Identifying Predictors of Medication Adherence in Adult Patients with Asthma: A Social Problem-Solving Approach

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Sara E. Voorhees

Christine Maguth Nezu, Ph.D., ABPP
Arthur M. Nezu, Ph.D., ABPP, D.H.L. (Hon.)

Asthma is a chronic respiratory illness that has become major public health concern due to its rapid increase in prevalence and increasing economic burden. Asthma management, which includes asthma control, perceived control of asthma and medication adherence, has been documented to be extremely poor. One of the main reasons for poor management includes low rates of medication adherence. The primary goal of this research study was to identify factors related to medication adherence that can eventually be integrated into clinical practice. Identifying these factors would help increase adherence rates and decrease the burden of asthma on individuals as well as the entire population.

The current study examined how individual variables are related to medication adherence in patients with asthma. Research has indicated that patients with high perceived stress are less likely to adhere to a prescribed medication regimen. Social problem-solving, which is the affective, cognitive and behavioral way individuals approach real world problems, is related to the management of various chronic conditions and may moderate the relationship between perceived stress and adherence outcomes. Adult asthma patients for this study were recruited from two different medical sites: an allergy and asthma private practice located in New Jersey and Drexel Pulmonary Medicine located in Philadelphia, PA. Self-report data was collected from participants ($N = 104$) including demographic

information, asthma control, perceived control of asthma, perceived stress, social problem-solving behaviors and medication adherence. Additional patient information was gathered using patient medical and pharmacy records. Bivariate correlational analyses demonstrated positive associations between perceived stress and dysfunctional social problem-solving tendencies and negative associations between perceived stress and self-report adherence. Lower perceived stress was also associated with more adaptive social problem-solving tendencies and higher asthma control. Lower perceived control of asthma was associated with the dysfunctional social problem-solving dimensions and higher pharmacy reports of adherence. Analyses also revealed relationships between higher self-report adherence and more adaptive problem-solving abilities. A hierarchical regression analysis revealed that lower perceived control of asthma was predictive of higher pharmacy refill adherence rates. Social problem-solving did not significantly moderate the relationship between perceived stress and medication adherence. Exploratory analyses indicated that lower self-reports of adherence, lower perceived control of asthma, and more maladaptive problem-solving tendencies were all predictive of higher perceived stress. Additionally, a one-way analysis of variance (ANOVA) was conducted to examine differences among racial and ethnic groups. Individuals who identified as White reported greater self-report adherence, less perceived stress, better social problem-solving abilities, higher perceived control of asthma, and better objective control of asthma, as compared to other racial and ethnic groups. Results suggest integrative medical and psychosocial treatments should be adapted for individuals of various racial and ethnic backgrounds. Interventions that target social problem-solving abilities and perceived stress may be particularly beneficial for improving patient's ability and perceived ability to successfully manage their asthma.

1. Introduction

According to the Global Initiative for Asthma (GINA), there are currently more than 300 million individuals worldwide with asthma. Asthma is a chronic respiratory condition that involves airway inflammation and airway obstruction, leading to symptoms such as coughing, wheezing, shortness of breath, chest pain, chest tightness and mucus production (GINA, 2012). This chronic illness has become a major public health concern due to its rapid increase in prevalence in the Western World. According to the Asthma and Allergy Foundation of America (AAFA), asthma prevalence has increased by 28% from 2001 to 2011. Additionally, asthma poses a significant and increasing economic burden due to high treatment costs and emergency room visits.

Researchers estimate that asthma costs the United States about $56 billion per year, including both direct and indirect costs (United States Environmental Protection Agency, 2013). Hospital stays are responsible for a majority of the direct cost of asthma on the United States, with medications and general health care services also accounting for a large portion of that cost. The Centers for Disease Control (CDC) state that patients with a primary diagnosis of asthma account for 10.5 million visits to physician offices and 1.8 million visits to the emergency department per year. In terms of indirect expenses, it is estimated that lost productivity from missed days of work or school costs the United States $5.9 billion annually with about 1 in every 3 adults missing at least one day of work per year (Barnett & Nurmagambetov, 2011). These costs could be greatly reduced by minimizing hospitalizations and emergency room visits. Asthma is commonly placed among the top 5 leading causes of preventable hospitalizations (Healthcare Cost and Utilization Project,

2015; Pappas, Hadden, Kozak, & Fisher, 1997), which is likely due to high levels of poor asthma management.

Numerous research studies have documented poor asthma management (Chapman, Boulet, Rea, & Franssen, 2008; Lavoie, Cartier, Labrecque, Bacon, Lemière, Malo, Lacoste, Barone, Verrier & Ditto, 2005). Asthma management typically includes 3 constructs: medication adherence, asthma control and perceived control of asthma (Cheung, LeMay, Saini, & Smith, 2014). Poorly managed asthma leads to high rates of emergency room visits, more frequent visits with physicians and daily disruptions in patients' lives. According to the CDC, 3 in every 5 people limit their daily activities because of their asthma. Previous research has also found associations between various psychosocial factors and asthma management. Researchers have hypothesized that the way individuals cope with and manage their condition can greatly impact asthma outcomes. Specifically, patient's attitudes and beliefs about their condition can influence outcomes from hospitalization rates (Adams, Smith & Ruffin, 2000) to asthma-related quality of life scores (Katz, Yelin, Eisner & Blanc, 2002; Mancuso, Rincon, McCulloch & Charlson, 2001). Additionally, coping strategies for managing their chronic condition have a negative impact on asthma related well-being, including increased number of sick days and hospital admissions (Adams et al., 2000; Bosley, Corden, & Cochrane, 1996). Many researchers have also indicated that asthma patients show increased bronchoconstriction in response to stress (Affleck, Apter, Tennen, Reisine, Barrows, Willard, Unger, & ZuWallack, 2000; Ritz, Steptoe, DeWilde, & Costa, 2000). Identifying and addressing these psychosocial factors is a major first step in developing comprehensive treatment plans for patients to effectively manage their asthma.

1.1 Medication Adherence

Medication adherence is one of the important constructs that encompasses asthma management. Adherence, defined broadly, is the extent to which a person's behavior corresponds with agreed-upon recommendations from a health-care provider (WHO, 2003). Medication adherence is vital for positive treatment responses and therefore keeping asthma symptoms under control. Recently, healthcare has shifted its focus by placing a greater emphasis on treatment outcomes. As a result, most providers forget about the mediating role that adherence has between treatment and outcomes (Brown & Bussell, 2011). Simply put, if patients are not taking their prescribed medications, they are not going to achieve optimal outcomes. Documented adherence rates tend to be extremely low. According to the American College of Preventive Medicine (ACPM), individuals with chronic conditions take only about half of their prescribed medication. In asthma specifically, research typically documents adherence rates between 30% and 40% (Windsor, Bailey, Richards Manzella, Soong, & Brooks, 1990).

Physicians typically consider asthma patients to be "adherent" when they use their medication 80% of the time or more (Tan, Sarawate, Singer, Elward, Cohen, Smart, Busk, Lustig, O'Brien, & Schatz, 2009; Krishnan, Bender, Wamboldt, Szefler, Adkinson, Zeiger, Wise, & Bilderback, 2012), however, numerous research studies have documented poor adherence to prescribed asthma medications (Bender, Milgrom, & Apter, 2003; Sumino & Cabana, 2013). Poor adherence is likely to lead to poor asthma control and increases in asthma exacerbations, which are associated with increased hospitalizations, leading to increased healthcare costs and risk of mortality. Some of the most commonly documented causes of nonadherence in asthmatics include anxiety regarding side effects, awkwardness

of inhaler use, denial of the severity of the illness, inadequate training in inhaler technique, lack of communication between patient and provider and forgetfulness (Brown & Bussell, 2011; Gillissen, 2007). Addressing the primary causes of nonadherence in asthmatics would be a major first step in developing effective interventions to improve adherence rates.

The National Heart, Lung and Blood Institute (NHLBI EPR-3) recommends treatment in the form of an inhaled corticosteroid (ICS) for patients with persistent asthma as the first line treatment. Inhaled corticosteroids are the most effective medications for long-term control of persistent asthma because the medication is inhaled directly into the lungs in order to reduce chronic airway inflammation (NHLBI, 2012). It is recommended that ICSs are taken daily as a preventive method to avoid asthma attacks and keep asthma symptoms under control. Since these medications should be taken daily, often patients will forget or decide to miss a dose, especially if they are not experiencing any symptoms. Research has also demonstrated that adherence is worse for inhaled medications as compared to oral medications (Tan, Sarawate, Singer, Elward, Cohen, Smart, Busk, Lustig, O'Brien, & Schatz, 2009), most likely due to the awkward nature or inconvenience of using an inhaler.

Detecting medication non-adherence remains a challenge in clinical practice because there are no standardized methods for assessing adherence behaviors. Cost effective methods include self-reports of adherence and clinician ratings, however, numerous research studies have stated that adherence is often greatly overestimated with self-report assessment methods (Brown & Bussell, 2011; Gillissen, 2007). Some objective measurement methods that have been used require electronic device monitors, review of pharmacy or medical records, and monitoring remaining doses by counting pills left in a bottle or weighing

inhaler canisters (Gillissen, 2007; Sumino & Cabana, 2013). Because self-report measures seem to be biased and inaccurate, more effective and easy methods for obtaining objective measures of adherence are needed. A multi-method approach is most effective for assessing medication adherence because significant differences are frequently found between subjective and objective reports of adherence, which have important clinical implications (Krishnan et al., 2012).

1.2 Asthma Control

Aside from medication adherence, asthma control and perceived control of asthma are two key constructs of asthma management. According to the CDC, asthma control is the most important measure of overall asthma health. Additional research emphasizes that the goal of asthma treatment should always be optimum asthma control (Nathan, Sorkness, Kosinski, Schatz, Li, Marcus, Murray, & Pendergraft, 2004). Typical assessment of asthma control includes objective questions about asthma symptoms, such as insight into the occurrence of shortness of breath, use of rescue medications (short-acting bronchodilators) or the frequency of nighttime awakenings due to asthma. It is very common for physicians to assess asthma control during regular office visits so that they have an idea of their patients' overall asthma health.

Psychological factors are particularly important for the management of asthma, which is why perceived control of asthma is included within the construct of asthma management. Perceived control of asthma refers to individuals' perceptions of their ability to cope with asthma and its exacerbations. Self-efficacy, locus of control and learned helplessness are important for understanding perceived asthma control (Katz, Yelin, Eisner, & Blanc, 2002). Researchers report that a lack of confidence in managing one's own illness

(low sense of asthma self-efficacy) increases anxiety, which can lead to asthma exacerbations and poor self-management skills (Katz et al. 2002; Taitel, Allen, & Creer, 1998; van der Palen, Klein, & Seydel, 1997). Greater perceived control is also associated with better health outcomes and more engagement from patients in self-management behaviors, including increased rates of medication adherence (Buckelew, Huyser, Hewett, Johnson, Conway, Parker & Kay, 1996; Kempen, van Heuvelen, van Sonderen, van den Brink, Kooijman & Ormel, 1999; Rhee, Parker, Smarr, Petroski, Johnson, Hewett & Walker, 2000; Smith, Christensen, Peck & Ward, 1994). These findings highlight that enhancing perceived control in asthma patients is likely to improve overall asthma management.

1.3 Stress and Asthma

The influence that stress has on physical illness is important to note. Psychological stress occurs when individuals appraise situations as being threatening or overwhelming along with the perception that adequate resources are not available to cope with the demands of the situation (Schneiderman, Ironson, & Siegel, 2005). Stress is commonly implicated in a variety of chronic illnesses due to its association with increased inflammation. Changes in emotional states, particularly negative changes, are accompanied by various changes in neuroendocrine and immunological functioning (Wright, Rodriguez, & Cohen, 1998). Recent advances in the field of psychoneuroimmunology can provide biological pathways for explaining the role of psychological stress in chronic illness.

With asthma specifically, multidirectional pathways link psychological stress to the frequency, duration and severity of symptoms experienced by asthma patients (Rand, Wright, Cabana, Foggs, Halterman, Olson, Vollmer, Wilson & Taggart, 2012; Rietveld, Everaerd, & Creer, 2000). It is likely that these pathways have a physiological basis. Many

different cells and their associated cytokines play a part in the complicated immune processes that regulate atopic diseases such as asthma. Various hormones and neuropeptides are released when individuals are experiencing stress and these same hormones and neuropeptides are also involved in regulating both inflammatory and airway response processes (Wright et al., 1998). The increased inflammation that is experienced during stress leads to increased bronchoconstriction in asthmatics, which narrows the airways and results in decreased lung functioning (Rand et al., 2012). These overlapping biological pathways provide evidence that stress plays a major role in asthma as a chronic condition.

Additional research suggests that perceived stress is strongly associated with asthma incidence and asthma hospitalizations. Rod, Kristensen, Lange, Prescott, & Diderichsen (2012) stated that high stress was associated with more than twice the risk of asthma and twice the risk of asthma hospitalization. Psychological stress is also likely to affect chronic illness on a behavioral level by greatly impacting how individuals self-manage their condition. In fact, stress is a risk factor for medication nonadherence in chronic conditions such as diabetes (Peyrot, McMurry, & Kruger, 1999), HIV (Gifford, Bormann, Shively, Wright, Richman, & Samuel, 2000), and asthma (Rand et al., 2012; Wright et al., 1998). Stress can also lead individuals to engage in adverse health behaviors such as poor diet, lack of physical activity and smoking (Rand et al., 2012). These health behaviors can serve as major triggers for asthma exacerbations. Additionally, researchers report that patients who experience chronic psychological stress do not respond as positively to asthma medication (Miller, Gaudin, Zysk, & Chen, 2009). Further, poorer outcomes to medications may lead to a sense of learned helplessness and increases in nonadherence. If patients do not believe that the medication is effective for them, they are likely to discontinue it.

The association between psychological stress and asthma has motivated researchers to include psychological interventions in treatment plans for asthma patients. Some of these interventions such as relaxation and guided imagery, cognitive stress-management, and self-esteem workshops have been associated with improvements in respiration and immune functioning (Lehrer, Feldman, Giardino, Song, & Schmaling, 2002; Wright et al., 1998). The development of additional psychosocial interventions that target patient stress and self-management of asthma are warranted to improve asthma outcomes.

