Abstract

Obesity and the Moderating Role of Caregiver Asthma-Related Illness Representations and Anxiety on Asthma Outcomes in Black and Latinx Youth

Introduction. Childhood obesity and asthma together have the potential to exacerbate asthma outcomes. This study aimed to examine first: the direct relationships between obesity and asthma control, child quality of life, quick relief medication use, and daily controller medication adherence, and second: the moderating role that caregiver asthma illness representations and child anxiety may have on these associations. **Methods.** 303 Latinx and Black-non Latinx children ages 10-17 years with a diagnosis of asthma, and their parents who participated in a larger RCT intervention were included in this cross-sectional secondary analysis which included data collected prior to the intervention. Participants were mainly recruited from asthma/pediatric clinics and emergency departments within the Bronx, NY. Child Body Mass Index (BMI) was measured and the sample was categorized into three BMI classes: obese (> 95th percentile), overweight (≥ 85th and < 95th percentile), and majority (< 85th percentile). **Results.** Adjusted analyses revealed that obesity was not associated with any of the outcome variables: asthma control, quality of life, Quick Relief medication use, or ICS/LTRA adherence. Furthermore, none of the relationships between obesity and the asthma outcome variables were moderated by caregiver asthma illness representations or by child anxiety. **Conclusion.** Contrary to hypotheses, obesity was not associated with any of the asthma outcome variables examined in this study. Differences between BMI classes may not have been significant for various reasons including unreliable self-report measures, sole reliance on BMI to categorize BMI classes, and exploration of alternative pathways such as

pulmonary function or asthma perception that potentially moderate the relationship among obesity and asthma in this sample.

Obesity and the Moderating Role of Caregiver Asthma-Related Illness Representations and Anxiety on Asthma Outcomes in Black and Latinx Youth

by

Jared DiCicco-Bloom

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The committee for this Dissertation consists of:

Jonathan Feldman, Ph.D., Chairperson, Ferkauf Graduate School of Psychology, Yeshiva University and Albert Einstein College of Medicine

Andrea H. Weinberger, Ph.D., Ferkauf Graduate School of Psychology, Yeshiva University and Albert Einstein College of Medicine

Jeffrey S. Gonzalez, Ph.D., Ferkauf Graduate School of Psychology, Yeshiva University and Albert Einstein College of Medicine

Readers:

Charles Swencionis, Ph.D., Ferkauf Graduate School of Psychology, Yeshiva University and Albert Einstein College of Medicine

Deepa Rastogi, M.B.B.S., M.S., George Washington University School of Medicine and Health Sciences, Children's National Health System

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Chapter I: Introduction

Background, Significance and Asthma Disparities

Asthma is a chronic condition afflicting the lungs and is characterized by excess mucus production following the inflammation and narrowing of the airways (Mayo Clinic, 2013; National Heart, Lung, and Blood Institute, 2014). The World Health Organization (WHO, 2017) estimates that as many as 235 million people across the world have a diagnosis of asthma. Currently, more than 5.5 million children under the age of 18 have asthma; at least 7.5% of all children in the US. Boys more than girls, and children with family incomes below the poverty threshold demonstrate greater rates of asthma prevalence (Centers for Disease Control [CDC], 2022. Moreover, as compared to Caucasian children, African American and Puerto Rican children exhibit higher rates of asthma prevalence (Akinbami et al., 2011; CDC, 2022 with Puerto Rican children most impacted (21.2%; Urquhart and Clarke, 2019). Children living in inner cities are less likely to utilize health care services and adhere to asthma medication regimens (Crocker et al., 2009; Williams et al., 2009).

Quick-relief (QR) medication for asthma flare-ups is often prescribed in conjunction with inhaled corticosteroids (ICS) to manage daily asthma symptoms (Groot et al. , 2015). Research continues to demonstrate the efficacy of ICS treatment in reducing the risk of exacerbations and the presence of asthma symptoms (van Aalderen & Sprikkelman, 2011). Moreover, evidence suggests that nonadherence to daily ICS is a prominent factor in the ineffectiveness of pediatric asthma treatment (Groot et al., 2015).

Discrepancies in asthma health outcomes, management, sociocultural engagement, and healthcare utilization contribute to the multifaceted nature of racial disparities in asthma (American Academy of Allergy Asthma and Immunology, 2019).

