HEALTH-RELATED DISPARITIES IN PEDIATRIC ASTHMA: MORBIDITY, ATTITUDES TOWARD ILLNESS, AND SYMPTOM PERCEPTION

by

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ABSTRACT

STEVEN JAMES HARDY. Health-related disparities in pediatric asthma: Morbidity, attitudes toward asthma, and symptom perception.
(Under the direction of DR. ANDREW HARVER)

Asthma disproportionately affects racial/ethnic minorities and children from low socioeconomic backgrounds; however, an explanation for these disparities is unclear. Furthermore, little is known about psychological outcomes that might vary by race/ethnicity and socioeconomic status (SES) in parallel with differences in physical health outcomes. Symptom perception accuracy—in this case, the degree of correspondence between estimated and actual peak flow—is one promising area of research that has only recently been applied to pediatric asthma in an attempt to explain disparities in asthma outcomes. Adding to the relevance of mental health outcomes in pediatric asthma, research suggests that certain psychological variables have a significant influence on symptom perception accuracy. Therefore, the current study sought to explore possible racial and socioeconomic differences in psychological outcomes, examine the role of symptom perception accuracy in pediatric asthma disparities, and investigate the impact of attitudes toward asthma on symptom perception accuracy. As part of participation in a large-scale pediatric asthma education program (Project On TRAC: Taking Responsibility for Asthma Control), 158 non-Hispanic Black (NHB) and White (NHW) children with persistent asthma between the ages of 8 and 15 years and their caregivers reported on demographic characteristics, signs and symptoms of asthma, asthma morbidity, health-related quality of life (HRQL), and attitudes toward asthma. These children also completed assessments of symptom perception accuracy by making

daily estimates of peak flow, which were then compared to actual peak flow measured by hand-held electronic spirometers at home. Results indicated that race influences symptom perception independent of SES. NHW youths were more accurate in estimating peak flow than NHB youths but the types of errors made (i.e., overestimating or underestimating peak flow) were generally similar between races. More accurate estimates of peak flow predicted higher HRQL. Attitudes toward asthma varied by SES but not by race, with higher SES predicting more positive attitudes. However, only a non-significant trend was identified for more favorable attitudes to predict more accurate peak flow estimates. As findings suggest that NHB youths are less likely to make accurate estimates of peak flow and symptom perception is associated with HRQL, researchers and clinicians should consider interventions to improve symptom perception as one strategy for reducing the disproportionate burden of asthma morbidity on NHB youths. Findings of the present investigation also highlight the importance of assessing psychological responses to pediatric asthma and providing treatment when indicated, particularly among children from low socioeconomic backgrounds. Additional research is needed to identify variables that mediate the relationship between symptom perception accuracy and asthma outcomes, develop interventions to improve symptom perception accuracy, and further explore the role of psychological variables in pediatric asthma self-management.

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CDC	centers for disease control and prevention
CATIS	children's attitudes toward illness scale
CFI	comparative fit index
CI	confidence interval
ED	emergency department
FEV_1	forced expiratory volume in 1 second
HRQL	health-related quality of life
IRB	institutional review board
MiniAQLQ	mini asthma quality of life questionnaire
NHLBI	national heart, lung, and blood institute
NHB	non-Hispanic Black
NHW	non-Hispanic White
PASS	pediatric asthma severity scale
PEFR	peak expiratory flow rate
PTSD	post-traumatic stress disorder
RMSEA	root mean square error of approximation
SES	socioeconomic status

CHAPTER 1: INTRODUCTION

Asthma is the most common chronic illness among children and adolescents in the United States (Akinbami, Moorman, Garbe, & Sondik, 2009). A variety of theories have been proposed to explain why asthma develops in certain people; however, the exact cause is unknown. Explanations include a genetic risk for developing allergies, early environmental exposure to allergens and irritants, viral respiratory tract infections during childhood, and altered development of the immune system (Bach, 2002; Gilmour, Jaakkola, London, Nel, & Rogers, 2006; Ho, 2010; Proud & Chow, 2006; Weiss, 2002). It is likely that some interaction between genetic and environmental factors contribute to the onset of asthma (Drake, & Galanter, & Burchard, 2008). Hyperreactivity of the airways underlies a cascade of physiological processes including bronchoconstriction, swelling of the airways, and increased mucus production that are activated by ‘triggers’ such as allergies, irritants, and exercise (McQuaid & Abramson, 2009). These physiological changes, which are often exacerbated by chronic inflammation, interact to intermittently impair lung function. Patients may easily detect some signs of asthma (e.g., wheezing, coughing) but they may also feel unconcerned or minimize more subjective symptoms (e.g., chest tightness or difficulty breathing). Asthma symptoms often interfere with sleep and daily activities and, when severe, can result in death (Centers for Disease Control and Prevention [CDC], 2007).

Long-acting controller medications can prevent asthma symptoms with consistent use; however, another important component of asthma management is avoiding known *triggers* of symptoms (National Heart, Lung, and Blood Institute [NHLBI], 2007). Triggers are unique to each individual and may fluctuate (e.g., over the course of the disease, by time of day, or by season) but common triggers include respiratory infections, allergens (e.g., pollen, mold, animal dander), airborne irritants (e.g., cigarette smoke, nitrogen dioxide) and certain emotional states or behaviors (e.g., excitement, stress, laughing, exercise; American Lung Association [ALA], 2010). Given the staggering economic costs associated with pediatric asthma, it is important to consider the factors that promote asthma self-management behaviors (e.g., taking medications as prescribed and avoiding triggers) that lead to well-controlled asthma.

For many children with asthma, acute episodes result in significant consequences including visits to the emergency department (ED), hospitalizations, and activity limitations. In the United States, childhood asthma accounts for approximately 12.8 million missed school days, often resulting in missed work by caregivers (CDC, 2007). Asthma is estimated to cost $19.7 billion annually, including $14.7 billion in direct health care costs and an additional $5 billion in lost productivity (ALA, 2009). Moreover, children with asthma report elevated rates of anxiety, depression, and stress (Janicke, Harman, Kelleher, & Zhang, 2008; Kean, Kelsay, Wamboldt, & Wamboldt, 2006; Otten, Van den Ven, Engels, & Van den Eijnden, 2009). The set of findings regarding the mental health correlates of asthma is of particular concern because children with asthma who exhibit high levels of anxiety and depression report greater healthcare utilization and account for greater healthcare costs (Goodwin, Messineo, Bregante, Hoven, & Kairam, 2005; Richardson, Russo, Lozano, McCauley, & Katon, 2008). Overall, pediatric asthma is associated with significant physical, psychosocial, and economic costs, and some groups—especially minorities—share a disproportionate burden of the disease.

Asthma prevalence rates have steadily increased from 3.6% in 1980 to 7.5% in 1995; however, this trend seems to have slowed (Akinbami et al., 2009). In 2007, a total of 9.1% of children in the U.S. (6.7 million) had an asthma diagnosis (Akinbami et al., 2009). Age and gender are prominent predictors of asthma prevalence and healthcare utilization. Older children and adolescents are more likely to be diagnosed with asthma; however, younger children utilize the healthcare system for asthma-related problems at considerably greater rates (Akinbami et al., 2009). Data also suggest that boys are more likely to have asthma and experience worse asthma-related outcomes, with higher rates of healthcare utilization and mortality (Akinbami et al., 2009). In addition to the variations in prevalence and morbidity that occur by age and gender, research suggests clear differences in asthma-related outcomes that vary by race/ethnicity and socioeconomic status (SES).

Non-Hispanic Black (NHB) children are disproportionately affected by asthma compared to non-Hispanic White (NHW) children. Research has demonstrated that NHB youths experience higher rates of asthma diagnosis (Akinbami, Rhodes, & Lara, 2005; Guevara, Mandell, Rostain, Zhao, & Hadley, 2006), more severe symptoms (Bai, Hillemeier, & Lengerich, 2007; Higgens, Wakefield, & Cloutier, 2005), and greater asthma morbidity (Evans et al., 2009; Gupta, Carrión-Carire, & Weiss, 2006; Wallace, Denk, & Kruse, 2004). Moreover, socioeconomic disadvantage differentially contributes to poor asthma outcomes among NHB children (Smith, Hatcher-Ross, Wertheimer, &

Kahn, 2005). Given these findings and evidence that increased asthma severity and repeated hospitalization increase risk for poor psychological outcomes (Vanderbilt et al., 2006), it is surprising that no studies have closely examined the disproportionate psychosocial toll asthma may have on NHB youths compared to NHW youths. In light of robust data depicting a major health concern and calls to increase research on health disparities (Asthma Disparities Working Group, 2012; Strunk, Ford, & Taggart, 2002; U.S. Department of Health and Human Services, 2000), many questions remain regarding the psychosocial functioning of NHB children with asthma and factors that explain the unequal burden endured by NHB youths. The present study explored possible relationships among race- and SES-based disparities in asthma outcomes by testing the associations between three related factors: (1) asthma morbidity; (2) psychological responses to asthma; and (3) the ability to accurately detect increases in airflow obstruction (i.e., symptom perception).

1.1 Disparities in Asthma Morbidity

Considerable racial/ethnic disparities in asthma outcomes exist: NHB children are 4.1 times more likely to visit the ED for asthma symptoms, 3 times more likely to be hospitalized, and 7.6 times more likely to die as a result of having asthma compared to NHW children (Akinbami et al., 2009). Research also indicates that while asthma control among certain races/ethnicities is improving, other groups are maintaining high levels of morbidity (Cohen et al., 2006; Ginde, Espinola, & Camargo, 2008; Gupta et al., 2006). For instance, from 1993 to 2005, White individuals exhibited a 25% decrease in asthma-related ED visits while rates of asthma-related ED visits for Black individuals remained unchanged (Ginde et al.). Rates of hospitalizations show similar trends over the past 20 years. White children have become less likely to be hospitalized for acute asthma episodes (from 11.5 to 8.1 per 10,000 population) but Black children have become more likely to be hospitalized (from 34.3 to 36.5 per 10,000 population; Gupta et al.). Despite these stark discrepancies in health outcomes between races/ethnicities, mounting evidence demonstrates that the root cause of these disparities may be linked to social determinants rather than to biological or genetic variation (LaVeist et al., 2007).

Socioeconomic status, defined by Oakes and Rossi (2003, p. 775) as a proxy for "differential access (realized and potential) to desired resources," is a clear determinant of health and a major contributor to asthma disparities in youths (Victorino & Gauthier, 2009). Multiple indicators of SES (e.g., parental education, occupational prestige, and income) are inversely related to pediatric asthma morbidity. Children from low socioeconomic backgrounds experience more frequent symptoms and poorer asthma-related outcomes (Chen, Matthews, & Boyce, 2002; Cope, Ungar, & Glazier, 2008; Dales, Choi, Chen, & Tang, 2002; Watson, Cowen, & Lewis, 1996). While an explanation for the inverse relationship between SES and asthma morbidity remains unclear, numerous factors are likely involved including the reduced odds of having health insurance, possessing limited knowledge of proper asthma management tasks, and exposure to unfavorable living conditions (e.g., high automobile traffic, mold, and violence).

Traditional indicators of SES such as parental education and income likely impact asthma status through the quality and location of housing as well as the degree of access to asthma care and medications. Neighborhood-level variables have received significant attention in recent research attempting to explain the relationship between SES and asthma morbidity. Several studies have documented that youths from low-income families who live in inner-city areas are often exposed to high levels of air pollution and experience more severe asthma symptoms (Gent, Koutrakis et al., 2009; Salam, Islam, & Gilliland, 2008; Wilhelm et al., 2008). Wilhelm and colleagues (2008) investigated the effects of traffic density and air pollution on children with asthma living in two large cities in southern California. Their findings revealed that, even after adjusting for race/ethnicity and poverty level, children who resided in areas with high traffic densities and air pollution had significantly greater odds of going to the ED or being hospitalized for asthma problems. Additionally, SES affects housing quality and exposure to indoor allergens (Kitch et al., 2000; Leaderer et al., 2002).

Research demonstrates that high concentrations of dust mite allergens in main living areas and children's bedrooms are associated with greater asthma severity (Gent, Belanger et al., 2009). Others have reported that children who are exposed to high levels of cockroach allergens in the home have more asthma symptoms, miss more school days, and report more unscheduled medical visits for asthma (Gruchalla et al., 2005). A study of children living in inner-city Baltimore found that those exposed to the highest concentrations of mouse allergen had significantly greater odds of having an unscheduled physician visit, ED visit, and hospital admission for asthma (Matsui et al., 2006). Moreover, some of the greatest levels of asthma morbidity have been observed among children living in poor housing conditions exposed to high household concentrations of cockroaches, mice, and mold (Warman, Silver, & Wood, 2009). Beyond air quality and allergen exposure, research suggests that living in an unsafe neighborhood, conceivably influenced by one's economic capacity to afford housing in a safe area, can influence asthma-related outcomes in a variety of ways.

Wright (2006) posits a physiological pathway between community violence and asthma outcomes such that repeated exposure to violence leads to dysregulation of the stress response (causing abnormal parasympathetic activity) and alterations in the immune system (predisposing one to respiratory tract infections), both of which may contribute to increased risk for asthma exacerbations. Wright also suggests behavioral pathways through which community violence may be associated with asthma outcomes. For example, living in a violent neighborhood may limit children's outdoor activities, thereby increasing exposure to potentially hazardous indoor allergens and contributing to a sedentary lifestyle and obesity, another risk factor for severe asthma (Beuther, Weiss, & Sutherland, 2006; Lessard, Turcotte, Cormier, & Boulet, 2008). Furthermore, living in an unsafe environment may lead to risky coping behaviors that exacerbate asthma symptoms (e.g., caregiver and/or youth cigarette use) or make it more challenging for families to access routine asthma care or travel to a pharmacy to fill prescriptions. Empirical research has clearly demonstrated a link between asthma and residing in a neighborhood subjected to high levels of violence. One study of primarily African American children and caregivers living in an urban area found that exposure to community violence was associated with more frequent nighttime asthma symptoms but fewer primary care visits (Walker, Lewis-Land, Kub, Tsoukleris, & Butz, 2008). Wright and associates (2004) reported that, compared to caregivers exposed to low levels of violence, caregivers who had been exposed to high levels of violence report greater perceived stress, smoked at higher rates, kept their children indoors more often, and were more likely to miss administrations of their children’s asthma medications. Notably, in this sample of children living in large urban cities, degree of exposure to violence was positively associated with asthma symptoms.

There are also indications of complex interrelationships among race/ethnicity, SES, and asthma outcomes. For example, some authors have demonstrated that racial/ethnic differences in asthma diagnosis are most pronounced among the very poor (Smith et al., 2005). Others have found that differences in health-related quality of life (HRQL) between Black and White children with asthma are largely attributable to socioeconomic factors (Evans et al., 2009). The influence of SES on asthma above and beyond the influence of race/ethnicity mirrors recent findings regarding health status among the general population.

LaVeist and colleagues (2007) studied the health of residents living in a low-income, racially/ethnically-integrated community in southwest Baltimore, Maryland. Contrary to national socioeconomic patterns in the U.S., the study’s sample was comprised of an equal number of African American and White residents and demonstrated no racial/ethnic differences in income or education level. While many small- and large-scale investigations suggest that African Americans are at greater risk for a variety of unfavorable health outcomes (Agency for Healthcare Research and Quality, 2008; Wiewel, Hanna, Begier, & Torian, 2011), LaVeist and colleagues (2007) found that many of these discrepancies did not exist in this socially integrated community. African American participants were less likely than White participants to report fair or poor health and furthermore, racial/ethnic disparities were reduced or absent for rates of obesity (Bleich, Thorpe, Sharif-Harris, Fesahazion, & LaVeist, 2010), diabetes (LaVeist, Thorpe, Galarraga, Bower, & Gary-Webb, 2009), and risk for hypertension (Thorpe, Brandon, & LaVeist, 2008). These findings highlight the importance of considering social context (e.g., neighborhood culture and resources) when studying the underlying mechanisms that contribute to racial/ethnic inequalities in health.

Theories aiming to explain disparities in asthma-related outcomes have centered on biological, individual, social, and environmental hypotheses (Forno & Celedon, 2009); however, research suggests that rather than identifying a single cause, the problem is best understood through complex, multilevel approaches that consider the interrelatedness of several domains (Canino, McQuaid, & Rand, 2009). Therefore, the current study adopted a biopsychosocial framework for investigating disparities in asthma-related outcomes in children by exploring interactions among demographic variables including race and SES, individual differences in symptom perception, and psychological responses in pediatric asthma.

