations in children, and rates of disability due to asthma are increasing (Bousquet, Bousquet, Godard, & Daures, 2005; Blair et al., 2007). Moreover, the prevalence of pediatric asthma has doubled from 1980 to 2000 (Sapra et al., 2005; Blair et al., 2007).

This observed increase in prevalence has been thought to be associated with rural and urban distribution of the population, increasing as more communities adopting modern lifestyles and becoming more urbanized (Bousquet, Ndiaye, Ait-Khaled, Annesi-Maesano, & Vignola, 2003; Gold & Wright, 2005). In addition to urbanization, changes in diet (Devereux, 2006) and the hygiene hypothesis (Becker, 2007) have been implicated as contributors to the relatively recent rise in asthma prevalence. The hygiene hypothesis expands on the urbanization theme by suggesting that cleaner environmental conditions are implicated in the rise of asthma prevalence due to having less exposure to allergens during immune system development, and are at least in part responsible for an increase in asthma prevalence in developed countries (Becker, 2007). Supporting this hypothesis, being in a farming environment, being exposed to cats, going to child care, having a large family during the immune system developing

years, as well as birth order have been associated with lower asthma prevalence (Becker, 2007).

The costs associated with the treatment of pediatric asthma are substantial. In 2002, health care expenditures for asthma totaled $14 billion (Blair et al., 2007). Most recently Kamble and Bharmal (2009) have estimated direct expenditures for the treatment of children with asthma in the U.S. at $6.39 billion. The same study determined that the annual direct medical expenditure attributable to asthma treatment (both adults and children) is estimated at approximately $37.2 billion in 2007 U.S. dollars, representing a significant portion of healthcare resource use in the U.S. (Kamble & Bharmal, 2009). Kamble and Bharmal's estimate is relatively higher than the previously reported estimates of cost in asthma, which range from $3.6 billion to $30.8 billion (Smith, Malone, Lawson, Okamoto, & Battista, 1997; Weiss, Gergen, & Hodgson, 1992; Weiss, Sullivan, & Lyttle, 2000; Druss et al., 2001; Wang et al., 2005; Lozano, Sullivan, Smith, & Weiss, 1999; Yelin et al., 2002).

Children with asthma use approximately double the level of health services (i.e., hospitalizations, outpatient visits, emergency department visits) relative to children without asthma (Sun, Kao, Lu, Chou, & Lue, 2007; Kamble & Bharmal, 2009). A study of the North Carolina Medicaid system reported the average annual health care cost for patients with asthma exceeded that of patients without asthma with similar demographic characteristics by over $1000 (Sapra et al., 2005). Moreover, approximately 20% of patients with asthma generated nearly 80% of direct expenditures (Sapra et al., 2005); suggesting a subset of patients with particular characteristics are at increased risk for using more health services. Given the high cost and increasing prevalence of asthma in

children and adolescents, enhancing our understanding of factors associated with health service utilization in this population is critical to facilitate appropriate cost containment strategies and improve the quality of care.

Mental Health and Asthma

Emotional causes have frequently been believed to be associated with asthma exacerbations (Bloomberg & Chen, 2005; Lehrer, 1998). However correlation does not imply causality, and the causal relationship between asthma and mental health has not been fully appreciated nor understood. Many studies fail to address mental health and asthma exclusively in children, often including a mixed age sample or exclusively adult populations. Therefore, studies using mixed samples or adult populations may be used to fill in any gaps in the literature.

ADHD and asthma. A 1996 literature review on the relationship between childhood asthma and ADHD failed to find any association between asthma and ADHD (Daly et al., 1996). However, the sample size of most studies contained within the literature review article seemed to not address asthma or ADHD directly or exclusively and had fairly small samples of youth with asthma. Hence, the literature has not been able to establish a clear association between asthma and ADHD and other externalizing psychiatric symptoms (e.g., OCD, ODD). Externalizing psychiatric disorders are manifested in children's outward behavior rather than (or in addition to) their internal thoughts and feelings. Internalizing psychiatric disorders are manifested in a children's inward behavior, and include depression and various types of anxiety, such as separation anxiety disorder and generalized anxiety disorder. In a longitudinal study examining the effects of internalizing and externalizing behavior problems in adolescence, there was no association noted between asthma prevalence and

externalizing symptoms; however, children diagnosed with asthma by age 5 years were at increased risk during adolescence for internalizing behavior problems (Alati et al., 2005).

Anxiety and depression association with asthma. Studies have found asthma patients to have higher rates of depressive and anxiety symptoms than healthy controls. In 2000, a literature review of asthma found that of 8 studies reviewed, all had indicated that depressive symptoms were more common in children and adults with asthma than in the general population (Zielinski et al., 2000). Up to this point, no consistency was obtained on the prevalence of formal depressive disorders and diagnoses in patients with asthma. In a study of 743 adults with asthma, Eisner, Katz, Lactao, and Iribarren, (2005) found 18% of all those adults with asthma had depressive symptoms based on the Center for Epidemiologic Studies Depression Scale.

Children and adolescents with asthma have higher rates of depressive and anxiety disorders. Goodwin et al. (2004) studied asthma in adolescence and young adulthood and found that asthma was also associated with an increased likelihood of major depression, panic attacks, and any anxiety disorder. Furthermore, the Youth Risk Behavior Survey has shown that high school students with asthma report higher rates of depressive symptoms such as hopelessness or feeling sad (45.3% vs 29.3%) than non-asthma peers (Bender, 2007).

In a prospective study examining the relationship between mental health problems in childhood at age 8 years and physical disorders at follow-up during early adulthood at ages 18 to 23 years, Goodwin and colleagues (2009) found that having early onset asthma (at age 8 years) was associated with moderate to severe conduct problems,

and moderate to severe depressive symptoms at start of the study. However, having incident onset of asthma at follow-up as a young adult was predicted by moderate and severe depressive problems at age 8 years (Goodwin et al., 2009). This association suggests childhood depression may be involved in the development of asthma yet correlation does not necessarily imply causation.

Katon et al. (2007) reported youth with asthma demonstrated twofold higher prevalence of comorbid DSM-IV anxiety and depressive disorders compared with non-asthma controls. Furthermore, a meta-analysis of childhood asthma studies revealed these children exhibited poorer behavioral and emotional functioning and had more internalizing and externalizing disorders than either comparison group of healthy peers or a normative sample (McQuaid et al., 2001). Glazebrook and colleagues (2006) reported children with asthma scored higher on measures of emotional disturbance than non-asthma controls. Likewise, Vila et al. (2000) determined in their study of French children with asthma between ages 8 years to 15 years that 42% had one or more DSM diagnoses.

Asthma and Mental Health Pathophysiology

While asthma is described as chronic inflammation involving airway hyperresponsiveness and bronchial obstruction leading to symptoms of coughing, wheezing, chest tightness, and dyspnea, the underlying pathophysiology of asthma can be present without overt symptoms (Kewalramani et al., 2008). Regulated by T lymphocytes, immune responses consist of T helper type 1 (Th1) or T helper type 2 (Th2) cells. Th1 cells are primarily involved in response to infection, whereas Th2 cells are primarily involved in the allergic response. Technically, asthma is a “disorder of the

conducting airways characterized by Th2 cell mediated inflammation and increased mediator release" (Kewalramani et al., 2008, pp. 4-5).

Asthma is often brought on by viral infection or allergen exposure. Antigen presenting cells (APCs) recognize the allergens and present them to T lymphocytes. If one is predisposed to the allergy phenotype, the T helper cells develop into Th2 cells inducing B lymphocytes to undergo a class switch from immunoglobulin M (IgM) to immunoglobulin E (IgE). IgE levels are typically increased in atopic asthma, as IgE binds to receptors on effector cells (e.g., mast cells, basophils and eosinophils) found in the respiratory mucosa leading to sensitization. Thereafter, when individuals are exposed to these allergens again the allergen is cross-linked with IgE molecules and induce the effector cells to degranulate. Thereby, the effector cells release a host of cell mediators including histamine, tryptase, cytokines, leukotrienes, and prostaglandins inducing asthma symptoms (Lily, 2005).

Asthma and other atopic disorders are thought to be exacerbated by psychological stress (Slattery, 2005). Some studies suggest that psychological stress shift cytokine balance from Th1 towards Th2, causing an immune dysregulation with more hyperresponsive immune response during periods of high stress. Higher periods of stress activate the sympathetic nervous system and hypothalamic-pituitary-adrenocortical axis leading to an increase in cortisol and catecholamine secretion, which suppress Th1 cytokines (e.g., IL-12, IFN-gamma) shifting immune response towards the Th2 phenotype leading to asthma pathogenesis (Chrousos, 2000).

Asthma is also associated with nocturnal symptoms and a decrease in lung function (Kewalramani et al., 2008). Those who have asthma have an increased

likelihood to have rhinitis (Bousquet et al., 2008). Both allergic rhinitis and nonallergic rhinitis are risk factors for sleep apnea (Kalpaklioğlu, Kavut, & Elili, 2009; Bousquet et al., 2008). Impaired sleep leads to daytime fatigue, difficulty concentrating, reduced productivity, deteriorating mood, overall lower quality of life and can exacerbate depression in individuals (McEwen, 2006). Additionally, impaired sleep due to sleep disordered breathing can be misdiagnosed as ADHD due to the substantial overlap between impairments of sleep disordered breathing and diagnostic criteria for ADHD (Owens, 2009). The extent that treating the sleep disorder has been suggested to normalize the ADHD scores and even find that 50% of children no longer met ADHD criteria (Owens, 2009). Generally, factors associated with impaired sleep are also considered depressogenic, and anxiety has been associated with the uncertainty of asthma and its attacks (Levenson, 2005). Other studies have suggested that increased anxiety can result from hypercapnia (or condition of elevated carbon dioxide in the blood associated) by directly impacting an activity change in the locus coeruleus. The locus coeruleus is the area of the brain associated with the noradrenergic system that supplies norepinephrine throughout the central nervous system, and ultimately manages one's physiological response to stress and panic (Carr, 1998; Zaubler & Katon, 1998).

In the review by Daly and colleagues (1996), some medications have been associated with ADHD like symptoms in some youth with asthma. Specifically, the asthma medications with ADHD symptomology include theophylline (Furukawa et al., 1988; Bender & Milgrom, 1992; Rachelefsky et al., 1986) and corticosteroids (Milgrom & Bender, 1993). Compared to children with asthma taking theophylline, youth with

asthma who discontinued the use of theophylline had a significant improvement on concentration scores from the Stroop Test I (Furukawa et al., 1988). Daly and colleagues' review suggests no evidence exists on asthma medications causing minimum symptoms for ADHD diagnostic criteria. However, their literature review article assessing the association between asthma medication and ADHD symptomology is limited by the small sample size ranges of 6 to 13 subjects in their compiled studies.

Asthma, Mental Health and Health Service Use

Studies suggest the presence of psychiatric diagnoses or childhood behavioral, social, or emotional problems are associated with greater pediatric health service utilization (Janicke, Finney, & Riley, 2001). This finding is especially important for those with pediatric asthma, as youth with asthma have been associated with mental health issues, most notably comorbid internalizing psychiatric diagnoses, such as depressive or anxiety disorders (Bussing et al., 1996; Vila et al., 2000; Craske et al., 2001; McQuaid et al., 2001; Ortega et al., 2002; Goodwin et al., 2004; Sapra et al., 2005; Feldman et al., 2006; Blackman & Gurka, 2007; Katon et al., 2007). The association between asthma and ADHD, however, has not been fully appreciated (Daly et al., 1996). This association between asthma and behavioral symptoms can result in greater asthma burden (Richardson et al., 2006), additive functional impairment (McQuaid et al., 2001; McCauley, Katon, Russo, Richardson, & Lozano, 2007), and increased asthma medications, emergency room visits (Nouwen, Freeston, Labbe, & Boulet, 1999), and hospitalizations (Dirks, Kinsman, Horton, Fross and Jones, 1978). Moreover, the association between asthma and psychiatric symptoms has been suspected to be associated with adverse effects of controller and rescue medications, difficulties with managing a life-threatening illness, family stress and low socioeconomic status, all of

which negatively impact both asthma symptomatology and psychiatric illness (Vila et al., 1998; McQuaid et al., 2001; Goodwin, Messineo, Bregante, Hoven, & Kairam, 2005; Mrazek, 1992).

ADHD association with health services.

The economic impact of ADHD on asthma is incomplete, as many studies fail to separate mental health services from other health care (Pelham, Foster, & Robb, 2006). Independently, ADHD has been discussed as contributing to increased general utilization and health costs (Guevara, Lozano, Wickizer, Mell, & Gephart, 2001). Specifically, in their study addressing ADHD utilization and cost, compared to youth without, those with ADHD had incurred significantly greater total costs ($1465 vs $690), and had 3.4 times more pharmacy fills (11.25/year vs 3.30/year), and 1.6 times more primary care visits (3.84/ year vs 2.36/year). While suggestive of increased use and higher costs, an association between asthma prevalence and ADHD has not been fully understood (Daly et al., 1996). It has been suggested, however, that ADHD may be actually misdiagnosed for what is an undiagnosed sleep disorder, like obstructive sleep apnea (Owens, 2009).

In a national Medicaid youth sample, externalizing conditions like ADHD have been associated with increasing costs and health services utilization (Chan, Zhan, & Homer, 2002). Overall costs for either ADHD or asthma have been shown generally to be similar. However, ADHD-related prescriptions costs, total out-of-pocket expenses, outpatient visits and prescriptions claims were higher for ADHD than asthma.

Anxiety and depression association with health services.

Few studies however have examined factors associated with health service use in children with asthma, much less the additive effect of psychiatric diagnoses.

Mohammed and colleagues' (2006) reported 40% of pediatric patients with asthma had two or more visits to the emergency department over a one-year retrospective period. Additionally, repeat visits were associated with younger patient age, presence of maternal asthma, and exposure to environmental triggers. However, psychiatric symptoms were not investigated as a predictor of emergency department visits.

In a study of pediatric and adult asthma patients, Sapra, Nielsen, and Martin (2005), detected increased healthcare costs for those patients presenting with a diagnosis of depression. Likewise, Goodwin and colleagues (2005) reported that symptoms of anxiety and depression were quite common among 5 to 11 year-old inner-city patients with asthma, and linked these psychiatric symptoms with an increase in health care utilization.

In a set of unadjusted analyses, Richardson et al. (2008) found that compared to youth with asthma alone, those with comorbid anxiety/depressive disorders had more primary care visits, emergency department visits, outpatient mental health specialty visits, other outpatient visits and pharmacy claims. Specifically after controlling for asthma severity and covariates, total health care costs were approximately 51% higher for youth with asthma that had depression with or without an anxiety disorder but not for youth with asthma that had an anxiety disorder alone. The authors discussed that most of the increase in health care costs was attributable to non-asthma and non-mental health related increases in primary care and laboratory/radiology expenditures.

Preliminary study of nonpsychiatric utilization and expenditure by psychiatric diagnosis group in Medicaid youth with asthma. In a Florida Medicaid study of youth with asthma, Jamoom and colleagues (2010) found that youth between

age 5 and 15 years with a comorbid externalizing psychiatric diagnosis, such as ADHD had fewer nonpsychiatric related ER visits and inpatient costs compared to those without the externalizing psychiatric diagnosis. Furthermore, Jamoom and colleagues contributed to the consistency in the literature with their cross-sectional findings that comorbid internalizing psychiatric diagnoses such as depression and anxiety were associated with a comprehensive increase in annual nonpsychiatric related expenditures as well as the amount of health care resources used. While their research finding assessed general trends associated with groups of psychiatric diagnoses and nonpsychiatric related expenditures and utilization in youth with asthma, they had several limitations which could be improved upon. Limitations from that study include both a liberal definition of asthma and mental health. For mental health, general psychiatric diagnostic groups (e.g., internalizing or externalizing) were used rather than individual psychiatric diagnosis type (e.g., ADHD, anxiety). Therefore, they suggest assessing individual mental health conditions rather than at the aggregate grouping by symptomology (Jamoom et al., 2010). Additionally, they did not require more than one ICD-9 diagnosis for asthma, thus increasing the likelihood for false positives. Specifically, their research suggests further assessment of asthma-specific services rather than the more general trends associated with assessing nonpsychiatric-related services. Improvement in stringent criteria for asthma diagnosis, assessing mental health treatment and asthma severity, assessing the effects of time with mental illness on the patterns of health service delivery, and using a longitudinal approach were targeted goals for future research.

Kewalramani, Bollinger, and Postolache (2008) indicate in their review of asthma and mood disorders that there exist overwhelming evidence on the high rate of co-occurrence of depression/anxiety and asthma for children, adolescents and adults, and further research is necessary to establish the link between these conditions and specifically whether "concurrent treatment of depression and anxiety in asthma patients improves asthma symptoms." Additionally the review implies the need to pay attention to different triggers, both environmental (e.g., spring pollen) and genetic (e.g., immunologic/cellular mediators of allergic response) that lead to increased periods of vulnerability.

Asthma Pharmacotherapy and Effects on Mood Disorders

Asthma Pharmacotherapy is divided into controller medications and rescue medications. Controller medications are taken on a daily basis, whereas rescue medications are used for acute asthma episodes to relieve episodes of crisis. Many of these medications can result in adverse psychological events, such as depression or anxiety symptomology (Kewalramani et al., 2008). Controller medications include inhaled corticosteroids (ICS), leukotrine modifiers, cromones, long-acting beta-adrenergic agonists (LABA), immunomodulators, and methylxanthines. Rescuer medications include anticholinergics, systemic corticosteroids, and short acting beta-androgenic agonists (SABA) (NAEPP, 2007).

Corticosteroids inhibit cytokine, prostaglandin, and leukotrienes production through preventing inflammatory cell activation and migration, and decreasing microvascular leakage (Kewalramani et al., 2008). Corticosteroids are considered the most potent and effective long-term anti-inflammatory medication for asthma (Kewalramani et al., 2008).

For those with acute asthma exacerbation, oral corticosteroid (OCS) bursts of prednisone and prednisolone are frequently prescribed.

Uses of systemic corticosteroids have been associated with depression, mania, and psychosis. In a study of adults evaluated for receiving a minimum of 40mg of prednisone for asthma exacerbation during at least a seven day period, Brown, Suppes, Khan, and Carmody (2002) found that after assessing patients before during and after systemic corticosteroid therapy with the Hamilton Rating Scale for Depression, the Young Mania Rating Scale, the Brief Psychiatric Rating Scale, and the Internal State Scale, there was a significant increase in manic symptoms. For patients with depression, their study found a reduction in symptoms compared to those without depression. However these changes resolved with discontinuation of the steroids. However other studies have suggested that chronic steroid use seems to be associated with an increase in depressive symptoms (Craig, Teets, Lehman, Chinchilli, & Zwillich, 1998). Brown, Vera, Frol, Woolston, and Johnson (2007) found in a follow up study, that those with asthma chronically using prednisone was associated with higher scores on psychiatric measures than those not on chronic steroids. For patients with moderate to severe asthma, a complex adjunct therapy in addition to ICS may include leukotrienes modifiers, LABAs, chromones, theophylline, and omalizumab, which the impact of these medications on comorbid depressive and anxiety disorders in patients with asthma have not been extensively studied (Kewalramani et al., 2008).

Other studies have found that depressive symptoms are associated with some of the steroids used in treating asthma. Morrison, Goli, Van Wagoner, Brown, and Khan (2002) studied 46 patients age 6 to 17 years who presented to a low-income family

asthma clinic. The clinic found 86% of children were on medium to high doses of inhaled corticosteroids for their asthma and 41% had mild to moderate airway obstruction on inhaled steroids. Furthermore, 30% of these patients also had Carroll Depression Scale-Revised scores consistent with likely, very likely or almost certain depressive disorder.

Leukotrine modifiers have been shown to decrease use of rescue medications, decrease night awakenings and improve lung function (NAEPP, 2007). According to Singular's package insert, Montelukast, a leukotrine receptor antagonist, has uncommonly been associated with dream abnormalities, drowsiness, insomnia, depression, and suicidal thoughts (Kewalramani et al., 2008). No effects on depression or anxiety have been reported for chromones, bronchodialtors, and immunomodulators like Omalizumab (Kewalramani et al., 2008). However, side effects of theophylline, a phosphodiesterase inhibitor, include seizures, insomnia, anxiety, and tachyarrhythmia. Theophyllines have decreased in use for children. Studies on the pharmacological side effects of asthma medications remain something that continues to be researched due to the large numbers of people impacted with asthma in the U.S.

Biological consequences of asthma include biological predispositions to mood and mental health conditions (Kewalramani et al., 2008). The complex interaction between asthma and the treatment of asthma have included increased depression, anxiety, and an inability to sleep. Insomnia seems to be a common side effect of asthma medications, but may also relate to allergic or nonallergic rhinitis. Asthma has a strong association with allergic rhinitis, which has been implicated in obstructive sleep apnea and sleep disordered breathing (Kalpaklioğlu, Kavut, & Elili, 2009; Owens, 2009).

Having sleep disordered breathing results in inability to concentrate and symptomology associated with depressive disorders and ADHD (Owens, 2009). Sleep disordered breathing has been reported as being often misdiagnosed as ADHD (Owens, 2009).

The treatment of mental health and asthma together seems quite complex. In one study by Pretorius (2004), it was suggested that some individuals receiving asthma treatments like corticosteroids that lower serotonin levels might present with symptoms of depression, ADHD, oppositional defiant disorder and even conduct disorder; and that treating the mental health comorbidity with selective serotonin reuptake inhibitors (SSRIs) and psycho-stimulants may result in the upregulating of serotonin levels, which in turn triggers asthma (Pretorius, 2004). Concerns surrounding the side effects of asthma medications and diagnosis of ADHD have been suggested but not supported by the literature (Daly et al., 1996). Furthermore, the same study did not show any effects of ADHD medications and the impacts on asthma. In fairness, the literature review reported small scale studies with fairly small sample sizes that did not support a significant association of ADHD on asthma or asthma medications causing ADHD.

Mental Health and Adherence to Treatments

Better consideration of mood disorders like depression and anxiety among individuals with asthma has been gaining momentum due to the potential for poor adherence to asthma medications (Kewalramani et al., 2008). Poor adherence has been observed in those suffering with specific chronic conditions like asthma. Among those with comorbid mood disorders, major depression was associated with poor adherence in diabetes care (Lin et al., 2004). Specifically, researchers suggest that major depression was associated with less physical activity, unhealthy diet, and lower adherence to oral hypoglycemic, antihypertensive, and lipid-lowering medications (Lin et

al., 2004). Generally, compared to those without depression, patients with depression are more likely to have other chronic comorbidities and are up to 3 times more likely to have adherence problems to medications prescribed for their medical comorbidities (Cramer & Rosenheck, 1998; DiMatteo, Lepper, & Croghan, 2000). While mood disorders like depression has led to poor adherence, some studies have shown antidepressant drug adherence improves comorbid disease medication adherence and reduced total medical costs for chronic disease (Katon, Cantrell, Sokol, Chino, & Gdovin, 2005).

A review article from the Lancet addressing medication adherence in youth and young adults with cancer, reports that up to 63% of patients do not adhere to their treatment regimens with adherence factors which include patient emotional functioning (e.g., depression and self-esteem), patient health beliefs (e.g., perceived illness severity and vulnerability), and family environment (e.g., parental support and parent-child concordance) (Kondryn, Edmonson, Hill, & Eden, 2010).

In a study of hypertension, 89 patients with mental health comorbidities, specifically psychotic disorders were matched with randomly selected age comparable subjects that were assessed for similar antihypertensive medication adherence (Dolder, Furtek, Lacro, & Jeste, 2005). Researchers found that those with psychotic disorder were significantly less likely to have controlled blood pressure during the first year study period, suggesting that mental health comorbidities adds a concern to medical providers monitoring of chronic disease treatment adherence (Dolder et al., 2005).

Some studies suggest poor adherence is more an issue of education and health beliefs. In a study assessing adherence in youth with asthma in Australia, poor

adherence was found to be associated with health beliefs held about specific asthma medications (Naimi et al., 2009). Therefore, one's health beliefs about asthma medications may not just impact adherence but ultimately their asthma-related utilization and expenditure.

Currently, the literature on asthma treatment adherence and mental health is quite limited (Opolski &Wilson, 2005). Asthma adherence has a negative association with age (McQuaid, Kopel, Klein, & Fritz, 2003). As children age, they may be at particular risk for poor adherence and clinicians need to be aware and adherence studies are needed in youth with asthma (McQuaid et al., 2003).

Summary of the Literature.

Asthma is a costly, prevalent condition impacting youth with asthma. Additionally, asthma has been associated with mental health conditions at relatively high rates compared to those without asthma. Large scale studies that assess the impact of mental health on the use and expenditure for youth with asthma have not been done despite the high asthma prevalence and cost. Mental health comorbidities may impact asthma medication adherence in youth with asthma. Additionally, having asthma symptoms (e.g., airway constriction) have been suggested to influence mental health condition symptomology and vice versa. Understanding the relationship of individual mental health conditions and mental health treatment impact on the medical care of chronic conditions like asthma represents a novel and important rationale behind conducting this study. Moreover, findings from this study have implications on the management and quality of care for such patients, such that findings may lead to better management and coordination of care. Thus, the underlying objective for this very important research to investigate the relationship between ADHD, anxiety, and

depression as a modifier of the relationship between youth with asthma and their asthma related service use. The effects of time on this relationship also have not been addressed in the literature. Time with a mental health condition should in theory impact adherence to asthma medications, continuity of care, and utilization patterns and expenditure for types of asthma-care (e.g., inpatient, outpatient, or medical care). While the effects of mental health treatment have not fully been discussed in the literature, an argument can be made that the treatment of mental health will improve adherence to asthma-related therapy (Katon et al., 2005; Kewalramani et al., 2008). Additionally assessing the exposure to the medical care system (e.g., mental health treatment) over time may have implications on disease management and coordination care. Therefore there is a need to conduct a longitudinal study to answer whether the experiences for youth with asthma that have mental health conditions and receive treatment for their mental health condition have improved asthma disease management, measured as utilization differences in asthma related care and asthma related pharmacological therapy.