Obesity and Asthma

The effects of obesity on health are pervasive and increase an individual's risk for developing a wide range of serious mental, physical, and medical conditions and/or diseases. Statistics from 2015-2016 (Hales et al., 2017) indicate that nearly 1 in 5 children (18.5%) from 2 to 19 years-of-age in the US has obesity, with a prevalence of approximately 15.8% (Yusuf et al., 2020) to 16.2% (National Health and Nutrition Examination Survey, 2022) in children 10 to 17 years-of-age. Additionally, the prevalence of obesity among Hispanic (25.8%) and non-Hispanic Black/AA (22.0%) children is significantly higher than non-Hispanic white (14.1%) and non-Hispanic Asian (11.0%) children (Hales et al., 2017).

While research implicating obesity and asthma is vast and multifaceted, findings predominantly indicate the underlying link and escalation in prevalence (Ali & Ulrik, 2013; Ford, 2005). Potential grounds for their association include inflammatory and physiological markers, steroid resistance, mechanical factors, and triggers to stress (Barros et al., 2006; Barros et al., 2017; Fantuzzi, 2005; Mohanan et al., 2014; Shore, 2008, 2013; Tashiro & Shore, 2019). Evidence seems to underscore the "obese asthma" phenotype in which obesity modifies the clinical presentation of asthma (Lang et al., 2011; Wood, 2015). Obese children tend to demonstrate worse asthma control (Lavoie et al., 2006; Maalej et al., 2012), higher rates of emergency department (ED) visits (Aragona et al., 2016), greater use of quick relief medication (Quinto et al., 2011), poorer quality of life (van Gent et al., 2007; Maalej et al., 2012), and diminished response to asthma treatment (Rastogi et al., 2015; Vinding et al.,

2016). Moreover, obese children seem to experience poorer lung function, increased risk of exacerbations, and worse disease-related outcomes (Ahmadizar et al., 2016; Eising et al., 2014; Lang et al., 2012; Okubo et al., 2016) further complicating the evaluation, treatment, and representation of disease.

Common Sense Model and Illness Representations

A widely applied theoretical framework of self-regulation, the common-sense model (CSM) (Leventhal et al., 1992), describes the processes involved in a patient's awareness of health threat and their patterns of coping. Such processes include orientation of affective responses, devising perceptions of threat and potential strategies for treatment, coordination of action to address the threat, and the continuous integration and evaluation of action plan efficacy and illness-progression. The CSM characterizes patient or "lay" perceptions or models of illness threats, contrary to "professional" models (as recommended by health care providers; HCPs), that influence the strategies enacted to manage such threats and ultimately guide health behavior (Diefenbach & Leventhal, 1996; Leventhal et al., 2003). The model also proposes 5 primary domains of illness beliefs comprising illness identity, timeline, causes, consequences, and perceived control (Leventhal et al., 1992). While children and parents tend to share the dynamic burden of asthma management, parents often assume greater responsibility during acute episodes of illness (Garnett et al., 2016; Sonney & Insel, 2016). Prior research demonstrates a link between self-reported non-adherence to daily (preventer) asthma medication and doubts in its efficacy alongside concern for potential adverse side-effects (Horne & Weinman, 2002). Additional barriers to adherence in adolescents often include exposure to misinformation, incorrect assumptions regarding their asthma, and current life circumstances (Wamboldt et al., 2011).

Illness Representations, Obesity and Asthma

Asthma illness representations (IR) comprise an individual's conception of asthma-related beliefs and can serve to underscore differences between patient and HCPs understanding of asthma. HCPs beliefs represent the professional model of asthma IRs and often advocate for varying uses of quick-relief and controller medications depending on the severity of symptoms. The professional model of asthma intends to achieve optimal control by viewing the condition as chronic and present despite periods without symptoms; emphasizing the use of daily ICS/LTRA (controller) medications (Sidora-Arcoleo et al., 2010a). The lay model of asthma IRs, often atrritubted to beliefs held by some pateints and/or families, consider asthma to be episodic, unpredictable, and difficult to control (Yoos et al., 2007). Upon further investigation of caregiver IRs of asthma, a plausible link between childhood obesity and worse asthma-related health outcomes may persist.