1.2 Psychological Responses in Pediatric Asthma

Children diagnosed with a chronic illness are at risk for emotional and behavioral problems (Barlow & Ellard, 2006; Hysing, Elgen, Gillberg, & Lundervold, 2009). While asthma is the most common chronic illness of childhood (Akinbami et al., 2009) and causes significant disruptions in daily living (Sotir, Yeatts, Miller, & Shy, 2006), few investigators have examined the mental health of children with asthma. There are, however, indications that youths with asthma often experience emotional problems in conjunction with their illness (Alati et al., 2005; Collins et al., 2008; Meuret, Ehrenreich, Pincus, & Ritz, 2006). A meta-analysis confirmed that children with asthma report elevated levels of both internalizing and externalizing behavior problems, with particularly high levels of anxiety and depression (McQuaid et al., 2001). It is estimated that adolescents with asthma are almost twice as likely as adolescents without asthma to meet criteria for an anxiety or depressive disorder (Katon et al., 2007). Research also demonstrates a vulnerability to the development of posttraumatic stress symptoms among some adolescents with asthma, with those who have experienced a life-threatening asthma event being more likely to meet criteria for PTSD (Kean et al., 2006). Specifically, adolescents who had experienced a life-threatening asthma event and their caregivers were significantly more likely to meet criteria for PTSD (20% and 29%, respectively) compared to adolescents with asthma who had never experienced a life-threatening asthma event and to a non-diagnosed control group (Kean et al., 2006). Additionally, indicators of poor asthma control such as frequent asthma symptoms and high levels of morbidity are associated with psychosocial problems, including anxiety, depression, conduct and other behavioral disorders, and peer relationship problems.

Calam and colleagues (2005) argue that an asthma diagnosis does not predispose a child to emotional or behavioral troubles but rather, the severity of the illness and associated functional morbidity are more salient predictors of adjustment. They discovered elevated levels of adjustment problems (e.g., anxiety disorders, conduct disorder, discord with peers) among youths with asthma compared to non-diagnosed comparisons; however, no differences existed between children with well-controlled asthma and controls. Others have presented conflicting evidence of the relationship between asthma severity and adjustment problems (Wamboldt, Fritz, Mansell, McQuaid, & Klein, 1998), but the majority of research is in line with the findings of Calam et al. (Katon et al., 2007; Klinnert, McQuaid, McCormick, Adinoff, & Bryant, 2000;

McCauley, Katon, Russo, Richardson, & Lozano, 2007). Despite an apparent association, the common use of cross-sectional designs has limited researchers' ability to draw conclusions regarding the direction of the relationship between asthma symptoms and psychological adjustment. For example, having a preexisting psychiatric disorder may lead to problems with treatment adherence, resulting in more severe symptoms and increased morbidity. Alternatively, severe asthma symptoms and functional impairment may trigger adverse emotional and/or behavioral responses. Additional research is needed to more fully understand the reciprocal relationship between asthma morbidity and psychosocial adjustment, particularly in groups already at risk for poor physical and mental health.

1.2.1 Disparities in Psychological Adjustment

Modest racial/ethnic differences exist in the prevalence of certain emotional and behavioral problems among children in the general population (Keiley, Bates, Dodge, & Pettit, 2000; Rushton, Forcier, & Schectman, 2002). For example, NHB children exhibit more internalizing problems than NHW children (Gross et al., 2006). More importantly, wide racial/ethnic and socioeconomic gaps are apparent in the rate at which NHB youths receive needed mental health services compared to NHW youths (Garland et al., 2005; Kataoka, Zhang, & Wells, 2002; Thompson & May, 2006). Garland and colleagues reported that among those at risk for psychiatric problems, NHB youths are half as likely as NHW youths to receive any form of mental health service regardless of age, gender, insurance coverage, or SES.

Much of the existing research on the mental health of children with asthma has involved racially/ethnically homogenous samples or restricted recruitment of NHB patients to those from geographically "urban" or "inner-city" environments. Goodwin and colleagues (2005) reported that 25% of pediatric patients with asthma recruited at an inner-city clinic (all from minority races/ethnicities) met criteria for a probable diagnosis of an anxiety disorder or depression. Data also suggest that possessing multiple characteristics independently associated with psychiatric issues (e.g., asthma and low SES) leads to greater depressive symptoms, anxiety, and overall psychological distress (Gillaspy, Hoff, Mullins, Van Pelt, & Chaney, 2002). Significant questions remain regarding the psychological adjustment of children with asthma and whether race/ethnicity, SES, and asthma morbidity interact to contribute to adjustment. Moreover, most published studies have used general tools rather than illness-specific assessments to measure the psychological effects of asthma on children, possibly obscuring effects related specifically to problems experienced by those with asthma.

1.2.2 Attitudes Toward Asthma

One promising method for assessing how children and adolescents adjust psychologically to a specific illness is to examine attitudes. Attitudes, which have long been a focus of study in social psychology, are relatively stable and subjective judgments of certain targets, often interpreted based on their valence (i.e., positive or negative attitudes; Fabrigar & Wegener, 2010). Targets can include a range of objects or concepts, including illnesses. Measuring attitudes toward an illness offers an advantage over measuring general psychiatric symptoms, which fluctuate over time and may represent problems unrelated to intermittent illness. Attitudes toward an illness reflect trait-like impressions that are inherently tied to the effects of a specific illness on self-concept and adjustment in relation to peers (Austin & Huberty, 1993).

Research suggests that attitudes toward illness are highly correlated with other indicators of adjustment in pediatric patients with chronic disease. For instance, in an investigation of adolescents with epilepsy, participants who had more severe epilepsy (e.g., frequent and debilitating seizures) reported less favorable attitudes toward their illness, and negative attitudes were associated with lower self-esteem (Heimlich, Westbrook, Austin, Cramer, & Devinsky, 2000). Related investigations show that in children with epilepsy, negative attitudes were correlated with increased depressive symptoms and behavioral problems and with lower ratings of happiness and satisfaction (Austin & Huberty, 1993; Austin, Smith, Risinger, & McNelis, 1994). Similarly, more negative attitudes toward illness are related to higher levels of anxiety and depression among youths with chronic arthritis (LeBovidge, Lavigne, & Miller, 2005).

Research on attitudes toward asthma have revealed significant associations between symptoms and attitudes, with adolescents with poorly controlled asthma reporting more negative attitudes toward their illness than adolescents with well-controlled asthma (Rhee, Belyea, & Elward, 2008). Less favorable attitudes toward asthma are correlated with adverse psychological outcomes including higher levels of anxiety and depressive symptoms and lower HRQL (Austin & Huberty, 1993; Austin et al., 1994; Briery & Rabian, 1999; Rhee et al., 2008). Less is known, however, about how attitudes might influence asthma management behaviors and other asthma-related outcomes. Recent evidence, though, suggests an important role of attitudes in the self-management of asthma, with more negative attitudes leading to a greater number of perceived barriers to self-management (Rhee, Belyea, Ciurzynski, & Brasch, 2009). Youths' attitudes toward asthma warrant greater attention; considering psychological responses to an illness offers not only a more holistic way of appraising overall health but also highlights factors amenable to intervention that can positively influence asthma self-management. For example, several studies have revealed cognitive and emotional variables that affect an important component of asthma self-management: symptom monitoring and appraisal.

1.3 Symptom Perception

Consistent monitoring of lung function and accurate detection of changes in airway obstruction (perceptual accuracy) are critical aspects of asthma management (Kotses, Harver, & Humphries, 2006). Fritz and colleagues (1996, p. 158) defined perceptual accuracy as, "the degree to which subjective assessment of asthma symptomatology/severity corresponds with an objectively measured rating of severity." This ability is important to consider because accurate appraisal of lung function can guide self-management decisions. Patients may be less likely to take action to prevent asthma exacerbations if they are unaware of poor or worsening lung function. On the other hand, patients who are sensitive to changes in lung function may engage in self-management activities in response to increasing airway obstruction.

1.3.1 Measurement of Symptom Perception in Asthma

A variety of methods have been proposed to estimate symptom perception accuracy in asthma. Lane (2006) reported that most researchers evaluate perceptual accuracy among patients with asthma by: (a) comparing a subjective report of perceived symptoms to an objective measure of pulmonary function, (b) comparing a patient's estimated pulmonary function to an objective measure of pulmonary function, or (c) observing a patient's ability to detect experimentally manipulated changes in airflow.

Each method of measuring perceptual accuracy has demonstrated utility, and inaccurate perceptions have been linked to clinically meaningful outcomes such as more frequent symptoms, greater functional impairment, life-threatening asthma episodes, and mortality (Davenport & Kifle, 2001; Fritz et al., 2007; Fritz, McQuaid, Spirito, & Klein, 1996; Kikuchi, Okabe, & Tamura, 1994; McQuaid et al., 2007).

The present investigation focused on the comparison between subjective and objective measures of pulmonary function. This approach offers advantages over alternative methods because it possesses the greatest clinical relevance (e.g., measurements are often taken in the field, allowing one to account for factors in the participant's natural environment that may confound perception; Fritz et al., 2007) and uses comparisons between subjective and objective measures of a single process (i.e., lung function) rather than two related but distinct constructs (e.g., perceived breathlessness and peak flow).

To quantify perceptual accuracy, investigators often calculate correlations between two quantities, subjective and objective measures of pulmonary function, usually peak expiratory flow rate (PEFR; Lane, 2006). However, there are inherent weaknesses to a correlational approach. In the present context, correlation coefficients portray the tendency of individuals to report estimates of pulmonary function that consistently align with objective measures. Such an analytic approach, however, fails to adequately illustrate the possible variance in perceptual errors (Fritz, Yeung et al., 1996). With respect to inaccurate estimations of symptoms, it is impossible to discern from a correlation coefficient whether a patient might systematically underestimate or overestimate objective pulmonary function. For example, an individual whose true pulmonary function was 60% personal best would theoretically produce an identical correlation coefficient for consistent subjective estimates of either 40% or 80% of personal best. In other words, correlation coefficients would be the same for individuals who consistently underestimated lung function by 20 points and those who consistently overestimated lung function by 20 points. This point is salient, as research has documented variability in the types of perceptual errors that people tend to make and in the clinical consequences that result from these errors (Fritz et al., 2010; McQuaid et al., 2007).

Although studies have documented the tendency of children and adolescents with asthma to overestimate levels of airway obstruction, some patients also fail to recognize dangerous levels of airway obstruction (Fritz et al., 2010); both are instances of perceptual error but each carries distinct consequences. For instance, children who reliably underestimate lung function may falsely sense dangerous levels of airway obstruction and, as a result, utilize asthma medications or healthcare services unnecessarily (Klein et al., 2004). Conversely, those who perceive sufficient lung function when it is actually compromised may demonstrate poor adherence to preventive medications or delay administration of quick-relief inhalers (Klein et al., 2004).

To account for the unique clinical implications of different types of perceptual errors in asthma, Fritz, Yeung and colleagues (1996) adapted the error grid analysis technique (Cox et al., 1985), originally designed to measure perceptual accuracy in patients with diabetes. In its first application in diabetes research, error grid analysis provided investigators with a clinically meaningful tool for comparing actual blood glucose levels with patients' subjective estimates of blood glucose. Objective and subjective value pairs recorded over a series of trials could be plotted on a grid with relevant metrics and categorized as clinically accurate estimates of blood glucose, clinically benign errors, overestimation of a normal blood glucose, underestimation of normal blood glucose, failure to detect hypoglycemia, failure to detect hyperglyciemia, estimating as hyperglycemic when hypoglycemic, or estimating as hypoglycemic when hyperglycemic (Clarke, Cox, Gonder-Frederick, Carter, & Pohl, 1987; Cox et al., 1989). In its first application to measuring symptom perception in asthma, estimated and actual PEFR values were transformed into percent of personal best units and plotted on an error grid. The grid displayed a single cutoff delineating between adequate PEFR (i.e., 80–100% of personal best) and clinically compromised PEFR (i.e., < 80% of personal best) based on the definition held at the time by the National Institutes of Health (Fritz, Yeung, et al., 1996). This attempt at adapting the error grid for use with patients with asthma also maintained the original cumbersome categorization procedure with plots falling into one of five *zones* (e.g., accurate, benign overestimation, benign underestimation, dangerous, or erroneous), thus limiting the error grid's clinical utility.

In 2004, Klein and colleagues proposed the "asthma risk grid" as a simplified error grid for measuring perceptual accuracy (Figure 1). The asthma risk grid uses cutoffs that correspond to the NHLBI's (1997) updated guidelines for dangerous, clinically compromised, and adequate lung function (i.e., < 50% of personal best, 50–80% of personal best, and 80–100% of personal best, respectively). Once plotted, pairs of subjective-objective values fall into one of three zones: Accurate, Dangerous (i.e., dangerously low lung function is perceived to be adequate), or Symptom Magnification (i.e., adequate lung function is perceived to be dangerously low). In a typical scenario, patients are instructed to make a personal estimate of pulmonary function and, subsequently, the actual peak flow is obtained using a peak flow meter or spirometer. This procedure is repeated several times (e.g., every day for 2 – 4 weeks) and each pair of subjective and objective values is plotted on an asthma risk grid. Ultimately, the proportion of estimates made in each zone of the grid can be calculated, with the sum of the percentages always totaling 100%. While intraindividual variations are expected, symptom perception tendencies can be readily labeled as the zone in which most estimates fall. Similarly, this approach can also be used to determine a patient's overall "accuracy" (i.e., percent of estimates in the Accurate zone only).

1.3.2 Perceptual Accuracy in Pediatric Asthma

Despite individual variability in perceptual accuracy, research suggests that many youths with asthma have difficulty accurately estimating lung function (Baker et al., 2000; Fritz et al., 2007). Depending on the objective measure of lung function used for comparison, an average of only 3% (using forced expiratory volume in 1 second [FEV_1]) to 13% (using PEFR) of children with asthma consistently make accurate estimates of pulmonary function (Feldman et al., 2007). Inaccurate perceptions of pulmonary function, either underestimating or overestimating airflow obstruction, can lead to increased functional impairment (McQuaid et al., 2007).

Fritz and colleagues (2007) asked children with asthma to monitor pulmonary function using portable electronic spirometers at home. The accuracy of subjective PEFR estimates was significantly associated with asthma morbidity. Specifically, greater proportions of accurate PEFR guesses were predictive of lower morbidity while more inaccurate PEFR guesses (both underestimations and overestimations) were predictive of higher morbidity. Feldman et al. (2007) supported and extended these findings, reporting that the baseline accuracy of symptom perception was related to asthma morbidity, both concurrently and prospectively at a one-year follow-up. However, data regarding racial/ethnic and socioeconomic differences in perceptual accuracy are limited and mixed.

Some researchers have reported that perceptual accuracy does not differ by race/ethnicity or SES (Fritz et al., 2007); others have reported that racial/ethnic minority youths and those with low SES estimate pulmonary function less accurately (Fritz et al., 2010; Koinis-Mitchell et al., 2009; Kopel et al., 2010; Yoos, Kitzman, McMullen, & Sidora, 2003). Still others have elected not to examine race/ethnicity and SES at all or to use these variables as covariates without reporting data regarding possible differences in accuracy (Chen, Hermann, Rodgers, Oliver-Welker, & Strunk, 2006; Feldman et al., 2007; McQuaid et al., 2007).

A recent study reported significant differences in the accuracy of estimates of lung function between NHW and Latino children with asthma (Fritz et al., 2010). For 5 weeks, participants used digital, hand-held spirometers to record estimates of peak flow and subsequently perform spirometry. Researchers examined trends in the accuracy of these guesses, calculating the proportion of entries that accurately or inaccurately estimated lung function. Inaccurate guesses were further distinguished as overestimations of peak flow (i.e., participants perceived lung function to be better than actual lung function) or symptom magnifications (i.e., participants perceived lung function to be worse than actual lung function).

In this study, Latino children with asthma made significantly fewer accurate estimates of peak flow (*M* = 62%) than NHW children with asthma (*M* = 71%; Fritz et al., 2010). Moreover, Latino participants more often magnified their symptoms (*M* = 26%) compared to NHW participants (*M* = 19%). Several variables that correlated with perceptual accuracy may partially explain these racial/ethnic differences in symptom perception. For instance, female gender was associated with lower accuracy and more symptom magnification, and the Latino group was comprised of significantly more females than the NHW group. In addition, family income was positively associated with accurate estimates of peak flow and negatively associated with symptom magnification. Adding to the salience of family income, 54% of Latino families were living below the poverty threshold compared to only 10% of NHW families. While these data highlight family income as a correlate of perceptual accuracy, no potential explanations for this finding were offered. Other variables related to poorer perceptual accuracy included: younger age, lower intelligence, and having a mean FEV_1 less than or equal to 80% of personal best during the symptom monitoring period. The findings that low income and poor lung function are associated with inaccurate symptom perception may underscore the relevance of asthma status to perceptual accuracy. Others have shown that greater asthma severity is related to less accurate perceptions of asthma symptoms following methacholine challenge in children (Chen et al., 2006). The investigation by Fritz and colleagues offered a unique look at differences in symptom perception between Latino and NHW children with asthma; however, similarly purposeful investigations of perceptual accuracy have not yet been conducted with a large sample of NHB children.