1.4 Social Problem-Solving

Social problem-solving (SPS) is defined as the interplay between affective, cognitive and behavioral factors in the process of identifying, discovering, and developing adaptive coping solutions for every day, real-life problems (Nezu, Nezu, & D'Zurilla, 2013). The construct of social problem-solving is made up of two distinct dimensions: problem orientation and problem-solving style. Problem orientation refers to a set of cognitive-affective schemas that characterize how individuals appraise and cope with problems. This dimension encompasses two independent types of problem orientation: positive problem orientation (PPO) and negative problem orientation (NPO). Positive problem orientation (PPO) includes individuals with a strong sense of self-efficacy in terms of coping, a tendency to view problems as challenges that require time and effort to solve, and a positive appraisal of negative emotions as being helpful to cope with stressful problems. Individuals with a negative problem orientation (NPO) tend to perceive problems as immediate threats and do not believe they have adequate resources to solve or cope effectively with problems. These individuals also tend to get emotionally distressed in the face of difficult or stressful problems. Problem orientation may vary depending on the type of problem an individual is

experiencing. Individuals may be categorized as having a positive problem orientation towards some life problems, but could also have a negative problem orientation regarding other problems, such as coping with a chronic illness (Nezu et al., 2013).

Problem-solving style is described as the cognitive-behavioral strategies individuals engage in when attempting to solve or cope with stressful problems (Nezu et al., 2013). This dimension of social problem-solving is made up of three different styles including rational/ planful problem-solving (RPS), avoidant problem-solving (AS), and impulsive-careless problem-solving (ICS). Planful problem-solving style is an adaptive approach to cope with difficult problems. It includes defining the problem, outlining goals to problem-solving, and identifying barriers that may be in the way of successfully solving or coping with the problem at hand. In contrast, the additional two problem-solving styles (AS and ICS) are considered dysfunctional or maladaptive styles that tend to exacerbate current problems or generate new problems. Individuals characterized as having an avoidant problem-solving style (AS) are inclined to procrastinate and circumvent active problem solving by waiting to see if the problem will work itself out or if other individuals will jump in to help resolve the situation. Impulsive-careless style (ICS) is exemplified by a thoughtless, incomplete and hasty approach to solving problems without the development of specific goals or consideration of potential outcomes to impulsive decisions. Along with avoidant style and impulsive-careless style, negative problem orientation is considered to be a maladaptive dimension of problem-solving, while positive problem orientation and planful problem-solving style are the adaptive dimensions that result in more effective problem-solving and lead to a variety of beneficial outcomes (Nezu et al., 2013).

Impairments in problem-solving abilities have been associated with difficulties coping with chronic illnesses. Living with a chronic illness typically requires daily decision-making and self-management skills. In addition to management regarding adherence to prescribed medications, patients make everyday decisions regarding what they are going to eat, if they are going to engage in physical activity, and whether or not they are going to engage in any adverse health behaviors such as smoking. Patients with chronic persistent asthma in particular must self-manage their condition by taking daily prescribed inhalers and avoiding negative health behaviors. These routine, daily decision-making processes require effective social problem-solving abilities for achieving optimal self-management of chronic illnesses (Bodenheimer, Lorig, Holman, & Grumbach, 2002).

While effective social problem-solving has yet to be adequately explored in asthma patients, it has been shown to be an important skill for a variety of chronic illness populations. For example, among patients recently diagnosed with cancer, individuals who engaged in problem-solving therapy had significantly lower scores of symptom limitation than participants in a control group (Doorenbos, Given, Given, Verbitsky, Cimprich, & McCorkle, 2005). Similarly, in a sample of patients with chronic pain, maladaptive problem-solving was related to increased levels of pain, increased functional disability, and even higher depression scores (Kerns, Rosenberg, & Otis, 2002). Furthermore, among patients with diabetes, individuals with the most maladaptive problem-solving abilities had the highest levels of distress, which compromised their ability to effectively self-manage their illness (Elliott, Shewchuk, Miller, & Richards, 2001). Together, these findings suggest that effective social problem-solving abilities may alleviate symptom burden, decrease stress and improve overall control and management in asthmatics.

Social problem-solving abilities may also play a role in medication adherence in patients with chronic illnesses. This specific association has not yet been adequately explored, however, problem-solving therapy has been used to foster the effectiveness of cognitive and behavioral intervention strategies. Researchers report that within an obese sample, participants in a problem-solving therapy group had significantly greater long-term weight reductions as compared to participants in control groups. It is possible that the behavioral strategies taught in the initial behavioral treatment phase of the intervention helped explained why participants who learned adaptive problem-solving abilities demonstrated better long-term adherence (Perri, Nezu, McKelvey, Shermer, Renjilian, & Viegener, 2001). Moreover, improvements in problem-solving abilities have been reported to mediate the relationship between treatment adherence and weight loss outcomes in a group of obese women. Researchers stated that adaptive problem-solving abilities were associated with greater weight reductions and better treatment adherence (Murawski, Milsom, Ross, Rickel, DeBraganza, Gibbons, & Perri, 2009). Problem-solving therapy may facilitate adherence because it helps patients cope with and overcome barriers that they may be experiencing. Some of these barriers stem from difficulties with motivation or actual skill deficits in overcoming obstacles related to adherence, including inadequate planning, missed physician visits, forgetfulness, and a lack of insight into illness. In sum, a social problem-solving framework might provide insight into how and why cognitive-behavioral variables may be associated with higher rates of medication adherence among asthmatics.

2. Current Study

2.1 Rationale

Despite numerous effective medications for asthma, management of this chronic condition remains suboptimal. Management tends to be poor due to extremely low rates of medication adherence in asthmatics. The current research study sought to determine associations between psychosocial factors and medication adherence and to identify factors that contribute to medication adherence. Identifying psychosocial variables that influence adherence levels is an important first step in designing effective interventions to improve medication adherence rates, and in turn improve asthma control and decrease mortality.

2.2 Hypotheses

2.2.1 Hypothesis 1: Correlational Analyses

(1) It was hypothesized that Pearson product-moment correlational analyses would demonstrate significant associations among all dimensions of SPS and asthma control (ACT), perceived asthma control (PCAQ), perceived stress (PSS) and pharmacy reports of medication adherence.

a. There will be positive associations among:
    i. Total scores on the SPSI-R:S and: asthma control, perceived control, and medication adherence.
    ii. Adaptive dimensions of SPS (PPO and RPS) and: asthma control, perceived control, and medication adherence.
    iii. Dysfunctional dimensions of SPS (NPO, ICS and AS) and perceived stress.
b. There will be negative associations among:
    i. Total score on the SPSI-R:S and perceived stress.
    ii. Adaptive dimensions of SPS (PPO and RPS) and perceived stress.
    iii. Dysfunctional dimensions of SPS (NPO, ICS and AS) and: asthma control, perceived control, and medication adherence.

2.2.2 Hypothesis 2: Hierarchical Regression Analyses

(2) Social problem-solving (SPS), asthma control (ACT), perceived asthma control (PCAQ) and perceived stress (PSS) would all significantly predict medication adherence, when controlling for demographic factors.

a. Asthma control, perceived asthma control and perceived stress would each account for a significant proportion of variation in pharmacy reports of medication adherence, when controlling for demographic factors.
b. SPS would significantly predict medication adherence, above and beyond the variance accounted for by demographic factors, asthma control, perceived asthma control and stress.
    i. Higher scores on the adaptive SPS tendencies would predict better adherence.
    ii. Higher scores on the dysfunctional SPS tendencies would predict poorer adherence.

2.2.3 Hypothesis 3: Moderation Analysis

(3) Social problem-solving (SPS) would be a significant moderator of the relationship between perceived stress (PSS) and medication adherence, when controlling for demographic factors.

a. It was hypothesized that adaptive SPS tendencies would attenuate the resulting impact of stress on pharmacy reports of medication adherence, when controlling for demographic factors.

3. Methods

3.1 Overview

The present study employed a cross-sectional self-report survey design to examine how patient-reported social problem-solving styles, asthma control, perceived control of asthma and perceived stress are related to asthma medication adherence. Participants were recruited in person from two locations: Drexel Pulmonary Medicine, located in Philadelphia, PA and Atlantic Research Center, LLC, located in Ocean Township, NJ. Preliminary analyses were conducted to examine descriptive statistics on demographic variables, patient medical record information, and quantitative self-report measures. Additionally, Pearson product-moment correlations were conducted to examine initial relationships among all variables. Pearson product-moment correlations, hierarchical regression, and moderation analyses were conducted to examine planned hypotheses.

3.2 Participants

Eligible participants included individuals who were 18 years of age or older and had received a physician diagnosis of mild, moderate or severe persistent asthma. Participants were able to read and understand English on at least a 4th grade level. Patients were also prescribed a daily inhaled corticosteroid (ICS) for their asthma and were willing to give the research team permission to obtain information regarding prescription refills. Finally, participants agreed to participate and gave informed consent. Patients were considered ineligible if they were diagnosed with any other significant pulmonary diagnoses (e.g. COPD), smoked more than 10 pack years, and/or were pregnant.

3.3 Measures

3.3.1 Demographics. Basic demographic information was collected from participants, including sex, age, race/ethnicity, relationship status, number of children, years of education, household income, employment status, sexual orientation, health insurance provider and religious identity. Participants were also asked to provide health information including current medications, number of daily prescribed medications, smoking history, alcohol consumption, level of physical activity, current and past mental health problems, current and past treatment for psychological or emotional distress, and diagnoses of any additional medical conditions. The Charlson Age-Comorbidity Index (Charlson, Szatrowski, Peterson, & Gold, 1994) was used to obtain a comorbidity score for each participant, based on age and diagnoses of other medical conditions. Additional information collected about asthma included family history of asthma, previous hospitalizations and emergency room visits for asthma in the past and within the last year, number of previous intubations from

asthma in the past and within the last year, and how frequently patients see their physician for asthma. The site of participation was also recorded.

3.3.2 Medical Record Information. Information was obtained from patient medical records and from the physician regarding individual's specific asthma diagnosis (mild persistent, moderate persistent, or severe persistent), the patient's primary physician at the site of participation and number of prescription refills. Specifically, the number of months a patient refilled his or her inhaled corticosteroid (ICS) prescription within the previous 12 months was collected. The medication possession ratio (MPR) is a commonly used method for quantifying objective measures of adherence (Hess, Raebel, Conner, & Malone, 2006). Participants' MPR was the number of times the prescription was filled divided by the period of time the patient has been prescribed the medication (not to exceed 1 year or 12 months) multiplied by 100.

3.3.3 Medication Adherence. In an effort to determine whether there are significant differences between pharmacy records of medication adherence and self-reports of medication adherence, the Medication Adherence Report Scale for Asthma (MARS-A) by Horne and Hankins (2002) was administered. Comprised of 10 items rated on a 5-point Likert scale from 1 (always) to 5 (never), the MARS-A assesses generic and asthma-specific medication use. Total scores are the average of 10 questions, with a total score of 5 reflecting the highest adherence behaviors. Participants were asked to report their controller inhaler use. Specific items included "I only use it when I feel breathless", "I forget to take it", and "I stop taking it for a while." The MARS-A has demonstrated good internal consistency (Cronbach's $\alpha = .85$) and principal component analyses have found that one factor accounts for most of the variance, suggesting that adherence is the only construct that

this assessment is measuring (Cohen, Mann, Wisnivesky, Horne, Leventhal, Musumeci-Szabó, & Halm, 2009).

3.3.4 Social Problem-Solving. Social problem-solving abilities were assessed using the 25-item Social Problem-Solving Inventory-Revised: Short form (SPSI-R:S) (D'Zurilla, Nezu, & Maydeu-Olivares, 2002). The SPSI-R:S provides a total score as well as subscale scores for each of the two problem orientation dimensions [positive problem orientation (PPO) and negative problem orientation (NPO)] and the three problem-solving styles [planful problem-solving style (RPS), impulsive/ careless style (ICS) and avoidant style(AS)]. The items are rated on a 5-point Likert scale ranging from 0 (not at all true of me) to 4 (extremely true of me), with higher total scores indicating more adaptive problem-solving tendencies and higher scores on each dimension indicating increased use of the associated orientation of problem-solving. The SPSI-R: S has demonstrated good to excellent internal reliability across all five dimensions (Cronbach's $\alpha = 0.79 - 0.95$) and high test-retest reliability ($r = 0.89 - .93$) (D'Zurilla, Nezu, & Maydeu-Olivares, 2002).

3.3.5 Asthma Control. Asthma control was measured with the 5-item Asthma Control Test (ACT) (Nathan, Sorkness, Kosinski, Schatz, Li, Marcus, Murray, & Pendergraft, 2004). This test is typically used in clinical practice as a way for physicians and patients to distinguish between poorly controlled and well controlled asthma. Items on this measure are rated on a 5-point Likert scale ranging from 1 (all of the time) to 5 (none of the time), with the highest score (25) indicating well controlled asthma. Examples items include: "In the past 4 weeks, how much of the time did your asthma keep you from getting as much done at work, school or at home?" and "During the past 4 weeks, how often have you had shortness of breath?" The ACT has demonstrated good internal consistency

(Cronbach's α = .84) and validity given its positive association with pulmonary function (Nathan et al., 2004).

3.3.6 Perceived Control of Asthma. The Perceived Control of Asthma Questionnaire (PCAQ) is an 11-item questionnaire that was used to assess individuals' perceptions of their ability to deal with asthma and its exacerbations (Katz, Yelin, Eisner, & Blanc, 2002). This overall construct represents self-efficacy, locus of control, and learned helplessness. Participants responded to a series of questions using a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree), with higher scores indicating perception of greater control. Some of the items are reversed scored and the total score ranges from 11 to 55. Select items from the measure include: "I can reduce asthma by staying calm and relaxed", "I have considerable ability to control my asthma", and "It seems as though fate and other factors beyond my control affect my asthma." The PCAQ has demonstrated acceptable internal consistency (Cronbach's α = .76) (Katz et al., 2002).

3.3.7 Perceived Stress. The Perceived Stress Scale (PSS) by Cohen, Kamarck, and Mermelstein (1983) was used to determine the degree to which individuals evaluate their lives as stressful. This scale is made up of 14 items that are rated on a 5-point Likert scale ranging from 0 (never) to 4 (very often). Example items include: "In the last month, how often have you felt nervous and 'stressed'?", "In the last month, how often have you been able to control irritations in your life?", and "In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?". The positively worded items on this scale are reverse scored and then all of the items are added to obtain a possible total score between 0 (no perceived stress) and 56 (the highest amount of perceived stress). The PSS has strong internal consistency (Cronbach's α = .85) and adequate test-

retest reliability (r = .55 - .85) (Cohen et al., 1983).