Features of this Study and Conceptual Overview

Study Features

This study will fill some of the existing literature gap by using several techniques to improve on the limitations of previous studies. In this study, health care utilization and expenditures are focused to asthma-specific use and expenditure, as distinct from prior studies that were using a general cost or non-asthma specific dependent variables. Second, this study improves on other definitions of asthma in the claims data by limiting the definition of asthma to those youth with at least 2 asthma claims in the data within the first year of the study, and then following the cohort for an entire 36 month period to

understand their mental health experience. Additionally, this study follows a vulnerable population, Florida Medicaid youth with asthma. The sample was adjusted to remove all those enrollees with over a 2 month gap in coverage at one time during the 36 month period (note that multiple gaps in eligibility was allowed, as long as those gaps in eligibility were not longer than a 62 day period). These eligibility gaps result from the constant enrollment and disenrollment that occurs in the Medicaid population.

The asthma literature displays consistency in the increased association between mental health conditions like depression and anxiety with asthma. However, the relationship has not been fully elucidated with respect to quantifying the effect of how mental health conditions impact asthma management and costs in youth with asthma (Kewalramani et al., 2008; Jamoom et al., 2010). Since a number of areas exist where the literature fails to illuminate the impact of common co-occurring individual mental health diagnosis (i.e., depression, anxiety, and ADHD) on asthma-related costs and service use, this study will address how co-occurring depression, anxiety, and ADHD will affect asthma-related utilization and expenditure.

Conceptual Framework

The literature implies that ADHD, anxiety, and depression would impact asthma outcomes in different ways. Therefore, in the proposed Mental Health Utilization Model for youth with asthma (Figure 2-1), mental health acts as a modifier of the asthma utilization relationship for those children with an asthma diagnosis. The underlying premise is that youth with asthma are going to use asthma related health services based on their age, sex, race/ethnicity, and SSI status. Since mental health comorbidities like ADHD, anxiety, and depression often accompany chronic conditions like asthma, as described in the literature, this conceptual model seeks to quantify,

explain, and understand the degree to which ADHD, anxiety and depression impact asthma-related outcomes.

The second part of this conceptual model reflects the time-related association by which the number of months one has ADHD, anxiety, and depression impacts asthma-related expenditure and utilization. It would be expected that different types of asthma-related services would have different time-related effects associated with length of time one has their mental health condition. This is particularly true if management of the specific mental health condition impacts adherence to asthma treatment or has a very different coordination for the care of mental health and asthma related services. For example, for youth with asthma that have a new diagnosis of depression, they may initially use more asthma services. However, adherence to medications represents a potential problem, as suggested by the literature. In theory the longer one has depression, the more likely they are to not manage their asthma and have higher inpatient care, or become less likely to adhere to asthma medication. If mental health services are handled outside of the medical home (i.e., psychiatrist referral), a psychiatrist may be unaware of asthma-related issues and the pediatrician may be unaware of mental health related issues. Hence, poor coordination of asthma and mental health care can result in different utilization trends. Understanding the length of time one has a mental health condition may help in further understanding the trends associated asthma-related utilization.

The third part of the model assesses the mediating effects of mental health treatment on the overall relationship between mental health and asthma-related services. The literature suggests poor adherence for those with comorbid depression to

pharmacological treatment for chronic conditions, like asthma. Having a treatment for the mental health condition like depression, should improve adherence to asthma treatment (e.g., direct asthma fills). This conceptual framework allows for the ability to assess the overall effects of ADHD, anxiety, and depression treatment on asthma related utilization. The literature suggests that mental health treatment for depression improves adherence to other chronic disease medications (Katon et al., 2005). The continuity of mental health treatment, whether you regularly fill and use your medication, happens to be another piece of the adherence (Katon et al., 2005). In other words just presence or absence of treatment does not indicate regular use. Therefore, the length of mental health treatment can offer insight as a proxy measure for adherence. This framework helps to address whether the presence or absence of treatment or a more continuous measure of mental health treatment has a larger effect on the propensity for youth with comorbid ADHD, anxiety, or depression to use asthma related services.

This utilization model provides a conceptual framework to generally analyze asthma-related health service use and expenditures among youth with asthma and the impact of mental health and associated mental health treatments for this population using claims data. This model intentionally omits other traditional behavioral components impacting utilization described frequently in the literature (e.g., parental factors, smoking, etc).

There are benefits to consider this model within a larger behavioral utilization model context. For example, Dr. Andersen posits using psychological characteristics as part of his predisposing characteristics in his Behavioral Model of Health Service Use (Andersen, 1995). One can see how a modified Andersen would potentially work in this

study, as well. However, for simplicity, this study is also addressing mental health treatment, which may for this population of continuously enrolled youth with asthma be thought of as implied utilization (i.e., one must use services to have treatment) but also thought of as an enabling resource (i.e., prior use increases future use), but also may be an indicator of need (i.e., as continuous mental health treatment may indicate regular adherence) for those with high number of months of continuous treatment. In this sample everyone is continuously enrolled, hence treatment has a variety of different roles in a traditional Andersen Behavioral approach. So the model proposed in Figure 3-1, allows for each component of this claims-based analysis to be accounted for in a simplified utilization model that allows for both mental health pathology as a modifier of asthma service use and mental health treatment as a mediator of the underlying mental health pathology. The Andersen Model can be called upon in discussing some of the findings with respect to some limitations of utilization analyses with claims data.

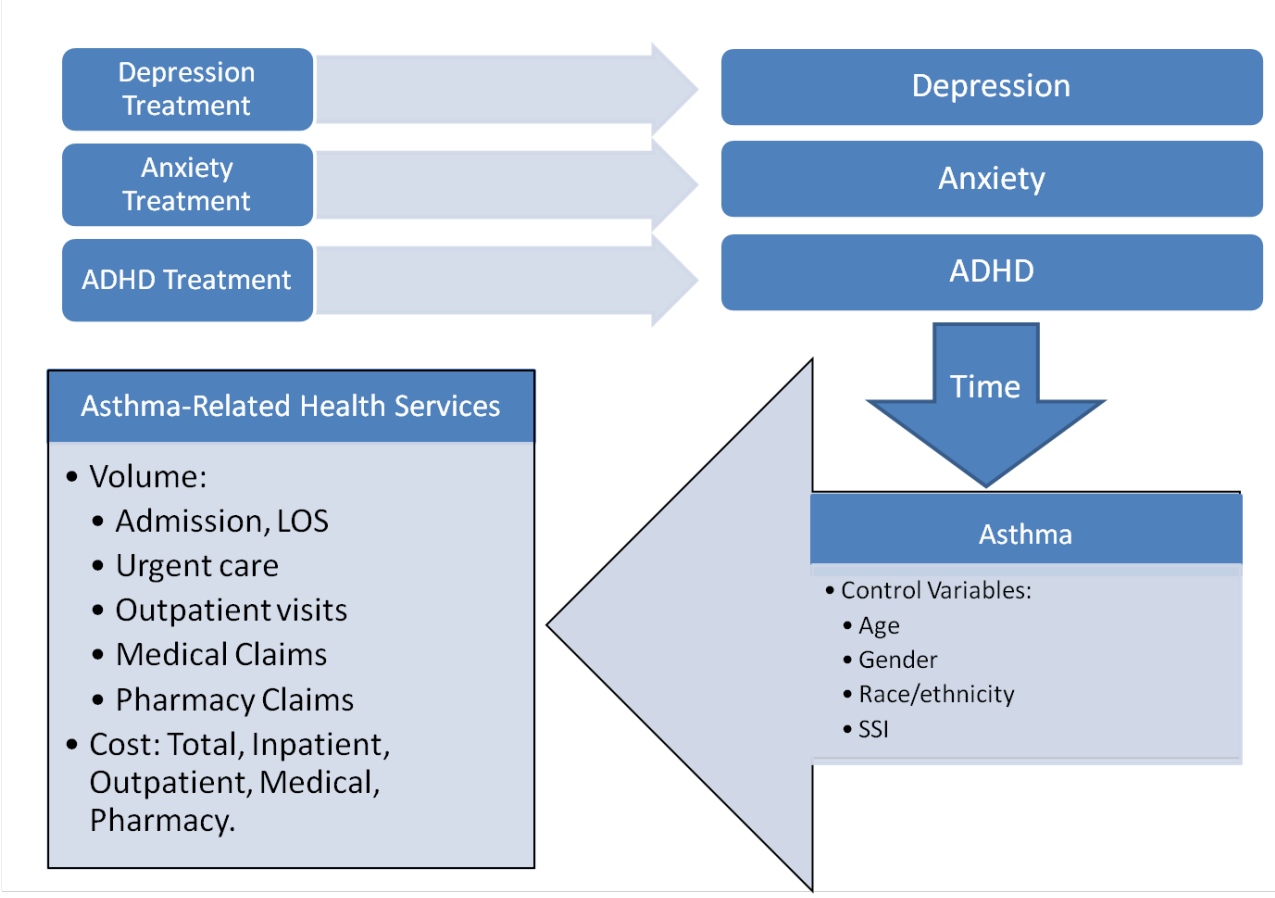

Figure 2-1. Mental health utilization model for youth with asthma. Overall conceptualization of mental health treatment mediating the underlying mental health conditions impact on modifying the delivery of asthma-related health services. Depression, anxiety, and ADHD modify the relationship between asthma and asthma related services. Additionally, the conceptualization assumes the number of months with a mental health diagnosis may have an effect on asthma related services. Lastly, mental health treatment (either presence or absence of the respective treatment or as continuous months of treatment) may mediate the relationship between mental health and asthma related services.

CHAPTER 3
METHODOLOGY

Research Questions and Hypotheses

This study addresses three main questions.

1. How does the presence of ADHD, anxiety, or depression among youth with asthma influence their asthma management, as measured as asthma-related health service use and expenditures?

2. Is there a relationship between onset of a diagnosis of ADHD, anxiety or depression among youth with asthma and their asthma management, as measured by asthma-related service use and expenditures?

3. If a relationship exists between having a diagnosis of ADHD, anxiety or depression among youth with asthma and their asthma, as measured by asthma-related health service use and expenditure, does treatment (either pharmacological and/or pharmacological or physician counseling) affect asthma management, as measured by asthma-related health service use and expenditures?

Hypothesis1a. The literature is incomplete regarding the association between asthma and ADHD. Generally, children with ADHD use significantly more medical resources and incur significantly higher costs than children without ADHD (Guevara et al., 2001). However, the associated increase in costs may not be the case in youth with asthma with respect to ADHD. Prior work by Jamoom et al. (2010) suggest that given at least some health care expenditure, youth with externalizing disorders or conditions where the psychiatric disorder is expressed externally (e.g., ADHD), had significantly lower annual nonpsychiatric-related inpatient, outpatient, and total expenditures compared to those without a comorbid externalizing psychological diagnosis. Additionally, having a comorbid externalizing psychiatric diagnosis was associated with significantly fewer nonpsychiatric-related annual inpatient admissions, shorter inpatient lengths of stay, fewer inpatient ED Visits, and fewer outpatient visits compared to those without externalizing psychiatric diagnosis. Therefore, with the exception of the

preliminary study by Jamoom et al., the literature on ADHD and asthma suggest no association between youth with asthma and ADHD. However, this study hypothesizes that those youth with asthma with a comorbid ADHD diagnosis should use fewer asthma-related services and expenditures compared to those without ADHD.

Hypothesis 1b &1c. The literature has suggested that youth with asthma that have a co-occurring depression and or anxiety have greater health service expenditures. Jamoom and colleagues (2010) have also supported the findings in the literature that those with comorbid internalizing psychiatric diagnoses (e.g., anxiety, depression) had incurred significantly more nonpsychiatric-related yearly inpatient admissions, longer length of stay, more inpatient ED visits, more outpatient visits, more outpatient ED visits, more medical/physician claims, and more pharmacy claims relative to those without internalizing diagnosis. The same study found that children with an internalizing psychiatric diagnosis were significantly more likely to have greater average yearly nonpsychiatric-related inpatient expenditures ($p<.001$), outpatient expenditures ($p<.001$), and medical/physician expenditures ($p<.01$) compared to those without an internalizing diagnosis. Therefore, based on prior literature and a prior study assessing this similar population, youth with asthma that have comorbid anxiety or depression should use more asthma-related services and incur greater expenditures compared to those without anxiety (1b) or depression (1c). Since adherence may be an issue for youth with comorbid depressive disorders, using less asthma-related pharmacy claims is also hypothesized.

Hypothesis 2. The impact of the number of months with a mental health condition may impact the utilization of asthma-related services. While this temporal relationship is

unclear, this study seeks to further understand the impact of time with a mental health condition on the association with asthma care. Ultimately, asthma related services may have independently different effects for the length one has depression, anxiety, or ADHD over time depending on the type of the health service used (e.g., pharmacy use vs. inpatient use) and mental health condition experience over time. From the literature, it is unclear whether mental health conditions trigger asthma or asthma triggers mental health issues or neither. Airway constriction and asthma symptomology has been implicated in changing brain function (Carr, 1998; Zaubler & Katon,1998; Kewalramani et al., 2008). While the evidence of changing brain function due to asthma symptomology has been implicated in the area of the brain associated with norepinephrine, fear, and panic, mental health symptomology triggering asthma attacks has also been duly noted (Blair et al., 2008; Lehrer, 1998). The asthma utilization differences associated with length of time with chronic ADHD, anxiety, or depression may help to explain these different trends. However, a significant increase or decrease in asthma utilization over time could suggest a feedback loop of requiring more or less utilization due to changing medical needs, which has relatively low mutability (Andersen, 1995). Therefore, needs related to the treatment of asthma may be complex for the number of months that youth with asthma have different mental health comorbidities. However, considering the length of time with ADHD, anxiety, and depression over time, stable utilization trends may be present. For example, the number of months one has anxiety or depression may be associated with more asthma-related inpatient care, suggesting poorly managed asthma or may be associated with decreased asthma pharmacy fills if asthma adherence is poor.

Ultimately, time effects for asthma medication use would be expected to be greater in those with better adherence. In theory, depression has been implicated in poor adherence in a variety of chronic conditions. Poor adherence has been associated with needing more emergency care (Katon et al., 2005). Therefore, the months one has a depressive disorder is hypothesized to be associated with a decrease in asthma medication over time, but associated with more asthma inpatient use over time; whereas better asthma treatment adherence would be associated with more asthma medication expenditure and use over time. ADHD and anxiety may have better utilization patterns over time, as described.

Hypothesis 3. From the literature, the impact of successful treatment of mental health comorbidities in youth with asthma remains unclear. However, it has been suggested by a number of studies that the regular treatment of mental health conditions help to improve chronic conditions, like asthma related outcomes through better adherence (Katon et al., 2005; Kewalramani et al., 2008). Therefore, I hypothesize that successful treatment for each mental health condition will mediate the asthma-related service use to appear more similar to those without mental illness (i.e., observe diminished effects in the presence of treatment variables for ADHD, anxiety, and depression). Direct treatment effects for all conditions should include more use and expenditure for pharmacological management of asthma.

Data Source

State of Florida Medicaid data will be used for analysis in this study. This section focuses on the design and scope of the Florida Medicaid Claims data, and limitations of the database used for this study.

State of Florida Claims Data

State of Florida Medicaid Claims Data represents the database for Medicaid claims from the State of Florida, which managed by the Agency for Health Care Administration (AHCA). Data analyzed for this study were extracted from the State of Florida Medicaid database. Data collected by AHCA resulted from the transaction of Medicaid patients generating a claim. Therefore, there was no complex sampling for these data. All collected data is stored and maintained by AHCA. All specific health care visit data were extracted from all children within the specified age range. This process allows for comparison of health care use patterns across all children with and without the specified mental health conditions (e.g., anxiety, depression, ADHD).

This existing administrative data comes from past stored Medicaid claims records. The variables extracted for analysis include gender, race/ethnicity, date of birth, diagnosis/treatment codes and dates, medications prescribed and dates prescribed, dollar amount paid by Medicaid for the medical visits/treatments, insurance provider, scrambled Medicaid ID number which is de-identified.

The extracted files were sent from AHCA to the Florida Center for Medicaid and the Uninsured. AHCA generated an eligibility file, inpatient file, outpatient file, pharmacy file, and medical physician file.

De-identified data. For the purposes of this study, the data set provided by AHCA contained no patient identifiers, as these data have been de-identified with only a unique, scrambled Medicaid ID number that is used for purposes to match all five claims files.

Inclusion Criteria

The Florida Medicaid claims that were received from AHCA include all eligibility and claims files from February 1, 2001 thru January 31, 2005 for children and adolescents aged 5 to 15 years as of February 1, 2001 that were enrolled in the Florida Medicaid Program. These claims data were then processed based on the following inclusion criteria.

- Continuous enrollment criteria: Enrolled in Florida Medicaid during the 36 month period with no more than 62 days of eligibility per lapse in coverage during the study period of January 1, 2002 to December 31, 2004. Multiple eligibility gaps of less than 62 days is permitted.
- Asthma criteria: Inpatient, outpatient, and medical physician claims file contained at least 2 proxy asthma diagnosis claims via ICD-9 code '493.x' in the year 2002.
- Pervasive developmental disorder criteria: Inpatient, outpatient, and medical physician claims file contained no more than 1 diagnosis of pervasive developmental disorders (ICD-9 code:'299.x') over a 3 year period were not included in this study. One diagnosis of PDD is allowed over a 3 year period to reduce excluding those with a false positive diagnosis for PDD.

Continuous coverage criteria. Continuous coverage conveys important protections and is strongly associated with utilization and access to health care services (Honberg, McPherson, Strickland, Gage, & Newacheck, 2005). For sample criteria of continuous coverage to be met, no enrollee must have more than a 62 day enrollment gap between enrollment periods. Initial enrollees pulled from the claims if they met the age criteria (5 to 15 years), and were enrolled in Florida Medicaid between February 1, 2001 and January 31, 2005.

The analytical eligible file was all those eligible Medicaid enrollees who had a start date from 2001 to 2004, and an eligible end date from 2002 to 2005. The total number of enrollees that met criteria was 73,914 enrollees. Enrollees were then assessed for gaps in coverage from January 1, 2002 to December 31, 2004. First eligibility gaps were

calculated from January 1, 2002 eligibility. Intermittent enrollment gaps were calculated by taking the difference between the last enrollment end date (plus one) from the next enrollment start date with a difference of “0” respecting no gap in coverage. If any eligibility gap was larger than 62 days, that enrollee was flagged as not being continuously enrolled. This allows for multiple lapses in coverage under 62 days at a time. Additionally exclusion flags were created for those who started their first eligible begin date after March 3, 2002. Another exclusion flag was created for those with last eligibility end date before October 31, 2004 representing 62 day earliest end latest dates for eligibility. Based on the 62 day gap rule and the two exclusion beginning and end dates, 38,607 enrollees had at least one 62 day gap in eligibility and were excluded. Therefore, 35,307 enrollees met the definition of continuous coverage.

Asthma criteria. This study is analyzing Medicaid youth with asthma. In order to truly analyze the effect of mental health in youth with asthma, a one year cohort of youth with asthma had to be constructed. The inclusion would have to be enrollees that have at least two ICD-9 diagnoses of asthma (Table 3.1) within the first year of the study (January 1, 2002 through December 31, 2002). These asthma diagnoses would be counted for the first year in the outpatient, inpatient, and medical physician claims database. Of the remaining 35,307 continuous covered enrollees, those without at least 2 ICD-9 diagnosis for asthma during the first year of the study were excluded from the sample (n=26973). Therefore, 8,334 enrollees had at least 2 ICD-9 diagnoses of asthma and were continuously covered on Medicaid.

Pervasive developmental disorder. To be included in the final sample, the 8,334 remaining enrollees that met both the inclusion definition of asthma and continuous

enrollment definition were evaluated for pervasive developmental delay as these enrollees require special services that would make the interpretability of mental health diagnosis difficult. If they had more than 1 ICD-9 diagnosis code for pervasive developmental disorders (e.g., autism), they were excluded from the study (n=93). The rationale to not exclude all pervasive developmental disorders claims could be due to codes relating to testing or false positives. There were only 38 members of the sample left in the final eligibility group that had one ICD-9 diagnosis code of '299.xx' (Table 3.1) over a 3 year period. Therefore the total sample is now 8,241 youth with asthma that are continuously covered over the 36.

Final eligible sample. The final sample contains 8,241 enrollees that had at least 2 diagnoses of asthma in the claims data that were continuously enrolled over the three year period without more than 1 diagnosis of pervasive developmental disorder during the 3 years period. This sample represents the eligible analytic sample.

Analytical working sample. For those 8,241 enrollees that met criteria, they were expanded into 36 person-month observations, and explanatory variables and dependent variables were created from the each of the claims file. Since all subjects have been enrolled in Medicaid all 3 years, there is not a need to control for length of enrollment in the Medicaid Program.

Description of Outcome, Explanatory, and Control Variables

Since this study aims to assess the impact of mental health diagnosis and related treatment on asthma related health services, outcome measures are limited to claims for all asthma-related services and expenditures.

All dependent variables of utilization and expenditure were created using 36 person months of Medicaid claims data and therefore, total expenditure and volume

data is accrued over one month for 36 observation months from January 1, 2002 until December 31, 2004. For purposes of longitudinal analysis, monthly assessment is then ranked 1 to 36 corresponding with the 36 months person-months between January 1, 2002 and December 31, 2004.

Asthma-Related Expenditures

Total monthly asthma health care expenditure represents an approach to quantify all asthma health care utilization and total asthma-related expense of care. Expenditures for Florida Medicaid claims are paid by the State of Florida. Expenditures or expenses in the claims database are direct payments to Medicaid providers by Florida Medicaid. Expenditure variables were constructed from the event files for inpatient, outpatient, medical/physician, and pharmacy. Total accrued person-month expenditure was created by summing all individual asthma specific expenditures for each individual unique scrambled Medicaid ID by month (Table 3.2).

Total asthma expenditure. Accrued monthly health care expenditures were calculated from the claims data to create 36 person-month entries for total monthly asthma-related expenditure variables from outpatient, inpatient, medical/physician, and pharmacy expenditures related to asthma. Two variables for asthma expenditure were created based on different pharmacy claims for asthma direct and asthma indirect expenditures (Table 3.2).

Volume Data

Asthma-related outpatient visits, urgent care visits, pharmacy claims for total, direct, indirect, rescuer, and controller asthma medications, inpatient admissions, inpatient length of stay and average length of stay that occurred over the defined monthly periods were calculated from the claims data (Table 3-2).

Outpatient visits. Outpatient visits relate to all claims that were accrued for each month from the outpatient file linked to specifically to the ICD-9 code for asthma.

Urgent care visits. Urgent care visits were defined from the outpatient claims file as claims with an ‘E’ visit flag. The ‘E’ Flag represents urgent care on an outpatient basis.

Pharmacy claims. Pharmacy claims relate to all pharmacy related claims accrued for each time period from the pharmacy file. Specific asthma and mental health related claims were defined through specific National Drug Code (NDC) and therapeutic class codes defined in Table 3-3. Pharmacy claims were defined as asthma-related total, direct, indirect, controller, and rescuer pharmacy claims. Direct asthma medications are considered all rescuer and controller medications. Rescuer and controller medication classifications help to understand utilization of mild asthma (e.g., reliance of rescuer medications) and moderate to severe asthma (e.g., reliance on controller medications). Indirect asthma pharmaceutical claims represent a proxy outcome measure of asthma exacerbations for out of control asthma, cough and colds, allergic rhinitis, and inflammation. Assessing the effect of indirect asthma-related claims helps to understand the association of pharmacy claims related to treating allergic and non-allergic rhinitis, a condition that is common among youth with asthma. The National Committee on Quality Assurance provided NDC codes for all measures of asthma related medications (NCQA, 2010), and was used to create the different pharmacy claim variables (see Table 3-3).

Monthly length of stay and average monthly length of stay. The monthly length of stay variable was created using a span of days using the beginning and end

date of service values for length of inpatient care accrued each person-month, this is same as monthly accrued inpatient file coverage days. The average monthly length of stay represents total length of stay days in a month divided by the number of admissions.

Admissions. To understand inpatient asthma-related volume of services, accrued monthly asthma-related admissions were counted.

Mental Health Time Effect

Trigger for mental health diagnosis. Over the 36 person-months, flags for ADHD, anxiety, and depression were created for the month that a diagnosis code for each condition was entered in the inpatient, outpatient, medical physician, or pharmacy claim files (Table 3-1). For each condition, these diagnosis flags triggered subsequent months to be classified with that specific mental health condition (e.g., depression). In otherwords, the first month that ADHD, anxiety, or depression claims is found over the 36 month period, or at the first incidence of ADHD, anxiety, and depression, that individual is flagged at that moment as having the respective condition for the remainder of the months. Hence, the first diagnosis of depression, anxiety, or ADHD acts as a trigger in the matrix and will be used as the primary explanatory variables to model to understand the association between time effects and the mental health condition with asthma-related services. There was no minimum number of months required to be flagged with an ADHD, anxiety, or depression diagnosis.

Mental Health Treatment

Flag for mental health pharmacological treatment. Over the 36 person-months of data, mental health treatment flags for ADHD, anxiety, and depression were created for any person-month where utilization attributed to each mental health condition was

occurred, as described in Table 3-3. A depression, anxiety, and ADHD flag was created for treatment indicating treatment was given in that month.