Others have demonstrated similar findings regarding racial/ethnic disparities in symptom perception. Koinis-Mitchell et al. (2009) reported that "ethnic minority" children with asthma were less accurate at guessing peak flow, but descriptive data regarding perceptual accuracy were not provided for specific racial/ethnic minority groups (*n* = 270; 20% NHB, 8% Biracial, 6% Hispanic, 1% American Indian). In this sample, SES—operationalized as parents' occupational prestige—was also positively associated with the accuracy of children's estimates of lung function but distributions by race/ethnicity and a test to evaluate differences in mean SES values were not reported.

Kopel and colleagues (2010) described similar findings with regard to SES and racial/ethnic minority status. They found that SES was significantly correlated with perceptual accuracy such that participants with low SES made fewer accurate estimates of lung function. There was also a significant relationship between SES and symptom magnification; the lower the SES, the more often children estimated their lung function to be worse than it actually was. Only an average of 62% of the estimates of peak flow made by children from racial/ethnic minorities were accurate compared to an average 77% of estimates made by White children. However, the practice of combining participants from racial/ethnic minorities into a single group for analysis is problematic. While certain experiences of racial/ethnic minority groups may be similar (e.g., discrimination and marginalization), most groups have distinct cultures that allow for unique experiences and, as such, analyzing them as a single group likely obscures significant between-group differences. In line with previous research (Fritz et al., 2010), Kopel and associates (2010) also identified other demographic variables that were significantly associated with perceptual accuracy. Particularly strong relationships were noted between perceptual accuracy and age (i.e., older participants made more accurate guesses of peak flow) and between perceptual accuracy and the number of true peak flow values at less than 80% of personal best and perceptual accuracy (i.e., participants with poorer lung function, on average, made less accurate guesses of peak flow; Kopel et al., 2010)

Studies with diverse samples and adequate statistical power to examine race/ethnicity- and SES-based differences in symptom perception are needed because they may yield insights regarding disparities in asthma management and differential rates of morbidity and mortality. Adding to the relevance of examining perceptual accuracy in NHB and low SES youths with asthma, the tendency to consistently underestimate or overestimate lung function is associated with greater asthma severity (Chen et al., 2006; Yoos et al. 2003). Some have hypothesized that this relationship results from a habituation to symptoms by patients who frequently experience poor lung function (Rietveld & Brosschot, 1999), making it more difficult to detect changes. NHB and low SES youths with asthma—who are more likely to exhibit compromised lung function and who are at increased risk for more severe asthma—may represent subgroups of the population at risk for habituation and the potentially harmful consequences of poor symptom perception. At the same time, groups who are more likely to experience severe consequences of asthma (e.g., frequent and/or life-threatening asthma episodes; many hospitalizations or visits to the ED) may be more likely to develop cognitive associations between changes in lung function and negative outcomes. Negative attitudes or fearful expectations may increase patients' sensitivity to small declines in lung function that would otherwise be appraised as benign, potentially leading to overuse of quick-relief medication, increased activity limitations, and avoidable healthcare utilization.

1.3.3 Influence of Psychological Factors on Perceptual Accuracy

Beyond the deleterious effects on quality of life and, potentially, asthma management behavior, certain psychological states and traits have been posited to influence symptom perception. For example, a robust positive relationship exists between negative affect and somatic complaints (Mora, Halm, Leventhal, & Ceric, 2007; Watson & Pennebaker, 1989). Others have extended this research by hypothesizing that psychological states can affect one's ability to detect interoceptive stimuli such as lung function. Theories proposed to explain this phenomenon have centered on how psychiatric symptoms may distract one's attention from internal sensations, produce predominantly negative interpretations of asthma symptoms, or lead to misinterpretations of psychiatric symptoms (e.g., anxiety) as worsening asthma (Koinis-Mitchell et al., 2009). These notions have garnered empirical support in multiple contexts; a recent systematic review found that anxiety, in particular, is positively associated with awareness of endogenous sensations such as heartbeat (Domschke, Stevens, Pfleiderer, & Gerlach, 2010). However, one investigation with children with asthma found that anxiety was unrelated to perceptual accuracy (Koinis-Mitchell et al.). Depressive symptoms appear to disrupt accurate interoception but the data regarding the nature of this relationship are mixed (Dunn, Dalgleish, Ogilvie, & Lawrence, 2007; Pollatos, Traut-Mattausch, & Schandry, 2009). De Peuter and colleagues (2007) demonstrated the influence of negative affectivity on symptom reporting in a sample of adults with asthma. Researchers gradually induced airflow obstruction via histamine provocation and asked subjects to report on the severity of their symptoms. This procedure was repeated the following day but saline was substituted for histamine—unbeknownst to the participants—to produce a benign physiological reaction. Patients high in negative affectivity reported more severe asthma symptoms in the absence of any true change in objective pulmonary measures.

These findings illustrate an apparent, though not well-understood, psychological aspect of symptom perception that merits additional research, particularly among children and adolescents. Discrepancies in the literature regarding the influence of affective factors on perceptual accuracy may be due to the variability in psychological constructs that have been measured in this context (e.g., anxiety, depression, and negative affect). It is notable that no research has explored how illness-specific attitudes might contribute to perceptual accuracy among children with asthma. Psychological measures that assess individuals' attitudes toward a specific illness may provide a salient approach to testing the influence of cognitive factors on the perception of symptoms related to the illness.

1.4 Summary of Relevant Literature and Gaps in Knowledge

While research has sufficiently documented disparities in physical health outcomes among youths with asthma, there are limited data examining disparities in mental health. Existing literature suggests that youths who have asthma are at risk for increased psychosocial distress. Additionally, data indicate that individuals with severe asthma who endure greater morbidity are more likely to experience adjustment problems. Based on these findings, NHB youths from low socioeconomic backgrounds—who are known to experience more frequent and severe asthma symptoms and greater morbidity—would appear to be particularly vulnerable to psychosocial distress related to their illness. However, little empirical evidence is available from which to draw such conclusions regarding potential differences in psychological responses to asthma.

Another body of research has identified cognitive and perceptual factors that impact asthma outcomes. Specifically, there is clear evidence that accuracy in perceiving asthma symptoms (e.g., airflow obstruction) is related to reduced asthma morbidity. Moreover, multiple investigators have reported that perceptual accuracy varies by SES and race/ethnicity, with minorities—particularly Latinos—and those with low SES exhibiting less accurate perceptions. Researchers have also found that the severity of asthma symptoms alters symptom perception, suggesting that racial/ethnic and SES differences in accuracy may be partially attributable to disease characteristics. While previous investigations have focused on symptom perception among Latino youths or pooled different racial/ethnic minority groups into a single group, no studies have specifically examined perceptual accuracy among NHB youths with asthma. Furthermore, research highlights an emotional component to symptom perception; negative affect, anxiety, and depression appear to disrupt the accurate detection of endogenous sensations. However, data regarding the influence of these general psychiatric symptoms are mixed and measures of illness-specific psychological adjustment, which have yet to be studied in this context, may have a more robust impact on perceptual accuracy.

1.5 Research Questions and Hypotheses

This project aimed to address gaps in the existing literature and improve upon the methodological rigor of previous research. Disparities in pediatric asthma morbidity were examined in terms of race- and SES-based differences in youths' attitudes toward asthma, and in terms of differences in symptom perception. To evaluate these relationships, a conceptual framework was proposed (see Figure 2) based on relevant findings and the Symptom Management Model (Dodd et al., 2001), which explains symptom status (e.g., functional status, morbidity, emotional status, quality of life) as the result of dynamic and complex interrelationships between one's symptom experiences and symptom management strategies. The Symptom Management Model highlights the subjective nature of symptom experiences and posits that the perception and evaluation of symptoms dictate responses that can worsen, maintain, or resolve symptoms. Symptom experiences, symptom management strategies, and outcomes are also theorized to function within (and be influenced by) a variety of domains, including the person (e.g., demographics, developmental level), health and illness (e.g., risk factors, existing disease or disability), and environment (e.g., physical location, interpersonal relationships, cultural beliefs). This model is aligned with the aims of the present investigation in that the accurate evaluation of physiological changes is viewed as an essential component to symptom management, and individual and social variables are believed to influence the way in which symptoms are perceived and evaluated.

In line with previous research, gaps in the literature, and relationships outlined in the Symptom Management Model, the current study addressed the following four general research questions: (1) Are there differences in attitudes toward asthma that vary by race (NHB and NHW participants) and SES? (2) Are there differences in symptom perception accuracy that vary by race (NHB and NHW participants) and SES? (3) To what degree do attitudes toward asthma relate to symptom perception accuracy? (4) Does the proposed conceptual model adequately predict asthma disparities (i.e., asthma morbidity and attitudes toward asthma)?

To address these questions, data were obtained from a sample of patients with moderate-to-severe persistent asthma originally recruited to participate in a large pediatric asthma educational intervention (Project On TRAC [Taking Responsibility for Asthma Control]). The demographic characteristics of the sample (e.g., primarily recruited from asthma and allergy specialist clinics and almost equal numbers of NHB and NHW youths with a long history of asthma) provided for a uniquely homogenous sample to test the relationships between race and asthma-related outcomes. Data were collected across three time points by patient- and caregiver-report and ecological assessment of perceptual accuracy. The following hypotheses were proposed to test associations relevant to the research questions:

Research Question 1: The first research question concerned a psychological outcome of having asthma—attitudes toward asthma. Specifically, the question sought to determine whether NHB and NHW participants differed in their attitudes and whether there was a relationship between SES and attitudes.

Hypothesis 1a: NHB youths would report less favorable attitudes toward asthma (Time 1) than NHW youths.

Hypothesis 1b: SES would be positively associated with favorable attitudes toward asthma (Time 1), such that higher SES would be correlated with more positive attitudes.

Research Question 2: The second research question focused on variables thought to influence the accuracy of symptom perception. The question sought to determine whether perceptual accuracy differed by race and whether a relationship existed between SES and perceptual accuracy.

Hypothesis 2a: NHB youths with asthma would demonstrate less accurate estimates of their peak flow than NHW youths.

Hypothesis 2b: SES would be positively associated with perceptual accuracy, such that higher SES would be correlated with higher proportions of estimates of lung function being classified as accurate.

Research Question 3: The third research question pertained to the possible influence of a psychological factor (i.e., attitudes toward asthma) on the accuracy with which youths with asthma estimate their peak flow.

Hypothesis 3: Favorable attitudes toward asthma (Time 1) would be positively associated with perceptual accuracy, such that more positive attitudes would be correlated with higher proportions of estimates of lung function being classified as accurate.

Research Question 4: The final research question concerned the fit of the proposed conceptual model, which aimed to partially explain racial disparities in asthma-related outcomes. The conceptual model, path model (see Figure 3), and the following hypotheses were developed based on a review of previous research and theory. Furthermore, these hypotheses build upon those previously described for research questions 1, 2, and 3.

Hypothesis 4a: The relationship between race and symptom perception accuracy would be partially mediated by signs and symptoms of asthma (path a + g in Figure 3).

Hypothesis 4b: The relationship between SES and symptom perception accuracy would be partially mediated by signs and symptoms of asthma (path d + g in Figure 3).

Hypothesis 4c: The relationship between race and symptom perception accuracy would be partially mediated by attitudes toward asthma (Time 1; path c + h in Figure 3).

Hypothesis 4d: The relationship between SES and symptom perception accuracy would be partially mediated by attitudes toward asthma (Time 1; path f + h in Figure 3).

Hypothesis 4e: The relationship between race and attitudes toward asthma (Time 2) would be partially mediated by signs and symptoms of asthma and measures of asthma morbidity (i.e., “asthma morbidity” and “health-related quality of life”; paths a + j, a + k + o, and a + i + n in Figure 3).

Hypothesis 4f: The relationship between SES and attitudes toward asthma (Time 2) would be partially mediated by signs and symptoms of asthma and measures of asthma morbidity (i.e., “asthma morbidity” and “health-related quality of life”; paths d + j, d + k + o, and d + i + n in Figure 3).

Hypothesis 4g: The relationship between race and measures of asthma morbidity (i.e., “asthma morbidity” and “health-related quality of life”) would be partially mediated by symptom perception accuracy (paths b + m and b + l in Figure 3).

Hypothesis 4h: The relationship between SES and measures of asthma morbidity (i.e., “asthma morbidity” and “health-related quality of life”) would be partially mediated by symptom perception accuracy (paths e + m and e + l in Figure 3).

CHAPTER 2: METHOD

Data collected for a study originally designed to improve asthma self-management (i.e., Project On TRAC: Taking Responsibility for Asthma Control[1]) were used to examine the current study's hypotheses. Project On TRAC was intended to explore: (1) the differential effects of three self-monitoring interventions on the correspondence between objective (i.e., actual airflow obstruction) and subjective (i.e., perceived levels of airflow resistance) measures of asthma; (2) the effects of resistive load discrimination training on participants' ability to discriminate between different levels of airflow resistance; and (3) whether improvements in the perception of airflow obstruction are associated with improved asthma control.

2.1 Design and Procedure

Approval of Project On TRAC's procedures was secured from the University of North Carolina at Charlotte's Institutional Review Board (IRB) prior to data collection. Separate IRB approval (Protocol #11-02-45) was obtained for the secondary data analyses conducted in the present investigation. Medical staff at each referral clinic used the eligibility criteria (described below) to identify and screen potential participants for Project On TRAC; research staff subsequently contacted interested families by telephone to verify eligibility and schedule an intake appointment. At this initial visit, caregivers

[1]Project On TRAC was supported by Grant Number R01HL068706 from the National Heart, Lung, And Blood Institute. This project is solely the responsibility of the author and does not necessarily represent the official views of the National Heart, Lung, And Blood Institute or the National Institutes of Health.

provided informed consent and youths provided informed assent, and both caregivers and youths completed study questionnaires.

Children who enrolled in the study participated in three weekly family-based asthma education classes involving, on average, between four and five families. The first class provided basic information regarding the nature of asthma (e.g., definition of asthma, consequences of asthma, and common misconceptions of asthma) and introduced a relaxation technique (progressive muscle relaxation). During the second session, families learned about personal asthma triggers, relaxation techniques, identification of early and late asthma symptoms, and the proper use and side effects of controller and quick-relief medications. At the conclusion of the second class, participants were randomly assigned to one of three symptom monitoring conditions: (1) asthma symptom diary only; (2) asthma diary and peak flow monitoring with feedback of PEFR results; or (3) asthma diary and peak flow monitoring with no feedback of PEFR results. For the purposes of the present investigation, data were only used from those participants who were assigned at random to one of the two conditions involving peak flow monitoring. The third asthma education session involved discussions of appropriate self-management of asthma including the use of peak flow meters and asthma diaries, how to use early asthma symptoms to guide behavior, and how to promote positive interactions with health care providers.

At the conclusion of the final education class, participants and their caregivers were provided with detailed instructions regarding the 30-day symptom monitoring procedure. Participants randomized to a peak flow condition were trained by researchers to use a portable electronic spirometer (Jaeger, model AM2+) to monitor lung function twice each day (once in the morning and once in the evening). In each peak flow condition, participants were instructed to record an estimate of peak flow with the device and to perform three forced expiratory maneuvers. Research staff made biweekly phone calls to participants to encourage completion of the self-monitoring procedures and answer questions. After the 30-day monitoring period, individual appointments were scheduled with participants to return their asthma diaries and spirometers and complete additional questionnaires. Additional activities were completed following this self-monitoring phase as part of Project On TRAC; however, data from other aspects of the study were not utilized in the present study and, therefore, are not described here. Participants were awarded stipends at the conclusion of each visit with research staff. Families received $25 at each of the three asthma education sessions and $50 at the meeting following the 30-day home monitoring period.