3.4 Data Collection and Procedure

Participants for the current study were recruited in person from two research sites, including Drexel Pulmonary Medicine, an outpatient pulmonary clinic located at 219 N Broad Street in Philadelphia, PA and Atlantic Research Center, LLC, a private allergy, asthma and immunology practice located in Ocean Township, NJ. Physicians at each recruitment site determined participant eligibility. Flyers approved by Drexel University's Institutional Review Board (IRB) were also posted in exam rooms and waiting areas to facilitate physician and patient self-referrals. In accordance with HIPAA, initial contact with eligible participants regarding study participation was made by the referring physician. If patients expressed interest in participating, the physician notified a trained research assistant who then entered the private exam room to obtain consent and administer the series of self-report questionnaires. Upon completion, participants were compensated for their time and effort with $5.00 for their choice of 2 SEPTA tokens or a gift card to Starbucks, Target, or Amazon.

3.5 Power Analysis

Sample size for the current study was determined using G*Power 3.1 (Faul, Erdfelder, Lang, & Buchner, 2007). Hypothesis 2 required the largest sample size (hierarchical multiple regression); therefore, this analysis was used for computation of the required sample size. To be conservative, it was estimated that all 7 potential covariates (demographic variables) would be controlled for along with all 4 predictors (ACT, PCAQ, PSS and SPSI). Assuming a medium effect size (.15) and alpha set at .05, this analysis required a sample size of 118 to achieve power of .80. Based on the results of this power

analysis and the potential for attrition and missing data, the required sample size was increased by 25%. Therefore, the goal was to recruit 148 participants.

Post hoc analyses were conducted to determine achieved power with the completed sample. One hundred four participants were recruited; however, pharmacy refill outcome data was only available for 71 participants. As discussed in the results section, four predictors and one covariate were included in the model for hypothesis 2. Based on this sample size, a medium effect size, and an alpha level of .05, achieved power for this hypothesis was .66. However, hypothesis one did achieve adequate power (.82). It is important to note that exploratory regression analyses were also adequately powered (.83).

3.6 Ethical Considerations

The physician and researcher notified the patient that their participation was entirely voluntary. Data collection only continued once consent was obtained. Participants provided consent that the researcher would be able to access asthma medication prescription refills from pharmacy records. Numeric codes were assigned to each participant to maintain confidentiality and to ensure that no identifying information remained on the questionnaires. All confidential information was kept in locked filing cabinets in a secure lab office at Drexel University and solely trained members of the research team had access to these confidential files. Finally, research assistants all underwent extensive training to handle sensitive participant information. It is important to note that if participants experienced any mild psychological distress while responding to measures related to stress or health they were free to terminate participation of the study at any point without any consequences or impact on medical care they are receiving from the recruitment site. Reimbursement was provided regardless of whether or not the participant completed the entire study and

participants were encouraged to ask questions or contact additional members of the research team with any questions or concerns.

4. Results

Data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 24. Preliminary analyses were conducted to examine characteristics of participants and to determine relationships among primary variables. Statistical analyses, as described below, were conducted to evaluate planned hypotheses and exploratory analyses. Assumptions of all proposed statistical analyses were examined and addressed prior to statistical examination. Complete datasets were defined as those in which the participant answered all questions for the outcome measures relevant to the hypotheses being tested.

4.1 Participant Characteristics

4.1.1 Participant Demographics

Descriptive statistics for all demographic variables were examined (see Table 1). The achieved sample size for this study was 104 participants, with 64 (61.5%) patients from Drexel Pulmonary Medicine and 40 (38.5%) patients from Atlantic Research Center, LLC. A majority of the participants in this sample were female (n = 78; 75%) and identified as White (n = 51; 49%). The remaining participants identified as Black/ African American (n = 39; 37.5%), Hispanic/ Latino (n = 7; 6.7%), Multiracial (n = 3; 2.9%), Asian (n = 2; 1.9%), Native Hawaiian/ Pacific Islander (n = 1; 1.0%), and Other (n = 1; 1.0%). The most common relationship status for participants was married or living with a partner (n = 51; 49%) and a majority reported that they have children (n = 75; 72.1%). The mean age of participants was 51.85 years old with a standard deviation of 15.77 and a range of 18 – 78 years old.

The most frequently reported religious identities were Catholic (*n* = 35; 33.7%) and Christian (*n* = 32; 30.8%) and most participants reported being somewhat religious (*n* = 55; 52.9%). Responses ranged in terms of estimated annual household income, level of education, and employment status. The greatest percentage of participants reported that they earn less than $20,000 (*n* = 30; 28.8%) while the next greatest percentage reported that they earn more than $100,000 (*n* = 28; 26.9%). Regarding employment status and level of education, a sizable group of participants are currently working full-time (*n* = 35; 33.7%) or are disabled/ unable to work (*n* = 29; 27.9%) and most have earned a college degree (*n* = 32; 30.8%). The most common types of health insurance were employment-based private plan (*n* = 49; 47.1%) and Medicare (*n* = 41; 39.4%).

4.1.2 Participant Health/ Medical Record Demographics

Descriptive statistics were examined for participant health variables and medical record information (see Table 2). Most participants never smoked or used tobacco products (*n* = 73; 70.2%) and never drink alcohol (*n* = 48; 46.2%). In terms of mental health, a majority of the sample reported that they have never suffered from or been diagnosed with a mental health problem (*n* = 79; 76.0%). For more than half of the participants, neither parent had been diagnosed with asthma (*n* = 54; 51.9%), while nineteen participants reported that their mother had asthma (18.3%) and thirteen participants reported that their father had asthma (12.5%). Most participants visited the emergency room (*n* = 55; 52.9%) for their asthma. Regarding diagnosis, a majority of the participants had either moderate persistent asthma (*n* = 47; 45.2%) or severe persistent asthma (*n* = 43; 41.3%).

4.2 Preliminary Analyses

4.2.1 Descriptive Statistics of Primary Variables

See Table 3 for descriptive statistics on all quantitative study measures. The primary variables of interest included pharmacy refill data, asthma control, perceived asthma control, self-report medication adherence, perceived stress and social problem-solving.

Pharmacy refill information was measured by calculating the number of times the patient filled their prescription within the previous 12 months. The mean for pharmacy refills, as assessed using the medication possession ratio (MPR), was 4.94 refills with a standard deviation of 4.06 and a range of 0 – 12. Higher scores represented more prescription refills and greater medication adherence. Skewness was determined to be .651, with a standard error of .285, indicating a significantly positively skewed distribution based on the Kolmogorov-Smirnov test of normality ($p < .001$). The Kolmogorov-Smirnov test is used for sample sizes greater than fifty (Field, 2013). A distribution with a positive skew has more scores that fall closer to the left of the distribution than to be expected in a normally distributed sample. For this variable, the positively skewed distribution suggests that many participants had pharmacy refill scores that clustered below the average of a normally distributed sample. Sample size for this variable was also limited due to incomplete availability of pharmacy information on many patients.

The mean for asthma control, as measured with the Asthma Control Test (ACT), was 16.99 with a standard deviation of 6.01 and a range of 5 – 25. Higher scores represent greater objective asthma control, with scores below 19 indicating poorly controlled asthma (Nathan et al., 2004). Skewness was determined to be -.212, with a standard error of .285, indicating a significantly negatively skewed distribution based on the Kolmogorov-Smirnov

test of normality ($p < .05$). A distribution with a negative skew has more scores that fall closer to the right of the distribution than to be expected in a normally distributed sample. In terms of this asthma control, the negatively skewed distribution suggests that many patients in this study had asthma control scores that clustered above the average of a normally distributed sample.

The mean for perceived asthma control, which was assessed using the Perceived Control of Asthma Questionnaire (PCAQ), was 39.18 with a standard deviation of 8.48 and a range of 17 – 55. Higher scores indicate greater perceived control of asthma. Based on the Kolmogorov-Smirnov test of normality, this distribution was normally distributed ($p > .05$).

The mean for self-report medication adherence, as measured with the Medication Adherence Report Scale for Asthma (MARS-A), was 4.23 with a standard deviation of 0.83 and a range of 1.6 – 5. Higher scores indicate greater self-reports of medication adherence. Skewness was determined to be -1.02, with a standard error of .285, indicating a significantly negatively skewed distribution ($p < .001$). A negatively skewed distribution has more score that fall to the right of the distribution than to be expected in a normally distributed sample. Regarding self-report medication adherence, this distribution suggests that many patients in this study had adherence scores that clustered above the average of a normally distributed sample.

The mean for perceived stress, as measured with the Perceived Stress Scale (PSS), was 21.58 with a standard deviation of 8.02 and a range of 3 – 46. Higher scores indicate greater levels of perceived stress in patients. Based on the Kolmogorov-Smirnov test of normality, this distribution was normally distributed ($p > .05$).

The mean for social problem-solving, as assessed using the Social Problem-Solving Inventory-Revised: Short Form, was 13.95 with a standard deviation of 2.63 and a range of 8.2 – 18.6. Higher scores indicate more adaptive social problem-solving tendencies. Based on the Kolmogorov-Smirnov test of normality, this distribution was normally distributed ($p > .05$).

4.2.2 Initial Associations

Bivariate correlation coefficients were computed among primary variables and demographic factors to determine if any factors should be controlled for in the main analyses and to check for multicollinearity. Based on previous literature, potential covariates might include sex, age, education, income, employment status, marital status and parental asthma (Rod, Kristensen, Lange, Prescott, & Diderichsen, 2012). None of these factors were significantly correlated with the outcome of medication adherence, however, significant differences were found in the study outcomes based on race. Therefore, race/ethnicity was the only demographic factor that was controlled for in the main analyses. Additionally, none of the variables had correlation coefficients greater than .7, indicating that multicollinearity was not an issue for the main regression analyses. Pearson product-moment correlational analyses revealed a positive association between both measures of asthma control: perceived control of asthma and objective asthma control ($r = .57$, $p < .01$). Interestingly, both measures of adherence (self-report and pharmacy refills) were also positively correlated with each other ($r = .31$, $p < .01$) (see Table 4).

4.3 Main Analyses

4.3.1 Hypothesis 1

The first hypothesis stated that correlational analyses would demonstrate significant associations between dimensions of social problem-solving with asthma control, perceived asthma control, perceived stress and pharmacy reports of adherence. Hypothesis one employed Pearson product-moment correlations to examine relationships among these primary variables (see Table 4). Correlations between the following variables were examined: medication adherence based on pharmacy refill data (MPR), perceived control of asthma based on the PCAQ, objective asthma control based on the ACT, perceived stress based on the PSS, self-report adherence based on the MARS-A, PPO (positive problem orientation) subscale of the SPSI, NPO (negative problem orientation) subscale of the SPSI, RPS (rational/ planful style) subscale of the SPSI, ICS (impulsive/ careless style) subscale of the SPSI, AS (avoidant style) subscale of the SPSI, and total social problem-solving scores based on the SPSI-R:S.

Pearson product-moment correlational analyses revealed positive associations between stress and negative problem orientation ($r = .51$, $p < .01$), impulsive-careless style ($r = .32$, $p < .01$), and avoidant style ($r = .41$, $p < .01$). Stress was negatively correlated with self-report medication adherence ($r = -.27$, $p < .01$), positive problem orientation ($r = -.20$, $p < .05$), and total social problem-solving scores ($r = -.53$, $p < .01$). Stress was also negatively correlated with perceived control of asthma ($r = -.40$, $p < .01$) and objective asthma control ($r = -.21$, $p < .05$). In addition, negative correlations were found between perceived control of asthma and negative problem orientation ($r = -.22$, $p < .05$), impulsive-careless style ($r = -.20$, $p < .05$) and avoidant style ($r = -.23$, $p < .05$). Similarly, objective asthma control was

negatively correlated with negative problem orientation (r = -.22, p < .05) and avoidant style (r = -.26, p < .01). Moreover, perceived control of asthma was negatively correlated with pharmacy refill adherence (r = -.31, p < .01). Self-report medication adherence was negatively correlated with negative problem orientation (r = -.22, p < .05), impulsive-careless style (r = -.22, p < .05), and avoidant style (r = -.30, p < .01), and positively correlated with total social problem-solving scores (r = .20, p < .01). In sum, higher perceived stress was associated with higher scores on all three dysfunctional dimensions of social problem-solving (NPO, ICS, and AS) and lower self-report adherence rates. Higher scores of positive problem orientation and higher total social problem-solving scores were associated with lower perceived stress. In addition, higher scores on both measures of asthma control were associated with lower levels of stress. Higher scores on the dysfunctional dimensions of social problem-solving were also associated with lower perceived control of asthma, while higher scores on negative problem orientation and avoidant style were associated with lower objective asthma control. Surprisingly, higher pharmacy refill rates were associated with lower perceived control of asthma. In terms of self-report adherence, high adherence was associated with lower scores on all three dysfunctional dimensions of social problem-solving and higher total scores of social problem-solving.

4.3.2 Hypothesis 2

The second hypothesis stated that social problem-solving, asthma control, perceived control of asthma and perceived stress would all significantly predict pharmacy reports of medication adherence, when controlling for necessary demographics. Hierarchical regression analysis was used to examine these primary variables and how they impact

medication adherence. All potential demographic covariates were planned to be entered into block one to control for these variables. Since the only demographic variable that was associated with the outcome of pharmacy refill data was race/ethnicity, this was the only covariate entered into block one. Perceived stress was then entered into block two and both measures of asthma control (perceived and objective) were entered into block three. Finally, social problem-solving was entered into block four to determine how much variance this variable is explaining in medication adherence, above and beyond the variance accounted for by covariates, perceived stress and asthma control.

A hierarchical regression analysis was conducted to determine which variables were significant predictors of medication adherence based on pharmacy refill information. Model one, including race/ethnicity as the predictor, was not significant in explaining variance in pharmacy refill data. Model two, which added perceived stress to the model, was also not significant. Objective asthma control and perceived control of asthma were added into model three. This model was significant in explaining variance in pharmacy refill medication adherence, $F(4, 66) = 4.223$, $p < .01$. Specifically, lower perceived control of asthma was associated with higher rates of adherence (see Table 5). In the fourth model, social problem-solving was included. Overall, this fourth model was significant, $F(5, 65) = 3.969$, $p < .01$, however, social problem-solving did not emerge as a significant predictor of pharmacy refill data. In this final model, only race/ethnicity and perceived control of asthma were significant predictors (see Table 5).

4.3.3 Hypothesis 3

The third hypothesis evaluated whether the relationship between stress and medication adherence was moderated by social problem-solving abilities. This hypothesis

was assessed with a moderation analysis using PROCESS (Hayes, 2013). A moderation occurs when the relationship between two variables changes in direction or strength as a function of a third variable (Field, 2013). PROCESS is an add-on program for SPSS that uses a linear regression-based analytic framework to analyze mediation and moderation analyses (Hayes, 2013).

The overall model for perceived stress and social problem-solving predicting medication adherence based on pharmacy refill data was not significant. Results indicated that social problem-solving did not serve as a significant moderator for the relationship between perceived stress and medication adherence.