Chronicity of mental health treatment. Over the 36 month period it is possible for many to not adhere to their mental health treatment, and a measure of treatment chronicity is needed. The definition of treatment chronicity for this study is a count of continuous months of mental health treatment that would restart at “0” if the child goes 3 months goes without a prescription fill for the specific mental health condition.

Mental Health and Pharmacological Counseling. Defined by ICD-9 codes of V66.3 and V67.3, and CPT codes of 90862, 90816, 90818, 90821, 90846, 90847, 90849, 96152, 96153, and 96154 to account for patients receiving some extra mental health or pharmacological consult during their medical experience. This variable captures counseling through either physician support or physician drug maintenance with their mental health condition.

Control Variables

Observed differences in the change of asthma related utilization and expenditure as the presence of mental health comorbidities could be associated with other individual characteristics (e.g., age). Control variables, therefore, assist in adjusting for range of factors known to affect health care utilization such as age, gender, race/ethnicity, and supplemental security income (SSI) status.

While other control factors implicated in asthma, such as urban/rural characteristics or air quality index (AQI), may impact asthma related utilization and expenditure through increased reports of environmental induced asthma (e.g., high pollen). However, this study seeks to understand the impact of mental health conditions and its treatment on asthma-related utilization and expenditure. Therefore, omission of

environmental triggers may be a source of omitted variable bias in these analyses yet should not impact the general relationship of co-occurring mental health and treatment on asthma-related utilization and expenditure. The expectation is that environmental causes of asthma should neither impact mental health nor mental health treatment, which is the purpose for this study. Future analyses may look to assess the impact of the environment on the magnitude of the association.

Demographic characteristics. Since Medicaid beneficiaries will be between age 5 years and 15 years, a discrete variable controlling for age at the beginning of each person month is used. A measure of supplemental security income (SSI) status controls for significant disability, morbidity, and complex care, and will be controlled for as a dichotomous variable of SSI and non-SSI status. To account for differences in health utilization and expenditure by sex, a dichotomous variable will be used to categorize male and female. Race and ethnicity has also been used to control for different health service utilization and expenditure patterns among groups, and race/ethnicity will be categorized into Caucasian, African American, Hispanic, and Other.

Study Design and Analytic Plan

Three years of claims data from January 1, 2002 until December 31, 2004 will be used to assess the objectives of this study. According to Shadish, Cook, and Campbell (2002), an interrupted-short time series design with control groups improves the strength of interpretability. Longitudinal data represents the best way to assess the impact of mental health comorbidity and treatment on asthma-related use and expenditures over time.

The primary analysis will use panel data methods to determine causation between mental health and asthma. Specifically, fixed and random effect models for utilization

will be used to estimate impact of mental health and treatment effects from the panel data (Wooldridge, 2006). For utilization data, the majority of analyses will used a fixed effect negative binomial regression to assess asthma specific utilization. However expenditures will be addressed through a variety of generalized estimating equations (GEE) with an unstructured correlation to allow for autocorrelation that tends to be common with panel data. This sort of analysis on predicting expenditure data is not a fixed effect model, as it considers population averages over the panel to model differences in expenditure.

Below is an example of deriving and fitting a fixed effect model to demonstrate the analytical approach to model utilization and expenditures. While not the only method used to predict the impact of asthma-related outcomes from control and explanatory variables in this study, represents one main analytical approach to model utilization.

Fixed Effect Model

The fixed-effects model is

$$Y_{ij} = a + x_{ij}\, b + v_i + e_{ij}. \tag{3-1}$$

From which it follows that

$$\bar{Y}_i = a + \bar{x}_i b + v_i + \bar{e}_i \tag{3-2}$$

Where $\bar{Y}_i$ $\bar{x}_i$ $\bar{e}_i$ are with averages of Y_{ij} x_{ij} e_{ij} within i.

Subtracting (3-2) from (3-1), to obtain

$$Y_{ij} - \bar{Y}_i = \left(x_{ij} - \bar{x}_i\right)b + \left(e_{ij} - \bar{e}_i\right) \tag{3-3}$$

From (3-3), a remains unestimated in this formula.

$$\bar{\bar{Y}} = a + \bar{\bar{x}} b + \bar{v} + \bar{\bar{e}} \tag{3-4}$$

Where $\bar{\bar{Y}}$ $\bar{\bar{x}}$ $\bar{v}$ $\bar{\bar{e}}$ are the grand averages of Y_{ij} x_{ij} v_i e_{ij}.

For instance,

$$\bar{\bar{Y}} = \frac{\sum_{i=1}^{n}\sum_{j=1}^{J_i} Y_{ij}}{total\, number\, of\, observations}.$$

Summing (3-3) and (3-4) to obtain,

$$Y_{ij} - \bar{Y}_i + \bar{\bar{Y}} = a + \left(x_{ij} - \bar{x}_i + \bar{\bar{x}}\right) b + \left(e_{ij} - \bar{e}_i + \bar{v}\right) + \bar{\bar{e}}. \quad (3\text{-}5)$$

Fixed effect models estimate the constraint $\bar{v}$ = 0, such that model estimates,

$$Y_{ij} - \bar{Y}_i + \bar{\bar{Y}} = a + \left(x_{ij} - \bar{x}_i + \bar{\bar{x}}\right) b + noise.$$

However, this FE model will estimate v_i fixed parameters. Fixed-effects regression produces consistent coefficient estimates and standard errors as ordinary regression when indicator (dummy) variables are included for each of the groups. Since the fixed-effects model is (3-1) and v_i are fixed parameters to be estimated, this is the same as

$$Y_{ij} = x_{ij}\, b + v_1\, d1_i + v_2\, d2_i + \ldots e_{it} \quad (3\text{-}6)$$

FE model of mental health as modifier of asthma services.

Using equation (3-6) to parameterize the equation such that,

$$Y_{ij} = x_{ij}\, \beta + \gamma D_j + \mu_{it}. \quad (3\text{-}7)$$

Consider a model with a dependent variable of asthma-related utilization and expenditure, Y_{ij}, of individual i, in panel month j.

$$Y_{ij} = Dep_{ij}\beta_1 + Anx_{ij}\beta_2 + ADHD_{ij}\beta_3 + Month_{ij}\beta_4 + +\gamma_8 age_j + \gamma_9 sex_j + \gamma_{10} Black_j + \gamma_{11} Hisp_j + \gamma_{12} oth_j + \gamma_{13} SSI_j + \mu_{it} \quad (3\text{-}8)$$

This example model shows the basic parameterized fixed effect model (3-8) describing each mental health diagnosis (i.e., ADHD anxiety, and depression) as a modifier in the delivery of asthma related services. For each mental health (i.e., ADHD,

anxiety, and depression) impact on asthma related services, interpretation is read through each mental health coefficient.

However, in order to obtain a causal association, adding condition*month interaction terms, allows for the temporal association between each condition and the person-month to be assessed. This condition*month interaction represents the number of months of having the mental health condition.

$$Y_{ij} = Dep_{ij}\beta_1 + Anx_{ij}\beta_2 + ADHD_{ij}\beta_3 + Month_{ij}\beta_4 + (Dep_{ij}Month_{ij})\beta_5 + (Anx_{ij}Month_{ij})\beta_6 + (ADHD_{ij}Month_{ij})\beta_7 + \gamma_8 age_j + \gamma_9 sex_j + \gamma_{10}Black_j + \gamma_{11}Hisp_j + \gamma_{12}oth_j + \gamma_{13}SSI_j + \mu_{it} \quad (3\text{-}9)$$

Using such a model (3-9), allows specific beta coefficients to determine the magnitude and fixed effects of ADHD, anxiety, and depression on asthma-related use and expenditure. The time related effects, or the effect of the number of months having the specific mental health condition, will be captured by the interaction terms between ADHD*Month, Anxiety*Month, and Depression*Month. The fixed effects for the control variables are represented through gamma coefficients age, sex, race/ethnicity, and SSI status, which are controlled in this model.

To answer the first hypothesis, model (3-8) or model (3-9) helps in understanding the mental health role as a modifier of asthma service. However, with model (3-9), analysis for each condition must take into account the number of months one has the specific mental health condition. The overall impact for each condition is addressed by jointly examining the significance for that condition as well as the respective coefficient on the interaction with time to fully assess the utilization effect of having the mental health condition (i.e., is time an effect modifier). In depression, for example, to assess

depression significance and magnitude, one would have to use the model without the time interaction (3-8). However, the model containing the time interaction (3-9) for depression, for example, the overall effect of depression would need to be assessed jointly (β_1 and β_5) as the effect of depression on utilization is split into both β_1 and β_5 and cannot be assessed independently for overall depression effect.

To answer the second hypothesis as to the temporal relationship between asthma service use and each mental health condition, the significance for the temporal interaction, specifically the coefficients associated with the mental health condition as well as the interaction of month and mental health condition must be considered. The question is essentially does the number of months with a mental health condition modify the effect of depression? Well to determine the answer, first the significance and magnitude of both β_1 and β_5 would need to be assessed. First, β_5 would represent the number of months of depression. The significance of the magnitude and directionality of this effect would describe depression trends over the 36 person month period. Whereas, β_1 does not assess the complete effect of time rather the general effect of depression on utilization not attributed to time. Hence the need to assess both β_1 and β_5 to consider the total effect of depression on specific asthma service utilization for both the time-effect of depression as well as the general effect of depression utilization and requires caution when talking about one without the other. Generally, the overall impact of depression (depression both with and without time effects) are contained and assessed in model 3-8. Model 3-9 allows for understanding the effects of time on asthma related utilization attributed to depression. For example, if the depression*month coefficient (β_5) has an incidence rate ratio over 1 with a p-value <0.05, this would

suggest significant positive utilization for those with depression over time. Then it's important to assess the magnitude and significance of the relationship for β_1 to fully understand the effect of the time. If the significance and directionality change, then time is an effect modifier and must be taken into account to fully understand the relationship of depression. In estimating the impact of time on asthma related use in comorbid anxiety, this would be done by assessing β_2 and β_6. For ADHD, the impact of time on asthma related use for those with comorbid ADHD would be done by assessing β_3 and β_7.

Again this approach only attributes utilization to the mental health condition after the mental health diagnosis occurs in the claims data. Therefore, before a mental health diagnosis is obtained in the claims, this does not count toward the effect. This provides better evidence for a causal effect. Thus, causality on asthma services and each mental health condition can be determined. However, caution is needed on causal inference due to limitations. Such limitations include false negatives in claims data for mental health condition identification. For example, those with ADHD, anxiety, and depression may have had claims prior to January 1, 2002 which would not appear in the claims data until after treated by the doctor and coded in the claims file. Also those with ADHD, anxiety or depression tend to be underreported in claims data (Spettell et al., 2003).

FE Model with mental health treatment as a mediator of mental health in asthma services.

Using equation (3-8) further parameterization of the equation is required to allow for new dummy variables were added for months of any anxiety, depression, and ADHD treatment.

Consider a fixed effects model with a dependent variable of asthma-related utilization and expenditure, Y_{ij}, of individual i, in panel month j, dummy variables for any pharmacological specific month treatment for ADHD, anxiety, and depression was added to the equation (3-10), as well as any pharmacological consult/ psychosocial counseling (MHC).

$$Y_{ij} = Dep_{ij}\beta_1 + Anx_{ij}\beta_2 + ADHD_{ij}\beta_3 + DepT_{ij}\beta_4 + AnxT_{ij}\beta_5 + ADHDT_{ij}\beta_6 + MHC_{ij}\beta_7 + Month_{ij}\beta_8 + \gamma_9 age_{ij} + \gamma_{10} sex_j + \gamma_{11} Black_j + \gamma_{12} Hisp_j + \gamma_{13} oth_j + \gamma_{14} SSI_j + \mu_{it} \quad (3\text{-}10)$$

For the next model, however, an additional variable per mental health treatment was created. This variable assesses the impact of consecutive mental health treatment. Mental health treatment laps of 3 months or more will reset to “0”. Hence, this variable represents the number of months of consecutive mental health treatment by attempting to control for mental health chronicity.

Therefore, model 3-11 represents these 3 added variables.

$$Y_{ij} = Dep_{ij}\beta_1 + Anx_{ij}\beta_2 + ADHD_{ij}\beta_3 + DepT_{ij}\beta_4 + AnxT_{ij}\beta_5 + ADHDT_{ij}\beta_6 + MHC_{ij}\beta_7 + CMDepT_{ij}\beta_8 + CMAnxT_{ij}\beta_9 + CMADHDT\beta_{10} + + Month_{ij}\beta_{11} + \gamma_{12} age_{ij} + \gamma_{13} sex_j + \gamma_{14} Black_j + \gamma_{15} Hisp_j + \gamma_{16} oth_j + \gamma_{17} SSI_j + \mu_{it} \quad (3\text{-}11)$$

To answer the third hypothesis, we must analyze each mental health condition from model (3-8) and (3-11) independently for the treatment effect on asthma-related utilization and expenditure and assess the respective coefficient on the interaction with time to fully understand the expenditure/use association of having treatment on the mental health condition. In depression treatment, for example, examining β_1, β_4, and β_8

will give an understanding of how comorbid depression treatment impacts asthma-related use and expenditure. In understanding the impact of anxiety treatment, this would be done by examining β_2, β_5, and β_9. For ADHD treatment, examining β_3, β_6, and β_{10} would allow for the assessment of the impact on asthma-related services. While the assumption of having consistent treatment is to imply controlled mental health, it may provide a good understanding of how regular mental health treatment impacts asthma-related services. The counseling variable allows for the assessment of the presence of mental health counseling and mental health pharmacological management impacts utilization.

Fixed Effects Model Assumptions

Using a FEM, certain assumptions must be stated. First for each i, the model is, $Y_{ij} = a + x_{ij}\beta + v_i + u_{it}$, where each beta coefficient represent parameters to estimate and a is the unobserved effect. Next, the assumption must be made that the data represents a random sample from the cross section. Third, each explanatory variable changes over time (for at least some i), and no perfect linear relationship exist among the explanatory variables. Fourth, for each time period, the expected value of the idiosyncratic error given the explanatory variables in all time periods and unobserved effect is zero (i.e., exogeneity assumption). These four assumptions make the fixed effect model estimator unbiased. Also, the Var$(u_{it}|X_i, a_i)$ = Var(u_{it}) = σ_u^2 for all t =1,…,T (Woodridge, 2006).

While fixed effects was used as an example to illustrate modeling the impact of mental health and mental health treatment on asthma-related utilization and expenditure, random effect models may also be used in the event that a fixed effect

model will not converge. Random effect assumes the above four assumptions plus additional requirement that the unobserved heterogeneity, a_i is independent of all explanatory variables at all time periods. If a_i is correlated, then fixed effects is preferred. Random effects does not allow for arbitrary correlation between the unobserved heterogeneity, a_i, and key explanatory variables, X_{itj}. Fixed effects tend to be preferable as it allows for estimating ceteris paribus effects, or effects that stay the same. However both have consistent estimates (Woodridge, 2006).

GEE Modeling

Using general estimating equation method allows for the fitting of population-averaged panel-data models, which allows a great deal of flexibility in fitting models. In STATA the option is xtgee, which fits general linear models and allows for the specification of within-group correlation structure for the panels. The xtgee command in STATA allow for the specifying a distribution and link function and within-group correlation. For the volume analyses, for example, a negative binomial distribution and link function with unstructured correlation was specified. This would represent a population averaged model, which is not the same as what would be observed in fixed effect models. For expenditure data, specifying a gamma distribution and log link function with unstructured correlation. For predicting expenditure using a logistic regression, the xtgee model specifying a binomial distribution with a link function of logit to obtain the natural log of the odds ln (y/(1-y)). For each of these models, predicted estimates and standard errors were obtained. The autocorrelation/autoregressive nature of panel data may lead to some problems with certain within-group correlation structures. Hence, autocorrelation is problematic with time series data when the error is

correlated over time, and testing for serial correlation is needed AR(q). Adjustment through correlation specification would improve autoregressive nature of time series data (Wooldridge, 2006).

There are a variety of different specifications of correlation available with xtgee in STATA. For example, use of the exchangeable, or compound symmetry, as the working correlation matrix with measured data and identity link function is equivalent to using a random effects model with a random intercept per cluster (Horton & Lipsitz, 1999). For small observations per cluster with a balanced and complete design, an unstructured matrix works quite well, yet for those with clustered observations, a lack of logical ordering for observations within a cluster may suggest an exchangeable correlation matrix (Horton & Lipsitz, 1999). Additionally specifying autoregressive (AR) correlation by the order number is allowed. The nature of 36 person months suggests 36 observations per cluster, may suggest selection of either an exchangeable, AR(#) or unstructured correlation matrix depending on the specific dependent variable.

GEE Model Assumptions

Unlike FEM for utilization/count data, GEE Models were used in constructing all logistic regression (if necessary) and gamma loglink regressions for all expenditure data. Two part models were used for expenditure data with a high number of zero dollar expenditure. Hence, two part models were constructed for inpatient and outpatient expenditures.

Asthma expenditure modeling would be adjusted based on amount of kurtosis. Manning and Mullahy (2001) suggests that kurtosis score over 4 would use a log-linear approach to estimating asthma expenditure. While a score under 4 would indicate using

a gamma distribution approach. All expenditure variables had a kurtosis score of 4 or less to use a gamma family distribution with log link using STATA (StataCorp, 2007).

Institutional Review Board Approval.

This study received University of Florida Institutional Review Board (IRB) approval on July 8, 2009 (#236-2009).

Software

All data programming was done using SAS 9 (SAS Institute Inc., Cary, NC), and all model estimates were generated using Stata 10.0 (StataCorp., 2007).

Table 3-1. ICD-9 codes used to select asthma, depression, anxiety, and ADHD

Heath Condition	ICD-9 Codes
Asthma	493.xx
Allergic Rhinitis	477.xx
Depression	296.2, 296.20, 296.21, 296.22, 296.23, 296.24, 296.25, 296.26, 296.3, 296.30, 296.31, 296.32, 296.33, 296.34, 296.35, 296.36, 296.9, 296.90, 296.99, 298.0, 293.83, 309.0, 309.1, 300.4, 311, 313.1
Anxiety	300.0, 300.00, 300.02, 300.09, 300.1, 300.10, 300.11, 300.12, 300.13, 300.14, 300.15, 300.16, 300.19, 300.2, 300.20, 300.21, 300.22, 300.23, 300.29, 300.3, 300.5, 293.84, 313.0
ADHD	314.0, 314.00, 314.01
PDD	299.xx

ICD-9 codes used in defining the different health conditions used in this study.

Table 3-2. Summary of monthly outcome measures

Asthma measures
Expenditure
Total expenditure 1 using indirect asthma medications
Total expenditure 2 using direct asthma medications
Total asthma-related inpatient expenditures
Total asthma-related outpatient expenditures
Total asthma-related medical physician expenditures
Total asthma-related pharmacy expenditures
Volume
Number of asthma-related admissions
Number of asthma related length of stay
Number of asthma-related outpatient visits
Number of asthma-related urgent care visits
Number of asthma-related medical claims
Number of asthma-related total pharmacy claims
Number of asthma-related direct pharmacy claims
Number of asthma-related indirect pharmacy claims
Number of asthma-related rescuer medications
Number of asthma-related controller medications

Dependent variables list used in this study.

Table 3-3. Pharmacy measures defined by Therapeutic Class or National Drug Code

Pharmacy measures	TCC	HEDIS NDC files from NCQA
Asthma Treatment		
Rescuer	J5D, J5A, J5F, A1D, J2B	SABA from asthma HEDIS
Controler	A1B, P5A, J5J, J5G, Z4B, J5D, Z2F, Z2L	Anticholinergics HEDIS, Asthma HEDIS w/o SABA
Direct Asthma	A1B, P5A, J5J, J5G, Z4B, J5D, Z2F, Z2L, J5A, J5F, A1D, J2B	Anticholinergics HEDIS, Asthma HEDIS
Indirect asthma: or allergic rhinitis	Q7A, Q7C, Q7E, Q7P, Q7W, B3A, B3J, B3K, B3R, B3T, B3X, B4Q, B4R, B4W, H6A, Z2A, H3A, H3E, H3F	Anticholinergics HEDIS, Pharyngeal antibiotics HEDIS
ADHD Treatment	H2A, H2V, H7Y	ADD/ADHD HEDIS
Anxiety Treatment	H2D, H2E. H2F, H7C, H2U, H2S, H7J, J7C	
Depression Treatment	H2U, H7B, H7N, H7D, H2S, H7C, H7E, H2W, H2X, H7Z, H7J	Depression HEDIS

TCC=Therapeutic class code; NDC = National Drug Code; NCQA HEDIS retrieved from http://www.ncqa.org/tabid/1091/Default.aspx

CHAPTER 4
RESULTS

Overview

The beginning of this section describes the sample characteristics and average monthly utilization and expenditure data for the sample of Medicaid youth with asthma. The second part of this section describes the models and estimates for negative binomial regression using fixed effects, random effects, or population averaged models. The third part of this results section analyzes expenditures using population averaged models.

For both volume and expenditure analyses, four models will be used to assess the association between mental health and mental health treatment on asthma-related service use and expenditure. Specifically, the four models:

- Model 1 tests whether ADHD, anxiety, and depression independently act as modifiers of asthma-related use.
- Model 2 tests whether months with the specific mental health diagnosis modifies the impact of ADHD, anxiety, and depression on asthma-related use and expenditure using the addition of month-mental health condition interaction terms added to model 1.
- Model 3 tests whether presence of mental health treatment mediates the association of ADHD, anxiety, and depression with asthma-related service use and expenditure.
- Model 4 adds to model 3 by including indicators for the number of months of ADHD, anxiety, and depression treatment to assess whether continuous mental health treatment has an additive effect on asthma-related service use and expenditure.

Sample Characteristics

Sample characteristics are reported in Table 4-1. The sample mean age was 11.2 years (s.d.=3.03) and consisted of more boys (55.7%) than girls. Also, the sample was racially and ethnically diverse, having 30.9% black, 25.7% white, 24% Hispanic, and

19.4% other. Approximately 30% of the sample had supplemental security income (SSI). Over the three year period, about 1 of 10 youth with asthma had depression (11.4%), 18.5% had ADHD, and 3.5% of youth with asthma had anxiety diagnosis. Over a third of the youth with asthma had allergic rhinitis over the 3 year period. Lastly, only 5.6% had received pharmacological consult or physician counseling over the three year period.

Average Monthly Expenditure

The average monthly expenditure for the sample of Medicaid youth with asthma are found in Table 4-2. Relative to those without ADHD, youth with comorbid ADHD had less average monthly inpatient expenditures ($23.68 vs. $25.67), yet more pharmacy ($61.57 vs $53.96) and total asthma expenditures ($108.39 vs.103.83). Compared to those without anxiety, youth with comorbid anxiety had higher observed average monthly asthma-related total expenditures ($150.86 vs. $97.73), direct expenditures ($128.85 vs. $82.28), pharmacy expenditures ($75.69 vs. $52.27), and inpatient expenditures ($48.71 vs. $21.83). Lastly average monthly expenditures for those with depression were higher for inpatient ($44.23 vs. $22.35), pharmacy ($61.43 vs. 54.35), direct ($131.22 vs. $100.46) and total asthma ($112.66 vs. $84.52) expenditures compared to those without depression.

Average Monthly Utilization

The observed average monthly asthma-related volume data for the sample can be found on Table 4-3. Compared to those without ADHD, youth with comorbid ADHD had fewer observed average monthly admissions (.0058 vs. .0064), fewer outpatient visits (.034 vs.038), fewer urgent care visits (.022 vs.024), and fewer medical claims (.28 vs. .32). However, those with comorbid ADHD had more total asthma-related pharmacy

claims (.97 vs. .86) compared to those without ADHD. Compared to those without anxiety, those with comorbid anxiety more average monthly admissions (.009 vs. .006), longer monthly length of stay (4.5 vs. 3.3), longer average monthly length of stay (4.4 vs. 3.1), more medical claims (.323 vs. .316), and more pharmacy claims (1.11 vs. 0.84). Compared to those without depression, those with comorbid depression was associated with more admissions (.009 vs. .006), longer length of stay (4.5 vs.3.3), longer average length of stay (4.3 vs. 3.1) and more total pharmacy claims (.98 vs. .86). However, depression was associated with fewer urgent visits (.23 vs .24) and fewer medical claims (.27 vs. .32) compared to those without.

The observed average pharmacy utilization is found in Table 4-3. For those with ADHD, there seemed to be more monthly direct (.61 vs. .57) and indirect (.42 vs. .36) pharmacy claims, as well as more controller claims (.35 vs. .30) relative to those without ADHD. For those with anxiety, there were more average monthly direct (.70 vs. .56) and indirect asthma (.49 vs. .35) related pharmacy claims, as well as more rescuer (.30 vs. .23) and controller (.37 vs. .30) medication use relative to those without anxiety. Depression had more average monthly direct (.60 vs. .58), indirect (.45 vs. .35), and controller (.34 vs. .30) medication use compared to those without depression.

Negative Binomial Regression

Prediction of utilization among youth with asthma was modeled through negative binomial regression. Negative binomial regression was fit for inpatient admissions, length of stay, outpatient and urgent care visits, and medical and pharmacy claims for youth with asthma on Medicaid. All 4 models described above were used to predict utilization controlling for age, sex, race/ethnicity, and SSI status. The majority of these models used a fixed effects analysis with the exception of inpatient admissions and

length of stay, which used random effects. Presentation of the results will be through two tables. The first table presents incident rate ratios (IRR) obtained through the fitted model. The second table presents the predicted mean estimates from the model.