2.2 Participants

Participants and their caregivers were recruited primarily from asthma and allergy clinics in the Charlotte, NC region. Patients were considered eligible for the study if they were between the ages of 8 and 15 years old, diagnosed with asthma according to American Thoracic Society standards for a minimum of two years, and had made at least one routine clinic visit for asthma in the past year. Additionally, eligible participants were considered to have at least moderate persistent asthma according to expert national guidelines (i.e., daily asthma symptoms, exacerbations at least two times per week that interfere with activities, and/or frequent use of a short-acting beta agonist). Patients were excluded from participation if they had another significant medical diagnosis (e.g., diabetes, epilepsy, attention deficit disorder, or mental retardation) or a physical disability that would interfere with the ability to complete the discrimination training intervention.

2.3 Measures

Demographic information and asthma history. Participants reported their age in years, gender, age diagnosed with asthma, and duration of asthma. Youths reported their ethnicity as Hispanic or non-Hispanic and subsequently, indicated their race as American Indian/Alaskan Native, Asian, Native Hawaiian/Pacific Islander, African American, Caucasian, or multi-racial. Additionally, participants were asked to report the number of siblings living at home, whether or not their mother and father lived at home, and if anyone else in the family had asthma.

Socioeconomic status. The Barratt Simplified Measure of Social Status (BSMSS; Barratt, 2006), an adaptation of the Hollingshead index (Hollingshead, 1975), was used to assess youth's SES at the time of enrollment in Project On TRAC. While no gold standard for measuring SES exists, this approach to evaluating SES has garnered widespread use and is based on weighed assessments of educational levels and occupation. Caregivers reported the highest level of school completed by each parent: less than 7th grade, junior high (9th grade), partial high school (10th or 11th grade), high school graduate, partial college (at least one year), college education, or graduate degree. To quantify educational achievement, each level of school is associated with a score ranging from 3 to 21 that increases by 3-point increments. Caregivers also indicated their occupation by identifying with a single cluster of related occupations that ranged in prestige from unemployed to occupations such as a physician, professor, or senior manager. Each occupational cluster is associated with a score ranging from 5 to 45 that increases by 5-point increments. For children living with both parents, the total education and total occupation scores were obtained by calculating the sum of mothers' and fathers' scores. Scores were summed rather than averaged to provide a more accurate appraisal of household resources. For instance, by summing scores of multiple caregivers within a home, a family with two caregivers who have both completed college and obtained employment as mid-level managers is presumed to have greater resources than a family with a single caregiver who has reached similar educational and occupational achievements. A total (i.e., household) SES score (potentially ranging from 8 to 132) was obtained by summing the education and occupation values.

Signs and symptoms of asthma. Caregivers completed the 8-item Pediatric Asthma Symptom Scale (PASS) at study enrollment to assess frequency and severity of asthma symptoms (Lara et al., 2000). Specifically, caregivers were asked to rate how often their child experienced symptoms over the last 4 weeks including cough, wheezing, shortness of breath, asthma attacks, and chest pain. Caregivers rated the frequency of these symptoms using a scale ranging from 1 (*never*) to 5 (*every day*). In addition, items assessed the number of asthma attacks occurring over the past 4 weeks, how often the child had been awakened at night due to asthma symptoms (ranging from 1 [*never*] to 5 [*every night*]), and perceived overall severity (1 = *very mild*, 2 = *mild*, 3 = *moderate*, 4 = *severe*, 5 = *very severe*). The reported number of asthma attacks occurring in the past 4 weeks was subsequently transformed to a 5-point scale where 1 = 0 attacks, 2 = 1 attack, 3 = 2-4 attacks, 4 = 5-12 attacks, and 5 = 13 or more attacks. Responses were summed to create a total score that ranges from 5 to 40, with higher scores indicating greater asthma severity. The total score was not calculated if responses to any items were missing. The instrument has demonstrated good validity and internal consistency, with alphas ranging from 0.81 to 0.87 (Lara et al., 2000). Cronbach's alpha in our sample was 0.88.

Symptom perception. Participants received a hand-held electronic spirometer (Jaeger, model AM2+) with which they were instructed to complete peak flow readings twice daily for 30 days. This particular spirometer has been used successfully with other field-based studies of symptom perception in pediatric asthma (McQuaid et al., 2007). Prior to making a peak flow recording, participants recorded an estimate of their current peak flow. The AM2+ software prevented participants from taking a peak flow reading until an estimate of peak flow had been recorded and would alert participants if an inadequate maneuver had been performed. Depending upon the experimental condition to which a participant was randomized, some spirometers revealed youths' actual peak flow values while other spirometers kept this value hidden. Because the AM2+ captures the date and time of forced expirations, it is possible to examine adherence to the peak flow monitoring protocol.

Testing hypotheses involving perceptual accuracy required that participants' subjective estimates of peak flow be plotted against corresponding actual peak flow values using error grid analysis (see Figure 1; Fritz et al., 1996; Fritz et al., 2007; Klein et al., 2004). For example, for every individual participant, his or her estimate of peak flow made one morning would be compared to the actual peak flow recorded the same morning. To standardize peak flow estimates and actual values across participants, peak flow scores were converted to percent personal best units. The best of each assessment's three expiratory maneuvers was recorded and the highest PEFR across time was used as the participant's "personal best". To avoid the possibility that artificial values might result in a misleading personal best score (e.g., due to coughing into the meter) PEFR values that were 1.96 standard deviations above the mean of each assessment's best of three were ignored. In such cases, the second highest PEFR from the set of three was used as the personal best. If the second highest PEFR from the set of three was also greater than 1.96 standard deviations above the mean of all best scores, the lowest PEFR from the set of three was used as the set's personal best score. In the rare event that all three blows from a single assessment time were above 1.96 standard deviations from the mean personal best score for all days, the lowest of the set of three PEFR values was used. Similarly, using the best of three scores is intended to correct for unusually low PEFR values that are the result of improper technique or effort.

Accuracy of perception of lung function was operationalized as the proportion of estimates for each participant that fell within the accurate zones (boxes 1, 5, and 9) and the ± 10% wedge. Analyses examined the proportion of estimates that fell within the symptom magnification (i.e., underestimating lung function; boxes 2, 3, and 6) and danger zones (i.e., overestimating lung function; boxes 4, 7, and 8) to discern whether variables that predict less accurate perceptions are differentially associated with certain types of misperceptions.

Attitudes toward asthma. The Child Attitude toward Illness Scale (CATIS) was administered to participants to gauge attitudes toward asthma (Austin & Huberty, 1993). The 13-item measure asks youths to answer questions such as, "How happy or sad is it for you to have asthma?" and "How often do you feel different from others because of your asthma?" Possible responses follow a 5-point format but the wording varies depending on the question (e.g., 1 = *very sad* [*very often*], 2 = *a little sad* [*often*], 3 = *not* *sure* [*sometimes*], 4 = *a little happy* [*not often*], 5 = *very happy* [*never*]). Responses to the CATIS are summed and then divided by the total number of items answered to provide a mean score that ranges from 1 to 5, with higher scores indicating more favorable attitudes toward asthma. The measure was originally validated with a sample of children diagnosed with either epilepsy or asthma and has been used previously as an indicator of psychosocial functioning among children with asthma (Rhee et al., 2008). Favorable attitudes as measured by the CATIS are strongly correlated with high self-efficacy and self-esteem (Heimlich et al., 2000) and low anxiety, depression, and behavior problems (Austin & Huberty, 1993; Austin et al., 1994; LeBovidge et al., 2005). The CATIS demonstrated good internal consistency in the present sample, with an alpha of 0.85. This scale was administered at multiple time points throughout Project On TRAC and two administrations were utilized for the current study to enable inspection of longitudinal relationships. Specifically, CATIS Time 1 was administered after the asthma education classes and CATIS Time 2 was administered after home-based peak flow monitoring.

Asthma morbidity. As asthma morbidity is a multidimensional construct that may describe healthcare utilization, functional impairment, or reduced quality of life, multiple methods were adopted. After completing the 30-day self-monitoring phase of the intervention, caregivers reported the number of times their child had been hospitalized or taken to the ED, made regular visits to their physician for asthma, made urgent/unscheduled physician visits, and missed school because of asthma in the last 4 weeks. As these reports were positively skewed with most participants indicating they had not had any of these experiences in the past month, responses were dichotomized (i.e., 0 = no events; 1 = any events) and summed. Scores on this Asthma Morbidity

Composite ranged from 0 to 4, with higher scores indicating greater asthma morbidity over the past 4 weeks. Cronbach's alpha for the Asthma Morbidity Composite in the current sample was 0.67.

The Mini Asthma Quality of Life Questionnaire (MiniAQLQ; Juniper, Guyatt, Cox, Ferrie, & King, 1999) was administered at the conclusion of the 30-day home-based peak flow monitoring period. The MiniAQLQ is a shortened 15-item version of the original 32-item Asthma Quality of Life Questionnaire (Juniper et al., 1992). This asthma-specific instrument assesses multiple domains of health-related quality of life including impact of symptoms (5 items), environmental stimuli (3 items), emotional function (3 items), and activity limitations (4 items). Participants indicated, for example, how much of the time during the last 2 weeks they had difficulty getting a good night's sleep because of asthma (symptom domain), felt bothered by or had to avoid going outside because of weather or air pollution (environment domain), felt frustrated as a result of asthma (emotion domain), or had been limited in participating in strenuous activities because of asthma (activity domain). Youths indicated how often they felt a certain way using a scale ranging from 1 (*all of the time* or *totally limited*) to 7 (*none of the time* or *not at all limited*). Means are calculated to produce the overall and domain scores, with higher scores indicating greater HRQL. Scores on the MiniAQLQ are correlated with scores on other well-established measures of HRQL such as the Medical Outcomes Survey Short Form 36 (SF-36; Juniper et al., 1999; Stewart, Hays, & Ware, 1988). Cronbach's alpha for the MiniAQLQ in our sample was 0.91. Alphas for the Symptoms (0.85), Environment (0.72), Emotions (0.67), and Activities domains (0.85) were acceptable.

CHAPTER 3: RESULTS

3.1 Preliminary Analyses

A total of 294 participants enrolled in Project On TRAC; most participants were recruited from asthma and allergy clinics (*n* = 223; 76%), followed by non-clinic sources (e.g., health fairs, word-of-mouth, or advertising; *n* = 53; 18%), and primary care and community health clinics (*n* = 18; 6%). The majority of participants were male (*n* = 199; 68%) and the mean age of participants was 10.12 years (*SD* = 1.68). Most participants described their ethnicity as non-Hispanic (*n* = 278; 97%). Those who described themselves as Hispanic (*n* = 8) often failed to report a race (*n* = 4) but two participants identified themselves as multi-racial; one reported being White, and one reported being Black. Youths identified their race as White (*n* = 134, 46%), Black (*n* = 129; 44%), multi-racial (*n* = 8; 3%), Asian (*n* = 4; 1%), or American Indian/Alaskan Native (*n* = 3; 1%). The modal education level achieved by mothers was partial college (*n* = 110; 38%) while fathers most often reported having earned a college degree (*n* = 70; 31%). Most mothers reported their occupation as unemployed (*n* = 86; 30%) and most fathers reported an occupation equivalent to a mid-level manager (*n* = 65; 30%). Participants did not differ by experimental condition (e.g., diary only, peak flow monitoring without feedback of results, peak flow monitoring with feedback of results) on any relevant demographic variable, suggesting that participants were randomized equivalently to groups (see Table 1).

To test the current set of hypotheses, only data from NHB and NHW participants who completed the 30-day home-based peak flow monitoring task (with at least 10 pairs of estimated and actual PEFR values) were analyzed (n = 158; NHB n = 71; NHW n = 87). Missing values were adjusted with the sample mean for the respective variable; 2.4% of all data points for all variables across participants were replaced in this manner.

Demographic characteristics of the final study sample are presented in Table 2. Equivalent numbers of children were randomly assigned either to the peak flow monitoring condition including feedback of results (n = 77) or to the peak flow monitoring condition without feedback of results (n = 81). NHB and NHW participants were distributed equally between experimental conditions, $\chi^2(1, 158) = 0.69$, $p = .41$, but NHB participants were less adherent to the self-monitoring task—making fewer peak flow assessments, $t(156) = -3.25$, $p < .05$. There were no differences in the gender distribution between NHB and NHW participants, $\chi^2(1, 158) = 0.00$, $p = .97$. However, NHB participants were significantly older than NHW participants and NHB participants had been diagnosed with asthma at an earlier age, $t(156) = 2.59$, $p < .05$ and $t(156) = -2.22$, $p < .05$, respectively. In addition, NHB participants reported lower SES compared to NHW participants, $t(156) = -3.32$, $p < .05$. NHB participants also came from smaller families, $t(156) = -2.71$, $p < .05$, though they reported similar numbers of children living at home, $t(156) = 0.38$, $p = .35$. Instead, differences in family size seemed to be related to the increased likelihood of NHB participants to have either a mother, $\chi^2(1, 154) = 5.06$, $p < .05$, or father, $\chi^2(1, 144) = 15.35$, $p < .05$, not living at home.

3.2 Analytic Approach

Descriptive statistics were calculated to examine variable characteristics and normality (see Table 3). Means and ranges for variables of interest were within reasonable limits, and the standard deviations indicated sufficient variability to warrant additional analysis. However, asthma morbidity indicators (ED visits, hospitalizations, urgent care physician visits, and missed school days) were positively skewed; therefore, these variables were dichotomized and summed to create a single indicator of morbidity, ranging from 0 to 4.

To explore the statistical fit of the conceptual model and the role of mediating variables in explaining disparities in asthma outcomes, three separate path analyses were conducted using bootstrapping (Preacher & Hayes, 2004). Bootstrapping offers potential advantages over the Sobel method of testing indirect effects, which requires very large samples and assumes all variables are normally and symmetrically distributed. In contrast, bootstrapping is a nonparametric technique that uses one sample as a population from which to simulate drawing numerous random samples (2000 in the present study), allowing estimation of standard errors and confidence intervals to assist in interpreting the significance of indirect effects (Preacher & Hayes, 2004). Each path model utilized a different measure of symptom perception accuracy (i.e., proportion of estimates of peak flow in the Accurate Zone, Danger Zone, or Symptom Magnification Zones).

In order to control for the possible influence of peak flow monitoring condition on dependent variables in the path models, differences between children randomized to peak flow monitoring conditions with and without feedback were explored. Peak flow monitoring condition was unrelated to measures of asthma signs and symptoms, asthma morbidity, or attitudes toward asthma. However, measures of symptom perception varied predictably as a function of experimental condition (see Table 4). Participants randomly assigned to the condition involving peak flow monitoring with feedback of results made a significantly greater proportion of guesses of peak flow that were classified as accurate and a significantly smaller proportion of guesses classified as overestimates of peak flow. Accordingly, the influence of experimental condition was controlled in subsequent path models predicting symptom perception accuracy and other endogenous variables. To accomplish this, each measure of perceptual accuracy (i.e., percent of estimates in the Accurate, Danger, and Symptom Magnification Zones) was regressed onto experimental condition (either peak flow monitoring with or without feedback of results) and standardized residuals were saved as new variables for use in subsequent path analyses. This process removed the variance accounted for by experimental condition, leaving the remaining proportion of variance unaccounted for by experimental condition free to be explained.

To evaluate for the presence of mediated pathways, standardized indirect effects (i.e., the cumulative product of each direct path weight included in the pathway) were examined. Path coefficients were determined to be statistically significant if $p < .05$ and the upper and lower bounds of 90% confidence intervals did not include zero. Standardized path coefficients representing direct effects are displayed for each of three path models (i.e., measuring symptom perception accuracy as either the proportion of estimates of peak flow in the Accurate, Danger, or Symptom Magnification Zone) in Figures 4, 5, and 6. Total effects, direct effects, and total indirect effects can be found in Tables 7, 8, and 9. Indirect effects for individual pathways were obtained by using

Wright's (1934) tracing rule, which specifies that the effect of a path consists of the cumulative product of the direct effect coefficients leading from a causal variable of interest through mediating variables until reaching the dependent variable of interest.

Finally, the overall fit of each path model was evaluated according to recommendations by Hu and Bentler (1999). The primary indicator used to determine model fit was the Chi-square statistic, with a non-significant Chi-square suggesting a good fit between the hypothesized path models and the data. Other indicators included the Comparative Fit Index (CFI), which represents an acceptable fit at 0.90 or higher and a good fit at 0.95 or higher, and the Root Mean Square Error of Approximation (RMSEA), which represents an acceptable fit at 0.08 or less and a good fit at 0.06 or less.