4.4 Exploratory Analyses

Additional analyses were conducted to examine which variables are predictive of stress in asthma patients. A hierarchical regression analysis was used to examine which of the primary variables (medication adherence, objective asthma control, perceived control of asthma, and social problem solving) predict perceived stress in patients with asthma. Since the sample size was low for pharmacy refill adherence, self-report assessment of adherence was used as the medication adherence measure in this statistical test. Correlational analyses revealed that race/ethnicity and income were both significantly associated with perceived stress, therefore, these demographic variables were entered into block one of the hierarchical regression as a way of controlling for them in the analysis. Self-report adherence was then entered into block two, objective asthma control and perceived control of asthma were both entered into block three, and social problem-solving was entered into block four.

A hierarchical regression indicated that the model for self-report adherence predicting perceived stress when controlling for race/ethnicity and income was significant,

$F(3, 94) = 6.581$, $p < .01$. Specifically, lower self-report of medication adherence was predictive of higher perceived stress (see Table 6). Model three, which added both measures of asthma control, was also significant, $F(5, 92) = 6.970$, $p < .001$. Perceived control of asthma emerged as a significant predictor of stress, such that those reporting lower perceived control of asthma were more likely to report higher levels of perceived stress. The overall model including social problem-solving, both assessments of asthma control, and self-report medication adherence, when controlling for race/ ethnicity, was significant $F(6, 91) = 12.604$, $p < .001$. In this final model, perceived control of asthma and social problem-solving both emerged as significant predictors of perceived stress (see Table 6). Results indicated that social problem-solving abilities significantly predicted stress, above and beyond variance accounted for by demographic factors, asthma control, and medication adherence, such that poorer social problem-solving abilities were associated with higher levels of perceived stress.

A one-way analysis of variance (ANOVA) was also conducted to examine how the outcome variables (i.e., pharmacy refill adherence, self-report adherence, perceived stress, social problem-solving, asthma control, and perceived control) differed as a function of race/ethnicity. Fifty-one individuals identified as White and 39 individuals identified as Black/African-American. Because of the small sample sizes for American Indian/Alaska Native, Asian, Native Hawaiian/Pacific Islander, Hispanic/Latino and Multiracial, these groups were combined into a category labeled “Other” ($n = 14$). ANOVAs indicated significant differences among racial/ethnic groups for all outcome variables except pharmacy refill data (see Table 7).

Bonferroni post-hoc analyses were conducted on each outcome to determine specific differences between groups. Individuals who identified as White (M = 4.488, SD = .737), reported significantly higher self-report adherence than individuals who identified as Black/African-American (M = 4.077, SD = .827), p = .048, as well as individuals who identified as Other (M = 3.736, SD = .865), p = .006 (see Table 8). On perceived stress, individuals who identified as Other (M = 28.214, SD = .8.322), reported significantly higher scores than individuals who identified as White (M = 20.200, SD = 6.975), p = .002, as well as individuals who identified as Black/African-American (M = 20.947, SD = 8.200), p = .006. Individuals who identified as White (M = 14.756, SD = 2.201), reported significantly higher social problem-solving scores than individuals who identified as Other (M = 12.300, SD = 2.632), p = .005. In terms of objective asthma control, individuals who identified as White (M = 19.284, SD = 5.886), reported significantly higher scores than individuals who identified as Black/ African-American (M = 15.436, SD = 5.113), p = .005, as well as individuals who identified as Other (M = 13.000, SD = 5.602), p = .001. Finally, individuals who identified as White (M = 41.431, SD = 8.638), reported significantly higher scores on perceived control of asthma than individuals who identified as Other (M = 34.857, SD = 7.502), p = .029 (see Table 8).

5. Discussion

5.1 Purpose

Asthma is a serious chronic illness that is typically poorly managed given the low rates of medication adherence and poor asthma control. Research has demonstrated that asthma patients show increased asthma symptoms in response to psychosocial factors such as high stress and negative coping skills (Ritz, Steptoe, DeWilde, & Costa, 2000). Little

research has addressed psychosocial aspects of asthma, specifically their relationship with asthma management techniques like medication adherence. Focusing on these psychosocial factors is an important step towards developing effective integrative treatment plans for patients with asthma.

The current study aimed to build upon and extend the current literature by examining psychological factors of asthma and medication adherence. Patients in this study reported demographic factors, medical record information regarding asthma diagnosis and prescription refills, self-reports of asthma medication adherence, objective asthma control, perceived control of asthma, perceived levels of stress, and social problem-solving tendencies. This study examined psychological factors that are associated with a diagnosis of asthma and medication adherence. Social problem-solving was assessed as a moderating variable and exploratory analyses were conducted to examine which factors explain perceived stress in asthma patients as well as differences in outcomes as a function of race/ethnicity.

5.2 Participant Characteristics

The sample consisted of mostly White middle-aged married women who are working full-time (see Table 1). The sample, however, was very diverse due to the demographic differences between participants recruited from Drexel Pulmonary Medicine and Atlantic Research Center, LLC (see Table 1). More than half of the sample from Drexel Pulmonary Medicine were Black/African American women and most of the sample had not received above a high school education. Moreover, these participants were mostly disabled or unable to work and had an estimated annual household income of below twenty-thousand dollars. Among these participants, there was almost an even split of those who are married or living

with a partner and those who are single. In contrast, the participants from Atlantic Research Center, LLC, were mostly highly educated White women with an estimated annual household income of above one-hundred thousand dollars. A majority of these participants reported that they work full-time and are married or living with a partner. Most of the participants from both sites have children and identify as Catholic or Christian. The differences between recruitment sites were expected based on the inner-city setting of Drexel Pulmonary Medicine and the suburban, upper-class nature of Atlantic Research Center, LLC.

Most participants in this sample had never smoked or used tobacco products and rarely drink alcohol. The lack of tobacco use is likely a result of the exclusion criteria, preventing heavy smokers from participating in the study. Additionally, the participants reported engaging in moderate levels of physical activity and most have never been diagnosed with any mental health diagnoses. Of those who had been diagnosed with mental health problems, the most frequent forms of psychological treatment were individual therapy, couple's therapy and prescription medication. More than half of the sample reported that neither one of their parents had asthma. Of those whose parents did have asthma, more participants reported maternal asthma, which the literature indicates is a stronger risk factor for asthma than paternal asthma (Sears, Holdaway, Flannery, Herbison, & Silva, 1996). Most of the participants from Atlantic Research Center, LLC, were never hospitalized nor visited the emergency room for their asthma, while about half of those from Drexel Pulmonary Medicine had been hospitalized and visited the emergency room for an asthma exacerbation. These results may be explained by the fact that a majority of the patients from Drexel Pulmonary had a diagnosis of severe persistent asthma, while most

patients from Atlantic Research Center, LLC, were diagnosed with moderate persistent asthma. Overall, very few patients had a diagnosis of mild persistent asthma. The plurality of participants in this sample reported that they see their physician at least every six months for their asthma, which is in line with recommendations from health care professionals (NHLB, 2012).

5.3 Preliminary Analyses

5.3.1 Descriptive Statistics on Primary Variables

Descriptive statistics of all self-report and medical record assessments were examined. Pharmacy refill data based on the medication possession ratio (MPR) ranged from the lowest possible score of 0 to the highest possible score of 12. This means that some patients had not filled their inhaled corticosteroid prescription at all within the previous 12 months, while other patients had filled their prescription every month throughout the year. The mean number of prescription refills for this sample was 4.94 times. In other words, most patients filled their controller inhaler less than half of the prescribed amount. This variability was positively skewed, which means many participants had pharmacy refill scores that clustered below the average of a normally distributed sample. The low rates of adherence in this sample are in line with extant literature – medication adherence rates for asthma patients tend to be extremely poor (Bender, Milgrom, & Apter, 2003; Sumino & Cabana, 2013). Sample size was limited for the pharmacy refill variable since pharmacy information was not attainable for a subset of patients in the sample. Many individuals use home delivery pharmacy services and therefore refill information could not be obtained for these patients. Additionally, physicians often give sample inhalers to patients for a variety of reasons, such as testing out a new inhaler or providing patients with samples of an inhaler their insurance

does not cover. Because this information was not documented by the pharmacy, sample inhaler use was not accounted for by this adherence measure. Furthermore, patients tend to use multiple different pharmacies and may switch between different inhaler prescriptions based on insurance coverage or patient preference. In this study, not all pharmacy or prescription information was available, which may have led to underreporting of refill rates.

Asthma control, as measured by the Asthma Control Test (ACT), ranged from a score of 5 (the lowest possible score) to 25 (the highest possible score). The distribution was negatively skewed compared to a normal distribution, meaning that patients reported better than average asthma control. Despite this negative distribution, however, the average score was 16.99, which still falls under the cutoff of 19 indicating poorly controlled asthma. The cutoff on this measure for poorly controlled asthma is relatively high, which suggests that the numerical average score of a normal distribution would still indicate extremely poor asthma control. One reason for higher than average reported asthma control scores could be due to the fact that most patients in this study were being seen by the physician for an outpatient, routine follow-up appointment. As a result, it is unlikely that they were experiencing exacerbated asthma symptoms at the time of this visit. Additionally, because this was an in-person study at a physician's office, patients may have been engaging in social desirability bias.

Perceived asthma control was measured using the Perceived Control of Asthma Questionnaire (PCAQ), which assesses individuals' perceptions of their ability to deal with asthma and its exacerbations. Scores on this measure ranged from 17 to 55, with higher scores indicating perception of greater control of asthma. This distribution was found to be normal, meaning that participant scores were evenly spread across the distribution.

According to this measure, there was a range of responses in perceived control of asthma, suggesting that patients vary in their levels of self-efficacy, locus of control and learned helplessness related to their asthma management.

The Medication Adherence Report Scale for Asthma (MARS-A) was also used to assess self-report medication adherence. Scores on this measure ranged from 1.6 to 5 (the highest possible score), with a negatively skewed distribution indicating higher than average self-report adherence. The high self-report scores of medication adherence in this study are in line with previous research suggesting that adherence is greatly overestimated with self-report assessment (Brown & Bussell, 2011; Gillissen, 2007). Again, it is very likely that social desirability bias played a role in the outcome of this assessment since patients want to appear more adherent to their medications than they probably are. While in the physician exam room, it is easy to assume that patients overestimated their levels of adherence. Patients also may not recognize their non-adherent behaviors, such as forgetting to take their inhaler or taking less than instructed. It is worth noting that there was probably a ceiling effect with this assessment since numerous patients reported perfect adherence and the mean (4.23) is very close to the maximum possible score.

Perceived stress, which was assessed using the Perceived Stress Scale (PSS), ranged dramatically within the sample (3 – 46). The scores for this measure fell along a normal distribution indicating that participant scores did not cluster towards either end of the distribution. Participants ranged from very little perceived stress to great amounts of perceived stress, with most scores clustering around the mean.

Social Problem-Solving, which was assessed by the Social Problem-Solving Inventory-Revised: Short Form (SPSI-R:S), was normally distributed. Participant scores on

this measure signify the range in patient social problem-solving abilities, from being extremely maladaptive to extremely adaptive, with most scores falling in the middle of the distribution.

5.3.2 Initial Associations

Bivariate correlations were conducted to examine initial relationships among variables. In existent literature, covariates for asthma medication adherence included sex, age, education, income, employment status, marital status and parental asthma (Rod, Kristensen, Lange, Prescott, & Diderichsen, 2012). These demographic variables were not significantly correlated with the outcome measure (i.e., medication adherence based on pharmacy refills), indicating that there was no need to control for these variables in the main analyses. However, race/ethnicity was significantly correlated with all of the primary variables. As a result, it was included as a covariate in the analyses. Initial associations were also evaluated to rule out potential issues of multicollinearity, which occurs when there is a strong correlation between two or more predictors, making it difficult to assess the individual importance of each predictor (Field, 2013). None of the primary variables were highly correlated (above .7), therefore all primary variables were included in the main analyses. It is interesting to note that despite the literature reporting significant differences between subjective and objective reports of adherence (Krishnan et al., 2012), self-report and pharmacy refill adherence were positively correlated in this study (see Table 4). There was also a positive association between both measures of asthma control, suggesting that these research participants were relatively accurate in assessing control of their asthma. However, both variables were included in the model given their moderate correlation and lack of multicollinearity.

5.4 Main Analyses

5.4.1 Hypothesis 1

Hypothesis one was partially confirmed. It was hypothesized that bivariate correlation analyses would demonstrate significant associations between all dimensions of social problem-solving (NPO, PPO, RPS, ICS, AS) with asthma control (ACT), perceived control of asthma (PCAQ), perceived stress (PSS) and pharmacy reports of medication adherence.

Hypothesis one employed Pearson product-moment correlations to examine relationships between primary variables (see Table 4). In line with the hypothesis, dysfunctional dimensions of social problem-solving (NPO, ICS, AS) were positively associated with perceived stress. This finding is in line with prior literature because those with more maladaptive social problem-solving tend to report higher levels of perceived stress (Nezu et al., 2013). Also, perceived stress was negatively correlated with positive problem orientation (PPO) and total social problem-solving scores, suggesting that individuals with more adaptive problem-solving tendencies reported lower levels of stress. Stress was also negatively correlated with self-report medication adherence. In other words, individuals who reported higher levels of adherence also reported lower levels of stress. Both assessments of asthma control were negatively correlated with stress, suggesting that higher levels of objective and perceived control of asthma are associated with less perceived stress. Additionally, all three dysfunctional dimensions of social problem-solving were negatively correlated with perceived control of asthma. Individuals with maladaptive social problem-solving tendencies reported lower perceived control of asthma, meaning that they were less likely to be coping effectively with their asthma and less likely to feel in control of

their asthma. Two of the dysfunctional dimensions (NPO and AS) were negatively correlated with objective asthma control. These findings mean that individuals with more maladaptive social problem-solving tendencies were more likely to have poorly controlled asthma characterized by increased use of rescue inhaler and functional impairments like waking up at night or being unable to get as much done at work, school or home. Unexpectedly, higher pharmacy reported rates of adherence (i.e., more refills) was associated with decreased perceived control of asthma. In other words, patients who do not feel in control of their asthma were likely to refill their inhalers more often. This relationship could mean that patients do not feel like they have internalized the abilities or skills to manage their asthma. Therefore, they may believe that they need medications and additional outside resources to cope with their chronic illness. Regarding self-report adherence, low adherence was associated with higher scores on all three dysfunctional dimensions of social problem-solving and higher adherence was associated with higher total social problem-solving scores. These results are also in line with the hypothesis and suggest that individuals with more maladaptive social problem-solving tendencies report lower levels of adherence, while more adaptive problem-solvers tend to report higher levels of adherence.