Inpatient Utilization. A fixed effects negative binomial model with random effects was used to construct IRRs (Table 4-4) and predict average monthly asthma related admissions (Table 4-5). With respect to monthly asthma-related admissions, the first model shows a statistically significant 33% ($p<0.01$) and 43% ($p<0.01$) increase in admissions for those with anxiety and depression, respectively, compared to those without. However, those without ADHD had 27% more admissions compared to those with ADHD. Therefore, these results support the first hypothesis suggesting mental health diagnosis is associated with the utilization of asthma services. Specifically, these results support the hypothesis of an increase in admissions use for anxiety and depression, yet a decrease in service use for those with ADHD. There were no significant mental health condition-month interactions observed in model 2, suggesting the number of months a person has any of the mental health diagnoses does not modify the association with asthma related inpatient admissions. Models 3 and 4 suggest mental health treatment diminishes the effect of all mental health conditions on asthma-related hospital admissions. Specifically for overall impact of treatment, model 3 finds that youth with asthma receiving anxiety treatment had 47% ($p<0.01$) more inpatient admissions than those not receiving treatment. Where no main ADHD treatment effect was observed, model 4 finds that continuous treatment of ADHD was associated with asthma related admissions. Specifically the rate of asthma-related admissions

decreased for every additional month of continuous ADHD treatment (IRR=.973, p<0.01).

A mixed effect (both fixed and random effect), negative binomial model examining monthly length of stay for those with inpatient admissions was used to construct IRRs (Table 4-6) and predict average monthly length of stay (Table 4-7). Addressing length of stay for those with inpatient admissions, the first model shows a significant 29% longer monthly length of stay (LOS) for those with anxiety compared to those without (3.95 vs. 3.05 (this notation represents those predicted estimates for average monthly asthma-related length of stay for anxiety being 3.95 days versus 3.05 days for those without, and this notation will be used throughout the results section); p<0.01). There were no significant mental health condition-month interactions observed in model 2, suggesting the number of months a person has a mental health diagnosis does not have an association with asthma related monthly length of stay. Models 3 and 4 suggests that mental health treatment did not diminish the effect of anxiety for asthma-related LOS, as anxiety maintained an elevated association with length of stay (Model 3: IRR=1.28, p<0.01; Model 4: IRR=1.26, p<0.01) compared to those without anxiety. No main treatment effects were associated with length of stay.

Medical claims. Results for the fixed effects negative binomial for the medical claims are found on Tables 4-8 (IRR) & 4-9 (predicted estimates). Model 1 illustrates youth with asthma that have ADHD (.26 vs. .23 (this notation represents predicted medical claims estimates for ADHD vs. those without ADHD, and will be used throughout the results section) or anxiety (.26 vs. .23) had an 11% and 13% significant increase in medical claims, respectively, compared to those without anxiety.

Depression, however, had fewer incident asthma-related medical claims (IRR = .900, p-value<0.001). Unlike anxiety, utilization for those with depression and ADHD were different than hypothesized. Model 2 suggests that the number of months with comorbid ADHD or depression diagnosis was associated with incident asthma-related medical claims. Namely, the rate of medical claims increased by 0.3% (p<0.05) for every additional month of having a diagnosis of ADHD. However, the number of months with depression was associated with fewer incident claims (IRR=.991). While the ADHD*month and depression*month terms were significant, the individual mental health disorders lost significance implying the number of months with the mental health condition adjusted away the main overall effect observed in model 1. Model 3 was assessed for the effects of mental health treatment. Youth with asthma with depression had fewer medical claims (IRR=.842, p<0.01) compared to those without depression, whereas those with anxiety had 8% (p<0.01) more medical claims compared to those without anxiety. Overall, those youth with asthma on ADHD, anxiety, and depression treatment had 23% (p<0.01), 10% (p<0.05), and 17% (p<0.01) more incident medical claims, respectively, compared to those not taking those medications. Overall diminished effects observed with treatment models (model 3 and model 4) suggest that those receiving treatment for anxiety and ADHD use medical claims similarly to those without the condition, whereas those receiving treatment for depression had resulted in fewer incident medical claims than those without depression. For continuous treatment effects from model 4, the rate of medical claims increased by 1.0% (p<0.05) for every additional month of continuous depression treatment. The main effect for depression

treatment (continuous or dichotomous) was associated with more asthma-related medical claims.

Outpatient visits. Fixed effects negative binomial regression for outpatient visits can be found on Tables 4-10 (IRR) and 4-11 (predicted estimates). The first model suggests that those with anxiety had 23% more outpatient visits (.63 vs. .52) compared to those without an anxiety. Thereby, suggesting that those with anxiety have a propensity to have more outpatient experiences compared to those without anxiety. There were no significant mental health condition-month interactions observed in model 2, suggesting the number of months a person has a mental health diagnosis does not modify the association with asthma related outpatient visits. Model 3 showed diminished effects for all 3 mental health conditions. Specific overall treatment effects for depression and anxiety treatment was observed. Youth receiving anxiety treatment had 49% more incident asthma-related outpatient visits ($p<0.01$) compared to those without. Those youth with asthma receiving depression treatment, however, had fewer asthma-related outpatient visits (IRR=.814, $p<0.05$) compared to those without. Overall mental health treatment diminishes the effect for all 3 mental health conditions association with asthma-related outpatient visits, such that those who received mental health treatment use asthma outpatient services similar to those without the condition. Model 4 did not show any continuous mental health treatment effects.

Urgent care visits. Fixed effects negative binomial regression models were constructed for urgent care utilization, results presented in Tables 4-12 (IRR) and 4-13 (predicted estimates). The first model suggests youth with anxiety had 33% more asthma-related urgent care visits (1.6 vs. 1.2, $p<0.01$) to those without anxiety.

Interaction terms for months of having any of the 3 mental health diagnoses were not significant in model 2, although some general associations with depression and anxiety were observed; that is, compared to those without anxiety, those with anxiety had 51% more urgent care visits (IRR=1.51; 1.5 vs.1.3, $p<0.01$) when controlling for months with anxiety; whereas controlling for months of depression, those with depression had incurred significantly fewer urgent care visits (IRR=0.700; .86 vs. 1.3; $p<0.05$) compared to those without depression. Model 3 suggested that overall depression treatment was associated with fewer urgent care visits (IRR=.654, $p<0.01$), where as anxiety treatment was associated with 77% more asthma-related urgent care visits ($p<0.01$). Model 4 suggested no appreciable continuous mental health treatment effects. While no significant relationship was observed for depression, anxiety, and ADHD, treatment diminishes the effect (e.g., IRR magnitude) of the mental health conditions association with asthma-related urgent care to be similar to those without the respective mental health condition.

Total monthly asthma pharmacy claims. Total monthly asthma-related pharmaceutical claims predicted estimates and incident rate ratios from the fixed effects negative binomial are found in Table 4-14 (IRR) and Table 4-15 (predicted estimates). Model 1 shows that youth with ADHD and anxiety have 19% (1.6 vs. 1.4, $p<0.01$) and 37% (1.9 vs. 1.4, $p<0.01$) more monthly total asthma-related fills than those without the respective conditions, whereas those with depression had significantly fewer total asthma-related fills (IRR=0.930; 1.3 vs. 1.4, $p<0.01$) compared to those without depression. Assessing the number of months with each mental health condition and the association with total asthma fills suggest that there was a significant interaction for

anxiety*month (p<0.01) as well as depression*month (p<0.01). The rate for total asthma fills increased by 0.4% (p<0.01) for every additional month of having an anxiety diagnosis. The rate for total asthma fills decreased for every additional month of having a depression diagnosis (IRR=.993, p<0.01). Controlling for number of months with depression, those with depression had 7.4% (p<0.01) more total asthma fills than those without depression. Controlling for number of months with ADHD and anxiety, those with ADHD and those with anxiety had 17% and 27% increase in total asthma fills, respectively, compared to those without ADHD and anxiety. Model 3 shows treatment diminishes the effect of ADHD and anxiety on asthma pharmacy claims, as ADHD (IRR=.990, p<0.01) and anxiety (IRR=1.24, p<0.01) suggest that those with ADHD and anxiety receiving treatment had more similar use to those without ADHD and anxiety. However, those with depression had fewer total fills, suggesting those with depression used even fewer total asthma fills compared to those without depression (IRR=.828, p<0.01). Those who had received ADHD, anxiety, and depression treatment had 49%, 26%, and 24% more monthly asthma-related total fills compared to those untreated for the respective mental health medication. Additionally having pharmacological counseling was associated with 24% greater asthma-related prescription fills (1.8 vs. 1.4, p<0.01). Model 4 assess continuous treatment effects. The rate of total asthma fills increased by 2% (p<0.01) for every additional month of continuous ADHD treatment. The rate of total asthma fills increased by 2% (p<0.01) for every additional month of continuous anxiety treatment.

Direct asthma pharmacy claims. Fixed effect negative binomial regression models for monthly direct asthma pharmacy claims are presented in Table 4-16 (IRR)

and 4-17 (predicted estimates). Model 1 shows youth with ADHD (IRR=1.15; 2.2 vs. 1.9, p<0.01) and anxiety (IRR=1.29, 2.4 vs. 1.9, p<0.01) have significantly more monthly direct asthma prescription fills compared to those without. Whereas, those with depression had significantly fewer direct asthma fills (IRR=.907; 1.80 vs 1.98, p<0.01) compared to those without. Similar to total asthma pharmacy claims, there was a significant effect associated with months with a mental health condition (ADHD*month (p<0.01), anxiety*month (p<0.01), and depression*month (p<0.01)) and direct asthma pharmaceutical claims. The interpretation for ADHD and anxiety suggest the number of months with ADHD (p<0.01) or anxiety (p<0.01) was associated with more direct asthma-related prescriptions. The number of months with depression was associated with fewer direct asthma fills (IRR=.991, P<0.01), yet the controlling for months of depression modified the main depression effect to having 9% more direct asthma pharmacy claims (IRR 1.09, p<0.01) compared to those without depression. Model 3 suggests that mental health treatment diminishes the effect for ADHD and anxiety on direct pharmacy claims, such that those receiving treatment for ADHD and anxiety fill direct asthma prescriptions similarly to those without ADHD or anxiety. However for depression, the effect of treatment resulted in even lower direct asthma-related prescription fills (IRR=.796, p<0.01) compared to those without depression. Those with physician counseling had 16% more direct asthma fills than those who did not receive physician counseling. Model 3 also show that overall treatment for all mental health conditions were associated with increased direct asthma-related prescription fills. Specifically, the mean effect of ADHD, anxiety, and depression treatment had used 44% (p<0.01), 18% (p<0.01), and 26% (p<0.01) more direct asthma fills, respectively,

compared to those not receiving the particular mental health treatment. In model 4, continuous treatment effects were observed. The rate of direct asthma pharmacy claims increased 0.9% ($p<0.01$) for every additional month of continuous ADHD treatment. The rate of direct asthma pharmacy claims increased 2.0% ($p<0.01$) for every additional month of continuous anxiety treatment.

Indirect asthma pharmacy claims. A fixed effect model negative binomial regression was used for indirect asthma pharmacy fills on Tables 4-18 (IRR) and 4-19 (predicted estimates). Model 1 shows that ADHD and anxiety were associated with a 17% (5.4 vs. 4.6, $p<0.01$) and 15% (5.3 vs. 4.6, $p<0.01$) increase, respectively, in indirect asthma prescription fills compared to those without ADHD or anxiety. Model 2 shows that the rate of indirect asthma claims decreased for every month with a depression diagnosis (IRR=.997, $p<0.05$). Controlling for months with the specific mental health condition, ADHD (IRR=1.17, $p<0.01$), anxiety (IRR=1.13, $p<0.01$), and depression (IRR=1.08, $p<0.05$) had significantly more indirect asthma claims compared to those without ADHD, anxiety, and depression. Model 3 assess the impact of mental health treatment as a mediator of ADHD, anxiety, and depression on indirect asthma prescription fills. Mental health treatment diminishes the effects for all mental health conditions. Specifically, mental health treatment resulted in fewer indirect asthma prescription fills for those with depression compared to those without depression (IRR=.925; 4.4 vs. 4.8, $p<0.01$), yet resulted in 8% more indirect fills for those with anxiety compared to those without anxiety (IRR=1.08; 4.9 vs. 4.5, $p<0.01$). Treatment effects are present, as those receiving ADHD, anxiety and depression treatment were associated with 38% ($p<0.01$), 24% ($p<0.01$), and 18% ($p<0.01$) more indirect asthma

prescription fills, respectively, compared to those not receiving the particular treatment. Also those having physician counseling had 67% ($p<0.01$) more indirect asthma-related pharmacy claims compared to those who did not. Model 4 shows continuous treatment effects were observed for ADHD and anxiety treatment. The rate of indirect asthma fills increased by 0.8% ($p<0.01$) for every additional month of continuous ADHD treatment. The rate of indirect asthma fills increased by 0.9% ($p<0.01$) for every additional month of continuous anxiety treatment.

Controller Medications. Tables 4-20 (IRR) and 4-21 (predicted estimates) show the GEE models with negative binomial for controller medications. Model 1 suggests that those with ADHD or anxiety had 11% and 10% more controller medication fills, respectively, compared to those without ADHD (IRR=1.11; .32 vs. .29, $p<0.01$) or anxiety (IRR=1.10; .33 vs. .29, $p<0.01$). Assessing the number of months with a mental health diagnosis from model 2, the rate of controller fills decreased for every additional month of having a depression diagnosis (IRR=.995, $p<0.01$), while the rate of controller fills increased by 2% ($p<0.05$) for every additional month with an ADHD diagnosis. Controlling for number of months with an ADHD and depression diagnosis, those with and ADHD or depression had 6% ($p<0.05$) and 7% ($p<0.05$) more controller fills compared to those without ADHD or depression. Model 3 assesses the impact of mental health treatment and controller medication use. Mental health treatment diminishes the effect for those with ADHD and anxiety. Depression had fewer monthly controller fills compared to those without depression, suggesting a further reduction in controller fills (IRR=.884; .256 vs.300; $p<0.01$). ADHD, anxiety, and depression treatment had 24% ($p<0.01$), 12% ($p<0.01$), and 21% ($p<0.01$) more asthma controller

fills, respectively, compared to those without the particular mental health treatment. Also, those receiving physician pharmacological counseling had a fewer controller medication fills than those who did not have such counseling (IRR=.905, $p<0.05$). For model 4, continuous ADHD treatment effects were observed. The rate of controller fills increased by 0.4% ($p<0.01$) for every additional month of continuous ADHD treatment.

Rescuer Medications. Rescuer medication modeling using GEE can be found on Tables 4-22 (IRR) and 4-23 (predicted estimates). Model 1 shows the anxiety and depression as modifiers of monthly rescuer medication utilization. Specifically those with anxiety had 21% (.29 vs. .23, $p<0.01$) more rescuer medication fills compared to those without. Those with depression had fewer monthly rescuer fills compared to those without depression (IRR =.869; .20 vs. .24, $p<0.01$). Model 2 shows the number of months with depression or anxiety was significantly associated with rescuer fills. Specifically, the number of months with depression was associated with fewer rescuer fills (IRR=.993, $p<0.01$), where rate of rescuer fills increased by 5% ($p<0.01$) for every additional month of anxiety diagnosis. Controlling for number of months with anxiety, those with anxiety had 11%more rescuer fills (IRR=1.11, $p<0.01$) compared to those without anxiety. Model 3 shows that those with ADHD and anxiety who receive treatment use asthma services similar to those without ADHD and anxiety. Specifically, ADHD and anxiety treatment diminishes the effects for ADHD and anxiety on asthma-related rescuer fills. Those with depression who received treatment use asthma services differently to those without depression, as those with depression had filled fewer rescuer medications compared to those without depression (i.e., difference between model 1 (IRR=.869, $p<0.01$) and model 3 (IRR=.812, $p<0.01$)). Those

receiving ADHD, anxiety, and depression treatment had 24% ($p<0.01$), 15% ($p<0.01$), and 13% ($p<0.01$) more rescuer medication fills, respectively, compared to those without the particular mental health treatment. Model 4 showed continuous treatment effects for depression and anxiety. Specifically, the rate of rescuer medication claims decreased for every additional month of continuous depression treatment (IRR=.993, $p<0.05$), whereas the rate of rescuer medication claims increased by 2% ($p<0.01$) for every additional month of continuous anxiety treatment.

Summary of Utilization Analyses

ADHD and utilization. ADHD modified asthma related utilization. Specifically, ADHD was associated with having fewer admissions yet more medical claims, and total, direct, indirect, and controller asthma-related medication fills. This utilization pattern suggests those with ADHD used more preventive and pharmacy services for their asthma, and had less emergency type care (e.g., admissions) than those without ADHD. Additionally, the number of months with ADHD was associated with more medical claims and pharmacy claims. ADHD treatment results in having more medical claims and more pharmacy fills across all categories (total, direct, indirect, rescuer, and controller medications), whereas the rate of admissions decreases for every additional month of continuous ADHD treatment. Treatment diminishes the effect of ADHD for all asthma utilization categories, as hypothesized.

Anxiety and utilization. Anxiety modified asthma related utilization. Specifically, anxiety was associated with having longer lengths of stay, more admissions, urgent care visits, medical claims, outpatient visits, and total, direct, indirect, controller and rescuer asthma-related medication fills. This utilization pattern suggests those with anxiety used more preventive and pharmacy services for their asthma, but also had

more emergency type (e.g., admissions, LOS, urgent care visits) care than those without anxiety. Additionally, the number of months with anxiety was associated with more utilization for total, direct, and rescuer pharmacy claims. The treatment of anxiety has main effects associated with more admissions, medical claims, outpatient visits, urgent care visits, and more pharmacy fills across all categories (total, direct, indirect, rescuer, and controller medications). Findings suggest that the treatment of anxiety may have implications for asthma-management. Treatment diminishes the effect of anxiety for all asthma utilization categories, as hypothesized.

Depression and utilization. Depression modified asthma related utilization. Specifically, depression was associated with having more admissions yet fewer medical claims, and total, direct, indirect, controller and rescuer asthma-related medication fills. This utilization pattern suggests those with depression used fewer preventive and pharmacy services for their asthma, and had more emergency type care than those without depression. Additionally, controlling for months with depression revealed an increase in utilization of medical claims and all pharmacy claims categories for those with depression relative to those without depression. However, the number of months with a depression diagnosis (i.e., the longer one has depression) was associated with a decrease in medical claims and all pharmacy claims categories. The treatment of depression was associated with more medical claims and more pharmacy fills across all categories (total, direct, indirect, rescuer, and controller medications), yet fewer outpatient visits urgent care visits compared to those not receiving depression treatment. This finding suggests some beneficial aspects to depression treatment on asthma-related treatment. Treatment of depression did not diminish the effect of

depression for all asthma-related categories. Specifically, treatment of depression diminished the effect of depression for asthma related admissions, outpatient visits, urgent care visits, and indirect pharmacy claims.

Generalized Estimating Equation Models and Expenditure Estimates

Four GEE models with gamma distribution and log link function with varying correlation structures were conducted for each asthma-related expenditure dependent variable to assess the three objectives of this study. Model 1 uses mental health triggers and control variables to assess the modifying impact of the mental health triggers on asthma-related expenditure. Model 2 uses mental health triggers, control variables and number of months with mental health diagnosis (e.g., condition*month interaction) to assess temporal effects on asthma-related utilization and expenditure. Models 3 and 4 use mental health triggers, control variables, and mental health treatment variables to assess treatment effects (Model 3 captures overall treatment effects, whereas 4 adds additional continuous mental health treatment).

Total and direct asthma expenditures. Models predicting total and direct asthma expenditures are presented in Table 4-24 and predicted estimates in Table 4-26 (total expenditures) and Table 4-27 (direct expenditures). For both total and direct asthma expenditures were fit to GEE with gamma distribution and log link function with an unstructured correlation.

Total monthly asthma-related expenditures. Model 1 illustrates that compared to those without anxiety, those with anxiety had incurred 29.1% greater monthly total asthma related expenditures (B=.291; predicted estimates for those with anxiety was $126.85 vs. predicted estimates for those without anxiety was $94.80, $p<0.01$) (Results will be presented from this point on with beta estimate, predicted expenditures for those

with vs. those without the mental health diagnosis and the specific p-value). The number of months for each mental health diagnosis was not significantly associated with total asthma expenditures. However, controlling for the number of months with anxiety and depression, in model 2, revealed a significant 22% and 21% increase in total asthma-related expenditures for those with anxiety ($125.77 vs. $94.81, $p<0.05$) and depression ($108.18 vs. $98.25, $p<0.05$), respectively, compared to those without anxiety and depression. Model 3 suggests that anxiety and depression treatment had no significant effects on total asthma expenditures for those with anxiety and depression. However, ADHD treatment resulted in those with ADHD having 10.4% less total asthma expenditures (B=-.104; $91.37 vs. $101.37, $p<0.05$) than those without ADHD. Mainly, mental health treatment diminished the effects of total asthma-related expenditures for all conditions to look more like those without the relative mental health condition. Those who received treatment for ADHD ($114.76 vs. $97.57, $p<0.01$), anxiety ($130.31 vs. $96.73, $p<0.01$), and depression ($132.67 vs. $96.74, $p<0.01$) had incurred 16.2%, 29.8%, and 31.6% greater total asthma expenditures, respectively, compared to those not receiving the particular mental health treatment. Model 4 did have a significant continuous anxiety treatment effect, such that the rate of total asthma-related expenditures increased by 2.2% ($p<0.01$).for each additional month of continuous anxiety treatment.

Direct monthly asthma-related expenditures. A similar pattern was seen in direct monthly asthma-related expenditures. Model 1 found those with anxiety had incurred 30.4% greater direct monthly asthma related expenditures compared to those without anxiety ($108.52 vs. $80.02, $p<0.01$). Again, the number of months with a

mental health diagnosis was not significantly associated with direct asthma-related expenditures. However, controlling for the number of months with an anxiety and depression diagnosis revealed that those with anxiety incurred 24.2% greater monthly direct asthma expenditures compared to those without anxiety (B=.242; $107.54 vs. $80.04, p<0.05), and those with depression incurred 23.2% greater monthly direct asthma-related expenditures than those without depression (B=.232; $93.70 vs. $82.74, p<0.05). Model 3 illustrated that mental health treatment diminished the effects of all mental health conditions for direct asthma expenditures. Treatment effects for ADHD suggest that those with ADHD incurred 11.6%less monthly direct asthma expenditures compared to those without ADHD ($76.66 vs. $86.12, p<0.05). Compared to those without treatment for each of the mental health conditions, treatment for ADHD (B=.130, $94.43 vs. $82.96, p<0.01), anxiety (B=.309, $11.45 vs. $81.48, p<0.01), and depression (B=.328; $113.62 vs. $81.85, p<0.01) was associated with incurring more direct monthly asthma expenditures compared to those without treatment. Model 4 finds that the rate for monthly direct asthma-related expenditure increased by 2.3% (p<0.01) for each additional month of continuous anxiety treatment.

Medical and pharmacy monthly asthma-related expenditures. Medical monthly asthma-related expenditures and pharmacy expenditures were modeled using GEE with gamma distribution, log link function, and correlation matrix specified with AR-6. The fit GEE model predictors can be found in Table 4-25 with predicted estimates for average monthly asthma-related medical expenditures in Table 4-28 and asthma-related pharmacy expenditures in Table 4-29.

Medical monthly asthma-related expenditures. In model 1, youth with anxiety had incurred 26.7% greater asthma-related medical expenditure (B=.267; $17.13 vs. $13.12, p<0.05) compared to those without anxiety. Model 1 suggests youth with comorbid depression incurred less medical expenditure compared to those without depression but the association is not significant (p<0.12). Temporal effects were not observed from Model 2, which suggest the number of months with a comorbid mental health condition was not associated with asthma-related medical expenditures. Treatment effects observed in Model 3 suggest treatment of ADHD and anxiety diminishes the effects for the association between ADHD and anxiety with asthma related medical expenditures. Those receiving ADHD treatment (B=.164; $15.72 vs. $13.34; p<0.01) and anxiety treatment (B=.163; $15.65 vs. $13.24; p<0.05) had incurred 16.4% and 16.3% greater monthly asthma-related medical expenditures, respectively, compared to those without the particular mental health treatment. Counseling with a physician or medication management consult was associated with incurring 39.6% less medical expenditures than those without such a consultation (B=-.396; $9.31 vs. $13.83, p<0.05). Continuous treatment effects for asthma-related medical expenditures were not observed in model 4.

Pharmacy expenditures. In model1, those with ADHD (B=.072; $59.19 vs. $55.06, p<0.01) and anxiety (B=.199; $66.22 vs. $54.25, p<0.01) incurred 7.2% and 19.9% greater monthly asthma-related pharmacy expenditures, respectively, compared to those without the mental health condition. However, those with depression had incurred 10.3% less asthma-related pharmacy expenditures (B=-.103; $51.27 vs. $56.81, p<0.01) compared to those without depression. Model 2 has a significant

depression-month interaction (B=-.010, p<0.01), indicating the rate of pharmacy monthly asthma-related expenditure decreased by 1.0% for every additional month with depression diagnosis. While controlling for the number of months with a depression diagnosis was associated with a main trend of decreasing pharmacy expenditures for every month with a depression diagnosis, the relative depression effect observed in model one lost significance (i.e., was adjusted away by the depression*month interaction). Model 3 finds ADHD, anxiety, and depression treatment diminishes the effect of ADHD, anxiety, and depression on monthly asthma-related pharmacy expenditures, supporting hypothesis 3. For those receiving ADHD ($70.33 vs. $54.18; p<0.01), anxiety ($66.24 vs. $54.93; p<0.01) and depression ($70.16 vs. $54.78; p<0.01) treatment incurred 26.1%, 18.7%, and 24.8% greater asthma-related pharmacy expenditures, respectively, compared to those not receiving the particular mental health treatment. Model 4 did show some significant effects when controlling for continuous mental health treatment. For every additional month of continuous anxiety treatment, the rate of monthly asthma-related pharmacy expenditures increased by 1.3% (p<0.01).