3.3 Results Addressing Research Question 1

To test Hypothesis 1a that NHB youths would report less favorable attitudes toward asthma than NHW youths, an independent samples *t*-test was calculated. Results did not support this hypothesis; NHB and NHW youths reported similar attitudes toward asthma at both Time 1 and Time 2, $t(156) = -0.66$, $p = .51$ and $t(156) = -0.29$, $p = .78$, respectively (see Table 5). Results of a path analysis, which tested the fit of the conceptual model previously described, indicated that race did not significantly predict attitudes toward asthma when controlling for experimental condition (see Tables 7, 8, and 9). A zero-order correlation was calculated to evaluate the hypothesis that SES would be positively associated with attitudes toward asthma (see Table 6). This hypothesis was supported by the results of the analysis, which indicated that as SES increased, attitudes toward asthma became more favorable ($r = .26$, $p < .05$). The path models confirmed this finding, indicating that SES had a significant direct effect on attitudes toward asthma (β = .26, $p < .05$), even after controlling for the influence of experimental condition.

3.4 Results Addressing Research Question 2

Hypothesis 2a—that NHB youths would demonstrate less accurate estimates of actual peak flow than NHW youths—was generally supported. As presented in Table 5, NHB youths made proportionally fewer estimates of peak flow in the Asthma Risk Grid's Accurate Zone, $t(156) = -2.98$, $p < .05$, and proportionally more estimates in the Danger Zone, $t(156) = 2.26$, $p < .05$, compared to NHW youths. However, race was unrelated to the proportion of estimates of peak flow in the Symptom Magnification Zone, $t(156) = 0.81$, $p = .42$. To further examine the effect of race on symptom perception accuracy, direct effects were examined via path analysis. These results confirmed that NHB race was associated with fewer peak flow estimates in the Accurate Zone ($\beta = -.21$, $p < .05$), even after controlling for the influence of experimental condition (Figure 4). NHB race, however, did not significantly predict the proportion of estimates in the Danger ($\beta = .14$, $p = .13$) or Symptom Magnification ($\beta = .08$, $p = .36$) Zones after controlling for experimental condition (Figures 5 and 6, respectively).

To evaluate hypothesis 2b (that SES would be positively associated with perceptual accuracy), zero-order correlations were calculated. Results did not support this hypothesis; SES was unrelated to the proportion of estimates of peak flow that fell in the Accurate ($r = .07$, $p = .42$), Danger ($r = -.13$, $p = .11$), or Symptom Magnification Zones ($r = .07$, $p = .38$). The results of separate path analyses corroborated these findings (Accurate Zone model: $\beta = .03$, $p = .70$; Danger Zone model: $\beta = -.10$, $p = .25$; Symptom Magnification Zone model: $\beta = .08$, $p = .35$).

3.5 Results Addressing Research Question 3

Zero-order correlations were used to test the association between attitudes toward asthma and the proportion of estimates of peak flow in each zone within the Asthma Risk Grid, as outlined in Hypothesis 3. Results did not support the hypothesis that attitudes toward asthma would be positively associated with symptom perception accuracy; correlations between CATIS 1 scores and the proportion of estimates of peak flow in the Accurate (r = .13, p = .09) and Danger (r = -.15, p = .07) Zones trended toward—but did not reach—statistical significance in the expected directions. Attitudes toward asthma were unrelated to the proportion of estimates that fell in the Symptom Magnification Zone (r = .01, p = .90).

Results of the subsequent path analyses were consistent with these observations: after controlling for experimental condition, attitudes toward asthma had a marginal direct effect on the proportion of estimates of peak flow in the Accurate Zone (β = .16, p = .07, CI_{90} = .01 - .31) and no direct effect on the proportion of estimates in either the Danger (β = -.14, p = .14) or Symptom Magnification (β = -.02, p = .82) Zones.

3.6 Results Addressing Research Question 4

Results failed to support hypotheses that signs and symptoms of asthma (hypothesis 4a) and attitudes toward asthma (hypothesis 4c) mediate the relationship between race and symptom perception accuracy. The total effect for race on symptom perception accuracy (controlling for the influence of experimental condition) was significant for the model measuring accuracy as the proportion of peak flow estimates in the Accurate Zone (β = -.21, p < .05) but not for estimates in either the Danger Zone (β = .13, p = .14) or Symptom Magnification Zone (β = .08, p = .36). As the only path model that produced a statistically significant total effect between race and symptom perception was the Accurate Zone model, indirect effects for only the Accurate Zone model were explored. Indirect effects of race on symptom perception accuracy were non-significant in the Accurate Zone model (β = .00, p = .94), as 100% of the total effect could be attributed to the direct effect. The tracing rule confirmed that signs and symptoms of asthma (β = .00) and attitudes toward asthma (β = -.00) did not mediate the relationship between race and symptom perception in the Accurate Zone model.

Signs and symptoms of asthma (hypothesis 4b) and attitudes toward asthma (hypothesis 4d) were also expected to mediate the relationship between SES and symptom perception accuracy; however, results failed to support these hypotheses. The total effect for SES on symptom perception accuracy—when controlling for experimental condition—was non-significant across all path models (see Tables 7, 8, and 9). The (non-significant) direct effects of SES on symptom perception accounted for 50%, 71%, and 100% of the total effect in models using the Accurate, Danger, and Symptom Magnification Zones, respectively. As such, no significant indirect effects of SES on symptom perception accuracy were detected in any of the path models tested (Accurate Zone model: β = .03, p = .22; Danger Zone model: β = -.03, p = .13; Symptom Magnification Zone model: β = .00, p = .92).

Hypothesis 4e that signs and symptoms of asthma and measures of asthma morbidity (i.e., "asthma morbidity" and "health-related quality of life") would mediate the relationship between race and attitudes toward asthma (Time 2) was not supported by the data. Race failed to influence attitudes toward asthma through any indirect pathways (see Tables 7, 8, and 9). This finding, however, was expected, given the absence of a direct association between race and attitudes toward asthma (at Time 2; $r = -.02$, $p = .78$).

The relationship between SES and attitudes toward asthma was expected to be partially mediated by signs and symptoms of asthma and measures of asthma morbidity (hypothesis 4f) but the results did not support this hypothesis. The total effect for SES on attitudes toward asthma (Time 2) instead trended toward significance for two of the path models (Accurate Zone model: $\beta = .05$, $p = .07$; Danger Zone model: $\beta = .05$, $p = .05$). Due to design limitations, direct effects could only be examined between SES and attitudes toward asthma at Time 1 (for all models: $\beta = .26$, $p < .05$). Therefore, indirect effects comprised 100% of the total effects of SES on attitudes toward asthma measured at Time 2. A non-significant trend was observed for the cumulative indirect effects of SES on attitudes toward asthma (Time 2) in the Accurate Zone and Danger Zone path models.

Results did not support hypothesis 4g that symptom perception accuracy would partially mediate the relationship between race and measures of asthma morbidity (i.e., “asthma morbidity” and “health-related quality of life”). As described in Tables 5 and 6, NHB and NHW participants did not differ significantly on the Asthma Morbidity Composite or HRQL; $t(156) = 0.75$, $p = .56$ and $t(156) = -1.96$, $p = .05$, respectively. As such, the total effects of race on the Asthma Morbidity Composite and HRQL were non-significant, when controlling for experimental condition. Indirect effects of race on the Asthma Morbidity Composite were found to be non-significant (Accurate Zone model: $\beta = .02$, $p = .46$; Danger Zone model: $\beta = .01$, $p = .74$; Symptom Magnification Zone model: $\beta = -.00$, $p = .91$). Similarly, indirect effects of race on HRQL were non-significant (Accurate Zone model: β = -.03, p = .37; Danger Zone model: β = -.01, p = .69; Symptom Magnification Zone model: β = .00, p = .94). Although symptom perception accuracy did not statistically mediate the relationship between race and HRQL, this pathway accounted for 100% of the indirect effect of race on HRQL (β = -.03) in the Accurate Zone model.

Lastly, it was expected that the relationship between SES and measures of asthma morbidity (i.e., "asthma morbidity" and "health-related quality of life") would be partially mediated by symptom perception accuracy (hypothesis 4h). Results did not support this hypothesis, as indirect effects trended toward—but did not reach—statistical significance for path models measuring symptom perception as the proportion of estimates in the Accurate and Danger Zones. As shown in Table 6, SES was significantly correlated with the Asthma Morbidity Composite, such that lower SES was associated with higher levels of asthma morbidity. Similarly, SES was significantly correlated with HRQL, such that higher SES was associated with higher HRQL.

The total indirect effect of SES on the Asthma Morbidity Composite trended toward significance in models using the Accurate (β = -.04, p = .08) and Danger Zones (β = .07, p = .05), but not the Symptom Magnification Zone (β = .03, p = .15). Furthermore, the indirect effect of SES on HRQL trended toward significance in models using the Accurate (β = .05, p = .07) and Danger Zones (β = .06, p = .05), but not the Symptom Magnification Zone (β = .04, p = .20). The tracing rule indicated that, for the Accurate Zone model, the pathway predicting the Asthma Morbidity Composite mediated by symptom perception was weak (β = .00)—accounting for a negligible proportion of the total indirect effect. This mediation pathway (i.e., SES predicts the Asthma Morbidity

Composite via symptom perception) was also weak (β = -.01) for the Danger Zone model. The indirect pathway via symptom perception also produced an insignificant indirect effect for SES on HRQL (Accurate Zone model: β = .00; Danger Zone model: β = .01).

Overall, the three path models tested to explore the current study's hypotheses did not fit the data closely. The path model that measured symptom perception accuracy as the proportion of estimates that fell in the Accurate Zone using the proportion of estimates of peak flow in the Accurate Zone was not a good fit, evidenced by a significant Chi-square statistic, a CFI below 0.90, and a RMSEA above 0.08; $\chi^2(12, N = 158) = 130.46$, $p = .000$, CFI = 0.47, RMSEA= 0.25. An equally poor fit was observed for the path model using the proportion of estimates in the Danger Zone to measure symptom perception accuracy; $\chi^2(12, N = 158) = 132.01$, $p = .000$, CFI = 0.45, RMSEA= 0.25. Lastly, the Symptom Magnification Zone path model also demonstrated a poor fit to the current data; $\chi^2(12, N = 158) = 134.19$, $p = .000$, CFI = 0.42, RMSEA= 0.26.

CHAPTER 4: DISCUSSION

The current study investigated race- and SES-based disparities in symptom perception, signs and symptoms of asthma, asthma morbidity, and attitudes toward asthma among children with asthma. Path analysis was used to test direct and indirect effects outlined in a conceptual model, which proposed that racial and socioeconomic differences in symptom perception accuracy would partially explain disparities in asthma symptoms and asthma morbidity. Moreover, analyses explored the effect of asthma health-related outcomes on attitudes toward asthma, as well as the effect of attitudes on symptom perception accuracy. This was the first study to describe differences in symptom perception accuracy exclusively between NHB and NHW children with asthma, and no prior study has similarly explored racial or socioeconomic disparities in children's attitudes toward asthma or the effect of asthma-specific attitudes on symptom perception. The present investigation has implications for clinical practice and future research including: screening for children at-risk for poor asthma outcomes, understanding of factors related to psychological adjustment in asthma, and identifying targets for interventions aiming to reduce health-related disparities among children with asthma.

Results of the current study documented for the first time that NHB and NHW children with asthma differ significantly in the accuracy with which they perceive lung function. However, race only predicted the proportion of accurate estimates of peak flow children made rather than the types of errors (i.e., underestimates or overestimates of peak flow). Contrary to predictions, SES was unrelated to symptom perception accuracy. SES was reliably correlated with asthma outcomes, such that higher SES was associated with fewer signs and symptoms and lower asthma morbidity. However, path analyses showed only non-significant trends toward direct and indirect effects of SES on asthma outcomes. SES had a significant direct effect on attitudes toward asthma in the expected direction, but no similar differences were attributable to differences between NHB and NHW participants. Finally, a trend consistent with expectations was observed that more favorable attitudes toward asthma lead to more accurate peak flow estimates; however, this trend did not reach statistical significance (p = .07). These overarching findings are explored in greater detail in the following sections.

4.1 Race- and SES-based Disparities in Attitudes Toward Asthma (Research Question 1)

Results of the present investigation failed to support Hypothesis 1a that NHB youths would report less favorable attitudes toward asthma than NHW youths. Instead, NHB and NHW participants reported similar attitudes. Although no previous studies have explored the presence of disparities in asthma-specific attitudes, this finding was unexpected, given the reported disparate rate at which NHB youths experience severe asthma symptoms (Bai et al., 2007; Evans et al., 2009; Gupta et al., 2006; Higgens et al., 2005; Wallace et al., 2004), and previous research suggesting that asthma symptoms and morbidity are related to adjustment (Calam et al., 2005; Katon et al., 2007; Klinnert et al., 2000; McCauley et al., 2007).

The current study's finding that NHB and NHW youths' attitudes toward asthma were equally favorable might be attributable to the absence of reliable racial disparities in signs and symptoms of asthma and asthma morbidity in the study sample. Hypothesized relationships outlined in the conceptual model suggested that physical health outcomes should predict mental health outcomes. As no differences in symptoms or morbidity were found between NHB and NHW youths with asthma, it is reasonable to assume that the favorability of their attitudes toward asthma would also be similar. The absence of disparities in symptoms and morbidity may be a function of the study's recruitment activities, and equivalencies between groups in access to health care. Participants in the current study were recruited primarily from asthma and allergy specialty clinics. Such patients tend to receive higher quality asthma care and experience more positive health outcomes (Diette et al., 2001; Finkelstein, Lozano, Farber, Miroshnik, & Lieu, 2002; Flores et al., 2009; Schatz et al., 2005).

Hypothesis 1b proposed that SES would be positively associated with attitudes toward asthma. This hypothesis was supported by both correlational and path analyses, which suggested that as SES increased, attitudes toward asthma became more favorable. No previous studies have explicitly tested the effect of SES on psychological outcomes among youths with asthma using an illness-specific measure of adjustment. However, the finding that SES is significantly associated with attitudes toward asthma is consistent with previous research demonstrating that low SES is predictive of greater psychological problems among those with asthma (Gillaspy et al., 2002). While prior research has identified an interactive effect between SES and racial/ethnic minority status, the current study's results indicated that SES affects attitudes toward asthma independent of race—highlighting the salience of social and possibly community resources in the development and maintenance of better psychological adaptation to asthma.

Signs and symptoms of asthma were unrelated to SES, but asthma morbidity was related to SES. Low SES participants may have reported more negative attitudes toward asthma because they also endured a greater asthma burden. Even though children from a wide range of socioeconomic backgrounds reported similar asthma symptoms, those from low SES families—who are less likely to possess the resources needed to manage symptoms or acute exacerbations when they occur—are faced with more frequent challenges in terms of managing daily activities and buffering the impact on psychological functioning. Future research should explore the relationship between SES and other measures of psychological adjustment that align better with diagnostic criteria for psychiatric disorders. Additional studies are also needed to improve our understanding of factors that mediate the relationship between SES and psychological adjustment, identify ways to adapt existing psychological interventions to target the barriers associated with low SES, and determine targeted and cost-effective methods for delivering interventions to youths with asthma who have fewer social or community resources.

4.2 Race- and SES-based Disparities in Symptom Perception Accuracy (Research Question 2)

Hypothesis 2a predicted that NHB youths with asthma would demonstrate less accurate estimates of peak flow than NHW youths. This hypothesis was supported but symptom perception did not vary by SES as hypothesized (Hypothesis 2b). Compared to NHB youths, NHW youths made significantly more estimates of peak flow that fell in the Accurate Zone. Moreover, on average, NHB participants made a significantly greater proportion of estimates of peak flow that fell in the Danger Zone. However, when examining direct effects in path analyses controlling for experimental condition and SES, race only predicted the proportion of estimates in the Accurate Zone. In other words, race significantly predicted the proportion of estimates that were accurate or inaccurate but did not discriminate reliably between the types of errors children are likely to make (i.e., overestimating or underestimating peak flow). Of note, the relationship between race and accuracy occurred independent of SES.

The current study is the first to specifically examine differences in symptom perception accuracy exclusively between NHB and NHW youths with asthma. Previous research has explored the influence of race/ethnicity on perceptual accuracy in children with asthma; however, most studies have relied on comparisons between NHW and heterogeneous “non-white” or “minority” groups and failed to report—or were insufficiently powered statistically to examine—differences due to variations in specific racial groups. Although racial/ethnic minorities may share certain social experiences, analyzing individuals with diverse cultural backgrounds and individual experiences as a single group likely obscures potential between-group differences. Despite such shortcomings, previous findings have documented significant disparities in the accuracy with which children estimate their asthma symptoms, with racial/ethnic minorities generally exhibiting less accurate symptom perception (Fritz et al., 2010; Koinis-Mitchell et al., 2009; Kopel et al., 2010).