Together, these findings add valuable information to the current literature. First, more maladaptive social problem-solving tendencies are associated with higher levels of perceived stress, lower perceived control of asthma, lower objective asthma control and lower self-reports of asthma medication adherence. These results suggest that improvements in the dysfunctional domains of problem-solving might help decrease levels of stress and improve asthma management. Specifically, interventions aimed at improving social-problem solving abilities may help increase perceived and objective asthma control and improve

medication adherence. Improvements in perceived control of asthma can decrease feelings of learned helplessness and help patients feel more in control of their chronic condition, while improvements in objective control would help patients be more productive on a daily basis by decreasing functional impairment from asthma. In addition, efforts to decrease stress in asthma patients could also lead to improvements in social problem-solving and asthma management. Targeting levels of perceived stress may help facilitate patient perceived control of their asthma, reduce daily limitations associated with their symptoms, and increase rates of medication adherence.

5.4.2 Hypothesis 2

Hypothesis two was partially confirmed. It was hypothesized that social problem-solving, asthma control, perceived asthma control and perceived stress would all significantly predict pharmacy reports of medication adherence.

Hypothesis two employed a hierarchical regression analysis to determine which variables would emerge as significant predictors of medication adherence in asthma patients, based on pharmacy refill history. The overall model was significant, meaning that these primary variables did account for a significant proportion of variance in the outcome of medication adherence. However, perceived control of asthma was the only variable significantly predicted medication adherence, when controlling for race/ethnicity. This means that perceived control of asthma was explaining a significant amount of variation in pharmacy reports of medication adherence. Specifically, lower levels of perceived control of asthma predicted higher pharmacy reports of adherence. As previously stated, the direction of this association between perceived control of asthma and pharmacy refills is surprising. Initially, it was hypothesized that higher perceived control of asthma would lead to better

adherence but the contrary seems to be true. This finding makes more sense after further examination of the specific perceived control of asthma measure. Participants were asked to agree or disagree with statements such as, "I can do a lot of things myself to cope with my asthma, I can reduce my asthma by staying calm and relaxed, and I have considerable ability to control my asthma." Patients scoring high on this measure are more likely to believe that they do not need resources other than themselves to successfully manage their asthma. Patients scoring low on this measure are more likely to rely on physicians and medications since they have lower self-efficacy and do not believe they are capable of managing their asthma on their own.

This noteworthy finding adds important information to the current understanding of perceived control of asthma and medication adherence. While research has documented the importance of patients feeling in control of their asthma (Katz et al. 2002; Taitel, Allen, & Creer, 1998; van der Palen, Klein, & Seydel, 1997), it is of utmost importance for patients to adhere to their daily inhaler use. It is possible that patients are overconfident in their abilities to manage their asthma, leading to beliefs that they do not need their medications. It may be important for physicians to increase patient awareness of the benefits of daily inhaler use and to stress the detrimental effects of poor adherence. In fact, increased medical knowledge and psychoeducation may be especially important for patients with higher perceived control of asthma.

5.4.3 Hypothesis 3

Hypothesis 3 was not confirmed. It was hypothesized that social problem-solving would modify (i.e., strengthen, weaken, change the direction) the relationship between stress and medication adherence. Social problem-solving did not significantly interact with stress

to predict pharmacy reports of medication adherence. The lack of significance within this analysis may be attributable to the low sample size for pharmacy reports of adherence. In accordance with the literature, limitations in assessment of this variable include the fact that many patients use home delivery pharmacy companies, multiple different pharmacies, frequently change their inhaled corticosteroid prescriptions, obtain samples from physicians, or intentionally decrease the dosage of medications when not experiencing symptoms (i.e., only using inhalers seasonally when allergy symptoms are increased). These findings stress the importance of obtaining reliable, objective assessments of medication adherence for asthma controller medications.

5.5 Exploratory Analyses

Exploratory analyses were conducted to evaluate the relationships between primary variables and perceived stress in asthma patients. Research has documented a strong link between psychological stress and asthma symptoms (Rand, Wright, Cabana, Foggs, Halterman, Olson, Vollmer, Wilson & Taggart, 2012; Rietveld, Everaerd, & Creer, 2000). Interpreting associations between stress and asthma might aid in the development of integrative treatment plans for patients with asthma that could improve self-management skills.

A hierarchical regression analysis was conducted to identify which of the primary variables significantly predict stress in patients with asthma. Due to the limited sample size of pharmacy refill as the adherence measure, the self-report assessment of adherence was used for this analysis. Additionally, race/ethnicity and income were both controlled for in this regression analysis given their significant correlation with perceived stress. Results of the analysis indicated that self-report medication adherence was a significant predictor of

perceived stress, when controlling for demographic variables. In particular, it was found that participants who reported lower adherence rates also reported higher levels of perceived stress. This finding is in line with current research, such that higher levels of stress are associated with poor adherence in individuals with asthma (Rand et al., 2012; Wright et al., 1998). Additionally, patients with lower levels of perceived control of asthma also reported higher stress. This finding is expected because a lack of confidence and self-efficacy in the management of a chronic illness has been associated with higher levels of stress. Furthermore, this analysis provided evidence that poorer social problem-solving abilities were associated with increased stress, even when controlling for variance explained by demographic factors and the additional primary variables. This finding highlights the important relationship between social problem-solving and stress. Further, it provides evidence that interventions aimed at improving social problem-solving abilities may help reduce stress in patients with asthma.

Exploratory analyses of variance (ANOVAs) were also run to examine racial/ethnic differences in psychological factors of asthma management. Results revealed differences among individuals who identify as White, Black/African-American and Other on every primary variable. Specifically, individuals who identify as White reported greater self-report adherence, less perceived stress, better social problem-solving abilities, higher perceived control of asthma, and better objective control of asthma, as compared to other racial and ethnic groups. These findings support extant literature and demonstrate the racial and ethnic disparities among patients with asthma (CDC, 2004). They also highlight the importance of recognizing that psychosocial treatment effectiveness may need to be adapted based on racial or ethnic identity. Tailored treatments and special considerations for racial and ethnic

minorities must be taken into account when designing and implementing treatment plans for diverse groups of patients.

5.6 Clinical Implications

Relatively few studies have examined psychosocial factors among asthma patients and even fewer have examined psychological factors of asthma management. Distress and poor psychosocial adjustment is common among individuals with chronic illnesses. Asthma in particular is typically characterized by poor self-management techniques, such as nonadherence to prescribed medication regimens and low levels of asthma control, both perceived and objective (Chapman et al., 2008). Poor asthma management has led to extreme increases in the cost of asthma as a chronic disease (i.e., hospitalizations, emergency room visits, missed work) (Healthcare Cost and Utilization Project, 2015). The current study identified psychological factors that may help improve asthma management and eventually decrease overall economic burden of asthma as a chronic illness.

Medication adherence is a crucial facet of asthma management and has been documented to be extremely poor (Windsor et al., 1990). This study is among few to look at two outcome measures of adherence, both objective and subjective. Patients and physicians both tend to overestimate the frequency that patients take their prescribed medications, which is why it is imperative to include a reliable objective report. Research supports the notion that a multi-method approach is necessary for assessing true adherence rates (Krishnan et al., 2012). While objective measures tend to be difficult to employ, this study was able to obtain pharmacy refill information on inhaled corticosteroids for most participants. In addition, examining the differences between subjective and objective data has important clinical implications for understanding whether this disparity exists. Despite

prior research observing differences between self-report and objective measures, the adherence measures in this study were positively correlated, showing that there was accordance between both assessment techniques.

This study is also among few to assess two measures of asthma control, both perceived control of asthma and objective asthma control, which are two constructs for understanding asthma management. Asthma control has been identified as the most important measure of overall asthma health (CDC, 2015). Additionally, psychological factors of self-efficacy, locus of control and learned helplessness, which were assessed through the perceived control of asthma measure, have been shown to have an impact on asthma exacerbations and management techniques (Katz et al. 2002). This study compared assessments of asthma control to determine how patient perception of psychological factors match up to their objective asthma control. Comparisons of these assessments are clinically important in developing psychosocial interventions that seek to teach patients how to identify actual asthma control and maximize perceived and actual control over their illness.

Identifying associations among asthma management factors and psychological factors such as social problem-solving and perceived stress are important first steps toward developing integrative treatment approaches (i.e., medical, psychological, and social) for patients with asthma. This research study identified important relationships among the dysfunctional dimensions of social problem-solving with higher perceived stress, lower perceived and objective control of asthma and lower self-report medication adherence rates. These results highlight the important role that adaptive social problem-solving abilities can have on decreased perceived stress and increased asthma control and medication adherence. Incorporating stress management into treatment for asthmatics may improve patient

perception of asthma control, objective asthma control and adherence rates. Increases in all these components of asthma management should ultimately lead to decreases in asthma exacerbations, hospitalizations and emergency room visits. Furthermore, decreased stress and increased social problem-solving abilities will hopefully lead to better psychosocial adjustment for patients with asthma.

In addition to advancing knowledge in this field, the results have meaningful clinical implications. The findings emphasize the importance of patient education regarding daily inhaler use. Contrary to what was hypothesized, participants who reported lower perceived control of asthma were more likely to refill their inhaled corticosteroids than participants reporting higher perceived control. Ratings of perceived control of asthma fall along the range from being entirely internal and believing that asthma is in one's own hands to being entirely external and believing that fate and other factors are in control of asthma. Previous research indicates that low perceived control of asthma is associated with increased asthma exacerbations and poor self-management techniques (Katz et al., 2002). However, the current findings suggest that patients with low perceived control are *more likely* to fill their asthma medications, possibly because they have an external locus of control and low self-efficacy surrounding their asthma. Such participants are more likely to rely on external factors (i.e., physicians, medications) to control their asthma. The present study suggests that anticipation of the degree of control individuals have over their illness does influence their motivation to engage in self-management behaviors. Specifically, individuals in this study who experienced low sense of control over their asthma may have had increased motivation to use their medications. These results have important implications for clinical practice since the ultimate goal is achieving both optimal asthma control and optimal adherence rates.

Treatment plans for asthma patients should incorporate psychoeducation and skill trainings, such as social problem-solving abilities, behavioral stress techniques, as well as practical medical education, for instance, the physical importance of daily inhaler use. The inclusion of these skills and techniques are likely to increase perceived control of asthma, actual control over asthma symptoms, and medication adherence.

Results also identify factors that are predictive of perceived stress in patients with an asthma diagnosis. Previous research provides evidence that stress plays a major role in asthma as a chronic condition, specifically showing links between high stress and increased hospitalizations along with poor self-management skills (Rand et al., 2012; Rod et al., 2012). Findings from the current study identify lower self-report adherence, lower perceived control of asthma, and poorer social problem-solving abilities as predictors of higher perceived stress. Impairments in social problem-solving abilities are associated with difficulties coping with chronic illness (Doorenbos et al., 2005; Kerns et al., 2002), which may be attributable to higher perceived stress in these patients. It is also possible that social problem-solving may be able to increase medication adherence by facilitating reductions in stress. Targeting these factors through integrative treatment approaches, healthcare providers may be able to decrease stress and improve overall psychosocial functioning in asthma patients.

Finally, this study identifies racial and ethnic disparities among psychological and self-management factors related to asthma. Notably, asthma does affects racial and ethnic groups differently. According to the CDC, asthma prevalence, morbidity, and mortality are all higher among certain racial/ethnic minority populations than among individuals who identify as White (2004). Black/African American and Hispanic/Latino asthma patients

report more emergency department visits, lifetime hospitalizations, severe acute exacerbations, and are less likely to use inhaled corticosteroids (Boudreaux, Emond, Clark, & Camargo, 2003). In addition, research has outlined evidence that the factors associated with ICS adherence differ greatly between patients who identify as White and those who identify as Black/African American (Wells, Pladevall, Peterson, Campbell, Wang, Lanfear, & Williams, 2008). Prior research, however, has mainly focused on racial and ethnic disparities among children and adolescents with asthma (Akinbami, Moorman, Simon, & Schoendorf, 2014), and has yet to explore detailed disparities among psychological outcomes in patients with asthma. Findings from this study highlight the importance of tailoring interventions aimed at improving psychosocial adjustment to racial and ethnic minority groups to improve adherence and overall psychosocial adjustment among all patients with asthma.

5.7 Limitations and Future Directions

The current study had several limitations that may constrain the generalizability of the results. While this study included a multi-method approach to assessing medication adherence, the distributions for both self-report and pharmacy refills may have been skewed. The pharmacy reports of adherence were difficult to obtain for a variety of reasons. First, many patients use home delivery pharmacies (i.e., Express Scripts, Prime Mail, Optum Rx), and pharmacy refill information from these pharmacies was not accessible and therefore analyses including this variable were slightly underpowered. Refill data may have been influenced by the fact that some patients refill their medications at multiple different pharmacies and information on only one pharmacy was obtained for each participant. This resulted in many pharmacies having very little refill information for patients since they may

have been switching from one pharmacy to another. Additionally, patients tended to switch inhaled corticosteroid inhalers based on what is covered by their insurance and on their preference for a specific type of inhaler. In this study, information about previous inhaler use was not recorded, resulting in less refill information for patients who may have been on multiple different inhalers within the past year. Furthermore, some of the patients in the study verbally reported that they only use their inhalers seasonally (i.e., when the weather is cold, during allergy season). Future researchers should ask patients if they use their inhalers year-round or if they alter the dosage either on their own or based on physician recommendations. Finally, information regarding sample inhalers was not collected. Many times, physicians will provide patients with samples of inhalers that may not be covered by their insurance or to get them started on an inhaler immediately before being required to pick up a prescription. This data was not collected, which suggest that pharmacy refill reports may have been lower than actual inhaler use.

Limitations also exist within the self-report medication adherence measure that was used. Many participants in this study expressed confusion while completing the self-report adherence measure, due to the awkward wording of some of the phrases. Further, participants may have been over-reporting adherence since they were completing these measures while in a physician exam room and with a researcher present. Moreover, this self-report measure does not assess levels of unintentional nonadherence, such as patients not realizing that they are being non-adherent (i.e., forgetfulness, confusion about dosage). Future research should focus on developing and utilizing more reliable assessments of adherence, both self-report and objective measures. If adequate resources are available, objective adherence methods such as electronic device monitors for inhalers or obtaining

information from insurance companies regarding all medication refills should be used. In terms of medication adherence, future researchers should also attempt to collect information regarding inhaler technique. While it may objectively look like a patient is taking their medication, they may have poor inhaler technique (i.e., inhaling too rapidly, failing to hold breath after inhaler use, actuating inhaler too early or too late), which can serve as a confounding variable for objective adherence measures.