Two part model for inpatient and outpatient expenditures. Given that the number of observations without any expenditure was high, a two part model was constructed for inpatient and outpatient expenditures. First part of the model is to first predict expenditures using logistic regression (Table 4-30). The odds of inpatient and outpatient expenditures are modeled using a binomial distribution and a logit link function with independent correlation. The second part is to model expenditure given at least some expenditure (Table 4-31). GEE models using exchangeable correlation matrix with the gamma distribution and log link function was used to predict inpatient

and outpatient expenditures given expenditures greater than $0.The final constructed predicted mean estimates of inpatient and outpatient expenditures are constructed by multiplying predicted probability estimates of expenditure by predicted estimates of expenditure given incurring some expenditure. Results are shown in Table 4-32 and Table 4-33 for prediction estimates of inpatient expenditure and Table 4-34 and Table 4-35 for prediction estimates of outpatient expenditure.

Inpatient expenditures. Model 1 reporting logistic regression for inpatient expenditures, shows the increased odds of having inpatient expenditures for anxiety (OR=1.34, p<0.01) and depression (OR=1.36, p<0.01), yet decreased for ADHD (OR=.768, p<0.01). The gamma regression for inpatient expenditures in Model 1, illustrates those with anxiety incurred 25.3% greater inpatient expenditures than those without anxiety (B=.253, $4694.57 vs. $3645.54, p<0.01). The combined predicted estimates are based on multiplying the probability of expenditure and the estimated inpatient expenditure given some expenditure. For those with anxiety and depression, combined estimates showed that both anxiety ($545.22 vs. $328.83) and depression ($496.12 vs. $338.63) were associated with greater predicted monthly inpatient expenditure compared to those without anxiety or depression. However, those with ADHD ($300.61 vs. $391.97) had less predicted monthly inpatient expenditures compared to those without ADHD.

The logistic regression for model 2 assessed the effect of the number of months with a mental health condition on the odds of having inpatient expenditure. The results from model 2 suggest that for every additional month with either an ADHD (OR=.991, p<0.01) or depression (OR=.995, p<0.05) diagnosis, the odds of having monthly

asthma-related inpatient expenditure decreases. Controlling for the number of months with depression, the odds of having inpatient expenditures significantly increased for those with depression compared to those without depression (OR=1.54, p<0.01). The number of months with anxiety was not associated with increased odds of having inpatient expenditure. However, controlling for the number of months with anxiety revealed an increase in odds of having inpatient expenditure for those with anxiety compared to those without anxiety (OR=1.34, p<0.01). The gamma regression for model 2 found no significant association between the numbers of months with a mental health diagnosis predicting inpatient expenditure given some expenditure. The combined predicted average monthly inpatient expenditures were lower for those with ADHD compared to those without ADHD ($304.58 vs. $391.88). The combined predicted average monthly inpatient expenditures were higher for anxiety and depression compared to those without anxiety ($553.45 vs. $326.45) or depression ($497.52 vs. $339.67).

Logistic regression for model 3 and model 4 shows mental health treatment slightly diminishes the effects for the odds of having inpatient expenditures for all mental health conditions, thus mental health treatment mediates the mental health condition. Receiving treatment was associated with decreased odds of inpatient expenditure for those with ADHD compared to those without ADHD (OR=.814, p<0.01). However, receiving treatment for anxiety and depression was associated with increased odds of inpatient expenditure for those with anxiety and depression compared to those without anxiety (OR=1.28, p<0.01) and depression (OR=1.35, p<0.01). ADHD treatment was associated with significant decrease in odds of inpatient expenditure compared to those

without ADHD treatment (OR=.823 p<0.01), whereas anxiety treatment was associated with an increase in the odds of inpatient expenditure (OR=1.13, p<0.01). Counseling was associated with a 1.23 times increase in the odds of having inpatient expenditure compared to those who did not receive counseling (OR=1.23, p<0.01). ADHD and anxiety treatment diminishes the odds of inpatient expenditure for those with ADHD and anxiety. Model 4 shows that the odds of inpatient expenditure decreased for every additional month of continuous ADHD treatment (OR=.983, p<0.01). The gamma regression for model 3 predicted inpatient expenditures given some expenditure. Treatment of anxiety and depression had diminished effects for those with anxiety and depression on asthma-related inpatient expenditures. Controlling for mental health treatment, those with anxiety had incurred 21.9% greater asthma-related inpatient expenditures compared to those without anxiety (p<0.05). No other treatment effects were observed nor were there continuous treatment effects observed in model 4. For model 3 and model 4 considering treatment effects, the combined predicted average monthly inpatient expenditures were lower for those with ADHD compared to those without ADHD (Model 3: $303.42 vs. 389.88; Model 4: $312.39 vs. $386.50). The combined predicted average monthly inpatient expenditures were higher for anxiety or depression compared to those without anxiety (Model 3: $514.19 vs. $333.20; Model 4: $490.32 vs. $337.08) or depression (Model 3: $489.30 vs. $339.33; Model 4: $500.83 vs. $337.68). In model 3 predicted estimates, those receiving ADHD or depression treatment had lower inpatient expenditure (ADHD: $335.38 vs. $371.94; depression: $357 vs. $369.68), respectively, compared to those not receiving treatment. Treatment of anxiety, however, was associated with greater monthly inpatient expenditure

($425.93 vs. $353.14). For model 4 considering continuous mental health treatment, those receiving ADHD or anxiety treatment had more inpatient expenditure than those not receiving ADHD treatment ($378.88 vs. $367.60) or anxiety treatment (383.32 vs. $367.18). Those receiving depression treatment have less average inpatient expenditures compared to those not receiving depression treatment ($367.28 vs. 368.76).

Outpatient expenditures. Model 1 uses logistic regression for predicting odds of monthly asthma-related outpatient expenditures. Those with ADHD or anxiety were associated with decreased odds for monthly asthma-related outpatient expenditures compared to those without ADHD (OR=.887, $p<0.01$) or anxiety (OR=.946, $p<0.01$). However, those with depression were associated with increased odds for monthly asthma-related outpatient expenditures compared to those without depression (OR=1.18, $p<0.01$). Gamma regression for model 1 found mental health conditions were not significant predictors of outpatient expenditures. The combined predicted outpatient expenditures were higher for anxiety or depression compared to those without anxiety ($128.32 vs. $125.69) or depression ($130.98 vs. $125.36). However, the combined predicted monthly asthma-related outpatient expenditures were lower for ADHD compared to those without ADHD ($116.42 vs. $128.34).

The logistic regression for model 2 assessed the effect of the number of months with a mental health condition on the odds of having outpatient expenditure. The results suggest that the odds of monthly asthma-related outpatient expenditures decreases for every additional month with ADHD (OR=.996, $p<0.01$) and decreases for every additional month with depression (OR=.996, $p<0.05$).Controlling the number of months

of having a mental health diagnosis, the odds of having outpatient expenditures increased for those with depression compared to those without depression (OR=1.28, p<0.01). Gamma regression for model 2 illustrated that for monthly asthma-related outpatient expenditures increased by 0.6% (p<0.01) for every additional month of having an ADHD diagnosis. Controlling for the number of months with a mental health diagnosis, those with ADHD had incurred 14% (B=-.140; $119.37 vs. $127.43, p<0.01) less monthly asthma-related outpatient expenditures compared to those without ADHD. The combined predicted outpatient expenditures were higher for anxiety or depression compared to those without anxiety ($128.95 vs. $125.52) or depression ($131.25 vs. $125.29). However, the combined predicted monthly asthma-related outpatient expenditures were lower for ADHD compared to those without ADHD ($119.37 vs. $127.43).

Logistic regression for Model 3 assesses the treatment effects for the odds of having monthly asthma-related outpatient expenditure, and illustrates that mental health treatment diminishes effects for all 3 mental health conditions on asthma-related outpatient expenditures. Receiving treatment was associated with decreased odds of outpatient expenditure for those with ADHD compared to those without ADHD (OR=.925, p<0.01). However, receiving treatment for anxiety was associated with increased odds of outpatient expenditure for those with anxiety compared to those without anxiety (OR=1.08, p<0.01). Treatment effects included the decrease in the odds of outpatient expenditure for those receiving ADHD or anxiety treatment compared to those with untreated ADHD (OR=.907, p<0.01) or untreated anxiety (OR=.641, p<0.01).Depression treatment was associated with an increase in the odds of having

outpatient expenditure compared to those untreated for depression (OR=1.29, p<0.01). Additionally, physician counseling was associated with decreased odds of having outpatient expenditure compared to those without physician counseling (OR=.941, p<0.01). Model 4 shows a decrease in odds of monthly outpatient expenditure for every additional month of continuous ADHD (OR=.990, p<0.01) and continuous anxiety treatment (OR=.974, p<0.01). The odds of monthly outpatient expenditures increase by 1% (p<0.01) for every additional month of continuous depression treatment. Gamma regression showed that treatment did not mediate the effect of outpatient expenditure. However, trends for all three ADHD, anxiety, and depression, seemed to exhibit some diminished effects (B closer to 0). Model 4 did have a significant effect for continuous treatment of anxiety, such that monthly asthma-related outpatient expenditures increased by 2.2% (p<0.01) for every additional month of continuous anxiety treatment. For model 3 and model 4 considering treatment effects, the combined predicted monthly asthma-related outpatient expenditures were lower for those with ADHD compared to those without ADHD (Model 3: $120.66 vs. 127.24; Model 4: $121.59 vs. $127.13). The combined predicted average monthly asthma-related outpatient expenditures were higher for anxiety or depression compared to those without anxiety (Model 3: $133.37 vs. $124.93; Model 4: $132.10 vs. $125.18) or depression (Model 3: $129.87 vs. $125.48; Model 4: $130.74 vs. $125.41). In model 3 predicted estimates, those receiving ADHD or anxiety treatment had lower monthly asthma-related outpatient expenditure, respectively, compared to those with untreated ADHD (Model 3: $114.34 vs. $127.07; Model 4: $118.64 vs. $126.75) or untreated anxiety (Model 3: $106.79 vs. $126.94; Model 4: $112.52 vs. $126.89). Those receiving treatment for depression had

greater predicted monthly asthma-related outpatient expenditure compared to those untreated for depression (Model 3: $132.65 vs. $125.70; Model 4: $134.04 vs. $125.74).

Summary of Expenditure Analyses

ADHD and expenditure. Generally, those with ADHD had less asthma-related total, direct, inpatient, and outpatient expenditures, yet had greater expenditures for monthly asthma-related pharmacy expenditures. This is similar to patterns observed in the negative binomial models for predicting utilization. Treatment of ADHD was associated with greater average monthly total, direct, medical and pharmacy asthma-related expenditures yet had less monthly asthma-related inpatient expenditures.

Anxiety and expenditure. Anxiety was associated with incurring 29% greater total asthma-related expenditures, 30.4% greater direct asthma expenditures, 26.7% greater asthma-related medical expenditures, 19.9% greater asthma-related pharmacy expenditure, and 25.3% greater asthma-related inpatient expenditures compared to those without anxiety. Additionally, those with anxiety had incurred more predicted inpatient expenditures compared to those without. Treatment of anxiety was associated with greater total, direct, inpatient, medical, and pharmacy expenditures.

Depression and expenditure. Depression was generally associated with incurring greater total, direct, and inpatient asthma-related monthly expenditures, yet less medical and pharmacy monthly expenditures. Treatment of depression had diminished effects for those with depression. Specifically, those with depression treatment had incurred greater total, direct, and pharmacy asthma-related monthly expenditures but also had less predicted inpatient expenditure.

Table 4-1. Sample characteristics of youth with asthma (n=8,241)

Sample Characteristics	% or Mean (s.d.)
Mean Age (s.d.)	11.23 (3.03)
Sex	
% Male	57.7%
Race/Ethnicity	
% White	25.7%
% Black	30.9%
% Hispanic	24.0%
% Other	19.4%
% Supplemental Security Income (ssi)	30.6%
% ADHD (over 3 yr, n=1,531)	18.5%
% Anxiety (over 3 yr, n=285)	3.5%
% Depression (over 3 yr, n=938)	11.4%
% Allergic Rhinitis (over 3yr)	35.5%
% w/ drug management consult/ counseling	5.6%

s.d. =standard deviation;
Characteristics of continuous enrolled youth with asthma in Florida Medicaid (n=8,241).

Table 4-2. Average monthly expenditure by mental health condition

	Inpatient	Outpatient	Medical	Pharmacy	Direct Asthma	Total Asthma
Mental Health condition	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)
ADHD	23.68 (2.00)	9.39 (.31)	13.75 (.53)	61.57 (.60)	89.45 (2.22)	108.39 (2.27)
No ADHD	25.67 (.93)	10.96 (.16)	13.23 (.18)	53.96 (.28)	88.09 (1.03)	103.83 (1.05)
Anxiety	48.71 (3.61)	10.48 (.40)	15.98 (.80)	75.69 (.88)	128.85 (3.86)	150.86 (3.90)
No Anxiety	21.83 (.81)	10.71 (.15)	12.92 (.16)	52.27 (.26)	82.28 (.91)	97.73 (.93)
Depression	44.23 (3.46)	10.22 (.38)	15.34 (.77)	61.43 (.70)	112.66 (3.67)	131.22 (3.69)
No Depression	22.35 (.82)	10.75 (.15)	13.01 (.17)	54.35 (.27)	84.52 (.92)	100.46 (.94)
Total	25.32 (.85)	10.68 (.14)	13.32 (.18)	55.31 (.25)	88.34 (.94)	104.63 (.95)

Average expenditure is for n=296,676 person months of 8,241 youth with asthma. Monthly expenditures are measured in unadjusted U.S. dollars. Based on the entire population, inpatient and outpatient information is diluted over 3 years among all youth with asthma.

Table 4-3. Average monthly use by mental health condition

	Inpatient Admissions	LOS*	Average LOS*	Outpatient Visits	Urgent Visits	Medical Claims
Mental Health condition	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)
ADHD	.0058(.00035)	3.7 (.19)	3.5 (.17)	.0339 (.0009)	.0217 (.0006)	.281 (.005)
No ADHD	.0064 (.00017)	3.5 (.08)	3.3 (.08)	.0384 (.0004)	.0244 (.0003)	.324 (.003)
Anxiety	.0092 (.00051)	4.5 (.19)	4.4 (.18)	.0377 (.0011)	.0232 (.0008)	.323 (.008).
No Anxiety	.0058 (.00015)	3.3 (.08)	3.1 (.07)	.0376 (.0004)	.0240 (.0003)	.316 (.003)
Depression	.0088 (.00016)	4.5 (.21)	4.3 (.21)	.0377 (.0011)	.0232 (.0007)	.273 (.006)
No Depression	.0059 (.00043)	3.3 (.08)	3.1 (.07)	.0376 (.0004)	.0240 (.0003)	.324 (.003)
Total	.0063 (.00015)	3.5 (.07)	3.4 (.07)	.0377 (.0004)	.0239 (.0003)	.317 (.003)

	Total Pharmacy Claims	Direct Pharmacy Claims	Indirect Pharmacy Claims	Controller Pharmacy Claims	Rescuer Pharmacy Claims
Mental Health condition	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)
ADHD	.968 (.007)	.614 (.005)	.421 (.003)	.345 (.003)	.238 (.002)
No ADHD	.860 (.003)	.572 (.002)	.355 (.002)	.295 (.001)	.243 (.001)
Anxiety	1.111 (.008)	.700 (.006)	493 (.004)	.368 (.004)	.304 (.003)
No Anxiety	.844 (.003)	.561 (.002)	.348 (.001)	.295 (.001)	.233 (.001)
Depression	.979 (.008)	.601 (.006)	.447 (.004)	.335 (.003)	.243 (.002)
No Depression	.863 (.003)	.576 (.002)	.354 (.001)	.299 (.001)	.242 (.001)
Total	.879 (.003)	.579 (.002)	.367 (.001)	.304 (.001)	.242 (.001)

SE= standard error; LOS=length of stay. *The length of stay variable was assessed conditional admission>0
LOS is the total length of stay for the month, whereas average LOS was equal to total monthly length of stay divided by number of admissions in that month.

Table 4-4. Incident rate ratios for monthly asthma related inpatient admissions

Mental Health	Model 1 IRR(CI)	Model 2 IRR(CI)	Model 3 IRR(CI)	Model 4 IRR(CI)
ADHD	.792 (.659,.951)**	.938 (.701,1.25)	.802 (.647,.995)*	.867 (.695,1.08)
Anxiety	1.33 (1.05,1.68)**	1.35 (.909,2.01)	1.09 (.827,1.43)	1.10 (.837,1.45)
Depression	1.43 (1.13,1.82)**	1.53 (1.02,2.30)*	1.28 (.977,1.68)	1.32 (1.01,1.74)*
Month	.968 (.963,.972)**	.970 (.964,.975)**	.969 (.964,.974)**	.970 (.965,.975)**
ADHD*month		.990 (.977,1.004)		
Anxiety*month		.999 (.982,1.02)		
Depression*month		.997 (979,1.02)		
Counseling			1.24 (.931,1.65)	1.25 (.937,1.66)
ADHD treatment			.926 (.719, 1.19)	1.04 (.792,1.36)
Anxiety treatment			1.47 (1.04, 2.07)*	1.42 (.977,2.05)
Depression treatment			1.25 (.887, 1.77)	1.39 (.956,2.02)
Continuous ADHD treatment				.973 (.952,.995)**
Continuous anxiety treatment				1.00 (.978,1.03)
Continuous depression treatment				.978 (.948,1.01)

IRR=Incident Rate Ratios, CI= 95% Confidence Intervals; p-value: * <0.05; ** <0.01; Dependent variables are asthma-specific tied to asthma ICD-9 codes; Negative binomial models controlled for age, gender, race, supplemental security income using random effects.

Table 4-5. Predicted mean estimates for monthly asthma-related inpatient admissions

Mental Health	Model 1 Mean (SE)	Model 2 Mean (SE)	Model 3 Mean (SE)	Model 4 Mean (SE)
All use	.00627 (.359)	.00627 (.357)	.00628 (.360)	.00628 (.360)
ADHD	.00520 (.368)	.00531 (.371)	.00526 (.373)	.00560 (.374)
No ADHD	.00656 (.357)	.00657 (.355)	.00656 (.360)	.00646 (.360)
Anxiety	.00789 (.372)	.00794 (.379)	.00671 (.381)	.00679 (.381)
No anxiety	.00595 (.359)	.00595 (.358)	.00618 (.361)	.00616 (.361)
Depression	.00842 (.373)	.00857 (.380)	.00768 (.380)	.00789 (.380)
No depression	.00588 (.359)	.00587 (.358)	.00600 (.362)	.00597 (.362)
ADHD treatment			.00586 (.381)	.00651 (.384)
No ADHD treatment			.00632 (.360)	.00626 (.361)
Anxiety treatment			.00889 (.397)	.00859 (.402)
No anxiety treatment			.00605 (.361)	.00607 (.362)
Depression treatment			.00771 (.399)	.00847 (.404)
No depression treatment			.00614 (.361)	.00610 (.362)
Counseling			.00764 (.384)	.00769 (.384)
No Counseling			.00617 (.359)	.00617 (.359)

SE=standard error; All predictions came from models in table 4-4.

Table 4-6. Incident rate ratios for monthly asthma related inpatient length of stay (if admissions>0)

Mental Health	Model 1 IRR(CI)	Model 2 IRR(CI)	Model 3 IRR(CI)	Model 4 IRR(CI)
ADHD	.950 (.849,1.06)	.943 (.782,1.14)	.923 (.806, 1.06)	.937 (.815,1.08)
Anxiety	1.29 (1.14,1.47)**	1.35 (1.07,1.69)**	1.28 (1.08, 1.50)**	1.26 (1.06,1.48)**
Depression	1.11 (.968,1.27)	1.09 (.859,1.39)	1.05 (.894, 1.24)	1.07 (.903,1.26)
Month	.996 (.992,.999)*	.996 (.992,1.000)*	.995 (.992,1.000)*	.996 (.992,.999)*
ADHD*month		1.00 (.978,1.01)		
Anxiety*month		.998 (.986,1.01)		
Depression*month		1.00 (.900,1.01)		
Counseling			1.12 (.960,1.30)	1.11 (.957,1.29)
ADHD treatment			1.04 (.873,1.23)	1.08 (.892,1.34)
Anxiety treatment			1.002 (.818,1.23)	.974 (.786,1.21)
Depression treatment			1.08 (.872,1.33)	1.10 (.881,1.38)
Continuous ADHD treatment				.992 (.977,1.01)
Continuous anxiety treatment				1.01 (.991,1.02)
Continuous depression treatment				.995 (.976,1.01)

IRR=Incident Rate Ratios, CI= 95% Confidence Intervals; p-value: * <0.05; ** <0.01; Dependent variables are asthma-specific tied to asthma ICD-9 codes; Negative binomial models controlled for age, gender, race, supplemental security income using random effects.

Table 4-7. Predicted mean estimates for monthly asthma-related length of stay

	Model 1	Model 2	Model 3	Model 4
Mental Health	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)
All use	3.18 (.146)	3.18 (.149)	3.17 (.149)	3.16 (.152)
ADHD	3.05 (.153)	3.05 (.160)	2.97 (.159)	2.99 (.163)
No ADHD	3.21 (.145)	3.21 (.147)	3.22 (.149)	3.20 (.153)
Anxiety	3.95 (.156)	3.94 (.166)	3.89 (.166)	3.83 (.170)
No anxiety	3.05 (.146)	3.06 (.149)	3.05 (.150)	3.05 (.153)
Depression	3.46 (.160)	3.46 (.170)	3.30 (.169)	3.33 (.173)
No depression	3.12 (.146)	3.12 (.149)	3.14 (.150)	3.13 (.153)
ADHD treatment			3.26 (.173)	3.39 (.181)
No ADHD treatment			3.16 (.149)	3.14 (.153)
Anxiety treatment			3.17 (.178)	3.08 (.185)
No anxiety treatment			3.17 (.150)	3.16 (.153)
Depression treatment			3.39 (.180)	3.46 (.187)
No depression treatment			3.15 (.150)	3.14 (.153)
Counseling			3.51 (.165)	3.49 (.168)
No Counseling			3.14 (.148)	3.14 (.152)

SE=standard error; All predictions came from models in table 4-6.

Table 4-8 Incident rate ratios for monthly asthma-related medical claims

Mental Health	Model 1 IRR(CI)	Model 2 IRR(CI)	Model 3 IRR(CI)	Model 4 IRR(CI)
ADHD	1.11 (1.06,1.16)**	1.05 (.981,1.13)	1.01 (.955, 1.06)	1.01 (.955,1.06)
Anxiety	1.13 (1.06,1.20)**	1.05 (.948,1.16)	1.08 (1.006, 1.15)*	1.08 (1.01,1.15)*
Depression	.900 (.845,.959)**	1.07 (.958,1.19)	.842 (.785, .903)**	.834 (.777,.895)**
Month	.968 (.967,.970)**	.969 (.967,.970)**	.969 (.968, .970)**	.969 (.968,.970)**
ADHD*month		1.003(1.000,1.006)*		
Anxiety*month		1.004(.9996,1.008)		
Depression*month		.991 (.987,.996)**		
Counseling			1.05 (.959, 1.15)	1.04 (.955,1.14)
ADHD treatment			1.23 (1.17,1.30)**	1.24 (1.18,1.32)**
Anxiety treatment			1.10 (1.01, 1.20)*	1.12 (1.02,1.23)*
Depression treatment			1.17 (1.07, 1.28)**	1.12 (1.02,1.24)**
Continuous ADHD treatment				.998 (.994,1.002)
Continuous anxiety treatment				.996 (.989,1.004)
Continuous depression treatment				1.01(1.002,1.018)*

IRR=Incident Rate Ratios, CI= 95% Confidence Intervals; p-value: * <0.05; ** <0.01; Dependent variables are asthma-specific tied to asthma ICD-9 codes; Negative binomial models controlled for age, gender, race, supplemental security income using fixed effects.

Table 4-9. Predicted mean estimates for monthly asthma-related medical claims

	Model 1	Model 2	Model 3	Model 4
Mental Health	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)
All use	.234 (.030)	.234 (.031)	.235 (.032)	.235 (.033)
ADHD	.255 (.035)	.253 (.038)	.236 (039)	.236 (.041)
No ADHD	.230 (.029)	.230 (.030)	.234 (.032)	.234 (.033)
Anxiety	.261 (.041)	.257 (.046)	.250 (.045)	.250 (.046)
No anxiety	.231 (.030)	.231 (.031)	.232 (.033)	.232 (.034)
Depression	.214 (.041)	.223 (.047)	.202 (.046)	.201 (.047)
No depression	.238 (.030)	.237 (.031)	.240 (.033)	.241 (.034)
ADHD treatment			.283 (.041)	.286 (.043)
No ADHD treatment			.230 (.032)	.230 (.033)
Anxiety treatment			.257 (.055)	.261 (.058)
No anxiety treatment			.233 (.033)	.233 (.034)
Depression treatment			.272 (.055)	.262 (.059)
No depression treatment			.233 (.032)	.233 (.034)
Counseling			.245 (.054)	.244 (.054)
No Counseling			.234 (.031)	.234 (.032)

SE=standard error; All predictions came from models in table 4-8.