Based on the present findings and previous research, mounting evidence affirms significant discrepancies in symptom perception accuracy exist between NHW children with asthma and children from racial/ethnic minorities. The mechanisms by which racial disparities in symptom perception accuracy develop remain unclear and continue to be an area of focus for future research, particularly since the relationship occurred after controlling for SES. Although others have suggested that difficulty accurately estimating lung function could be the result of experiencing more severe symptoms (Chen et al., 2006; Yoos et al. 2003) or habituation to symptoms by patients who frequently experience poor lung function (Rietveld & Brosschot, 1999), the current study found racial differences in symptom perception accuracy despite no evidence of racial differences in symptom severity. Methodological differences in the measurement of symptom perception accuracy and asthma severity highlight still unknown pathways that underlie the relationship between race and symptom perception. Future research should incorporate multiple measures of symptom perception and asthma severity, as well as focus on language used to describe symptoms, experience and training with peak flow meters, and the role of family and cultural variables in modeling and reinforcing accurate appraisals of symptoms (e.g., McQuaid et al., 2007).

4.3 Effect of Attitudes Toward Asthma on Symptom Perception Accuracy (Research Question 3)

Attitudes toward asthma were expected to predict symptom perception accuracy but results indicated that attitudes and symptom perception were unrelated. Although a trend was observed between attitudes and (a) accurate estimates of peak flow and (b) overestimates of peak flow in the expected directions, these relationships did not reach statistical significance. This was the first study to examine the influence of asthma-specific attitudes on symptom perception. Our findings are in line with the only other study known to describe the relationship between psychological adjustment (anxiety) and perceptual accuracy in pediatric asthma (Koinis-Mitchell et al., 2009) but deviates from the wider body of literature on symptom perception in adults (De Peuter et al., 2007; Domschke et al., 2010; Mora et al., 2007; Pollatos et al., 2009).

Developmental factors may moderate the influence of psychological factors on symptom perception. For example, it might be that the symptom perception becomes more susceptible to disruption from cognitive and emotional factors as one ages. The current findings also point to the importance of examining differential effects of various psychological constructs (e.g., anxiety, depression, negative affect, attitudes) in this context. The absence of a relationship between attitudes toward asthma and symptom perception in the current study reflects the limited role attitudes have on endogenous symptom detection among children with asthma. However, given previous research suggesting that psychological factors influence symptom-reporting, future research could investigate whether illness-specific measures of adjustment affect accurate recall of past symptoms—a skill that relies more on attention and memory (and is more susceptible to emotional interference; for a review, see Suls & Howren, 2012) than immediate estimation of peak flow. Such relationships could be further explicated with longitudinal studies to determine if symptom perceptions become more accurate as psychiatric symptoms decline with psychological intervention.

4.4 Indirect Effects Investigated Using Path Analysis (Research Question 4)

Race was hypothesized to indirectly influence symptom perception accuracy through its effects on signs and symptoms of asthma (hypothesis 4a) and attitudes toward asthma (hypothesis 4c). However, results suggested that neither of these pathways produced a statistically significant indirect effect. Instead, 100% of the total effect of race on symptom perception accuracy could be attributed to a direct effect, after controlling for experimental condition and SES. This result is most likely due to the absence of differences between NHB and NHW children on both signs and symptoms of asthma and attitudes toward asthma. Limited variability between groups on these hypothesized mediators meant that indirect effects were unlikely to exist. As suggested earlier, the lack of racial differences in asthma symptoms could be a function of access to care in study participants: most participants received asthma care from asthma and allergy specialists. In addition, SES accounted for the majority of variance explained in attitudes toward asthma, thus highlighting the importance of resources in the formation of asthma-specific attitudes and limiting the statistical viability of an attitudes-mediated pathway between race and symptom perception. Despite such findings, it would be informative to examine these causal pathways in other samples that have limited access to specialty care—where disparities may be more pronounced and of great importance. Other mediators should also be explored to improve our understanding of the social and behavioral variables (e.g., familial responses to children's symptom reports, modeling and reinforcement of accurate appraisals of symptoms, support from friends) that might explain racial differences in perceptual accuracy in children with asthma. In addition, certain individual differences should continue to be considered as possible contributors to perceptual accuracy, as other researchers have identified a variety of possible explanations including intelligence, processing speed, and attention (Fritz et al., 2010; Koinis-Mitchell 2009).

Results also showed that neither signs and symptoms of asthma (hypothesis 4b) nor attitudes toward asthma (hypothesis 4d) mediated the hypothesized relationship between SES and symptom perception—due, principally, to the lack of a relationship between SES and symptom perception. The absence of a relationship between SES and symptom perception was in contrast to results from one other study, which found an effect for SES (measured as occupational prestige) even after controlling for race

(Koinis-Mitchell et al., 2009). This inconsistency could be a function of differences in sample characteristics. Although Koinis-Mitchell and colleagues did not report the proportion of participants that were recruited from each source, they did indicate that many children were recruited from the waiting areas of urgent care clinics, primary care clinics, and asthma summer camps. The participants in their study who were recruited from urgent care clinics and summer camps may have been less likely to be receiving the sort of routine asthma care that promotes continuity of services and, possibly, the development of accurate symptom perception. In addition, although participants from the present study and Konis-Mitchell and colleagues' work may have had similar levels of (and variability in) SES, other contextual factors could be modifying the practical implications of SES in the two studies. In other words, the mean SES score for the present sample might afford a child from this study access to high-quality asthma care whereas the same SES score for a child in another context (e.g., different availability of specialists in the community, different state healthcare policies) might be insufficient to achieve access to the same quality of care. Future research should aim to clarify the role of SES by directly measuring constructs (e.g., availability of asthma specialists, proximity to providers, type of health insurance, poverty-related stress), for which traditional indicators of SES (i.e., parental education and occupation) are often meant to be proxies.

Racial (hypothesis 4e) and socioeconomic (hypothesis 4f) disparities were expected to explain differences in attitudes toward asthma; however, results suggested that these pathways did not produce significant indirect effects. The absence of associations between race/SES and signs and symptoms of asthma was likely a primary reason for the lack of any indirect effects. Of note, SES was significantly correlated with morbidity measures (i.e., Asthma Morbidity Composite and MiniAQLQ) but not with signs and symptoms of asthma. Theory and previous research guided the development of the conceptual model and, as such, asthma symptom severity was modeled to mediate the influence of demographic variables. However, current results suggest that the model might produce a better fit if asthma morbidity (rather than asthma symptom severity) is modeled to mediate the relationship between SES and attitudes toward asthma.

Finally, symptom perception accuracy was proposed to mediate the influence of race (hypothesis 4g) and SES (hypothesis 4h) on asthma morbidity but results did not support these hypotheses. This result was expected for the mediation hypothesis involving SES, as SES was found to be unrelated to all indicators of symptom perception accuracy. A racial difference, however, was observed in the proportion of estimates of peak flow made in the Accurate Zone and the proportion of estimates in the Accurate Zone predicted HRQL, but such race-related effects did not statistically mediate the relationship.

Mixed findings were noted regarding the relationship between symptom perception and asthma morbidity. Although youths who made more estimates of peak flow that were classified as accurate also scored higher on the MiniAQLQ, they did not differ from the less accurate youths on the Asthma Morbidity Composite. The finding that more accurate estimators of peak flow did not experience reduced asthma morbidity in the form of lower healthcare utilization (i.e., Asthma Morbidity Composite) is in contrast to previous research, which has highlighted important clinical implications of perceptual accuracy in pediatric asthma (Feldman et al., 2007; Fritz et al., 2007; Fritz et al., 2010; McQuaid et al., 2007). Similarities between the current findings and those of others can be drawn, however, in that accurate symptom perception seems to be a stronger predictor of functional limitations and the subjective impact of asthma on daily living (i.e., HRQL) than objective counts of healthcare contacts. This observation raises questions about why symptom perception would predict one form of asthma morbidity but not another. One explanation may be that accurate estimators of peak flow are better able to manage basic aspects of daily asthma self-management that minimize the burden of minor symptoms. Accurate symptom perception, however, may not be sufficient to avert more severe symptoms that necessitate treatment from a physician. Alternatively, awareness of one's ability to accurately detect peak flow may contribute to the development of high self-efficacy for managing symptoms. In turn, greater confidence in one's ability to manage symptoms may decrease the subjective impact of asthma symptoms on day-to-day functioning but not necessarily prevent asthma exacerbations or emergency physician visits altogether.

Current results may also suggest that, in this sample, factors beyond symptom perception accuracy are responsible for the observed disparities in asthma morbidity that varied by SES. It is possible that children in the current study possessed certain protective factors that children in other studies have not. As discussed earlier, most children in our sample received asthma care from specialists—possibly buffering the impact of less accurate symptom perceptions. It is reasonable to assume that children receiving regular asthma care with substantive social and community resources would exhibit low levels of morbidity regardless of perceptual accuracy. This does not mean, however, that symptom perception plays an insignificant role in determining asthma outcomes. Rather, accurate symptom perception might better predict cognitive constructs (e.g., self-efficacy) or behaviors (e.g., adherence to medications and avoidance of asthma triggers) that lead to lower asthma morbidity or other favorable asthma outcomes not tested in the current path model. There may also have been long-term advantages of perceptual accuracy that were not detected as the current study utilized a one-month self-monitoring task to quantify symptom perception accuracy and measured asthma morbidity as a retrospective recall of asthma-related events over the same one-month period. Alternatively, the current results might reflect an ‘accuracy threshold’ such that accurately estimating peak flow only provides clinically meaningful reductions in asthma morbidity up to a certain point. For example, estimating peak flow accurately 70% of the time might be sufficient to result in similar levels of morbidity as estimating peak flow accurately 100% of the time. Future research should focus on determining ways in which symptom perception accuracy affects self-management behaviors and the degree to which symptom perception may interact with contextual factors to produce the effects on asthma morbidity that have been described elsewhere. Specifically, it would be useful to measure a wider array of cognitive, affective, and behavioral measures to establish the factors associated with perceptual accuracy in pediatric asthma. In addition, future research should consider longitudinal approaches that incorporate multiple assessments of symptom perception to evaluate the degree to which accuracy—and the relationship between accuracy and asthma morbidity—changes over time.

4.5 Limitations

Several study limitations could explain the lack of empirical support for some of the study’s hypotheses. First, sampling characteristics (e.g., children were primarily recruited from asthma and allergy specialist clinics, most participants resided in a single geographical region) limited the generalizability of our findings to other populations. However, results from the present investigation also offer unique insights into the effects of adequate asthma care on asthma disparities: among our sample of NHB and NHW youths with generally well-controlled asthma, racial differences in asthma outcomes faded. Socioeconomic differences in asthma outcomes, instead, seemed more salient in our sample of well-controlled youths, as asthma morbidity varied reliably by SES. Future research should use multi-site designs to recruit representative samples from various geographical regions and from a wide range of referral sources within these regions. Researchers should also consider a variety of socioeconomic indicators when exploring pediatric asthma disparities, as results from the current study suggest that SES may be a better predictor of disparities than race in certain cohorts.

Other limitations involved use of Asthma Morbidity Composite and, more generally, self-report measures and multiple informants. Due to positive skewness, individual items assessing asthma morbidity were dichotomized and summed to create a composite variable. This composite variable demonstrated relatively low internal consistency and thus, may have been a poor indicator of asthma morbidity. However, the Asthma Morbidity Composite was significantly correlated in the expected directions with related variables such as signs and symptoms of asthma and health-related quality of life, suggesting that it was likely providing an adequate measurement of the intended construct. The use of self-report measures may also have been problematic, as many of these measures relied on accurate recall of symptoms, healthcare utilization, and functional impairment over several weeks. Furthermore, by relying on caregivers to rate the frequency of signs and symptoms of their child's asthma, certain symptoms could have been experienced that were not reported by caregivers on the PASS (e.g., chest tightness that was never described to a caregiver or wheezing that occurred at school). These limitations could be addressed in future research by verifying the accuracy of self-reports with clinic data and children or by utilizing ecological tools to record significant asthma-related events, cognitions, or emotions as they occur.

Although the proposed conceptual model was grounded in theory and existing literature, the poor overall fit of the model suggests that the model was misspecified for the current sample, with some important variables likely missing from the model. Findings from the current study, however, also offer insights into how to improve upon existing theory. For example, the Symptom Management Model (Dodd et al., 2001) makes no assumptions about which components of the model are more proximal to one another and, therefore, it is challenging to identify areas in which to intervene that are likely to have the greatest, most expeditious, or cost-effective impact on health outcomes. In line with the Symptom Management Model, the current study's results suggest that symptom perception plays an important role in determining asthma outcomes (i.e., HRQL); however, symptom perception did not have a uniform effect on all asthma outcomes. Instead, accurate symptom perception had a greater impact on HRQL than healthcare utilization. In the future, researchers should attempt to clarify which aspects of health and behavior are most likely to be influenced by symptom perception. Researchers should also investigate more exhaustive models of asthma disparities that include explanatory variables beyond symptom perception, such as self-management behaviors, asthma-related beliefs and expectations, health literacy, and family support and supervision.

4.6 Conclusions and Clinical Implications

Results of the current study supported the prediction that attitudes toward asthma would vary by SES, with higher SES being associated with more favorable attitudes. This effect was independent of race, as NHB and NHW children reported similar attitudes toward asthma. NHB youths exhibited less accurate estimates of peak flow compared to NHW youths. NHB youths also made more overestimates of their true peak flow. However, when controlling for experimental condition, race only predicted the proportion of accurate guesses. SES, on the other hand, was unrelated to symptom perception. Similarly, attitudes toward asthma had no effect on perceptual accuracy. Current results failed to identify causal pathways between: (a) SES and attitudes toward asthma or (b) race and symptom perception. As many of the disparities in asthma outcomes described in past research were not present in our sample, results could not support mediation hypotheses seeking to explain race- and SES-based differences in asthma outcomes. Although accurate symptom perception predicted HRQL, none of the indicators of symptom perception produced an indirect effect of demographic variables (i.e., race, SES) on asthma outcomes. This finding suggests that in this sample of youths with well-controlled asthma, accurate symptom perception may play less of a role in minimizing asthma symptoms and morbidity than it does in samples of youths with poorly controlled asthma. In other words, it may be that as asthma becomes better controlled, the clinically meaningful effects of accurate symptom perception decrease. Conversely, among children for whom consistent access to quality asthma care is limited and asthma exacerbations are common, accurate symptom perception might play a more crucial role in asthma self-management.

Although a number of the study's mediation hypotheses were not supported by results, practical implications can be gleaned from the study. First, in our sample, SES—but not race—was related to asthma morbidity (including HRQL). This finding highlights that in contexts similar to the present study's, disparities in asthma outcomes between NHB and NHW children are not as pronounced as previous research would suggest. Close clinical care and collaboration with social workers, mental health providers, and school and community leaders should be provided, however, for those children from families with limited resources. Interventions could aim to link low SES families to asthma education programs, arrange for transportation to medical appointments, facilitate referrals for psychological treatment, and identify sources of affordable asthma care, medications, and supplies.

Second, because children with poorly controlled asthma, regardless of race, reported more negative attitudes toward asthma, mental health services should target children who experience greater healthcare utilization and functional impairment as a result of having asthma. Practitioners should also identify creative ways to increase access to mental health services for children from low socioeconomic backgrounds, as SES was a salient predictor of problems adjusting emotionally to asthma. For example, mobile health clinics have been used in urban neighborhoods of Miami (Brito et al., 2010) and in New Orleans after Hurricane Katrina (Olteanu et al., 2011) to provide integrated medical and mental health services to children from low socioeconomic backgrounds.

Finally, it is useful to know that NHB youths similar to those in the current sample, on average, make less accurate estimates of peak flow compared to NHW youths. Current results indicate that making accurate estimates of peak flow predicts higher HRQL and other researchers have reported that less accurate symptom perceptions lead to greater asthma morbidity (Feldman et al., 2007; Fritz et al., 2007; Fritz et al., 2010; McQuaid et al., 2007). Clinical researchers should continue exploring educational and behavioral interventions to improve perceptual accuracy. Improvements in symptom perception accuracy seem to be possible through behavioral training (Kotses, Hyseni, Harver, Walford, & Hardy, 2010) and interventions to improve accuracy could be harnessed as one step toward reducing racial/ethnic disparities in asthma morbidity.