In terms of asthma control, limitations likely exist due to the ceiling effect of the asthma control test results. Many patients in this study reported perfectly controlled asthma and given the familiarity of the assessment with routine check-in with physicians, they may be in the habit of over-reporting their asthma control. There is also evidence that patients' self-report of asthma control is not always accurate. According to the guidelines by the National Asthma Education and Prevention Program (NAEPP), despite high rates of rescue inhaler use, urgent care visits, and emergency room visits, patients tend to rate their asthma as more well controlled than they should (Murphy, Meltzer, Blaiss, Nathan, Stoloff, & Doherty, 2012). These findings speak to the need for more accurate ways to identify objective asthma control and teach patients to more effectively identify poorly controlled asthma. For future studies, it would be useful to examine if patients with higher perceived control of asthma have fewer asthma exacerbations, even if they are less adherent. It is possible that these patients do not use their medication as often because they are actually better able to manage the physiological aspects of asthma through improved stress and coping skills. Future studies should consider incorporating physiological assessments to determine actual versus perceived inflammation along with objective and perceived asthma control measures. In terms of asthma control, it would also be interesting to include

information on when a patient received his or her asthma diagnosis. A patient who was diagnosed in childhood may have a vastly different experience with their asthma diagnosis as compared to someone who was more recently diagnosed in adulthood.

Another limitation of the present study is the self-report, cross-sectional research design. The self-report nature of the study increased the likelihood of response bias and social desirability, which is likely what occurred with the asthma control test and the self-report adherence scale. Participants may have been attempting to display themselves in a positive light by reporting perfect adherence and perfectly controlled asthma. Likewise, the fact that the study survey completion was done at the physician's office may have also increased biases. Future studies should attempt to incorporate more methods within the multi-method approach to data collection in an effort to supplement self-report data. For example, obtaining information from physicians on their perceptions of patients' asthma control and psychosocial adjustment, along with including qualitative responses could lead to a better understanding of the patient's medical and psychological experience of their asthma.

The fact that the assessments were completed in-person could have also served as a limitation for this study. Aside from facilitating social desirability bias, the in-person nature prevented many patients from participating in the study due to time restraints. Future research might offer an online option for research participation so that patients can complete the questionnaires on their own time, in a comfortable environment. Participation in the study was also only available to patients at one of two outpatient physician practices. An online option could include a wide range of asthma patients with diverse backgrounds and from a variety of sites throughout the country. It would also be helpful to collect data from

patients at an inpatient setting who may be experiencing more severe, acute asthma exacerbation. In addition, participation in this study was limited to patients seeing a respiratory specialist (i.e., pulmonologist, allergist) in an outpatient setting, and a majority of these patients had well-controlled asthma at the time of their routine follow-up visit. Specialists tend to have a better perception of patient asthma control, while general practitioners tend to overestimate asthma control in their patients. In addition, research suggests that specialists implement asthma management plans and recommendations more often than any other physicians (i.e., family practitioners, internists) (Murphy et al., 2012). These differences in practitioners could be another explanation for high rates of asthma control in this sample and underline how important it is for asthmatics to see a specialist who will implement asthma management recommendations to improve asthma outcomes.

Future research should seek to include a more racially/ethnically diverse sample. In the current sample, most research participants identified as White or Black/African-American, leaving a very small sample size of other racial and ethnic minorities. There is a large amount of variability in this "other" group, so future studies should attempt to look at specific differences among all racial and ethnic groups. While this research study highlights differences in the outcome variables as a function of race and ethnicity, research has not yet identified why such disparities are occurring. Some extant work suggests that racial and ethnic differences are a result of genetic variations along with differing environmental exposures, socio-economic status, adverse childhood experiences, and psychological and cultural differences among ethnic groups (Forno, & Celedón, 2009), but attempts to fully address these discrepancies have not yet been successful. These findings are clinically important because they highlight the need for specified treatments and varying needs of

diverse racial and ethnic groups. Future research and publications should attempt to look at differences by site and should control for socioeconomic status when analyzing racial and ethnic disparities. While racial and ethnic differences were found in this study, there are confounding variables (i.e., setting, employment status, socioeconomic status) that may also explain such disparities.

5.8 Summary and Conclusion

Asthma is a serious public health concern with its increasing prevalence and increasing economic burden over the last decade. In addition to the physical limitations that patients with asthma struggle with, psychosocial adjustment to the chronic illness remain challenging. Understanding the factors that impact adjustment and outcomes for asthma patients is critical for improving and implementing psychosocial support and integrative treatment modalities. The current study highlights the importance of the role of social problem-solving and perceived stress in the evaluation of asthma management. Specifically, individuals with more adaptive social problem-solving tendencies report less stress, higher perceived control of asthma, better objective asthma control, and higher self-report medication adherence. Results also indicate that higher stress in asthma patients is associated with lower self-report adherence, and that more adaptive social problem-solving abilities and higher perceived control of asthma are predictive of less perceived stress. This research study also identifies differences in asthma management and psychological factors as a function of race/ethnicity. Overall, results suggest that further research examining psychosocial factors that are predictive of medication adherence as well as more effective ways to assess adherence is warranted. Psychosocial interventions that include medical education need to be developed and integrated in treatment plans for patients with asthma.

These interventions should focus on the improvement of self-management skills, such as asthma control, perceived control, and adherence, as well as behavioral stress techniques and coping skills to manage perceived stress. Research should aim to recruit more diverse samples to further examine discrepancies in asthma maintenance and psychosocial adjustment among patients of varying racial and ethnic backgrounds. Future studies should also consider utilizing a multi-method assessment approach, including information from physicians, pharmacies, and physiological measures to accurately assess adherence. Integration of these approaches will help asthma patients manage their chronic illness physically and psychologically by providing them with the resources and support that they need and deserve.

Table 1

Table 1. Participant Demographic Variables

	Total (*N* = 104)	**Drexel Pulmonary** (*n* = 64)	**Atlantic Research Center** (*n* = 40)
Sex	***n (%)***	***n (%)***	***n (%)***
Male	26 (25.0%)	17 (26.6%)	9 (22.5%)
Female	78 (75.0%)	47 (73.4%)	31 (77.5%)
Race/ Ethnicity			
White	51 (49.0%)	17 (26.6%)	34 (85.0%)
Black/ African American	39 (37.5%)	35 (54.7%)	4 (10.0%)
American Indian/ Alaska Native	0 (0.0%)	0 (0.0%)	0 (0.0%)
Asian	2 (1.9%)	1 (1.6%)	1 (2.5%)
Native Hawaiian/ Pacific Islander	1 (1.0%)	1 (1.6%)	0 (0.0%)
Hispanic/ Latino	7 (6.7%)	6 (9.4%)	1 (2.5%)
Multiracial	3 (2.9%)	3 (4.7%)	0 (0.0%)
Other	1 (1.0%)	1 (1.6%)	0 (0.0%)
Relationship Status			
Married/ Living with a partner	51 (49.0%)	25 (39.1%)	26 (65.0%)
Divorced/ Separated	13 (12.5%)	11 (17.2%)	2 (5.0%)
Widowed	8 (7.7%)	5 (7.8%)	3 (7.5%)
Single/ Never married	32 (30.8%)	23 (35.9%)	9 (22.5%)
Children			
Yes	75 (72.1%)	48 (75.0%)	27 (67.5%)
No	29 (27.9%)	16 (25.0%)	13 (32.5%)
Education			
Some elementary education	1 (1.0%)	1 (1.6%)	0 (0.0%)
Some high school	10 (9.6%)	8 (12.5%)	2 (5.0%)
High school diploma	25 (24.0%)	23 (35.9%)	2 (5.0%)
Some college	21 (20.2%)	12 (18.8%)	9 (22.5%)
College degree	32 (30.8%)	15 (23.4%)	17 (42.5%)
Graduate degree	15 (14.4%)	5 (7.8%)	10 (25.0%)
Estimated Household Income			
< $20,000	30 (28.8%)	27 (42.2%)	3 (7.5%)
$20,000 - $40,000	16 (15.4%)	14 (21.9%)	2 (5.0%)
$40,000 - $60,000	5 (4.8%)	4 (7.8%)	0 (0.0%)
$60,000 - $80,000	5 (4.8%)	1 (1.6%)	4 (10.0%)
$80,000 - $100,000	16 (15.4%)	6 (9.4%)	10 (25.0%)
> $100,000	28 (26.9%)	8 (12.5%)	20 (50.0%)
Not reported	4 (3.8%)	3 (4.7%)	1 (2.5%)
Employment			
Working full-time	35 (33.7%)	11 (17.2%)	24 (60.0%)
Working part-time	11 (10.6%)	6 (9.4%)	5 (12.5%)
Unemployed, seeking work	7 (6.7%)	6 (9.4%)	1 (2.5%)
Disabled/ unable to work	29 (27.9%)	27 (42.2%)	2 (5.0%)
Volunteer	1 (1.0%)	1 (1.6%)	0 (0.0%)
Retired	16 (15.4%)	11 (17.2%)	5 (12.5%)
Student	5 (4.8%)	2 (3.1%)	3 (7.5%)
Sexual Orientation			
Heterosexual	95 (91.3%)	58 (90.6%)	37 (92.5%)

Homosexual (Gay/ lesbian)	3 (2.9%)	2 (3.1%)	1 (2.5%)
Bisexual	3 (2.9%)	2 (3.1%)	1 (2.5%)
Other	1 (1.0%)	1 (1.6%)	0 (0.0%)
Not reported	2 (1.9%)	1 (1.6%)	1 (2.5%)
Religious Identity			
Agnostic	3 (2.9%)	0 (0.0%)	3 (7.5%)
Atheist	4 (3.8%)	3 (4.7%)	1 (2.5%)
Buddhist	3 (2.9%)	2 (3.1%)	1 (2.5%)
Catholic	35 (33.7%)	14 (21.9%)	21 (52.5%)
Christian	32 (30.8%)	29 (45.3%)	3 (7.5%)
Jewish	6 (5.8%)	2 (3.1%)	4 (10.0%)
Hindu	0 (0.0%)	0 (0.0%)	0 (0.0%)
Mormon	0 (0.0%)	0 (0.0%)	0 (0.0%)
Muslim	2 (1.9%)	2 (3.1%)	0 (0.0%)
Not affiliated, but religious/ spiritual	6 (5.8%)	4 (6.3%)	2 (5.0%)
No religious/ spiritual identity	7 (6.7%)	5 (7.8%)	2 (5.0%)
Other	5 (4.8%)	3 (4.7%)	2 (0.0%)
Not reported	1 (1.0%)	0 (0.0%)	1 (2.5%)
Religiosity			
Not at all religious	21 (20.2%)	11 (17.2%)	10 (25.0%)
Somewhat religious	55 (52.9%)	30 (46.9%)	25 (62.5%)
Very religious	27 (26.0%)	22 (34.4%)	5 (12.5%)
Not reported	1 (1.0%)	1 (1.6%)	0 (0.0%)
Health Insurance			
Private plan (employment-based)	49 (47.1%)	16 (25.0%)	33 (82.5%)
Private plan (direct-purchase)	3 (2.9%)	2 (3.1%)	1 (2.5%)
Medicare	41 (39.4%)	35 (54.7%)	6 (15.0%)
Medicaid	8 (7.7%)	8 (12.5%)	0 (0.0%)
Military health care	0 (0.0%)	0 (0.0%)	0 (0.0%)
Uninsured	1 (1.0%)	1 (1.6%)	0 (0.0%)
Not reported	1 (1.0%)	1 (1.6%)	0 (0.0%)

	M* ± *SD	***Range***	***M* ± *SD***	***Range***	***M* ± *SD***	***Range***
Patient Age	51.85 ± 15.77	18 – 78	53.98 ± 14.73	19 – 77	48.50 ± 16.95	18 – 78

Table 2

Table 2. Participant Health/ Medical Record Demographics

	Total (*N* = 104)	**Drexel Pulmonary** (*n* = 64)	**Atlantic Research Center** (*n* = 40)
Smoking Status	***n (%)***	***n (%)***	***n (%)***
Current smoker (daily)	3 (2.9%)	3 (4.7%)	0 (0.0%)
Current smoker (occasionally)	1 (1.0%)	0 (0.0%)	1 (2.5%)
Past smoker	27 (26.0%)	22 (34.4%)	5 (12.5%)
Never smoked/ used tobacco products	73 (70.2%)	39 (60.9%)	34 (85.0%)
Alcohol Use			
Never	48 (46.2%)	38 (59.4%)	10 (25.0%)
0-3 days/ month	28 (26.9%)	16 (25.0%)	12 (30.0%)
1 day/ week	9 (8.7%)	4 (6.3%)	5 (12.5%)
2 days/ week	7 (6.7%)	2 (3.1%)	5 (12.5%)
3 days/ week	4 (3.8%)	2 (3.1%)	2 (5.0%)
4 days/ week	4 (3.8%)	1 (1.6%)	3 (7.5%)
5 days/ week	1 (1.0%)	0 (0.0%)	1 (2.5%)
6 days/ week	1 (1.0%)	1 (1.6%)	0 (0.0%)
7 days/ week	2 (1.9%)	0 (0.0%)	2 (5.0%)
Physical Activity			
Sedentary, inactive	11 (10.6%)	10 (15.6%)	1 (2.5%)
Seldom active	20 (19.2%)	14 (21.9%)	6 (15.0%)
Moderately active	64 (61.5%)	37 (57.8%)	27 (67.5%)
Vigorously active	8 (7.7%)	2 (3.1%)	6 (15.0%)
Not reported	1 (1.0%)	1 (1.6%)	0 (0.0%)
Presence of Mental Health Diagnosis			
Yes	24 (23.1%)	16 (25.0%)	8 (20.0%)
No	79 (76.0%)	48 (75.0%)	31 (77.5%)
Not reported	1 (1.0%)	0 (0.0%)	1 (2.5%)
Past psychological treatment			
None	62 (59.6%)	40 (62.5%)	21 (52.5%)
Individual therapy	21 (20.2%)	14 (21.9%)	7 (17.5%)
Group therapy	1 (1.0%)	1 (1.6%)	0 (0.0%)
Couple's therapy	3 (2.9%)	1 (1.6%)	2 (5.0%)
Family therapy	1 (1.0%)	0 (0.0%)	1 (2.5%)
Medication	2 (1.9%)	1 (1.6%)	1 (2.5%)
More than 2 of the above	14 (13.5%)	7 (10.9%)	7 (17.5%)
Current psychological treatment			
None	84 (80.8%)	50 (78.1%)	34 (85.0%)
Individual therapy	12 (11.5%)	9 (14.1%)	3 (7.5%)
Group therapy	0 (0.0%)	0 (0.0%)	0 (0.0%)
Couple's therapy	1 (1.0%)	1 (1.6%)	0 (0.0%)
Family therapy	2 (1.9%)	1 (1.6%)	1 (2.5%)
Medication	3 (2.9%)	1 (1.6%)	2 (5.0%)
More than 2 of the above	2 (1.9%)	2 (3.1%)	0 (0.0%)
Parental Asthma			
Mother	19 (18.3%)	12 (18.8%)	7 (17.5%)
Father	13 (12.5%)	11 (17.2%)	2 (5.0%)