Table 4-10. Incident rate ratios on monthly asthma-related outpatient visits

Mental Health	Model 1 IRR(CI)	Model 2 IRR(CI)	Model 3 IRR(CI)	Model 4 IRR(CI)
ADHD	.995 (.875,1.13)	1.02 (.861,1.21)	1.03 (.895, 1.18)	1.04 (.906,1.19)
Anxiety	1.23 (1.05,1.43)**	1.25 (.972,1.61)	1.11 (.948, 1.31)	1.11 (.946,1.31)
Depression	.917 (.786,1.07)	.802 (.627,1.03)	.941 (.800, 1.11)	.941 (.800,1.11)
Month	.974 (.971,.977)**	.974 (.970,.977)**	.973 (.971, .977)**	.974 (.971,.977)**
ADHD*month		.998 (.993,1.008)		
Anxiety*month		.999 (.989,1.01)		
Depression*month		1.01 (.998,1.02)		
Counseling			1.07 (.717, 1.61)	1.06 (.705,1.58)
ADHD treatment			.931 (.828, 1.05)	.951 (.844,1.07)
Anxiety treatment			1.49 (1.22,1.83)**	1.46 (1.18,1.80)**
Depression treatment			.814 (.669, .990)*	.811 (.661,.994)*
Continuous ADHD treatment				.991 (.982,1.001)
Continuous anxiety treatment				1.01 (.988,1.03)
Continuous depression treatment				1.00 (.984,1.02)

IRR=Incident Rate Ratios, CI= 95% Confidence Intervals; p-value: * <0.05; ** <0.01; Dependent variables are asthma-specific tied to asthma ICD-9 codes; Negative binomial models controlled for age, gender, race, supplemental security income using fixed effects.

Table 4-11. Predicted mean estimates for monthly asthma-related outpatient visits

Mental Health	Model 1 Mean (SE)	Model 2 Mean (SE)	Model 3 Mean (SE)	Model 4 Mean (SE)
All use	.531 (.134)	.531 (.135)	.534 (.141)	.535 (.143)
ADHD	.529 (.143)	.530 (.147)	.545 (.153)	.552 (.154)
No ADHD	.531 (.132)	.532 (.133)	.532 (.140)	.531 (.143)
Anxiety	.634 (.151)	.634 (.159)	.586 (.160)	.586 (.162)
No anxiety	.517 (.134)	.518 (.135)	.536 (.142)	.527 (.144)
Depression	.492 (.150)	.479 (.157)	.507 (.159)	.507 (.161)
No depression	.537 (.134)	.538 (.136)	.538 (.142)	.539 (.144)
ADHD treatment			.501 (.152)	.511 (.155)
No ADHD treatment			.537 (.141)	.537 (.143)
Anxiety treatment			.780 (.174)	.764 (.178)
No anxiety treatment			.522 (.142)	.523 (.144)
Depression treatment			.440 (.171)	.511 (.176)
No depression treatment			.541 (.142)	.537 (.144)
Counseling			.571 (.237)	.562 (.238)
No Counseling			.532 (.136)	.533 (.139)

SE= standard error; All predictions came from models in table 4-10.

Table 4-12. Incident Rate Ratios for asthma-related urgent visits

Mental Health	Model 1 IRR(CI)	Model 2 IRR(CI)	Model 3 IRR(CI)	Model 4 IRR(CI)
ADHD	1.07 (.900,1.27)	1.07 (.854,1.33)	1.09 (.912, 1.30)	1.10 (.918,1.31)
Anxiety	1.33 (1.10,1.61)**	1.51 (1.10,2.07)**	1.18 (.969, 1.44)	1.18 (.962,1.44)
Depression	.852 (.704,1.03)	.700 (.515,.952)*	.917 (.752, 1.12)	.919 (.753,1.12)
Month	.977 (.972,.983)**	.977 (.971,.982)**	.977 (.972, .983)**	.977 (.972,.983)**
ADHD*month		1.000 (.993, 1.007)		
Anxiety*month		.994 (.983,1.01)		
Depression*month		1.01 (.998,1.02)		
Counseling			.862 (.304, 2.45)	.848 (.303,2.38)
ADHD Treatment			.960 (.832, 1.11)	.976 (.844,1.13)
Anxiety Treatment			1.77 (1.38, 2.29)**	1.72 (1.33,2.24)**
Depression Treatment			.654 (.510, .840)**	.655 (.506,.848)**
Continuous ADHD treatment				.992 (.980,1.005)
Continuous anxiety treatment				1.01 (.986,1.04)
Continuous depression treatment				.999 (.974,1.03)

IRR=Incident Rate Ratios, CI= 95% Confidence Intervals; p-value: * <0.05; ** <0.01; Dependent variables are asthma-specific tied to asthma ICD-9 codes or asthma-specific pharmacy claims (Table 3-3); Negative binomial models controlled for age, gender, race, supplemental security income using fixed effects.

Table 4-13. Predicted average estimates of monthly asthma-related urgent visits

Mental Health	Model 1 Mean (SE)	Model 2 Mean (SE)	Model 3 Mean (SE)	Model 4 Mean (SE)
All use	1.25 (.314)	1.26 (.315)	1.28 (.334)	1.28 (.335)
ADHD	1.32 (.322)	1.32 (.325)	1.37 (.343)	1.38 (.344)
No ADHD	1.24 (.312)	1.24 (.314)	1.26 (.333)	1.26 (.334)
Anxiety	1.61 (.326)	1.66 (.333)	1.47 (.347)	1.47 (.348)
No anxiety	1.21 (.314)	1.21 (.315)	1.25 (.334)	1.25 (.335)
Depression	1.09 (.325)	1.05 (.331)	1.19 (.345)	1.19 (.347)
No depression	1.28 (.314)	1.29 (.316)	1.30 (.334)	1.30 (.335)
ADHD treatment			1.23 (.341)	1.26 (.342)
No ADHD treatment			1.28 (.333)	1.28 (.335)
Anxiety treatment			2.19 (.358)	2.13 (.361)
No anxiety treatment			1.24 (.334)	1.23 (.335)
Depression treatment			.858 (.356)	.862 (.359)
No depression treatment			1.31 (.334)	1.31 (.335)
Counseling			1.11 (.595)	1.10 (.590)
No Counseling			1.29 (.319)	1.29 (.321)

SE=standard error; All predictions came from models in table 4-12.

Table 4-14. Incident Rate Ratios for monthly asthma-related total pharmacy claims

Mental Health	Model 1 IRR(CI)	Model 2 IRR(CI)	Model 3 IRR(CI)	Model 4 IRR(CI)
ADHD	1.19 (1.15,1.22)**	1.17 (1.12,1.22)**	.990 (.958, 1.02)	.971 (.934,1.004)
Anxiety	1.37 (1.32,1.42)**	1.27 (1.21,1.35)**	1.24 (1.19,1.29)**	1.22 (1.17,1.27)**
Depression	.930 (.896,.965)**	1.07 (1.01,1.14)**	.828 (.795,.863)**	.814 (.781,.849)**
Month	.988 (.987,.989)**	.988 (.987,.989)**	.989 (.988,.989)**	.988 (.987,.989)**
ADHD*month		1.001 (.999,1.002)		
Anxiety*month		1.004 (1.002,1.006)**		
Depression*month		.993 (.991,.995)**		
Counseling			1.24 (1.13,1.36)**	1.20 (1.10,1.32)**
ADHD Treatment			1.49 (1.45,1.54)**	1.45 (1.41,1.50)**
Anxiety Treatment			1.26 (1.21,1.32)**	1.20 (1.15,1.25)**
Depression Treatment			1.24 (1.18,1.29)**	1.24 (1.19,1.30)**
Continuous ADHD treatment				1.02 (1.01,1.02)**
Continuous anxiety treatment				1.02 (1.01,1.02)**
Continuous depression treatment				.998 (.995,1.002)

IRR=Incident Rate Ratios, CI= 95% Confidence Intervals; p-value: * <0.05; ** <0.01; Dependent variables are asthma-specific tied to asthma ICD-9 codes or asthma-specific pharmacy claims (Table 3-3); Negative binomial models controlled for age, gender, race, supplemental security income using fixed effects.

Table 4-15. Predicted average estimates of monthly asthma-related total pharmacy claims

Mental Health	Model 1 Mean (SE)	Model 2 Mean (SE)	Model 3 Mean (SE)	Model 4 Mean (SE)
All use	1.42 (.026)	1.42 (.026)	1.43 (.028)	1.43 (.028)
ADHD	1.62 (.028)	1.63 (.029)	1.42 (.031)	1.40 (.031)
No ADHD	1.37 (.025)	1.37 (.026)	1.44 (.027)	1.45 (.027)
Anxiety	1.85 (.030)	1.83 (.032)	1.71 (.033)	1.68 (.033)
No anxiety	1.35 (.026)	1.35 (.026)	1.38 (.028)	1.38 (.028)
Depression	1.34 (.031)	1.38 (.033)	1.23 (.033)	1.22 (.034)
No depression	1.44 (.026)	1.44 (.026)	1.49 (.028)	1.50 (.028)
ADHD treatment			2.03 (.030)	1.98 (.031)
No ADHD treatment			1.36 (.028)	1.36 (.028)
Anxiety treatment			1.77 (.035)	1.69 (.036)
No anxiety treatment			1.40 (.028)	1.41 (.028)
Depression treatment			1.74 (.035)	1.75 (.036)
No depression treatment			1.41 (.028)	1.41 (.028)
Counseling			1.75 (.052)	1.70 (.052)
No Counseling			1.41 (.026)	1.41 (.027)

SE=standard error; All predictions came from models in table 4-14.

Table 4-16. Incident Rate Ratios for monthly direct asthma pharmacy claims

	Model 1	Model 2	Model 3	Model 4
Mental Health	IRR(CI)	IRR(CI)	IRR(CI)	IRR(CI)
ADHD	1.15 (1.11,1.20)**	1.11 (1.06,1.17)**	.989 (.950,1.03)	.974 (.936,1.01)
Anxiety	1.29 (1.23,1.34)**	1.16 (1.09,1.24)**	1.20 (1.14,1.25)**	1.18 (1.13,1.23)**
Depression	.907 (.868,.948)**	1.09 (1.02,1.17)**	.806 (.769,.847)**	.796 (.758,.835)**
Month	.988 (.987,.989)**	.988 (.987,.989)**	.989 (.988,.990)**	.988 (.987,.989)**
ADHD*month		1.002(1.001,1.004)**		
Anxiety*month		1.005(1.003,1.007)**		
Depression*month		.991 (.989,.994)**		
Counseling			1.16 (1.01,1.32)*	1.11 (.973,1.27)
ADHD treatment			1.44 (1.39,1.48)**	1.40 (1.36,1.45)**
Anxiety treatment			1.18 (1.12,1.24)**	1.13 (1.07,1.19)**
Depression treatment			1.26 (1.19,1.32)**	1.27 (1.20,1.34)**
Continuous ADHD treatment				1.009 (1.007,1.011)**
Continuous anxiety treatment				1.02 (1.01,1.02)**
Continuous depression treatment				.997 (.992,1.001)

IRR=Incident Rate Ratios, CI= 95% Confidence Intervals; p-value: * <0.05; ** <0.01; Fixed effect models controlled for age, gender, race, supplemental security income. Pharmacy claims are defined in Table 3-3.

Table 4-17. Predicted average estimates of monthly direct asthma pharmacy claims

	Model 1	Model 2	Model 3	Model 4
Mental Health	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)
All use	1.95 (.037)	1.95 (.037)	1.94 (.039)	1.93 (.039)
ADHD	2.17 (.040)	2.17 (.040)	1.92 (.043)	1.89 (.043)
No ADHD	1.88 (.037)	1.89 (.037)	1.95 (.039)	1.94 (.039)
Anxiety	2.40 (.041)	2.36 (.043)	2.25 (.044)	2.21 (.045)
No anxiety	1.87 (.037)	1.87 (.037)	1.88 (.039)	1.88 (.040)
Depression	1.80 (.042)	1.87 (.044)	1.63 (.045)	1.61 (.046)
No depression	1.98 (.037)	1.98 (.037)	2.02 (.039)	2.02 (.039)
ADHD treatment			2.66 (.042)	2.60 (.042)
No ADHD treatment			1.85 (.039)	1.85 (.039)
Anxiety treatment			2.26 (.046)	2.16 (.047)
No anxiety treatment			1.91 (.039)	1.91 (.040)
Depression treatment			2.39 (.047)	2.40 (.047)
No depression treatment			1.90 (.039)	1.89 (.040)
Counseling			2.21 (.076)	2.12 (.075)
No Counseling			1.92 (.037)	1.92 (.037)

SE= standard error; All predictions came from models in Table 4-16.

Table 4-18. Incident Rate Ratios for monthly indirect asthma pharmacy claims

	Model 1	Model 2	Model 3	Model 4
Mental Health	IRR(CI)	IRR(CI)	IRR(CI)	IRR(CI)
ADHD	1.15 (1.10,1.20)**	1.17 (1.11,1.24)**	1.005 (.961,1.05)	.995 (.950,1.04)
Anxiety	1.17 (1.12,1.23)**	1.13 (1.06,1.22)**	1.08 (1.03,1.14)**	1.07 (1.02,1.13)**
Depression	1.02 (.967,1.07)	1.08 (1.00,1.16)*	.925 (.878,.976)**	.911 (.863,.960)**
Month	.987 (.986,.989)**	.987 (.986,.989)**	.988 (.987,.989)**	.987 (.986,.988)**
ADHD*month		.999 (.998,1.001)		
Anxiety*month		1.002 (.999,1.004)		
Depression*month		.997 (.995,.999)*		
Counseling			1.67 (1.18,2.38)**	1.57 (1.12,2.20)**
ADHD treatment			1.38 (1.33,1.42)**	1.35 (1.30,1.40)**
Anxiety treatment			1.24 (1.18,1.31)**	1.22 (1.15,1.29)**
Depression treatment			1.18 (1.12,1.25)**	1.18 (1.11,1.24)**
Continuous ADHD treatment				1.008(1.006,1.011)**
Continuous anxiety treatment				1.009(1.005,1.013)**
Continuous depression treatment				1.001 (.997,1.005)

IRR=Incident Rate Ratios, CI= 95% Confidence Intervals; p-value: * <0.05; ** <0.01; Pharmacy claims are defined in Table 3-3. Fixed effect models controlled for age, gender, race, supplemental security income

Table 4-19. Predicted average estimates of monthly indirect asthma pharmacy claims

	Model 1	Model 2	Model 3	Model 4
Mental Health	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)
All use	4.76 (.083)	4.77 (.084)	4.69 (.088)	4.60 (.086)
ADHD	5.29 (.085)	5.31 (.085)	4.70 (.090)	4.58 (.089)
No ADHD	4.60 (.083)	4.60 (.083)	4.68 (.087)	4.61 (.086)
Anxiety	5.44 (.086)	5.42 (.087)	4.99 (.091)	4.86 (.090)
No anxiety	4.63 (.084)	4.64 (.084)	4.62 (.088)	4.54 (.087)
Depression	4.82 (.087)	4.89 (.088)	4.41 (.091)	4.27 (.090)
No depression	4.74 (.083)	4.75 (.084)	4.76 (.087)	4.69 (.086)
ADHD treatment			6.16 (.089)	5.94 (.088)
No ADHD treatment			4.48 (.087)	4.40 (.087)
Anxiety treatment			5.72 (.092)	5.50 (.091)
No anxiety treatment			4.60 (.088)	4.52 (.087)
Depression treatment			5.45 (.092)	5.34 (.091)
No depression treatment			4.62 (.086)	4.53 (.087)
Counseling			7.43 (.193)	6.90 (.186)
No Counseling			4.44 (.082)	4.39 (.081)

SE=standard error; All predictions came from models in Table 4-18.

Table 4-20. Incident Rate Ratios for asthma controller pharmacy claims

Mental Health	Model 1 IRR(CI)	Model 2 IRR(CI)	Model 3 IRR(CI)	Model 4 IRR(CI)
ADHD	1.10 (1.06,1.13)**	1.06 (1.01,1.11)*	.975 (.937,1.02)	.968 (.930,1.01)
Anxiety	1.11 (1.06,1.16)**	1.09 (1.02,1.16)*	1.03 (.983,1.08)	1.03 (.978,1.08)
Depression	.987 (.943,1.03)	1.07 (.999,1.15)*	.884 (.839,.931)**	.878 (.833,.925)**
Month	.992 (.991,.993)**	.993 (.991,.994)**	.993 (.992,.994)**	.993 (.992,.994)**
ADHD*month		1.002(1.000,1.004)*		
Anxiety*month		1.001 (.998,1.004)		
Depression*month		.995 (.992,.998)**		
Counseling			.905 (.822,.983)*	.899 (.828,.976)*
ADHD treatment			1.24 (1.21,1.27)**	1.23 (1.20,1.26)**
Anxiety treatment			1.12 (1.07,1.17)**	1.11 (1.06,1.17)**
Depression treatment			1.21 (1.15,1.26)**	1.19 (1.14,1.25)**
Continuous ADHD treatment				1.004(1.001,1.006)**
Continuous anxiety treatment				1.002 (.997,1.006)
Continuous depression treatment				1.004 (.999,1.008)

IRR=Incident Rate Ratios, CI= 95% Confidence Intervals; p-value: * <0.05; ** <0.01; Pharmacy claims are defined in Table 3-3. Generalized estimating equations with negative binomial family and link with unstructured correlation was used to control for age, gender, race, supplemental security income.

Table 4.21. Predicted average monthly estimates of asthma controller claims

	Model 1	Model 2	Model 3	Model 4
	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)
All average use	.292 (.029)	.292 (.030)	.292 (.030)	.292 (.031)
ADHD	.321 (.032)	.323 (.033)	.285 (.034)	.283 (.035)
No ADHD	.285 (.029)	.285 (.029)	.294 (.030)	.295 (.030)
Anxiety	.327 (.035)	.327 (.038)	.303 (.038)	.302 (.038)
No anxiety	.286 (.029)	.286 (.030)	.290 (.030)	.291 (.031)
Depression	.288 (.035)	.289 (.039)	.256 (.039)	.254 (.039)
No depression	.293 (.029)	.294 (.030)	.300 (.030)	.301 (.031)
ADHD treatment			.379 (.032)	.375 (.033)
No ADHD treatment			.284 (.030)	.284 (.031)
Anxiety treatment			.335 (.037)	.334 (.038)
No anxiety treatment			.289 (.030)	.289 (.031)
Depression treatment			.370 (.037)	.365 (.038)
No depression treatment			.288 (.030)	.288 (.031)
Counseling			.259 (.050)	.257 (.050)
No counseling			.295 (.029)	.295 (.030)

SE=standard error; All predictions came from negative binomial models on Table 4-20.

Table 4-22. Incident Rate Ratios for asthma rescuer pharmacy claims

Mental Health	Model 1 IRR(CI)	Model 2 IRR(CI)	Model 3 IRR(CI)	Model 4 IRR(CI)
ADHD	.989 (.950,1.03)	.972 (.922,1.03)	.892 (.852,.935)**	.897 (.856,.940)**
Anxiety	1.21 (1.15,1.27)**	1.11 (1.03,1.19)**	1.12 (1.06,1.19)**	1.11 (1.05,1.17)**
Depression	.869 (.825,.917)**	.975 (.902,1.05)	.812 (.765,.862)**	.816 (.769,.867)**
Month	.989 (.988,.990)**	.989 (.988,.990)**	.990 (.989,.991)**	.990 (.989,.991)**
ADHD*month		1.001 (.999,1.003)		
Anxiety*month		1.005(1.002,1.009)**		
Depression*month		.993 (.990,.997)**		
Counseling			.926 (.854,1.004)	.925 (.853,1.002)
ADHD treatment			1.24 (1.19,1.28)**	1.24 (1.20,1.29)**
Anxiety treatment			1.15 (1.09,1.22)**	1.10 (1.04,1.17)**
Depression treatment			1.13 (1.07,1.20)**	1.15 (1.09,1.22)**
Continuous ADHD treatment				.997 (.994,1.001)
Continuous anxiety treatment				1.02 (1.01,1.02)**
Continuous depression treatment				.993 (.988,.999)*

IRR=Incident Rate Ratios, CI= 95% Confidence Intervals; p-value: * <0.05; ** <0.01; Pharmacy claims defined in Table 3-3. Generalized estimating equations with negative binomial family and link with unstructured correlation was used to control for age, gender, race, supplemental security income.

Table 4.23. Predicted average monthly estimates of asthma rescuer claims

	Model 1	Model 2	Model 3	Model 4
	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)
All average use	.235 (.028)	.235 (.028)	.235 (.029)	.235 (.030)
ADHD	.232 (.032)	.232 (.034)	.210 (.035)	.210 (.036)
No ADHD	.236 (.027)	.235 (.028)	.242 (.029	.241 (.030)
Anxiety	.289 (.035)	.289 (.039)	.267 (.039)	.262 (.040)
No anxiety	.228 (.028)	.227 (.029)	.231 (.030)	.230 (.030)
Depression	.203 (.037)	.204 (.041)	.190 (.040)	.190 (.041)
No depression	.241 (.028)	.242 (.029)	.245 (.029)	.244 (.030)
ADHD treatment			.302 (.040)	.303 (.035)
No ADHD treatment			.230 (.030)	.230 (.030)
Anxiety treatment			.278 (.040)	.263 (.041)
No anxiety treatment			.233 (.030)	.233 (.030)
Depression treatment			.272 (.040)	.278 (.042)
No depression treatment			.233 (.030)	.233 (.030)
Counseling			.215 (.049)	.215 (.049)
No counseling			.237 (.028)	.236 (.029)

SE= standard error; All predictions came from negative binomial models on Table 4-22.

Table 4-24. Predictors of monthly total and direct asthma-related expenditure

	Total expenditure Beta (CI)	Direct expenditure Beta (CI)
Model 1		
ADHD	-.019 (-.104, .067)	-.049 (-.144, .046)
Anxiety	.291 (.174, .408)**	.304 (.174, .436)**
Depression	.082 (-.035, .198)	.110 (-.022, .241)
Model 2		
ADHD	-.085 (-.207, .038)	-.127 (-.266, .013)
Anxiety	.224 (.033, .415)*	.242 (.023, .460)*
Depression	.212 (.021, .402)*	.232 (.014, .450)*
Month	-.016 (-.018,-.013)**	-.017 (-.019,-.014)**
ADHD*month	.004 (-.001, .010)	.005 (-.002, .011)
Anxiety*month	.003 (-.005, .012)	.003 (-.006, .012)
Depression*month	-.007 (-.015, .001)	-.006 (-.016, .003)
Model 3		
ADHD	-.104 (-.199,-.009)*	-.116 (-.223,-.010)*
Anxiety	.111 (-.015, .238)	.116 (-.027, .258)
Depression	-.052 (-.178,.073)	-.022 (-.163, .119)
ADHD treatment	.162 (.073, .251)**	.130 (.026, .233)**
Anxiety treatment	.298 (.142, .454)**	.309 (.129, .489)**
Depression treatment	.316 (.164, .467)**	.328 (.153, .503)**
Counseling	.039 (-.115, .194)	.021 (-.146, .188)
Model 4		
ADHD	-.109 (-.205,-.012)*	-.115 (-.224,-.007)
Anxiety	.074 (-.054, .201)	.076 (-.067, .219)
Depression	-.039 (-.165, .088)	-.003 (-.145, .139)
ADHD treatment	.152 (.060, .244)**	.125 (.018, .232)*
Anxiety treatment	.249 (.084, .414)**	.253 (.062, .444)**
Depression treatment	.352 (.193, .513)**	.374 (.188, .599)**
Continuous ADHD treatment	.003 (-.005, .011)	.001 (-.008, .010)
Continuous anxiety treatment	.022 (.008, .037)**	.023 (.007, .039)**
Continuous depression treatment	-.014 (-.029, .001)	-.016 (-.033, .001)
Counseling	.037 (-.118, .191)	.020 (-.147, .187)

CI= 95% Confidence Intervals; p-value: * <0.05; ** <0.01; Dependent variables are asthma-specific tied to asthma ICD-9 codes; Generalized estimating equations w/ gamma family and log link were used to control for age, gender, race, supplemental security income. Total and direct expenditures modeled w/ unstructured correlation.

Table 4-25. Predictors of monthly asthma related medical and pharmacy expenditure

	Medical expenditure Beta (CI)	Pharmacy expenditure Beta (CI)
Model 1		
ADHD	.022 (-.122, .167)	.072 (.013, .131)**
Anxiety	.267 (.087, .447)**	.199 (.123, .276)**
Depression	-.144 (-.324, .035)	-.103 (-.179,-.026)**
Model 2		
ADHD	-.069 (-.284, .148)	.106 (.013, .199)*
Anxiety	.290 (-.018, .598)	.102 (-.033, .238)
Depression	.021 (-.283, .325)	.078 (-.056, .212)
Month	-.024 (-.029,-.019)**	-.000 (-.002, .002)
ADHD*month	.006 (-.004, .016)	-.002 (-.006, .003)
Anxiety*month	.000 (-.014, .014)	.005 (-.001, .011)
Depression*month	-.010 (-.024, .004)	-.010 (-.015,-.004)**
Model 3		
ADHD	-.032 (-.181, .118)	-.060 (-.122,.002)
Anxiety	.168 (-.020, .355)	.084 (.003, .164)*
Depression	-.165 (-.351, .021)	-.233 (-.312,-.153)**
ADHD treatment	.164 (.088, .241)**	.261 (.222, .300)**
Anxiety treatment	.163 (.019, .307)*	.187 (.115, .260)**
Depression treatment	.029 (-.110, .168)	.248 (.178, .318)**
Counseling	-.396 (-.773,-.020)*	-.059 (-.187, .069)
Model 4		
ADHD	-.029 (-.179, .122)	-.068 (-.132,-.004)*
Anxiety	.159 (-.030, .347)	.061 (-.021, .142)
Depression	-.171 (-.357, .014)	-.232 (-.313,-.151)**
ADHD treatment	.174 (.097, .250)**	.260 (.220, .300)**
Anxiety treatment	.160 (.014, .306)*	.164 (.089, .238)**
Depression treatment	.022 (-.119, .163)	.256 (.184, .328)**
Continuous ADHD treatment	-.009 (-.021, .003)	.002 (-.003, .008)
Continuous anxiety treatment	.006 (-.015, .027)	.013 (.004, .022)**
Continuous depression treatment	.004 (-.017, .025)	-.002 (-.012, .007)
Counseling	-.379 (-.751,-.007)*	-.068 (-.197, .060)

CI= 95% Confidence Intervals; p-value: * <0.05; ** <0.01; Dependent variables are asthma-specific tied to asthma ICD-9 codes or asthma-specific pharmacy claims (Table 3-3); Generalized estimating equations w/ gamma family and log link were used to control for age, gender, race, supplemental security income. Medical and pharmacy expenditures were modeled w/ AR-6 correlation.