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APPENDIX A: FIGURES

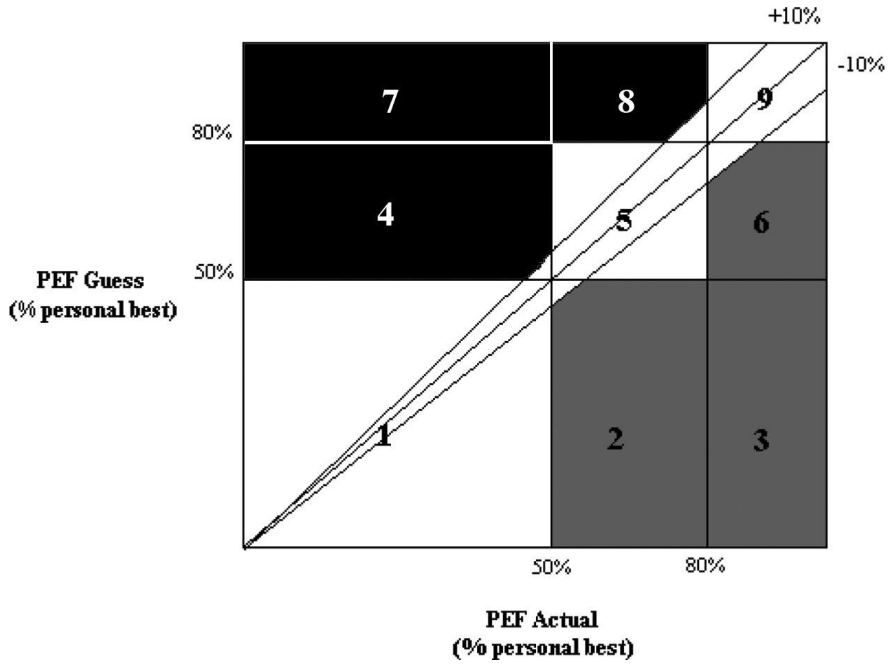

Figure 1. Asthma Risk Grid. Accurate estimates of peak flow include points that are plotted in zones 1, 5, 9, and the ± 10% wedge. Points in zones 2, 3, and 6 indicate underestimation of actual lung function (symptom magnification) while points in zones 4, 7, and 8 indicate overestimation of actual lung function (danger zone). From "The Asthma Risk Grid: Clinical Interpretation of Symptom Perception," by R. B. Klein, N. Walders, E. L. McQuaid, S. Adams, D. Yaros, and G. Fritz, 2004, Allergy and Asthma Proceedings, 25, p. 3. Copyright (2004) by Oceanside Publications, Inc. Reprinted with permission.

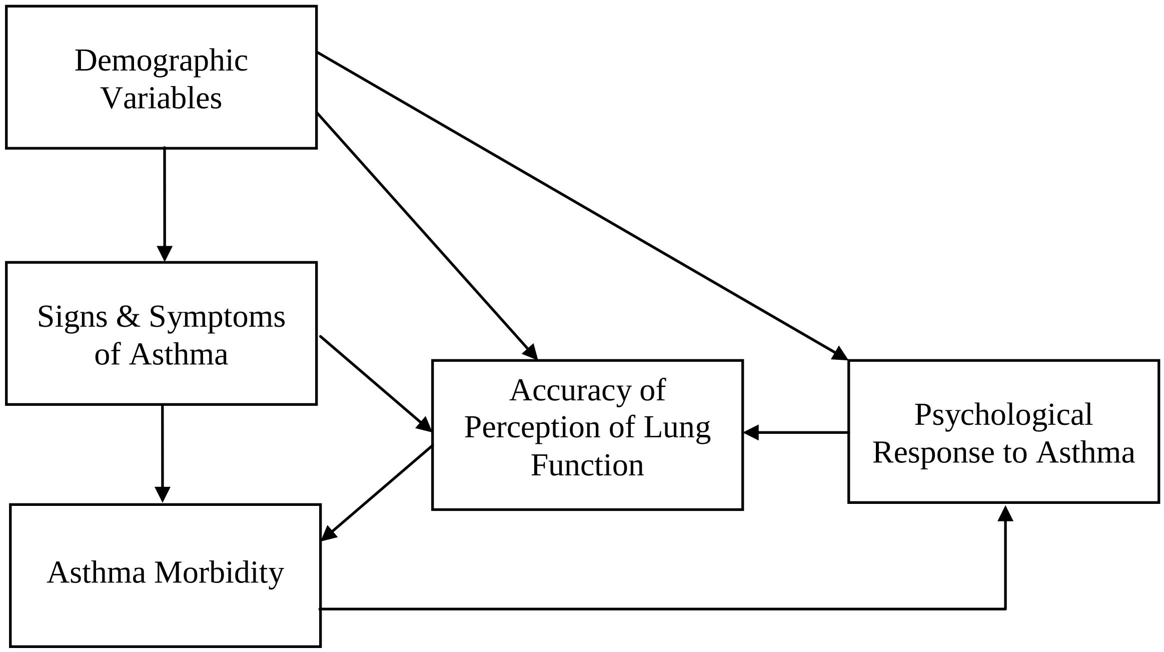

Figure 2. Conceptual model of the role of symptom perception accuracy in pediatric asthma disparities

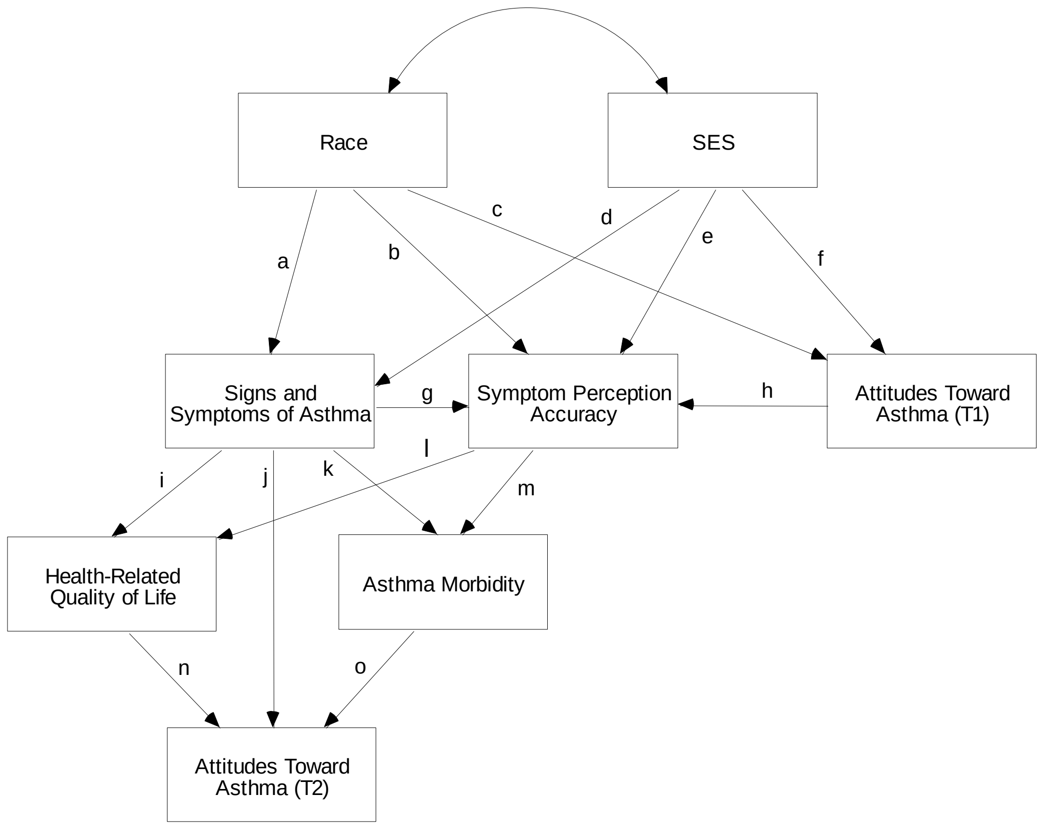

Figure 3. Diagram of hypothesized relations. Letters were included to identify each path in corresponding analyses. “Race” was coded as 1 = Non-Hispanic Black, 0 = Non-Hispanic White.

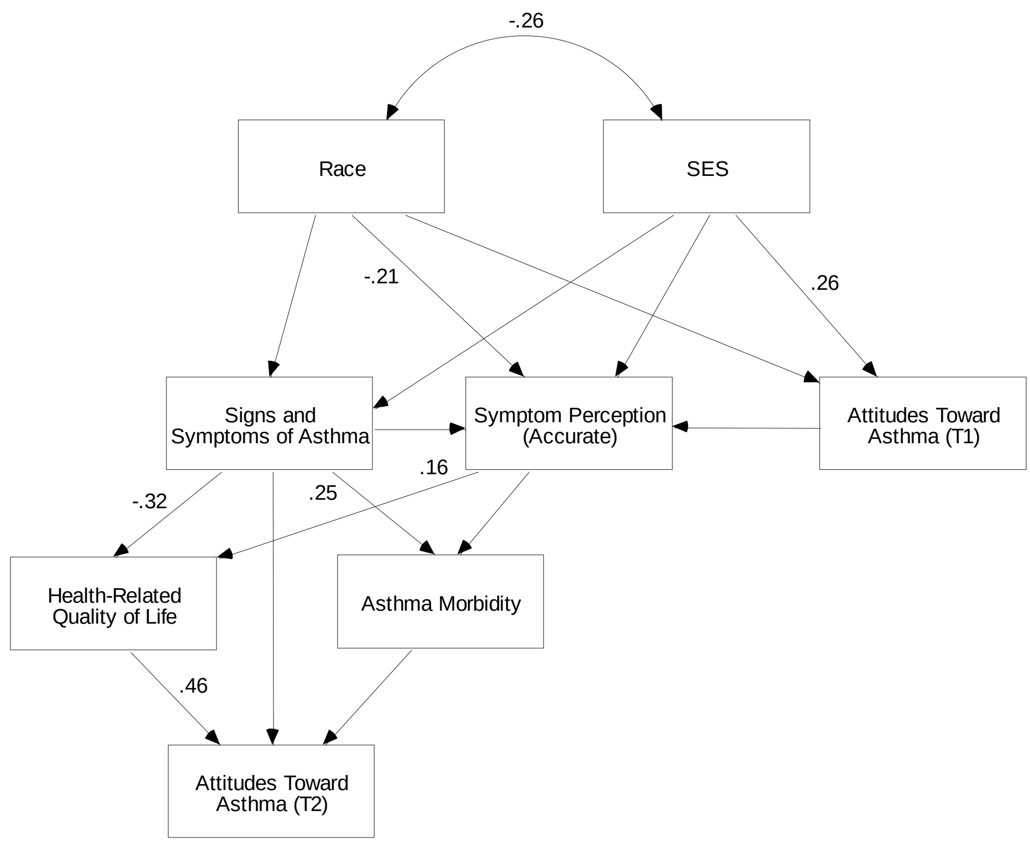

Figure 4. Results of path analysis model (standardized coefficients) measuring symptom perception accuracy as the proportion of estimates of peak flow that fell in the Accurate Zone. Only statistically significant path coefficients for direct effects are displayed. “Race” was coded as 1 = Non-Hispanic Black, 0 = Non-Hispanic White.

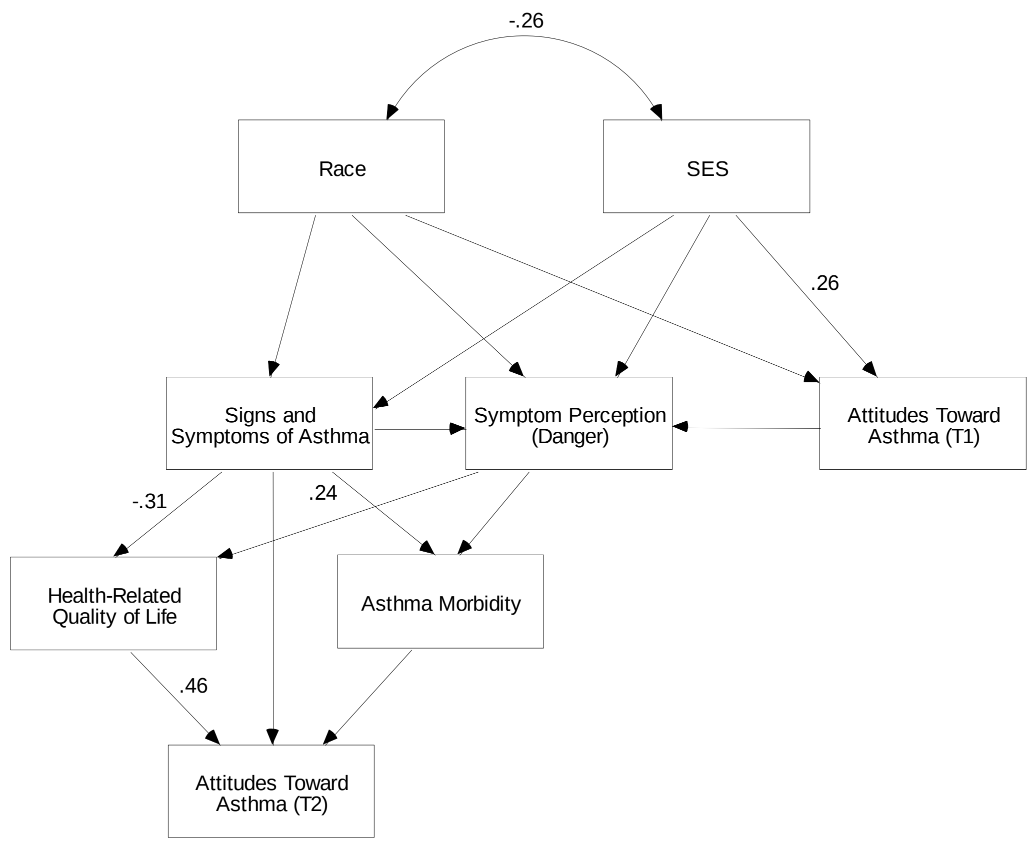

Figure 5. Results of path analysis model (standardized coefficients) measuring symptom perception accuracy as the proportion of estimates of peak flow that fell in the Danger Zone. Only statistically significant path coefficients for direct effects are displayed. “Race” was coded as 1 = Non-Hispanic Black, 0 = Non-Hispanic White.

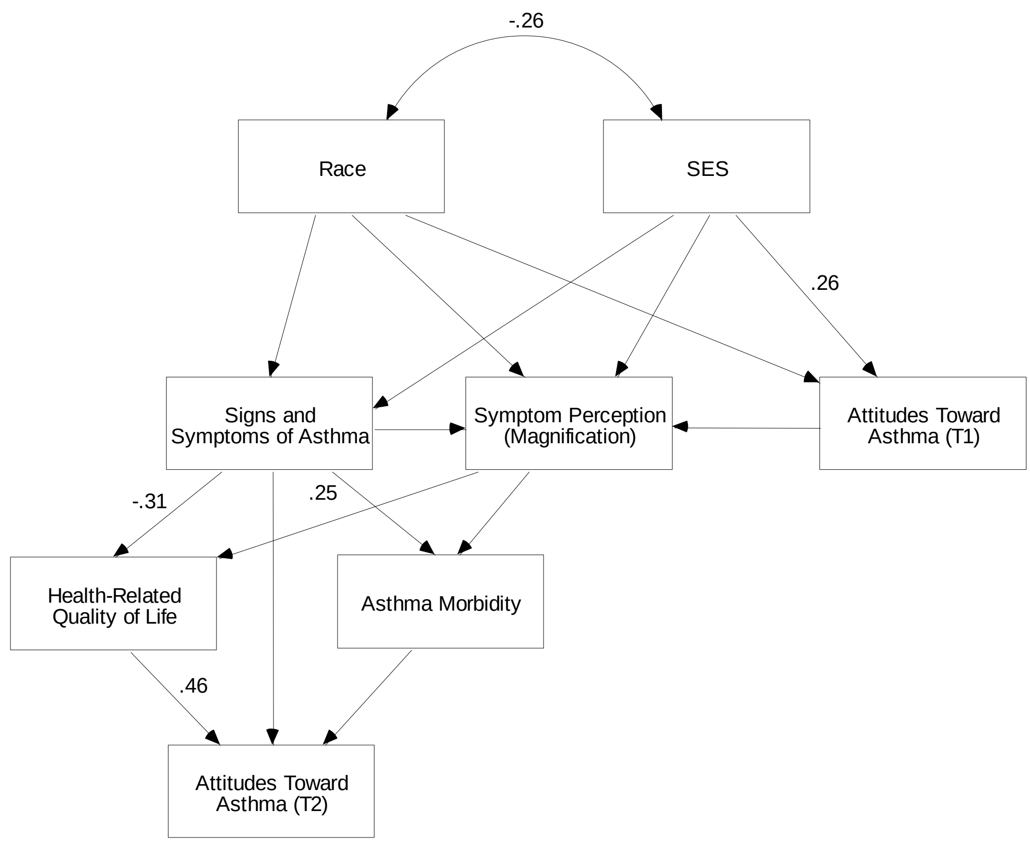

Figure 6. Results of path analysis model (standardized coefficients) measuring symptom perception accuracy as the proportion of estimates of peak flow that fell in the Symptom Magnification Zone. Only statistically significant path coefficients for direct effects are displayed. “Race” was coded as 1 = Non-Hispanic Black, 0 = Non-Hispanic White.