Both	1 (1.0%)	1 (1.6%)	0 (0.0%)
Don't know	17 (16.3%)	13 (20.3%)	4 (10.0%)
Neither	54 (51.9%)	27 (42.2%)	27 (67.5%)
Ever been hospitalized for asthma			
Yes	47 (45.2%)	36 (56.3%)	11 (27.5%)
No	57 (54.8%)	28 (43.8%)	29 (72.5%)
Been hospitalized in the past year			
Yes	18 (17.3%)	16 (25.0%)	2 (5.0%)
No	86 (82.7%)	48 (75.0%)	38 (95.0%)
Ever visited the ER for asthma			
Yes	55 (52.9%)	41 (64.1%)	14 (35.0%)
No	49 (47.1%)	23 (35.9%)	26 (65.0%)
Been to the ER in the past year			
Yes	32 (30.8%)	26 (40.6%)	6 (15.0%)
No	72 (69.2%)	38 (59.4%)	34 (85.0%)
Ever been intubated			
Yes	11 (10.6%)	9 (14.1%)	2 (5.0%)
No	93 (89.4%)	55 (85.9%)	38 (95.0%)
Been intubated in the past year			
Yes	3 (2.9%)	3 (4.7%)	0 (0.0%)
No	101 (97.1%)	61 (95.3%)	40 (100%)
Physician visits for asthma			
Once per month	14 (13.5%)	13 (20.3%)	1 (2.5%)
Every 3 months	38 (36.5%)	27 (42.2%)	11 (27.5%)
Every 6 months	42 (40.4%)	21 (32.8%)	21 (52.5%)
Once per year	7 (6.7%)	1 (1.6%)	6 (15.0%)
Less than once per year	3 (2.9%)	2 (3.2%)	1 (2.5%)
Asthma diagnosis			
Mild persistent	14 (13.5%)	10 (15.6%)	4 (10.0%)
Moderate persistent	47 (45.2%)	24 (37.5%)	23 (57.5%)
Severe persistent	43 (41.3%)	30 (46.9%)	13 (32.5%)

Table 3

Table 3. Total and Subscale Scores for Primary Variables

	M* ± *SD	***Range***
Pharmacy Refill[1] (*N* = 71)		**0 – 12**
Total Score	4.94 ± 4.06	0 – 12
Asthma Control[2] (*N* = 104)		**5 – 25**
Total Score	16.99 ± 6.01	5 – 25
Perceived Asthma Control[3] (*N* = 104)		**11 – 55**
Total Score	39.18 ± 8.48	17 – 55
Self-Report Adherence[4] (*N* = 104)		**0 – 5**
Total Score	4.23 ± 0.83	1.6 – 5
Perceived Stress[5] (*N* = 102)		**0 – 56**
Total Score	21.58 ± 8.02	3 – 46
Social Problem-Solving[6] (*N* = 103)		**0 – 20**
Total Score	13.95 ± 2.63	8.2 – 18.6
Positive Problem Orientation (PPO)	13.10 ± 4.74	0 – 20
Negative Problem Orientation (NPO)	5.05 ± 4.68	0 – 17
Rational/ Planful Style (RPS)	12.11 ± 4.55	0 – 20
Impulsive/ Careless Style (ICS)	5.38 ± 3.85	0 – 17
Avoidant Style (AS)	5.01 ± 4.51	0 – 18

Note. Higher pharmacy refill scores indicate better adherence. Higher asthma control scores indicate better asthma control. Higher perceived control of asthma scores indicate higher perceived control of asthma. Higher self-report adherence scores indicate better adherence. Higher perceived stress scores indicate more stress. Higher social problem-solving scores indicate more adaptive social problem-solving tendencies.

[1] Pharmacy refill was assessed using the medication possession ratio (MPR).
[2] Asthma control was measured with Asthma Control Test (ACT).
[3] Perceived asthma control was measured with Perceived Control of Asthma Questionnaire (PCAQ).
[4] Self-report adherence was measured with Medication Adherence Report Scale for Asthma (MARS-A).
[5] Perceived stress was measured with Perceived Stress Scale (PSS).
[6] Social Problem-Solving was measured with Social Problem-Solving Inventory-Revised: Short Form (SPSI-R:S).

Table 4

Table 4. Bivariate Correlations of Primary Study Variables

Variable	1	2	3	4	5	6	7	8	9	10	11
(1) Pharmacy Refill (MPR)	—										
(2) Perceived Control (PCAQ)	-.31**	—									
(3) Asthma Control (ACT)	-.12	.57**	—								
(4) Perceived Stress (PSS)	.00	-.40**	-.21*	—							
(5) Self-Report Adherence (MARS)	.31**	.13	.18	-.27**	—						
(6) PPO (SPSI)	.01	-.05	-.04	-.20*	-.08	—					
(7) NPO (SPSI)	-.21	-.22*	-.22*	.51**	-.22*	.05	—				
(8) RPS (SPSI)	-.00	-.04	-.04	-.14	-.04	.69**	.18	—			
(9) ICS (SPSI)	-.16	-.20*	-.18	.32**	-.22*	.14	.61**	.16	—		
(10) AS (SPSI)	-.14	-.23*	-.26**	.41**	-.30**	.04	.63**	.17	.68**	—	
(11) Social Problem-Solving	.18	.18	.19	-.53**	.20*	.53**	-.67**	.43**	-.64**	-.69**	—

Note. *$p < .05$, **$p < .01$

Table 5

Table 4. Asthma Control, Stress and Social Problem-Solving Predicting Adherence

Model 1	**B**	**Std. Error**	**β**	**t**	***p***
Race/ Ethnicity	-.492	.257	-.225	-1.919	.059
Model 2					
Race/ Ethnicity	-.568	.276	-.259	-2.059	.043
Perceived Stress	.048	.063	.096	.762	.449
Model 3					
Race/ Ethnicity	-.723	.277	-.331	-.2.615	.011
Perceived Stress	-.029	.064	-.058	-.462	.646
Asthma Control	-.036	.095	-.054	-.377	.708
Perceived Asthma Control	-.186	.067	-.394	-2.792	.007
Model 4					
Race/ Ethnicity	-.695	.274	-.318	-2.535	.014
Perceived Stress	.028	.072	.055	.381	.704
Asthma Control	-.047	.095	-.070	-.494	.623
Perceived Asthma Control	-.178	.066	-.375	-2.683	.009
Social Problem-Solving	.305	.191	.209	1.597	.115

Note. R^2 = .051 (p = .059) for Model 1; ΔR^2 = .008 (p = .449) for Model 2; ΔR^2 = .145 (p < .01) for Model 3; ΔR^2 = .030 (p = .115) for Model 4. The gray shading is used to indicate significant findings.

Table 6

Table 6. Adherence, Asthma Control, and Social Problem-Solving Predicting Perceived Stress

Model 1	**B**	**Std. Error**	**β**	**t**	***p***
Race/ Ethnicity	1.342	.495	.287	2.710	.008
Income	-.482	.403	-.126	-1.194	.235
Model 2					
Race/ Ethnicity	1.061	.501	.227	2.119	.037
Income	-.488	.395	-.128	-1.235	.220
Medication Adherence	-2.112	.936	-.220	-2.256	.026
Model 3					
Race/ Ethnicity	.973	.486	.208	2.004	.048
Income	-.299	.397	-.078	-.754	.453
Medication Adherence	-1.907	.895	-.198	-2.131	.036
Asthma Control	.203	.161	.148	1.259	.211
Perceived Asthma Control	-.367	.104	-.386	-3.544	.001
Model 4					
Race/ Ethnicity	.745	.426	.159	1.749	.084
Income	.542	.379	.142	1.429	.156
Medication Adherence	-1.066	.796	-.111	-1.339	.184
Asthma Control	.132	.141	.096	.935	.352
Perceived Asthma Control	-.354	.090	-.372	-3.912	.000
Social Problem-Solving	-1.531	.280	-.494	-5.463	.000

Note. $R^2 = .129$ ($p < .01$) for Model 1; $\Delta R^2 = .045$ ($p < .05$) for Model 2; $\Delta R^2 = .101$ ($p < .01$) for Model 3; $\Delta R^2 = .179$ ($p < .001$) for Model 4. The gray shading is used to indicate significant findings.

Table 7

Table 7. ANOVA Displaying Differences in Primary Variables as a Function of Race/ Ethnicity

Pharmacy Refill Adherence	**df**	**Mean Square**	**F**	***p***
Between Groups	2	31.030	1.933	.153
Within Groups	68	16.055		
Total	70			
Self-Report Adherence				
Between Groups	2	3.867	6.208	.003
Within Groups	101	.623		
Total	103			
Perceived Stress				
Between Groups	2	363.310	6.231	.003
Within groups	99	58.306		
Total	101			
Social Problem-Solving				
Between Groups	2	38.938	6.195	.003
Within Groups	100	6.285		
Total	102			
Asthma Control				
Between Groups	2	292.765	9.436	.000
Within Groups	101	31.027		
Total	103			
Perceived Control of Asthma				
Between Groups	2	278.458	4.062	.020
Within Groups	101	68.554		
Total	103			

Note. The gray shading is used to indicate significant findings.

Table 8

Table 8. Means and Standard Deviations of Outcomes as a Function of Race/ Ethnicity

		M* ± *SD	
Outcome Variable	**White (*n* = 51)**	**Black/ African American (*n* = 39)**	**Other (*n* = 14)**
Pharmacy Refill Adherence	5.71 ± 4.11	5.00 ± 4.24	3.00 ± 2.95
Self-Report Adherence	4.49 ± .737	4.08 ± .827	3.74 ± .865
Perceived Stress	20.20 ± 6.98	20.95 ± 8.20	28.21 ± 8.32
Social Problem-Solving	14.76 ± 2.20	13.52 ± 2.82	12.30 ± 2.63
Asthma Control	19.28 ± 5.89	15.44 ± 5.11	13.00 ± 5.60
Perceived Control of Asthma	41.43 ± 8.64	38.18 ± 8.05	34.86 ± 7.50

Note. "Other" includes individuals who identify as American Indian/Alaska Native, Asian, Native Hawaiian/Pacific Islander, Hispanic/Latino and Multiracial.

Appendix A: Measures

Demographic Questionnaire

1. How old are you? _____

2. What is your sex?
   - ☐ Male
   - ☐ Female

3. How would you best describe your race/ ethnicity?
   - ☐ White/ Caucasian
   - ☐ Black/ African American
   - ☐ American Indian/ Alaska Native
   - ☐ Asian
   - ☐ Native Hawaiian/ Pacific Islander
   - ☐ Hispanic/ Latino
   - ☐ Multiracial
   - ☐ Other

4. What is your current relationship status?
   - ☐ Married/ Living with a partner
   - ☐ Divorced/ Separated
   - ☐ Widowed
   - ☐ Single/ Never married

5. Do you have children?
   - ☐ Yes
     - If yes, how many children do you have? _____
   - ☐ No

6. What is the highest level of education that you have completed?
   - ☐ No Formal Education
   - ☐ Some Elementary Education
   - ☐ Some Middle School
   - ☐ Some High School
   - ☐ High School Diploma
   - ☐ Some College
   - ☐ College Degree
   - ☐ Graduate Degree

7. What is your estimated household income? (The <u>combined</u> income of <u>all adults living in your household,</u> including salaries and wages, retirement income, food stamps, and investment gains). Please remember that this information is confidential.
   - ☐ <$20,000
   - ☐ $20,000 - &40,000
   - ☐ $40,000 - $60,000
   - ☐ $60,000 - $80,000
   - ☐ $80,000 - $100,000
   - ☐ >$100,000

8. What is your current employment status?
   - ☐ Working full-time
   - ☐ Working part-time
   - ☐ Unemployed, seeking work
   - ☐ Disabled/ unable to work
   - ☐ Volunteer
   - ☐ Retired
   - ☐ Student

9. How would you best describe your sexual orientation?
   - ☐ Heterosexual
   - ☐ Homosexual (Gay/ lesbian)
   - ☐ Bisexual
   - ☐ Other, please specify: _____

10. What is your current religious identity?
   - ☐ Agnostic
   - ☐ Atheist
   - ☐ Buddhist
   - ☐ Catholic
   - ☐ Christian
   - ☐ Jewish
   - ☐ Hindu
   - ☐ Mormon
   - ☐ Muslim
   - ☐ Not affiliated, however, I am religious/ spiritual
   - ☐ No religious/ spiritual identity
   - ☐ Other, please specify: _____

11. How religious do you consider yourself to be?
   - ☐ Not at all religious
   - ☐ Somewhat religious
   - ☐ Very religious

12. What type of health insurance do you currently have?
   - ☐ Private plan (employment-based)
   - ☐ Private plan (direct-purchase)
   - ☐ Medicare
   - ☐ Medicaid
   - ☐ Military health care
   - ☐ Uninsured
   - ☐ Other

13. Smoking status:
    - ☐ Current smoker (daily)
    - ☐ Current smoker (occasional)
    - ☐ Past smoker
    - ☐ Never smoked or used tobacco products

14. How often do you drink alcohol (any amount)?
    - ☐ Never
    - ☐ 0-3 days/ month
    - ☐ 1 day/ week
    - ☐ 2 days/ week
    - ☐ 3 days/ week
    - ☐ 4 days/ week
    - ☐ 5 days/ week
    - ☐ 6 days/ week
    - ☐ 7 days/ week

15. On average, how many alcoholic drinks do you consume in a typical week?
    _____

16. How would you describe your level of physical activity?
    - ☐ Sedentary, inactive
    - ☐ Seldom active
    - ☐ Moderately active
    - ☐ Vigorously active

17. Are you currently taking any medication (prescription or over the counter)?
    - ☐ Yes
        - o If so, please list all current medications here:

          _____

          _____

          _____
    - ☐ No

18. How many prescription medications do you take on a daily basis? _____

19. Have you ever suffered from or been diagnosed with any mental health problems (e.g., anxiety, depression, alcohol or drug abuse)?
    - ☐ Yes
    - ☐ No

20. Have you ever been in treatment for psychological or emotional distress?
    - ☐ Yes
    - ☐ No

21. What type(s) of therapy have you tried in the past? (Check all that apply).
    - ☐ Individual therapy
    - ☐ Group therapy
    - ☐ Couple's therapy
    - ☐ Family therapy
    - ☐ Medication for psychological/ emotional distress

22. Are you currently in treatment for psychological or emotional distress?
    - ☐ Yes
    - ☐ No

23. What type(s) of therapy are you currently using? (Check all that apply).
    - ☐ Individual therapy
    - ☐ Group therapy
    - ☐ Couple's therapy
    - ☐ Family therapy
    - ☐ Medication for psychological/ emotional distress

24. Have you ever been diagnosed with any of the following medical conditions? (Check all that apply) (To be scored using the Charlson Age-Comorbidity Index (CACI) calculator).