Table 4-26. Predicted average estimates of total asthma expenditure

Mental Health	Model 1 Mean (SE)	Model 2 Mean (SE)	Model 3 Mean (SE)	Model 4 Mean (SE)
All average use	99.47 (.053)	99.50 (.055)	99.17 (.057)	99.37 (.059)
ADHD	98.01 (.063)	97.96 (.068)	91.37 (.069)	91.21 (.072)
No ADHD	99.85 (.052)	99.70 (.053)	101.37 (.056)	101.71 (.058)
Anxiety	126.85 (.075)	125.77 (.085)	108.70 (.081)	105.58 (.084)
No anxiety	94.80 (.053)	94.81 (.055)	97.26 (.057)	98.04 (.059)
Depression	106.42 (.075)	108.18 (.085)	95.01 (.081)	96.26 (.083)
No depression	98.09 (.053)	98.25 (.056)	100.10 (.057)	100.06 (.059)
ADHD treatment			114.76 (.071)	113.94 (.074)
No ADHD treatment			97.57 (.056)	97.85 (.059)
Anxiety treatment			130.31 (.096)	124.55 (.102)
No anxiety treatment			96.73 (.057)	97.14 (.059)
Depression treatment			132.67 (.095)	137.60 (.100)
No depression treatment			96.74 (.057)	96.67 (.060)
Counseling			102.85 (.093)	102.79 (.095)
No counseling			98.88 (.055)	99.10 (.057)

SE=standard error; All predictions came from gamma regression models on Table 4-24.

Table 4-27. Predicted average estimates of direct asthma total expenditure

Mental Health	Model 1 Mean (SE)	Model 2 Mean (SE)	Model 3 Mean (SE)	Model 4 Mean (SE)
All average use	84.21 (.058)	84.23 (.060)	84.03 (.062)	84.19 (.064)
ADHD	80.98 (.069)	80.86 (.076)	76.66 (.077)	76.86 (.800)
No ADHD	85.06 (.056)	84.92 (.058)	86.12 (.061)	86.27 (.064)
Anxiety	108.52 (.083)	107.54 (.095)	92.41 (.090)	89.57 (.093)
No anxiety	80.02 (.058)	80.04 (.061)	82.32 (.062)	83.02 (.065)
Depression	92.22 (.083)	93.70 (.095)	82.53 (.090)	83.98 (.093)
No depression	82.63 (.058)	82.74 (.061)	84.37 (.063)	84.24 (.065)
ADHD treatment			94.43 (.080)	94.22 (.083)
No ADHD treatment			82.96 (.062)	83.15 (.065)
Anxiety treatment			111.45 (.109)	105.90 (.116)
No anxiety treatment			81.84 (.062)	82.22 (.065)
Depression treatment			113.62 (.107)	118.77 (.114)
No depression treatment			81.85 (.063)	81.74 (.065)
Counseling			85.70 (.101)	85.74 (.104)
No counseling			83.90 (.060)	84.07 (.063)

SE=standard error; All predictions came from gamma regression models on Table 4-24.

Table 4-28. Predicted mean estimates of monthly asthma-related medical expenditure

Mental Health	Model 1 Mean (SE)	Model 2 Mean (SE)	Model 3 Mean (SE)	Model 4 Mean (SE)
All average use	13.60 (.122)	13.64 (.125)	13.53 (.126)	13.46 (.127)
ADHD	13.85 (.135)	13.91 (.143)	13.19 (.140)	13.15 (.142)
No ADHD	13.55 (.121)	13.55 (.123)	13.61 (.124)	13.53 (.126)
Anxiety	17.13 (.147)	17.55 (.161)	15.64 (.152)	15.44 (.154)
No anxiety	13.12 (.123)	13.12 (.125)	13.24 (.126)	13.15 (.128)
Depression	12.02 (.146)	12.23 (.161)	11.74 (.152)	11.61 (.153)
No depression	13.89 (.123)	13.99 (.126)	13.85 (.126)	13.78 (.128)
ADHD treatment			15.72 (.131)	15.78 (.133)
No ADHD treatment			13.34 (.126)	13.26 (.128)
Anxiety treatment			15.65 (.145)	15.64 (.147)
No anxiety treatment			13.24 (.126)	13.33 (.128)
Depression treatment			13.91 (.144)	13.75 (.146)
No depression treatment			13.51 (.126)	13.44 (.128)
Counseling			9.31 (.219)	9.41 (.218)
No counseling			13.83 (.121)	13.74 (.123)

SE=standard error; All predictions came from gamma regression models on Table 4-25.

Table 4-29. Predicted mean estimates of monthly asthma-related pharmacy expenditure

Mental Health	Model 1 Mean (SE)	Model 2 Mean (SE)	Model 3 Mean (SE)	Model 4 Mean (SE)
All average use	55.88 (.042)	55.97 (.044)	55.61 (.044)	55.66 (.046)
ADHD	59.19 (.048)	59.52 (.052)	53.04 (.051)	52.75 (.053)
No ADHD	55.06 (.042)	55.13 (.043)	56.32 (.044)	56.48 (.045)
Anxiety	66.22 (.055)	66.14 (.062)	59.71 (.058)	58.58 (.060)
No anxiety	54.25 (.042)	54.24 (.044)	54.91 (.045)	55.14 (.046)
Depression	51.27 (.054)	52.04 (.062)	45.76 (.057)	45.84 (.059)
No depression	56.81 (.042)	57.09 (.044)	57.74 (.045)	57.82 (.046)
ADHD treatment			70.33 (.048)	70.32 (.050)
No ADHD treatment			54.18 (.044)	54.21 (.046)
Anxiety treatment			66.24 (.057)	64.79 (.059)
No anxiety treatment			54.93 (.045)	55.01 (.046)
Depression treatment			70.16 (.057)	70.74 (.059)
No depression treatment			54.78 (.045)	54.77 (.046)
Counseling			52.64 (.075)	52.21 (.077)
No counseling			55.82 (.043)	55.91 (.045)

SE=standard error; All predictions came from gamma regression models on Table 4-25.

Table 4-30. Predictors of expenditure vs. no expenditure for inpatient and outpatient monthly asthma related services

	Inpatient OR (CI)	Outpatient OR (CI)
Model 1		
ADHD	.768 (.741,796)**	.887 (.868,.907)**
Anxiety	1.34 (1.28,1.40)**	.946 (.917,.976)**
Depression	1.36 (1.30,1.42)**	1.18 (1.14,1.21)**
Model 2		
ADHD	.940 (.861,1.03)	.971 (.923,1.02)
Anxiety	1.34 (1.19,1.51)**	.962 (.890, 1.04)
Depression	1.54 (1.36,1.74)**	1.28 (1.19, 1.39)**
Month	1.04 (1.04,1.04)**	1.05 (1.05,1.05)**
ADHD*month	.991 (.988,.995)**	.996 (.994,.998)**
Anxiety*month	1.000 (.995,1.01)	.999 (.996,1.002)
Depression*month	.995 (.990,.9996)*	.996 (.993,.999)*
Model 3		
ADHD	.814 (.780,.850)**	.925 (.901,.951)**
Anxiety	1.28 (1.22,1.35)**	1.08 (1.04,1.12)**
Depression	1.35 (1.28,1.42)**	1.11 (1.07,1.15)
ADHD treatment	.823 (.775,.875)**	.907 (.875,.941)**
Anxiety treatment	1.13 (1.04,1.23)**	.641 (.603,.681)**
Depression treatment	.961 (.882,1.05)	1.29 (1.21,1.37)**
Counseling	1.23 (1.17,1.29)**	.941 (.908,.974)**
Model 4		
ADHD	841 (.805,.878)**	.945 (.919,.972)**
Anxiety	1.27 (1.20,1.34)**	1.11 (1.07,1.15)**
Depression	1.35 (1.28,1.42)**	1.11 (1.07,1.15)**
ADHD treatment	.965 (.898,1.04)	.989 (.948,1.03)
Anxiety treatment	1.07 (.960,.1.19)	.831 (.772,.897)**
Depression treatment	.927 (.832,1.03)	1.17 (1.08,1.25)**
Continuous ADHD treatment	.983 (.979,.987)**	.990 (.914,.980)**
Continuous anxiety treatment	1.00 (.998,1.01)	.974 (.969,.978)**
Continuous depression treatment	1.006 (1.000, 1.013)*	1.01 (1.002,1.012)**
Counseling	1.23 (1.17,1.30)**	.947 (.914,.980)**

OR=Odds Ratio, CI= 95% Confidence Intervals; p-value: * <0.05; ** <0.01
Generalized estimating equations with binomial family and logit link with independent correlation controlled for age, gender, race, supplemental security income.
Dependent variables are asthma specific (Table 3-1).

Table 4-31. Predictors of monthly inpatient and outpatient expenditure for asthma related services (assuming expenditure > $0)

Predictors of Expenditure	Inpatient Beta (CI)	Outpatient Beta (CI)
Model 1		
ADHD	-.035 (-.177, .107)	-.030 (-.088, .028)
Anxiety	.253 (.082, .423)**	.052 (-.031, .135)
Depression	.118 (-.057, .292)	-.045 (-.128, .038)
Model 2		
ADHD	-.070 (-.304, .164)	-.140 (-.238,-.041)**
Anxiety	.170 (-.140, .481)	.039 (-.118, .196)
Depression	.156 (-.160, .472)	-.089 (-.244, .066)
Month	.000 (-.005, .005)	-.003 (-.005,-.001)**
ADHD*month	.002 (-.010, .013)	.006 (.002, .011)**
Anxiety*month	.005 (-.010, .020)	.001 (-.006, .008)
Depression*month	-.002 (-.017, .013)	.002 (-.005, .009)
Model 3		
ADHD	-.071 (-.243, .101)	-.009 (-.080, .061)
Anxiety	.219 (.008, .431)*	.024 (-.070, .118)
Depression	.107 (-.100, .314)	-.024 (-.117,.070)
ADHD treatment	.067 (-.149, .282)	-.051 (-.138, .037)
Anxiety treatment	.055 (-.219, .329)	.094 (-.045, .233)
Depression treatment	.001 (-.279, .282)	-.081 (-.218, .056)
Counseling	.048 (-.148, .244)	.025 (-.005, .080)
Model 4		
ADHD	-.062 (-.238, .113)	-.013 (-.085, .059)
Anxiety	.168 (-.049, .385)	-.003 (-.098, .091)
Depression	.135 (-.074, .345)	-.015 (-.109, .079)
ADHD treatment	.061 (-.174, .295)	-.060 (-.155, .035)
Anxiety treatment	-.015 (-.305, .275)	-.014 (-.169, .141)
Depression treatment	.062 (-.239, .363)	-.020 (-.173, .134)
Continuous ADHD treatment	-.000 (-.020, .019)	.002 (-.005, .090)
Continuous anxiety treatment	.019 (-.003, .042)	.022 (.010, .035)**
Continuous depression treatment	-.014 (-.040, .013)	-.011 (-.024, .001)
Counseling	.039 (-.157, .235)	.021 (-.070, .113)

CI= 95% Confidence Intervals; p-value: * <0.05; ** <0.01
Generalized estimating equations with gamma family and log link with exchangeable correlation controlled for age, gender, race, supplemental security income.
Dependent variables are asthma specific (Table 3-1).

Table 4-32. Models 1 and 2 two part model predicted mean estimates of asthma-related inpatient expenditure ($)

Mental Health	Model 1 Any Use	Model 1 Mean Expenditure	Model 1 Predicted Mean	Model 2 Any Use	Model 2 Mean Expenditure	Model 2 Predicted Mean
All average use	.090	3796.57	369.33	.090	3794.03	369.55
ADHD	.075	3691.54	300.61	.076	3686.21	304.58
No ADHD	.095	3821.53	391.97	.095	3816.25	391.88
Anxiety	.111	4694.57	545.22	.111	4699.00	553.45
No anxiety	.086	3645.54	328.83	.086	3631.80	326.45
Depression	.112	4188.25	496.12	.114	4182.57	497.52
No depression	.086	3722.53	338.63	.086	3725.15	339.67

This two part model uses predicted probability estimates of inpatient use from logistic regression (Table 4-30) and the predicted estimated inpatient monthly mean expenditure given expenditure>$0 from gamma regression (Table 4-31) to calculate predicted mean expenditure.

Table 4-33. Models 3 and 4 two part model predicted mean estimates of asthma-related inpatient expenditure ($)

Mental Health	Model 3 Any Use	Model 3 Mean Expenditure	Model 3 Predicted Mean	Model 4 Any Use	Model 4 Mean Expenditure	Model 4 Predicted Mean
All average use	.090	3791.22	368.60	.090	3784.69	368.77
ADHD	.078	3578.92	303.42	.080	3598.70	312.39
No ADHD	.094	3843.33	389.88	.093	3829.87	386.50
Anxiety	.108	4557.76	514.19	.107	4354.49	490.32
No anxiety	.087	3659.85	333.20	.087	3681.45	337.08
Depression	.112	4144.85	489.30	.112	4237.82	500.83
No depression	.086	3724.47	339.33	.086	3701.70	337.68
ADHD treatment	.077	4029.60	335.38	.088	4000.48	378.88
No ADHD treatment	.092	3770.00	371.94	.091	3765.48	367.60
Anxiety treatment	.100	3990.54	425.93	.096	3732.52	383.32
No anxiety treatment	.090	3777.94	363.14	.090	3788.61	367.18
Depression treatment	.088	3796.02	357.72	.085	4010.42	367.28
No depression treatment	.091	3790.90	369.68	.091	3770.41	368.76
Counseling	.107	3965.55	452.64	.107	3925.18	449.94
No counseling	.089	3779.25	361.63	.089	3775.04	362.04

This two part model uses predicted probability estimates of inpatient use from logistic regression (Table 4-30) and the predicted estimated inpatient monthly mean expenditure given expenditure >$0 from gamma regression (Table 4-31) to calculate predicted mean expenditure.

Table 4-34. Models 1 and 2 two part model predicted mean estimates of asthma-related outpatient expenditure ($)

Mental Health	Model 1 Any Use	Model 1 Mean Expenditure	Model 1 Predicted Mean	Model 2 Any Use	Model 2 Mean Expenditure	Model 2 Predicted Mean
All average use	.394	319.09	126.12	.394	319.01	126.09
ADHD	.373	311.33	116.42	.374	312.82	119.37
No ADHD	.399	320.74	128.34	.399	319.45	127.43
Anxiety	.383	333.90	128.32	.384	334.19	128.95
No anxiety	.396	316.99	125.69	.396	316.71	125.52
Depression	.425	306.96	130.98	.428	304.33	131.25
No depression	.389	321.00	125.36	.389	321.05	125.29

The two part models use predicted probability estimates of outpatient use from logistic regression (Table 4-31) and the predicted estimates of average outpatient monthly expenditure given some expenditure>$0 from gamma regression (Table 4-32) to calculate predicted mean expenditure.

Table 4-35. Models 3 and 4 two part model predicted mean estimates of asthma-related outpatient expenditure ($)

Mental Health	Model 3 Any Use	Model 3 Mean Expenditure	Model 3 Predicted Mean	Model 4 Any Use	Model 4 Mean Expenditure	Model 4 Predicted Mean
All average use	.394	319.10	126.06	.394	319.65	126.13
ADHD	.380	316.55	120.66	.384	316.27	121.59
No ADHD	.397	319.53	127.24	.396	320.36	127.13
Anxiety	.408	325.72	133.37	.414	318.74	132.10
No anxiety	.392	318.03	124.93	.391	319.79	125.18
Depression	.414	312.56	129.87	.414	315.56	130.74
No depression	.391	320.01	125.48	.391	320.28	125.41
ADHD treatment	.374	304.49	114.34	.392	302.40	118.64
No ADHD treatment	.396	320.25	127.07	.394	321.15	126.75
Anxiety treatment	.305	348.96	106.79	.356	315.36	112.52
No anxiety treatment	.399	317.66	126.94	.396	319.88	126.89
Depression treatment	.448	295.29	132.65	.427	313.76	134.04
No depression treatment	.391	320.20	125.70	.392	319.93	125.74
Counseling	.381	326.69	124.94	.383	326.18	125.00
No counseling	.395	318.56	126.12	.395	319.26	126.19

The two part models use predicted probability estimates of outpatient use from logistic regression (Table 4-31) and the predicted estimates of average outpatient monthly expenditure given some expenditure>$0 from gamma regression (Table 4-32) to calculate predicted mean expenditure.

CHAPTER 5
DISCUSSION

Overview

This study uses negative binomial and gamma regressions to predict asthma-related utilization and expenditures for three unique mental health conditions (e.g., ADHD, anxiety, and depression) and their treatment on Medicaid youth with asthma. The findings of this study are expanded for each specific mental health condition and the associations with each asthma-related outcome. These findings generally suggest that comorbid ADHD, anxiety, and depression and the respective mental health pharmacological treatment have a wide range of associations and implications for the delivery of services for youth with asthma. The findings for each of the associations between ADHD, anxiety and depression with asthma-related services (e.g., inpatient, outpatient, medical, and pharmacological services) have strong policy implications with respect to the management and coordination of care among youth with asthma on Florida Medicaid. Future research, strengths, and limitations of this study are addressed.

Summary and Interpretation of Findings

This study addressed gaps in the asthma and mental health literature by using several techniques to improve on the limitations of previous studies. In this study, health care utilization and expenditures was limited to asthma-specific use and expenditure. Additionally, asthma was defined conservatively as having least 2 ICD-9 asthma diagnoses within the first year of the study. This study uses a large sample (n=8,241) of continuously enrolled Medicaid youth with asthma from the state of Florida. This cohort was analyzed over a 36 month period through a longitudinal design. The main feature of

this study was to bring specific attention to individual mental health diagnosis of ADHD, anxiety, and depression and the impact on asthma-related utilization and expenditures. Additionally, the study addressed the need to look at the pharmacological impact of mental health treatment on the underlying relationship between mental health and asthma-related care. This study implies that treatment for psychiatric conditions may have an impact on asthma related care.

Generally, this study sought to achieve 3 objectives, which include:

1. To understand the impact of 3 unique mental health conditions as a modifier of asthma-specific utilization and expenditures.
2. To understand the association of the number of months with a mental health condition on the use and expenditure of asthma-specific services.
3. To understand the impact of mental health treatment for 3 unique mental health conditions as a mediator of asthma-specific utilization and expenditures.

The below discussion sections address these three objectives by mental health diagnosis and asthma-related services.

ADHD and Asthma-Related Services

While other studies have not found any association between childhood asthma and ADHD (Daly et al., 1996), this study reports a large sample of youth with asthma that have a high prevalence of ADHD (i.e., 18.5% of this sample has ADHD). The prevalence of ADHD in Florida is about half that observed in this study at 9.2% (CDC, 2005), suggesting a higher prevalence of ADHD in this Medicaid population of continuously enrolled youth with asthma. Since youth with asthma have an increased likelihood for obstructive sleep apnea, assessing each youth with asthma for sleep disordered breathing has been suggested (Bousquet et al., 2008; Kalpaklioğlu et al., 2009; Owens, 2009).The issue of sleep disorders being misdiagnosed as ADHD

becomes an important consideration to explain the underlying higher ADHD prevalence observed in this study.

Findings from this study suggest asthma-related services are used differently among those with ADHD compared to those without ADHD. In this study, the hypothesized effect for youth with comorbid ADHD was to observe a decrease in asthma-specific use and expenditure. However, this was not universally observed across all asthma-related services. Generally, having comorbid ADHD was associated with significant decrease in inpatient monthly admissions and expenditures. This was consistent with earlier studies by Jamoom and colleagues (2010). However, ADHD was associated with a significant increase in asthma-related medical claims, and asthma-related pharmacy claims, including total, direct, controller, and indirect pharmacy claims suggesting better adherence to asthma medications and coordination of asthma care.

The associated asthma-related prescription expenditures were higher for those with ADHD compared to those without ADHD, and this may be indicative of youth with ADHD being high users of pharmacy claims as previously described (Chen et al., 2002). However this can also relate to better adherence and better coordination of care (Katon et al., 2005). Additionally, differences in ADHD adherence has been observed (Gau et al., 2008), and this may ultimately impact asthma treatment adherence based on different factors associated within the Medicaid population. Poor adherence in childhood with ADHD has been associated with older age, later onset of ADHD, family history of ADHD, higher paternal education level, and multi-dose administration (Gau et al., 2008). This study did not address many of those characteristics due to the nature of claims data and very different sample characteristics (e.g., Taiwanese population).

Another rationale for the improved adherence and asthma management relates to the continuity of care within the medical home for those with ADHD. Pediatricians are more likely to treat ADHD then refer them outside of their medical home (Stein et al., 2008). Specifically in a recent sample of 659 pediatricians, 70% agreed that pediatricians should be responsible for treating and managing ADHD. Therefore, pediatricians are not only more involved in the treatment of asthma but their patients' overall ADHD treatment as well. This may be a very different experience for other mental health conditions that physicians are more likely to refer to a specialty mental health clinic (e.g., depression, anxiety). Those with ADHD and asthma are, in theory, receiving an overall higher quality of care for the management of their asthma and ADHD by not necessarily having to leave their medical home.

A temporal effect was observed for those with ADHD, such that the number of months one has an ADHD diagnosis is associated with an increase in medical claims, controller medications, and inpatient and outpatient expenditures. The general trend of the longer one has ADHD, the more asthma-related medical, controller, and direct pharmacy claims. This increase in utilization was described in treating ADHD (Guevara et al., 2001), and potentially may extend toward beneficial asthma treatment (Kewalramani et al., 2008). Also, there was a decreased propensity to use inpatient services. These findings suggest that those with comorbid ADHD have improved coordination of care, better management and adherence to their asthma regimen. The positive effects for ADHD generally may be a combination of more exposure to the medical environment, more pediatrician ownership for the treatment and management of the ADHD and asthma rather than referring ADHD to psychiatric services where the

asthma may not be addressed with the mental health condition, treated within a medical home, and better pharmacological management of ADHD and asthma medications (Guevara et al., 2001; Kewalramani eet al., 2008; Stein et al., 2008).

ADHD was associated with significant reduction in total expenditure when treatment variables were included. Treatment of ADHD was associated with an overall effect of having more medical claims and more pharmacy fills across all categories. The continuous use of ADHD medications was associated with fewer inpatient admissions. ADHD treatment diminishes the effects of ADHD on monthly asthma related total expenditures and all asthma related pharmacy expenditure. For example, without ADHD treatment, ADHD was associated with an increase in asthma related pharmacy expenditures compared to those without ADHD. However, controlling for ADHD treatment resulted in a significant reduction in total asthma-related pharmacy expenditure effectively mediating asthma specific pharmacy expenditure for ADHD. Other treatment effects that require attention include potential protective effects of ADHD treatment. Further understanding into the medications used in ADHD and the impact on asthma control can help explain some of the improved care observed in this study. ADHD treatment was associated with an increase in medical claims and all pharmacy claims, and the increase pharmacy utilization while not hypothesized, makes logical sense due to increased access to pharmacy based on better continuity of care (i.e., ADHD and asthma controlling medication) and physician coordination within the medical home. This also is consistent with the ADHD literature of increased pharmacy utilization (Chen et al., 2002; Guevara et al., 2001).

Anxiety and Asthma-Related Services

Findings from this study suggest that youth with anxiety use asthma-related services differently than those without anxiety. As hypothesized, anxiety was associated with greater asthma-related utilization and expenditures across all asthma-related service categories. The rationale for the increase in all asthma-related use and expenditure categories is multifaceted. Having used more asthma-related inpatient and urgent care is indicative of poorly coordinated and controlled asthma. However, high asthma-related pharmacy fills and expenditures imply asthma medication adherence is not necessarily an issue. Hence, the larger problem may relate to coordination of care.

Coordination of asthma and anxiety management relates directly to the continuity of care within and outside the medical home for those with anxiety and asthma. Pediatricians are less likely to treat anxiety and refer youth with anxiety to psychiatrists as they do not believe it is part of their responsibility to treat anxiety (Stein et al., 2008). The result is psychiatric care that is done outside of the medical home. Specifically in a recent sample of 659 pediatricians, 29% agreed that pediatricians should be responsible for treating and managing anxiety disorders. Therefore, it can be assumed that pediatricians are only involved in the treatment of asthma not the anxiety. The coordination of management from providers outside of the medical home becomes even more important in the context of the role anxiety plays for the management of asthma. Hence, coordination and continuity of care for those with anxiety and asthma requires further insight and context into how those conditions are managed. This study finds that those with anxiety and asthma are, in theory, receiving care (e.g., higher general use and expenditure). However, the quality of care for the management of their asthma and anxiety may not necessarily be the best, as they are likely to be leaving their medical

home for anxiety care resulting in asthma coordination and management problems. This study did not control for where anxiety and asthma health services were processed. Hence, this study did not address whether asthma was being assessed in the psychiatric facility or in the pediatrician's office and is an area for future research.