APPENDIX B: TABLES

Table 1

Descriptive Statistics and Results of Tests for Differences Among Conditions for All Project On TRAC Participants Randomized to an Experimental Symptom-Monitoring Condition

	Diary Only (*n* = 88)	PEFR Monitoring Without Feedback (*n* = 90)	PEFR Monitoring With Feedback (*n* = 90)	*F*	χ^2
Male Gender	61 (69%)	59 (66%)	62 (69%)		0.28
Age	10.08 ± 1.52	10.11 ± 1.70	10.01 ± 1.72	0.09	
Age Diagnosed	3.18 ± 2.51	3.42 ± 2.68	3.43 ± 2.62	0.28	
Asthma Duration	6.90 ± 2.97	6.71 ± 3.08	6.55 ± 2.72	0.32	
Mother in Home	86 (100%)	84 (97%)	87 (98%)		2.83
Father in Home	57 (72%)	66 (83%)	66 (78%)		2.44
Children in Home	2.26 ± 0.92	2.38 ± 0.96	2.20 ± 0.88	0.88	
Family Size	3.93 ± 1.14	4.16 ± 1.10	3.91 ± 1.04	1.38	
SES	76.39 ± 26.61	78.81 ± 23.03	75.21 ± 23.43	0.51	

Note. $N = 269$. All comparisons $p > .05$. “Age” ranged from 8 to 15 years old. “Age Diagnosed” ranged from birth to 13 years old. “Asthma Duration” ranged from 0 to 14 years. “Children in Home” ranged from 1 to 6. “Family Size” ranged from 2 to 8. “SES” ranges from 15 to 121. Participants with missing data were excluded from these analyses.

Table 2

Descriptive Statistics and Results of Tests for Differences Between Non-Hispanic Black and White Participants Who Completed Daily Peak Flow Monitoring

	Race			
	NHB (n = 71)	NHW (n = 87)	t	χ^2
Male Gender	50 (70%)	61 (70%)		0.00
Age	10.44 ± 1.76	9.75 ± 1.59	2.59*	
Age Diagnosed	2.95 ± 2.53	3.87 ± 2.67	-2.22*	
Asthma Duration	7.49 ± 3.02	5.87 ± 2.42	3.66*	
Mother in Home	65 (94%)	85 (100%)		5.06*
Father in Home	40 (68%)	79 (93%)		15.35*
Children in Home	2.25 ± 0.94	2.39 ± 0.89	-0.94	
Family Size	3.85 ± 1.15	4.30 ± 0.95	-2.71*	
SES	71.95 ± 22.69	83.52 ± 21.13	-3.32*	
Number of Peak Flow Pairs	42.03 ± 14.79	50.14 ± 16.22	-3.25*	

Note. “NHB” = Non-Hispanic Black. “NHW” = Non-Hispanic White. * indicates $p < .05$. “Age” ranged from 8 to 15 years old. “Age Diagnosed” ranged from birth to 11 years old. “Asthma Duration” ranged from 0 to 14 years. “Children in Home” ranged from 1 to 6. “Family Size” ranged from 2 to 8. “SES” ranged from 20 to 121. “Number of Peak Flow Pairs” ranged from 10 to 103.

Table 3

Descriptive Statistics for All Participants Included in the Study Sample (n = 158)

	Mean ± *SD*	Range
CATIS Time 1	3.35 ± 0.69	1.38 – 5.00
CATIS Time 2	3.52 ± 0.71	1.23 – 5.00
% Estimates in Accurate Zone	64.80 ± 24.42	7.35 – 100.00
% Estimates in Danger Zone	19.56 ± 23.84	0.00 – 92.65
% Estimates in Symptom Magnification Zone	15.63 ± 21.18	0.00 – 83.33
PASS	18.39 ± 4.94	8.00 – 32.00
Asthma Morbidity Composite	0.77 ± 1.11	0.00 – 4.00
AQLQ	5.19 ± 1.31	1.00 – 7.00

Note. “CATIS” represents scores on the Children’s Attitudes Toward Illness Scale. “PASS” represents scores on the Pediatric Asthma Symptom Scale. “AQLQ” represents scores on the Mini Asthma Quality of Life Questionnaire. CATIS scores can potentially range from 1 to 5. PASS scores can potentially range from 8 to 40. % Estimates in Accurate, Danger, and Symptom Magnification Zones can potentially range from 0 to 100. PASS scores can potentially range from 8 to 32. Asthma Morbidity Composite scores can potentially range from 0 to 4. AQLQ scores can potentially range from 1 to 7.

Table 4

Results of Tests for Differences Between Participants Assigned to Peak Flow Monitoring With Feedback or Peak Flow Monitoring Without Feedback

	PEFR Monitoring With Feedback (n = 77)	PEFR Monitoring Without Feedback (n = 81)	t
CATIS Time 1	3.33 ± 0.70	3.36 ± 0.69	-0.31
CATIS Time 2	3.48 ± 0.75	3.55 ± 0.67	-0.61
% Estimates in Accurate Zone	74.15 ± 18.94	55.91 ± 25.80	5.08*
% Estimates in Danger Zone	11.79 ± 13.52	26.95 ± 28.77	-4.27*
% Estimates in Symptom Magnification Zone	14.05 ± 16.27	17.13 ± 24.99	-0.92
PASS	18.58 ± 5.45	18.21 ± 4.42	0.47
Asthma Morbidity Composite	0.83 ± 1.17	0.72 ± 1.04	0.65
AQLQ	5.24 ± 1.33	5.13 ± 1.30	0.53

Note. N = 158. * indicates $p < .05$. "CATIS" represents scores on the Children's Attitudes Toward Illness Scale. "PASS" represents scores on the Pediatric Asthma Symptom Scale. "AQLQ" represents scores on the Mini Asthma Quality of Life Questionnaire. CATIS scores can potentially range from 1 to 5. PASS scores can potentially range from 8 to 40. % Estimates in Accurate, Danger, and Symptom Magnification Zones can potentially range from 0 to 100. PASS scores can potentially range from 8 to 32. Asthma Morbidity Composite scores can potentially range from 0 to 4. AQLQ scores can potentially range from 1 to 7.

Table 5

Results of Tests for Differences Between Non-Hispanic Black and White Participants Who Completed Daily Peak Flow Monitoring

	NHB (*n* = 71)	NHW (*n* = 87)	*t*
CATIS Time 1	3.31 ± 0.73	3.38 ± 0.66	-0.66
CATIS Time 2	3.50 ± 0.76	3.53 ± 0.66	-0.29
% Estimates in Accurate Zone	58.54 ± 23.60	69.91 ± 24.02	-2.98*
% Estimates in Danger Zone	24.32 ± 25.54	15.68 ± 21.73	2.26*
% Estimates in Symptom Magnification Zone	17.14 ± 21.80	14.41 ± 20.71	0.81
PASS	18.49 ± 5.35	18.31 ± 4.61	0.22
Asthma Morbidity Composite	0.85 ± 1.15	0.71 ± 1.07	0.75
AQLQ	4.96 ± 1.40	5.37 ± 1.21	-1.96

Note. $N = 158$. * indicates $p < .05$. "CATIS" represents scores on the Children's Attitudes Toward Illness Scale. "PASS" represents scores on the Pediatric Asthma Symptom Scale. "AQLQ" represents scores on the Mini Asthma Quality of Life Questionnaire. CATIS scores can potentially range from 1 to 5. PASS scores can potentially range from 8 to 40. % Estimates in Accurate, Danger, and Symptom Magnification Zones can potentially range from 0 to 100. PASS scores can potentially range from 8 to 32. Asthma Morbidity Composite scores can potentially range from 0 to 4. AQLQ scores can potentially range from 1 to 7.

Table 6

Zero-Order Correlations Among Variables Included in Path Models

	1	2	3	4	5	6	7	8	9	10
1. SES	—									
2. Race	-.26*	—								
3. PASS	-.14	.02	—							
4. CATIS 1	.26*	-.05	-.29*	—						
5. % Accurate Zone	.07	-.23*	.04	.13	—					
6. % Danger Zone	-.13	.18*	.01	-.15	-.62*	—				
7. % Symptom Magnification Zone	.07	.06	-.06	.01	-.46*	-.42*	—			
8. Morbidity	-.24*	.06	.25*	-.18*	-.07	.06	.01	—		
9. AQLQ	.25*	-.16	-.31*	.38*	.15	-.13	-.03	-.34*	—	
10. CATIS 2	.18*	-.02	-.29*	.71*	.06	-.06	-.00	-.25*	.51*	—

Note. $N = 158$. * indicates $p < .05$. "Race" was coded as 1 = Non-Hispanic Black, 0 = Non-Hispanic White. "PASS" represents scores on the Pediatric Asthma Symptom Scale. "CATIS 1" represents scores on the first administration of the Children's Attitudes Toward Illness Scale. "% Accurate Zone" represents the proportion of estimates of peak flow that fell in the Accurate Zone. "% Danger Zone" represents the proportion of estimates of peak flow that fell in the Danger Zone. "% Symptom Magnification Zone" represents the proportion of estimates of peak flow that fell in the Symptom Magnification Zone. "Morbidity" represents scores on the Asthma Morbidity Composite. "AQLQ" represents scores on the Mini Asthma Quality of Life Questionnaire. "CATIS 2" represents scores on the second administration of the Children's Attitudes Toward Illness Scale.

Table 7

Total, Direct, and Indirect Effects (Standardized Units) for the Path Model With Perceptual Accuracy Measured as the Proportion of Estimates in the Accurate Zone

	Accurate	CATIS 1	PASS	Morbidity	AQLQ	CATIS 2
Total R^2	.08	.07	.02	.07	.12	.27
Race						
Total Effect	-.21*	.01	-.02	.02	-.03	-.01
Direct Effect	-.21*	.01	-.02	—	—	—
Indirect Effect	.00	—	—	.02	-.03	-.01
SES						
Total Effect	.06	.26*	-.14	-.04	.05	.05
Direct Effect	.03	.26*	-.14	—	—	—
Indirect Effect	.03	—	—	-.04	.05	.05
Accurate						
Total Effect	—	—	—	-.10	.16*	.08*
Direct Effect	—	—	—	-.10	.16*	—
Indirect Effect	—	—	—	—	—	.08*
CATIS T1						
Total Effect	.16	—	—	-.02	.03	.01
Direct Effect	.16	—	—	—	—	—
Indirect Effect	—	—	—	-.02	.03	.01
PASS						
Total Effect	.08	—	—	.24*	-.30*	-.28*
Direct Effect	.08	—	—	.25*	-.32*	-.13
Indirect Effect	—	—	—	-.01	.01	-.15*
Morbidity						
Total Effect	—	—	—	—	—	-.06
Direct Effect	—	—	—	—	—	-.06
Indirect Effect	—	—	—	—	—	—
AQLQ						
Total Effect	—	—	—	—	—	.46*
Direct Effect	—	—	—	—	—	.46*
Indirect Effect	—	—	—	—	—	—

Note. $N = 158$. * indicates $p < .05$. “Race” was coded as 0 = NHW, 1 = NHB. “SES” represents socioeconomic status. “Accurate” represents the proportion of estimates of peak flow that fell in the Accurate Zone. “CATIS 1” represents scores on the first administration of the Children’s Attitudes Toward Illness Scale. “PASS” represents scores on the Pediatric Asthma Symptom Scale. “Morbidity” represents scores on the Asthma Morbidity Composite. “AQLQ” represents scores on the Mini Asthma Quality of Life Questionnaire. “CATIS 2” represents scores on the second administration of the Children’s Attitudes Toward Illness Scale.

Table 8

Total, Direct, and Indirect Effects (Standardized Units) for the Path Model With Perceptual Accuracy Measured as the Proportion of Estimates in the Danger Zone

	Danger	CATIS 1	PASS	Morbidity	AQLQ	CATIS 2
Total R^2	.06	.07	.02	.07	.11	.27
Race						
Total Effect	.13	.01	-.02	.01	-.01	.00
Direct Effect	.14	.01	-.02	—	—	—
Indirect Effect	-.00	—	—	.01	-.01	-.00
SES						
Total Effect	-.14	.26*	-.14	-.05	.06	.05
Direct Effect	-.10	.26*	-.14	—	—	—
Indirect Effect	-.03	—	—	-.05	.06	.05
Danger						
Total Effect	—	—	—	.07	-.11	-.06
Direct Effect	—	—	—	.07	-.11	—
Indirect Effect	—	—	—	—	—	-.06
CATIS T1						
Total Effect	-.14	—	—	-.01	.02	.01
Direct Effect	-.14	—	—	—	—	—
Indirect Effect	—	—	—	-.01	.02	.01
PASS						
Total Effect	-.03	—	—	.26*	-.31*	-.28*
Direct Effect	-.03	—	—	.25*	-.31*	-.13
Indirect Effect	—	—	—	-.00	-.00	-.15*
Morbidity						
Total Effect	—	—	—	—	—	-.06
Direct Effect	—	—	—	—	—	-.06
Indirect Effect	—	—	—	—	—	—
AQLQ						
Total Effect	—	—	—	—	—	.46*
Direct Effect	—	—	—	—	—	.46*
Indirect Effect	—	—	—	—	—	—

Note. $N = 158$. * indicates $p < .05$. “Race” was coded as 0 = NHW, 1 = NHB. “SES” represents socioeconomic status. “Danger” represents the proportion of estimates of peak flow that fell in the Danger Zone. “CATIS 1” represents scores on the first administration of the Children’s Attitudes Toward Illness Scale. “PASS” represents scores on the Pediatric Asthma Symptom Scale. “Morbidity” represents scores on the Asthma Morbidity Composite. “AQLQ” represents scores on the Mini Asthma Quality of Life Questionnaire. “CATIS 2” represents scores on the second administration of the Children’s Attitudes Toward Illness Scale.

Table 9

Total, Direct, and Indirect Effects (Standardized Units) for the Path Model With Perceptual Accuracy Measured as the Proportion of Estimates in the Symptom Magnification Zone

	Sx Mag	CATIS 1	PASS	Morbidity	AQLQ	CATIS 2
Total R^2	.01	.07	.02	.06	.10	.27
Race						
Total Effect	.08	.01	-.02	-.00	.00	.00
Direct Effect	.08	.01	-.02	—	—	—
Indirect Effect	.00	—	—	-.00	.00	.00
SES						
Total Effect	.08	.26*	-.14	-.03	.04	.04
Direct Effect	.08	.26*	-.14	—	—	—
Indirect Effect	.00	—	—	-.03	.04	.04
Sx Mag						
Total Effect	—	—	—	.03	-.05	-.02
Direct Effect	—	—	—	.03	-.05	—
Indirect Effect	—	—	—	—	—	-.02
CATIS T1						
Total Effect	-.02	—	—	-.00	.00	.00
Direct Effect	-.02	—	—	—	—	—
Indirect Effect	—	—	—	-.00	.00	.00
PASS						
Total Effect	-.05	—	—	.25*	-.31*	-.29*
Direct Effect	-.05	—	—	.25*	-.31*	-.13
Indirect Effect	—	—	—	.00	-.00	-.16*
Morbidity						
Total Effect	—	—	—	—	—	-.06
Direct Effect	—	—	—	—	—	-.06
Indirect Effect	—	—	—	—	—	—
AQLQ						
Total Effect	—	—	—	—	—	.46*
Direct Effect	—	—	—	—	—	.46*
Indirect Effect	—	—	—	—	—	—

Note. N = 158. * indicates $p < .05$. “Race” was coded as 0 = NHW, 1 = NHB. “SES” represents socioeconomic status. “Sx Mag” represents the proportion of estimates of peak flow that fell in the Symptom Magnification Zone. “CATIS 1” represents scores on the first administration of the Children’s Attitudes Toward Illness Scale. “PASS” represents scores on the Pediatric Asthma Symptom Scale. “Morbidity” represents scores on the Asthma Morbidity Composite. “AQLQ” represents scores on the Mini Asthma Quality of Life Questionnaire. “CATIS 2” represents scores on the second administration of the Children’s Attitudes Toward Illness Scale.