    - ☐ AIDS
    - ☐ Metastatic solid tumor
    - ☐ Moderate or severe liver disease
    - ☐ Any non-metastatic solid tumor
    - ☐ Malignant lymphoma
    - ☐ Leukemia
    - ☐ Diabetes with end organ damage
    - ☐ Moderate or severe renal disease
    - ☐ Hemiplegia
    - ☐ Diabetes without end organ damage
    - ☐ Mild liver disease
    - ☐ Ulcer disease
    - ☐ Connective tissue disease
    - ☐ Chronic pulmonary disease
    - ☐ Dementia
    - ☐ Cerebrovascular disease
    - ☐ Peripheral vascular disease
    - ☐ Congestive heart failure
    - ☐ Myocardial infarction

25. Do your biological parent(s) have asthma?
    - ☐ Mother
    - ☐ Father
    - ☐ Both
    - ☐ Don't know
    - ☐ Neither

26. Have you ever been hospitalized for your asthma?
    - ☐ Yes
        - If yes, how many times? _____
    - ☐ No

27. Have you been hospitalized in the past year for your asthma?
    - ☐ Yes
        - If yes, how many times? _____
    - ☐ No

28. Have you ever visited the emergency room for your asthma?
    - ☐ Yes
        - If yes, how many times? _____
    - ☐ No

29. Have you visited the emergency room in the past year for your asthma?
    - ☐ Yes
        - If yes, how many times? _____
    - ☐ No

30. Have you ever been intubated for your asthma?
    - ☐ Yes
        - If yes, how many times? _____
    - ☐ No

31. Have you been intubated in the past year for your asthma?
    - ☐ Yes
        - If yes, how many times? _____
    - ☐ No

32. How often do you see your physician for your asthma?
    - ☐ At least once per month
    - ☐ Once every 3 months
    - ☐ Once every 6 months
    - ☐ Once per year
    - ☐ Less than once per year

Medical Record Questionnaire

1. What site is the participant a patient at?
   - ☐ Atlantic Research Center, LLC
   - ☐ Drexel Pulmonary Medicine
   - ☐ Cooper University Hospital, Camden
   - ☐ Cooper University Hospital, Voorhees

2. Who is the patient's primary physician at this location?

   a. _____

3. What is the patient's asthma diagnosis?
   - ☐ Mild persistent
   - ☐ Moderate persistent
   - ☐ Severe persistent

4. How many times has the patient refilled his/ her controller medication (ICS) prescription in the past 12 months? (Information obtained from pharmacy records).

   _____

Medication Adherence Report Scale—Asthma (MARS-A)

Questions about using your controller/ preventer inhaler:

- Many people find a way of using their inhaler that suits them.
- This may differ from the instructions on the label or from what their doctor has said.
- We would like to ask you a few questions about how you use your inhaler.

Here are some ways in which people have said that they use their controller inhaler.
For each of the statements, please pick the answer that best applies to you.

		Always	Often	Sometimes	Rarely	Never
1	I only use it when I need it.					
2	I only use it when I feel breathless.					
3	I decide to miss out a dose.					
4	I try to avoid using it.					
5	I forget to take it					
6	I alter the dose.					
7	I stop taking it for a while.					
8	I use it as a reserve, if my other treatment doesn't work.					
9	I use it before doing something which might make me breathless.					
10	I take less than instructed.					

Social Problem-Solving Inventory-Revised: Short Form (SPSI-R:S)

INSTRUCTIONS. Below are some ways that you might think, feel, and act when faced with problems in everyday living. We are not talking about the ordinary hassles and pressures that you handle successfully every day. In this questionnaire, a problem is something important in your life that bothers you a lot, but you don't immediately know how to make it better or stop it from bothering you so much. The problem could be something about yourself (your thoughts, feelings, behavior, health, or appearance), your relationships with other people (your family, friends, teachers, or boss), or your environment and the things you own (your house, car, or money).

Please read each statement carefully and choose one of the numbers below that best shows how much the statement is true of you. See yourself as you usually think, feel, and act when you are faced with important problems in your life these days. Circle the number that is the most true of you. For example, using the following rating scale (which is at the top of each page), if you believe that the statement "Whenever I have a problem, I believe that it can be solved" is "Very True of Me," then you would circle the number "3."

Not at All True of Me	Slightly True of Me	Moderately True of Me	Very True of Me	Extremely True of Me
0	**1**	**2**	**3**	**4**

1. I feel threatened and afraid when I have an important problem to solve.

   0 1 2 3 4

2. When making decisions, I do not evaluate all of my options carefully enough.

   0 1 2 3 4

3. I feel nervous and unsure of myself when I have an important decision to make.

   0 1 2 3 4

4. When my first efforts to solve a problem fail, I know if I persist and do not give up too easily, I will be able to eventually find a good solution.

   0 1 2 3 4

5. When I have a problem, I try to see it as a challenge, or opportunity to benefit in some positive way from having the problem.

   0 1 2 3 4

Not at All True of Me	Slightly True of Me	Moderately True of Me	Very True of Me	Extremely True of Me
0	**1**	**2**	**3**	**4**

6. I wait to see if a problem will resolve itself first, before trying to solve it myself.

0 **1** **2** **3** **4**

7. When my first efforts to solve a problem fail, I get very frustrated.

0 **1** **2** **3** **4**

8. When I am faced with a difficult problem, I doubt that I will be able to solve it on my own no matter how hard I try.

0 **1** **2** **3** **4**

9. Whenever I have a problem, I believe that it can be solved.

0 **1** **2** **3** **4**

10. I go out of my way to avoid having to deal with problems in my life.

0 **1** **2** **3** **4**

11. Difficult problems make me very upset.

0 **1** **2** **3** **4**

12. When I have a decision to make, I try to predict the positive and negative consequences of each option.

0 **1** **2** **3** **4**

13. When problems occur in my life, I like to deal with them as soon as possible.

0 **1** **2** **3** **4**

14. When I am trying to solve a problem, I go with the first good idea that comes to mind.

0 **1** **2** **3** **4**

Not at All True of Me	Slightly True of Me	Moderately True of Me	Very True of Me	Extremely True of Me
0	**1**	**2**	**3**	**4**

15. When I am faced with a difficult problem, I believe that I will be able to solve it on my own if I try hard enough.

0 **1** **2** **3** **4**

16. When I have a problem to solve, one of the first things I do is get as many facts about the problem as possible.

0 **1** **2** **3** **4**

17. When a problem occurs in my life, I put off trying to solve it for as long as possible.

0 **1** **2** **3** **4**

18. I spend more time avoiding my problems than solving them.

0 **1** **2** **3** **4**

19. Before I try to solve a problem, I set a specific goal so that I know exactly what I want to accomplish.

0 **1** **2** **3** **4**

20. When I have a decision to make, I do not take the time to consider the pros and cons of each option.

0 **1** **2** **3** **4**

21. After carrying out a solution to a problem, I try to evaluate as carefully as possible how much the situation has changed for the better.

0 **1** **2** **3** **4**

22. I put off solving problems until it is too late to do anything about them.

0 **1** **2** **3** **4**

Not at All True of Me	Slightly True of Me	Moderately True of Me	Very True of Me	Extremely True of Me
0	**1**	**2**	**3**	**4**

23. When I am trying to solve a problem, I think of as many options as possible until I cannot come up with any more ideas.

0 **1** **2** **3** **4**

24. When making decisions, I go with my "gut feeling" without thinking too much about the consequences of each option.

0 **1** **2** **3** **4**

25. I am too impulsive when it comes to making decisions.

0 **1** **2** **3** **4**

Please be sure that you completed all 25 questions.
Thank you!

Reference: D'Zurilla, T. J., Nezu, A. M., & Maydeu-Olivares A. Social Problem-Solving Inventory – Revised (SPSI-R): Technical Manual. North Tonawanda, NY: Multi-Health Systems; 2002.

Asthma Control Test (ACT)

The Asthma Control Test ™ provides a numerical score to help you and your healthcare provider determine if your asthma symptoms are well controlled.

1. In the past 4 weeks, how much of the time did your asthma keep you from getting as much done at work, school or at home?

All of the time	Most of the time	Some of the time	A little of the time	None of the time
1	**2**	**3**	**4**	**5**

2. During the past 4 weeks, how often have you had shortness of breath?

More than Once a day	Once a day	3 to 6 times a week	Once or twice a week	Not at all
1	**2**	**3**	**4**	**5**

3. During the past 4 weeks, how often did your asthma symptoms (wheezing, coughing, shortness of breath, chest tightness or pain) wake you up at night or earlier than usual in the morning?

4 or more nights a week	2 to 3 nights a week	Once a week	Once or twice	Not at all
1	**2**	**3**	**4**	**5**

4. During the past 4 weeks, how often have you used your rescue inhaler or nebulizer medication (such as albuterol)?

3 or more times per day	1 or 2 times per day	2 or 3 times per week	Once a week or less	Not at all
1	**2**	**3**	**4**	**5**

5. How would you rate your asthma control during the past 4 weeks?

Not Controlled at All	Poorly Controlled	Somewhat Controlled	Well Controlled	Completely Controlled
1	**2**	**3**	**4**	**5**

Perceived Control of Asthma Questionnaire (PCAQ)

Strongly Agree	Agree	Don't know/ neutral	Disagree	Strongly Disagree
5	**4**	**3**	**2**	**1**

1. I can reduce my asthma by staying calm and relaxed.

   5 4 3 2 1

2. Too often, my asthma just seems to hit me out of the blue.

   5 4 3 2 1

3. If I do all the right things, I can successfully manage my asthma.

   5 4 3 2 1

4. I can do a lot of things myself to cope with my asthma.

   5 4 3 2 1

5. When I manage my personal life well, my asthma does not affect me as much.

   5 4 3 2 1

6. I have considerable ability to control my asthma.

   5 4 3 2 1

7. I would feel helpless if I couldn't rely on other people for help when I'm not feeling well from asthma.

   5 4 3 2 1

8. No matter what I do, or how hard I try, I just can't seem to get relief from my asthma.

   5 4 3 2 1

9. I am coping effectively with my asthma.

   5 4 3 2 1

Strongly Agree	Agree	Don't know/ neutral	Disagree	Strongly Disagree
5	**4**	**3**	**2**	**1**

10. It seems as though fate and other factors beyond my control affect my asthma.

5 **4** **3** **2** **1**

11. Asthma is controlling my life.

5 **4** **3** **2** **1**

Reference: Katz, P. P., Yelin, E. H., Eisner, M. D., & Blanc, P. D. (2002). Perceived control of asthma and quality of life among adults with asthma. *Annals of Allergy, Asthma & Immunology*, *89*(3), 251-258.

Perceived Stress Scale (PSS)

Instructions: The questions in this scale ask you about your feelings and thoughts during the last month. In each case, you will be asked to indicate how often you felt or thought a certain way. Although some of the questions are similar, there are differences between them and you should treat each one as a separate question. The best approach is to answer each question fairly quickly. That is, don't try to count up the number of times you felt a particular way, but rather indicate the alternative that seems like a reasonable estimate. For each question choose from the following alternatives:

Never	Almost Never	Sometimes	Fairly Often	Very Often
0	**1**	**2**	**3**	**4**

1. In the last month, how often have you been upset because of something that happened unexpectedly?

   0 1 2 3 4

2. In the last month, how often have you felt that you were unable to control the important things in your life?

   0 1 2 3 4

3. In the last month, how often have you felt nervous and "stressed"?

   0 1 2 3 4

4. In the last month, how often have you dealt successfully with irritating life hassles?

   0 1 2 3 4

5. In the last month, how often have you felt that you were effectively coping with important changes that were occurring in your life?

   0 1 2 3 4

6. In the last month, how often have you felt confident about your ability to handle your personal problems?

   0 1 2 3 4

Never	Almost Never	Sometimes	Fairly Often	Very Often
0	**1**	**2**	**3**	**4**

7. In the last month, how often have you felt that things were going your way?

0 **1** **2** **3** **4**

8. In the last month, how often have you found that you could not cope with all the things that you had to do?

0 **1** **2** **3** **4**

9. In the last month, how often have you been able to control irritations in your life?

0 **1** **2** **3** **4**

10. In the last month, how often have you felt that you were on top of things?

0 **1** **2** **3** **4**

11. In the last month, how often have you been angered because of things that happened that were outside of your control?

0 **1** **2** **3** **4**

12. In the last month, how often have you found yourself thinking about things that you have to accomplish?

0 **1** **2** **3** **4**

13. In the last month, how often have you been able to control the way you spend your time?

0 **1** **2** **3** **4**

14. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

0 **1** **2** **3** **4**

Reference: Cohen, S., Kamarack, T., & Mermelstein, R. (1983). A global measure of perceived stress. Journal of Health and Social Behavior, 24(4), 385-396.

Appendix B: Recruitment Flyer

Do you have a diagnosis of Asthma?

If so, you may qualify to participate in a research study.

Drexel University is recruiting volunteers to participate in a research study about ***social problem-solving****,* ***stress*****,** ***asthma control****, and* ***medication adherence****.*

Research Goals:

The purpose of this research study is to better understand how the ways in which people solve real-life problems and the experience of perceived stress can impact medication adherence behaviors. This information may be helpful in the development of programs to improve medication adherence in asthma patients.

Participation involves completing a one-time survey that asks questions about how you typically solve problems in your life, how controlled your asthma is, your current levels of perceived stress, and medication-taking tendencies.

Eligibility:

You may be able to participate in this research study if you…

- ✓ Have a diagnosis of mild, moderate or severe persistent asthma
- ✓ Are 18 years of age or older
- ✓ Are able to read and understand English on at least a 4th grade level
- ✓ Are prescribed a daily controller inhaler (ICS)

Interested in participating?

Let your physician know if you would like to be contacted by the research team

Contact *Sara* at:

(215) 553-7123

asthma.problemsolving@gmail.com

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