The role of anxiety in comorbid medical illness has been suggested as something not to ignore (Roy-Byrne et al., 2008). This study agrees with other emerging data suggesting anxiety disorders rival depression in terms of risk, comorbidity and outcome. Using more services and having greater expenditures suggests that this population should be monitored closely by physicians with better coordination of care and routine follow-up. The increase in services and expenditures for youth with comorbid anxiety may be indicative of greater severity of disease pathology. Since the study did not control for asthma severity influencing utilization, it is recommended that future studies include a measure of severity to further understand why this population of youth with asthma that are using significantly more services and expenditures.

There were significant time effects for those with anxiety on monthly total, direct, and rescuer asthma-related pharmacy utilization. These effects suggested increased pharmacy utilization is due, in part, to the months of having an anxiety diagnosis. The longer one has anxiety the greater the general utilization and expenditure. The implications for length of time with anxiety on asthma care suggest physicians and patients alike may benefit from a review of anxiety and asthma protocols as they relate to improved long term pharmacological management and coordination to reduce negative asthma outcomes.

For example, anxiety treatment was associated with more asthma-related inpatient care. This association may relate to anxiety treatment exacerbating asthma, disease severity, potentially harmful pharmacological interactions, or poorly managed, coordinated asthma care (Roy-Byrne et al., 2008; Stein et al., 2008). However, there may be drug interactions, or potential side effects that are unable to be addressed by this study. Specifically, such pharmacological effects may occur over time to influence the biochemical pathways by which these drugs operate (Kewalramani et al., 2008; Pretorius, 2004). For example, taking SSRIs or psycho-stimulants used to treat depression, anxiety, and ADHD and may impact “up-regulation” of serotonin levels and possibly trigger asthma attacks (Pretorius, 2004).

The relationship between asthma and anxiety disorders suggest that psychopharmacological might improve asthma control. Anxiety treatment resulted in diminished effect for anxiety across all asthma-related utilization and expenditure, signifying anxiety treatment helps to mediate asthma utilization and expenditure to an extent for those with anxiety. The difference may be statistically significant, but of little practical or clinical significance.

These findings suggest that despite more interaction with the medical environment their anxiety contributes to high asthma-related service use and expenditures. Strong increased expenditures and utilization patterns in this population require more careful attention to their chronic disease management. A focus should, therefore, be on decreasing asthma-related inpatient care.

Depression and Asthma-Related Services

Findings from this study suggest that those youth with depression use asthma-related services differently from youth without depression. However the original

hypotheses were met with mixed findings. As hypothesized, depression was associated with significantly greater monthly inpatient admissions, which is consistent with other studies (Mohammed et al., 2006; Richardson et al, 2008). However, those with comorbid depression used significantly less asthma maintenance services (e.g., medical claims, pharmacy claims). Youth with comorbid depression incurred significantly less asthma-related monthly medical claims and used significantly less total, direct, and rescuer pharmacy claims compared to those without depression. The combination of having significantly greater inpatient admissions, while having lower total monthly asthma-related pharmacy expenditures compared to those without depression and lower asthma-related pharmacy prescriptions filled may be due to poor adherence, poor coordination of depression and asthma management, or differences in asthma severity.

Therefore, this study suggests that those youth with depression like other instances in the literature of comorbid depression in chronic disease (e.g., hypertension, diabetes) may be experiencing poor adherence to asthma treatment regimens, evidenced by higher monthly inpatient admissions compared to those without depression. Other possibilities include that youth with asthma that have comorbid depression are sicker. Since this study does not control for asthma severity or depression severity, this currently cannot be assessed and is discussed further as a limitation.

The number of months with depression diagnosis was assessed for each of the asthma-related outcomes. The number of months with depression was associated with fewer asthma-related medical and pharmacy claims with every additional month of

having a depression diagnosis. Therefore the longer one has depression, the more likely the youth with depression is not filling his/her asthma medications resulting in potentially poor adherence. Perhaps there is an initial founder effect, where the doctor diagnoses the mental health condition during the youth with asthma's well-check visit. Since most pediatricians do not feel it is their responsibility to manage and treat depression (Stein et al., 2008), they refer the treatment of the youth with asthma's depression to a psychiatric clinic outside the medical home. Therefore, if the asthma is addressed through routine well-check visit within the medical home, and the psychiatrist only focuses on the depression, then coordination of care and ultimately the management of the asthma may suffer over time. The coordination and management of both the depression and asthma are poor due to being outside of the medical home and having poorly coordinated mental health and asthma services. Another possibility was that the depression was either more acute in nature to result in a decrease in utilization over time. However, coupled with the first hypothesis it may reflect poor adherence and a trend towards less interaction with the medical environment (e.g., less routine care) such that when such an adverse event occurs it yields initial costlier care (e.g., increased incident inpatient admissions).

In general, receiving treatment mediated the asthma-related use and expenditure for those with depression. Specifically, depression treatment diminishes the effect of depression on inpatient admissions, as hypothesized. Depression treatment (both presence of and continuous treatment) was associated with increased medical claims and more asthma-related pharmacy expenditure and utilization. Therefore suggesting depression treatment was associated with better asthma management and potentially

better adherence. Depression treatment was also associated with reduced urgent care visits (IRR=.655, $p<0.01$) suggesting that depression treatment has some protective aspects for reducing the need for urgent care. Depression treatment was associated with increased asthma-related total, direct, rescuer and controller pharmacy claims suggesting increase in utilization for depression treatment improves adherence or at least filling of asthma related medication.

However, coordination of depression and asthma management may also be a concern. Pediatricians are less likely to treat depression and refer youth with anxiety to psychiatrists as they do not believe it is part of their responsibility to treat anxiety (Stein et al., 2008). The result is psychiatric care is done outside of the medical home. Specifically in a recent sample of 659 pediatricians, 25% agreed that pediatricians should be responsible for treating and managing child/adolescent depression (Stein et al., 2008). Similarly experienced with anxiety, pediatricians are only involved in the treatment of asthma not the underlying mental health condition (e.g., depression). The coordination of management from providers outside of the medical home becomes even more important for context of the role depression plays for the management of asthma. Again, this was a very different experience for those with ADHD who are treated for their ADHD and asthma within the same medical home and have apparently better asthma management. Hence, better disease management requires better coordination and continuity of care for those with depression and asthma.

Asthma-Related Pharmacy Claims and Expenditures

This study assesses large scale impact of depression, anxiety, and ADHD impact on asthma-related pharmacy claims. Generally, anxiety and ADHD have higher asthma-related monthly pharmacy utilization. However, there may be multiple effects which

relate to the success of asthma management between the two mental health groups. Asthma medications may have adverse impacts for those with anxiety and depression (Pretorius, 2004), whereas those with ADHD may benefit from stimulants (Daly et al., 1996).

The implication of depression being associated with less asthma-related pharmacy utilization may ultimately lead to higher cost inpatient care due to poor medication adherence (Katon et al., 2005; DiMatteo et al., 2000; Cramer et al., 1998). This finding may require further understanding as many other factors may be in play with respect to adherence to asthma related treatment for youth with asthma, from specific drug interactions to parental behavior with respect to access. However, the literature suggests depression is associated with poor adherence to asthma treatment (Katon et al., 2005; DiMatteo et al., 2000; Cramer et al., 1998).

The other interesting finding is that treatment for mental health was associated with increase in asthma medication use suggesting youth with asthma receiving mental health treatment are more likely to fill asthma medications. Additionally, youth with comorbid anxiety have higher asthma-related pharmacy claims leading to greater reliance on rescuer and controller medications, suggesting an issue of coordination of care.

Use of rescuer medication and controller medications were assessed in this study. Rescuer medication use is meant for temporary relief for mild to moderate asthma. Most youth with asthma that have more moderate to severe asthma rely on controller medications (Rodrigo & Rodrigo, 2002; Blair et al., 2008). There is significantly more controller use for youth with comorbid ADHD. The use of controller medications may

help in stabilizing asthma and reduce the chance for an asthmatic episode needing medical intervention. The aspects of ADHD that may be potentially interesting to explore include what specific aspects of regular use of ADHD medications contribute to the protective effect of reducing the odds of having inpatient use (OR=.983).

Policy and Research Implications

The implications for this study involve understanding a new role that mental health and mental health treatment play in chronic disease management for youth with asthma.

ADHD was associated with better adherence and this may be a result of better coordination of care within the medical home. ADHD may also be a misdiagnosis for obstructive sleep apnea or sleep disordered breathing, which may result in many similar diagnostic criteria symptomology observed in ADHD (Owens, 2009). It is important to consider why this population had twice the prevalence of ADHD compared to the rest of the state of Florida.

Additionally, 50% of the original sample didn't meet continuously enrolled criteria, and that may represent a large set of youth that have a variety of different characteristics from this study sample of continuously enrolled Medicaid youth with asthma. Having gapes in coverage may result in less coordination and continuity of care for these youth. Further study that accounts for discontinuity in Medicaid coverage may be warranted.

Coordination of care seems to be a really important implication from this study. As we uncover the relationship in utilization for mental health and chronic disease we can start to understand the importance of coordination of mental health treatment on the overall management of asthma. Coordination of care is better in theory for those with

ADHD, however when doctors are referring out mental health conditions like depression and anxiety, the problem becomes a silo or possible lack of coordination between the two providers; where the psychiatrist is responsible for that patient's mental health treatment, and the pediatrician is responsible for the asthma management. The problem is the mental health and asthma may be viewed as mutually exclusive problems. However, they must be treated in context (Kewalramani et al., 2008). If both the pediatrician and the psychiatrist are not coordinating the asthma and mental health management, the care suffers.

Some have suggested that many pediatric asthma hospitalizations might be prevented if parents and children were better educated about the child's condition, medications, and the need for follow-up care and avoiding known disease triggers (Flores, Abreu, Tomany-Korman, & Meurer, 2005; Coffman, Cabana, Halpin & Yelin, 2008).

A key issue is how many parents are aware of potential interactions between the medications for asthma and treatment for mental health conditions. ADHD, anxiety, and depression symptomology have not received much attention in the literature since smaller studies assessing medication in ADHD and asthma were completed by Daly and colleagues (1996). This study encourages more research and attention to larger studies like this one to assess the impact of asthma specific medications on both mental health and asthma related outcomes.

Treatment tends to be associated with improved asthma-related care as use tends to exhibit diminished effects. However the specific medication interaction and other multiple factors involving education on the triggers that exacerbate one's specific

asthma may help to reduce costly care (Flores et al., 2005). Some side effects of some asthma medications, and the potential interactions associated with SSRIs may trigger potential asthma attacks, and this specific aspect could use more attention by the medical and pharmacological communities (Pretorius, 2004). This study supports at least further research to elucidate the actual pharmacological medication interactions for those with asthma and those that have depression, anxiety, and ADHD.

Study strengths. This study has fulfilled the call to address the impact of mental health and mental health treatment on asthma-related utilization and expenditure (Blair et al., 2008; Kewalramani et al., 2008; Roy-Byrne et al., 2008). The strengths of this study include being one of the first large longitudinal studies to address mental health and mental health treatment in a large chronic condition, childhood asthma. This study's findings are generalizable to youth with asthma that are continuously enrolled in Florida Medicaid, and these findings extend to most national Medicaid populations. Additionally, the 36 month cohort of more than 8,000 youth with asthma was continuously enrolled in Medicaid suggesting that all had similar access to asthma-related services. This study also addressed specific mental health associations w/ the delivery of asthma services, and improves on other methods through using a longitudinal approach.

This study also improved upon earlier studies by including robust methods and cohort definitions for asthma. Claims data represent a good measure of service use and expenditures to analyze the objectives of this study and obtain good estimates of expenditure and utilization for this population. Furthermore all expenditure and utilization were attributed to asthma through ICD-9 coding and national standards from

the National Center for Quality Assurance to define mental health as well as mental health and asthma treatment variables.

The definition of asthma for this cohort was having 2 ICD-9 codes for asthma within the first 12 months of the study. This strict definition allows for better identification of youth with asthma to avoid false positives in this sample. The definition of mental health was based on the concept of a trigger allowing for mental health diagnosis at any month in the 36 month observation period. This method provides a 3 year opportunity to assess mental health as it is diagnosed in a cohort of youth with asthma.

This study also brings more attention to policy relating to mental health and asthma. Specifically, this study reported a strong association between ADHD and asthma that has not been observed in the literature. Additionally, poor adherence to asthma treatment was suggested for youth with asthma that have depression, and this study adds to the consistency of the literature (Katon et al., 2005). Coordination and management of care issues were also suggested by the general findings for youth with asthma that have anxiety.

Future Research

Future research is needed to address the main findings of the study. First, there is a need to understand how differently ADHD, anxiety, and depression are coordinated with the pediatrician who manages the asthma care. Understanding the difference in coordination and referral practices helps to understand the effect of a medical home on asthma-related care. Second, future research needs to address the cause of asthma medication adherence issues among those with depression. Strategies for improving adherence in asthmatic youth with depression are also indicated. This may involve understanding the parental role in compliance and ensuring adherence to treatment

regimens. Third, asthma and mental health severity need to be addressed with respect to each asthma-related outcome. Understanding the relationship between asthma and mental health severity would eventually help to quantify the effect of severity on asthma-related services. Moreover, complex medication interactions between asthma and drugs to treat mental health (e.g., SSRIs, ADHD medications) need to be assessed through wide scale studies. Additionally, influence of behavioral, environmental, and parental factors on asthma-related utilization and needing to be addressed in future studies. Lastly, specific types of asthma need to be assessed for these observed findings, as different etiologies of asthma (i.e., exercise-induced, intrinsic, allergic asthma) may have very different associations with mental health and mental health treatment (Blair et al., 2008).

Limitations of Study

While strengths of this study are remarkable, there are several noteworthy limitations that should be addressed.

Generalizability. The generalizeability of this study's findings are specific to a continuously enrolled sample of Florida Medicaid youth with asthma. While most likely able to be expanded to other continuously enrolled Medicaid youth with asthma, these findings are not generalizable to those discontinuously enrolled Medicaid youth. Over half of the original sample (n=38,607) was excluded because they did not meet the definition of continuous enrollment, and that may represent a potential problem to external validity.

A large number of youth with asthma were not included in the sample based on not meeting criteria for continuous eligibility or meeting the string definition of asthma within the first 12 month period of the study. Addressing limitations of large intermittent

periods between enrollment, or enrollment gaps, represent a challenge in working with claims data. Using the inclusion criteria of no more than 62 days of gap at a time ensured that a basic definition of continuous enrollment was met. Using at least two asthma diagnoses within the first year allowed for more confidence in reducing the number of false positives. However, this increases the chance of removing those youth with mild asthma and forming a more severe cohort. Results may not be generalizable to people with gaps in coverage who may have different help seeking behavior.

Additionally, asthma-specific triggers may be different within each state with environmental fluctuations in air quality indicators associated with triggering asthma (e.g., ozone) (Blair et al., 2008). Environmental triggers are unlikely to be correlated with mental health diagnosis as mental health diagnosis tends to be equally distributed. For this study, mental health is consistent across all counties regardless of environmental exposures. Therefore, controlling for environment was not necessary.

Asthma severity. The impact of asthma severity on asthma-related use and expenditure was not fully controlled for in this study. While the supplemental security income was represented as a measure of comorbidity and disability, it does not capture asthma severity. An accepted algorithm to calculate asthma severity was not attempted with this specific claims data. However, studies using a measure of self-perceived asthma severity had significant associations with depressive symptoms than studies that used an objective measure (Opolski & Wilson, 2005). Hence, that may have risk adjusted some of the effect associated with depression. Using a proxy measurement of asthma severity has been noted in the literature (Richardson et al., 2006; Birnbaum et al., 2009), using controller and rescuer medications to partly obtain an objective

measure of asthma severity. Specifically assessing the issue of asthma severity, anxiety and depression were associated with increased asthma symptom burden (Richardson et al., 2006). Hence using anxiety and depression as a proxy for asthma severity would not have been realistic. This study assumes that asthma severity is equally distributed across all mental health conditions. However, the obvious limitation is that the assumption is not correct, as asthma symptom burden has been associated with anxiety and depression.

Since the majority of utilization models used a fixed effect model, we were able to account for individual variation rather than variation between individuals, which reduces some of the impact of not controlling for asthma severity. However, random effects models were used to calculate utilization for inpatient admissions and length of stay. The inpatient outcomes thereby accounted for variation between individuals as well, which led to potentially more efficient estimates. Both random and fixed effects allow for consistent estimates of utilization for each mental health condition and its treatment.

Claims data. Using claims data while a powerful approach for assessing utilization and expenditure, has often a high number of false positives and negatives associated in the coding process. The diagnostic and treatment variables were constructed through proxy ICD-9, NDC, and TCC coding, which is not necessarily an ideal characteristic of these data.

Using a fixed approach reduced some omitted variable bias as these models do not measure differences between individuals, but measure within individual variation holding all variables fixed within samples, among demographic and other control variables (e.g., personal medical histories). For random effect analyses the need for

more control variables helps to reduce the chance for correlation between the explanatory variables and any unobserved heterogeneity. This provides for more efficient estimates when there is no correlation between the two. However, some omitted variables can include parental use, behavioral trends (e.g., smoking), and asthma severity.

Mental health classification. The focus of this study was on the relationship between individual mental health diagnosis and the impact of mental health treatment on Medicaid youth with asthma. The severity for each mental health condition assessed in this study was not quantified or controlled for creating some limitation. Additionally, flags for mental health condition were triggers from the moment a diagnosis occurred. Generally, measuring mental health remains a challenge, as mental health tends toward being underreported in claims data, representing another limitation of this study. However, this study did not adjust or control for those who had an acute mental health episode, effectively threatening the internal validity for the trigger for each mental health condition. Essentially, acute mental health episodes were coded as having that condition and an early enough episode of ADHD, anxiety, and depression would dilute the association if the acute mental health condition resolved itself. Therefore, the internal validity of each mental health variable may be threatened in some capacity. Effects of this sort of bias would dilute the effects for those youth with asthma that have chronic ADHD, anxiety, and depression.

The mental health trigger for depression, anxiety and ADHD represent one approach to assess the impact of causality on the impact of mental health on asthma use and expenditures. The limitation with this method involves the omission of a

preexisting condition prior to the first diagnosis of depression, anxiety, and ADHD for this study. Hence, depression, anxiety, and ADHD may be underreported.

Pharmacological classification and treatment variables. HEDIS supported NDC codes obtained from NCQA were compiled for pharmacological treatment for depression, ADHD, and asthma medications (e.g., anticholinergics, rescuer and controller medications) were used to create asthma-related pharmacy and mental health treatment flags. However all treatments for depression, for example, may not have been identified through claims data. Additionally for mental health treatment, claims data underreports mental health counseling. Maturation effects may be diluted due to mental health treatment visit and diagnosis incongruity, however using a depression, anxiety, and ADHD trigger attempted to correct for this possibility.

Asthma utilization is complex, multi-factorial

Asthma expenditure and use in this study are based on the claims coding process. All diagnostic codes in the claims for one event may not truly reflect the full extent of use and expenditure attributed to the specific medical condition coded in the claims. Hence, coding for the diagnosis of asthma may have just been briefly discussed relating to asthma during the visit and disguise the true nature of visit (e.g., ADHD management). For example, if asthma was a primary, secondary, or tertiary diagnosis code in the claims, the expenditure and use associated with the visit may not be unique to asthma, other codes listed for that specific event in the claims data. Additionally the order of the diagnosis may not reflect order of importance based on different physician attention to coding details. This study does not discriminate utilization or expenditure by primary, secondary or tertiary order diagnosis coding for asthma or other conditions.

This study therefore, assumes equal weight to all ICD-9 codes of asthma present in the claims files.

Additionally, while considering the primary explanatory variables, other variables were not included in this study to account for utilization. Asthma is multifactorial and etiology of asthma often depends on interactions between genetic susceptibility and environmental factors. Susceptibility genes include those involved in immunity and smooth muscle, fibroblast proliferation, or cytokine production regulation immunity (e.g., T-helper, cytokines, ADAM33 gene, tumor necrosis factor-α). Often impacted by triggers of asthma, which may have a strong environmental cause include allergen exposure (e.g., dust mite, roach, pets), diet deficiencies (e.g., low vitamin C and vitamin E), perinatal factors (e.g., young maternal age, poor maternal nutrition, prematurity, low birthweight, and lack of breast feeding) (Blair et al., 2008). While these environmental and genetic factors are specific to asthma, this study uses claims data which does not control for these other causes of asthma.

Asthma utilization is also multifactoral relying on population characteristics that are predisposed in the population like gene-environment interactions or mental health condition, or involve enabling resources which may include presence of insurance to transportation to the clinic, family structures, parental education and perceived need. The Andersen model would suggest that more such variables that are unavailable from claims data are needed to fully appreciate the predicted model of use for mental health utilization in youth with asthma (Andersen, 1995). This study did not use parental utilization or parental characteristics in adjusting for asthma-related utilization. Often mental health conditions like depression tend to run in families, parents are enablers of

health seeking behavior, and help their child in navigating through the medical environment. Additionally, parents are charged with carrying out medication regimens. This study did not address parental involvement in medication adherence and potential influence in utilization. If children are depressed, parents may be as well. Family histories may play a role in better physician awareness. Children with depression may be less likely to communicate needs to psychiatrist relating to asthma and vice versa with the pediatrician, resulting in a failure of coordination of care. Argues for the inclusion of psychiatric services within the medical home concept, as is exemplified by the treatment for ADHD.

Asthma and psychological health. Bender and colleagues (2000) suggest that mild to moderate asthma has imposed modest effects on daily life but explicitly state "not the psychological health" in youth with asthma. Hence, there is a literature that exists that psychological health is not altered in youth with asthma. However, multiple studies including this one, have suggested and quantified a higher association of psychiatric diagnosis and differential utilization among such a group. This study goes even as far as suggesting a temporal relationship between different mental health conditions and asthma-specific use.

Lastly, claims data represents a powerful approach to understanding expenditure and utilization patterns. However, this kind of analysis with claims data does contain false positives (e.g., having an asthma ICD-9 diagnosis code in the claims yet does not have asthma) and false negatives (e.g., having an asthma diagnosis but not coded in the claims data) when used for proxy measures of diagnosis. However the false negatives and positives should be randomly distributed. Data from claims are only as

good as the provider and clinic that entered them into the system and are an inherent form of bias within this study. Physicians and clinics have multiple reimbursement incentives and practices that can influence the diagnostic coding process. Therefore, the false positives or those with an incorrectly coded ICD-9 diagnosis for asthma, depression, anxiety, ADHD, and false negatives, or those that did not actually have the condition represent a limitation of working with claims data. This study attempted to control for this by making sure that at least 2 ICD-9 codes of a specific condition were used in identifying asthma, a main criteria for sample eligibility.

While assessing utilization and expenditure through this sort of modeling is an extremely powerful and flexible method to analyze longitudinal data, assumptions are made that asthma is not triggered by any other exposure. Asthma triggers include allergen exposure, diet, infection, exercise, inhaled irritants, emotion, aspirin, and GERD (Blair et al., 2008), yet not all triggers were taken into account by these models.

Conclusion

This study looks at the effects of individual mental health conditions and the impact of mental health treatment on asthma use and expenditure. ADHD, anxiety, and depression modified the delivery of asthma related services for Medicaid youth with asthma in Florida. This study represents the first large scale study to address the issue of mental health and mental health treatment on asthma-related utilization and expenditure using a continuously enrolled cohort of Florida Medicaid youth with asthma.

ADHD was associated with less inpatient care, yet more asthma-related pharmacy care and medical claims, suggesting better management and coordination of care. Depression was associated with more admissions, yet less asthma-related pharmacy care, suggesting poor adherence to asthma medications. Anxiety was associated with

more inpatient, outpatient, medical, and pharmacy care, suggesting poor management and coordination of asthma-related care. Treatment of ADHD and depression was associated with improved asthma-related pharmacy care and medical claims, and less inpatient care. Treatment of anxiety resulted in more expenditure and utilization for all categories of asthma care, including inpatient care.

Policies to address include close monitoring of youth with anxiety and depression treatment may be warranted to ensure youth with asthma with comorbid psychiatric conditions have better asthma outcomes to manage their asthma in presence of mental health comorbidities. In addition to addressing strategies to improve adherence to asthma treatment for youth with depression, continuity of care through medical homes requires more attention for this population. The issues associated with anxiety and depression being treated outside of the pediatrician office may result in poor coordinated and managed care for youth with depression and anxiety. .Those with comorbid ADHD had better control of their asthma than those with anxiety and depression. This study sought to address utilization and expenditure among ADHD, anxiety, and depression, findings suggest 3 very different experiences with asthma-related services.

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BIOGRAPHICAL SKETCH

Eric Wayne Jamoom was born in the spring of 1979, in New York City, New York to Victor and Randee Jamoom. When Eric was four months old, his father died of a massive heart attack at 32. The apparent passing of nearly every paternal relative at early ages from heart disease instilled a curiosity around genetics and chronic disease. Therefore, Eric received his Bachelor of Science in Microbiology/ Cell Science from the University of Florida in May of 2001, and his Master of Science in Medical Genetics and training in genetic counseling from the University of Minnesota in August of 2003. Not just wanting to inform individual patients of their personal and family health, Eric decided he wanted to explain the health and the delivery of health services for vulnerable populations. So in 2005, Eric came to UF to pursue his Master of Public Health and doctoral degree in Health Services Research. While at the University of Florida, Eric has had a number of different research collaborations and teaching opportunities including working with the Research Rehabilitation and Training Center on Health and Wellness' Expert Health Status Measurement Panel, completing an internship at the Florida Center for Medicaid and the Uninsured, and developing, collecting and implementing outreach studies in Medicaid clinics across Gainesville. Eric has published multiple articles and journal entries during his time at UF. After receiving his Ph.D. in 2010, Eric moved to Washington, DC, as an Associate Health Services Research Fellow at the National Center for Health Statistics. He plans on applying his experiences to tackle the current challenges associated with the delivery of health services and assessing the effects of electronic health records.