Such beliefs have been associated with adherence to daily controller medication (Desager et al., 2018), disease knowledge, and asthma management (Peterson-Sweeney et al., 2003). Some parental IRs of asthma have also been related to greater preference for alternative, less effective treatments and discordance with professional models of asthma (Sidora-Arcoleo et al., 2007; Yoos et al., 2007). Parental beliefs about asthma were compared using the Asthma Illness Representations Scale (AIRS) in mainly poor, less educated, ethnic minority parents in the Bronx and in primarily non-poor, Caucasian parents with higher levels of education from Rochester (Sidora-Arcoleo et al., 2010a). Bronx parents reported longer episodes of asthma, more frequent acute care visits, and total AIRS scores aligning more closely with the lay model than parents from Rochester. Fewer reports of asthma symptoms, acute care services, less disease severity, and better relationships with the HCP

were associated with IRs aligned with the professional model. Furthermore, parents with IRs in greater accordance with professional models of asthma are more likely to adhere to the medication regimens prescribed (Yoos et al., 2007). If parents of obese children perceive asthma as unresponsive to treatment, more severe, and less controllable, then such children will experience even greater disease burden. Parents may further limit or discourage their child's participation in activities and exercise that are shown to improve overall health based on such beliefs which may ultimately induce worse asthma outcomes (Oudjedi & Aissa, 2020; Wanrooij et al., 2014). Thus, for obese children, deficits in asthma management will be associated with parental IRs that align more closely with lay models of asthma.

Anxiety and Asthma

The National Survey of Children's Health (NSCH) suggests that 7.1% of children 3 to 17 years-of-age are classified with some type of anxiety disorder (Ghandour et al., 2019). Furthermore, meta-analytic data demonstrate that anxiety disorders are highly comorbid for children and adolescents with asthma (Katon et al., 2004). Some propose that children with asthma exhibit a genetic predisposition and heightened vulnerability to developing comorbid mood disorders (Kewalramani et al., 2008), which may negatively impact their quality of life (Sundbom et al., 2016) and ability to control symptoms of asthma (Strine et al., 2008).

Anxiety, Obesity, and Asthma

Some literature tends to suggest that obese children with asthma may be more prone to magnifying the intensity of their symptoms (Kopel et al., 2010) in light of their increased susceptibility to certain asthma triggers such as exercise induced bronchoconstriction (EIB) or dyspnea (Sah et al., 2013; Wright et al., 2010). Moreover, children with asthma and comorbid anxiety may exhibit biases in their interpretation of threat scenarios (Sicouri et al.,

2017), potentially distorting disease burden. Parents with anxiety and/or anxiety-like traits also seem to influence their child's ability to adaptively process potential environmental threats (Aktar et al., 2017). Certain forms of anxiety in those with asthma have been associated with increased restriction to activity, poorer quality of life, and greater use of quick relief medication (Feldman et al., 2009; Feldman et al., 2013). Overestimation, mislabeling, and poor perception of symptoms in individuals with asthma have been associated with recurrent hospitalizations and excessive reliance on short-acting beta-2 agonists (SABA; or quick relief medication) (Davis et al., 2009; Dirks & Schraa, 1983; Main et al., 2003). In particular, children with anxiety seem more prone to overperception of symptoms and reliance on quick relief medication (Feldman et al., 2013). Furthermore, the overuse of quick relief medication has been linked to the heightened risk of adverse effects, poorer adherence to daily asthma medication, worse asthma control, and overutilization of acute care services (Cole et al., 2013; Kaplan et al., 2020). If obese children are more prone to misperceiving symptoms, then unnecessary activity restriction and greater reliance on short-term relief medication appears imminent. The endorsement of anxiety would seem to amplify such confusion over symptoms and tendencies to modify suggested asthma treatment. If obese children with asthma tend to experience poorer asthma control and quality of life, then those endorsing concurrent anxiety may experience even worse asthma outcomes (Shams et al., 2018).

Obesity and Poor Asthma Outcomes: Amplified by Illness Representations and Anxiety

While pathways of moderation implicating caregiver asthma IRs and child anxiety have yet to be examined, a body of literature continues to accrue suggesting that such factors may negatively amplify the relationship between obesity and asthma outcomes. The

detrimental link between obesity and asthma has been demonstrated across meaningful domains of asthma health including worse asthma control (Lavoie et al., 2006; Maalej et al., 2012), higher rates of ED visits (Aragona et al., 2016), poorer quality of life (van Gent et al., 2007; Maalej et al., 2012), greater use of quick relief medication (Quinto et al., 2011), diminished response to asthma treatment (Rastogi et al., 2015; Vinding et al., 2016), increased risk of exacerbations, and worse disease-related outcomes (Ahmadizar et al., 2016; Eising et al., 2014; Lang et al., 2012; Okubo et al., 2016). Vulnerable populations of children with obesity and asthma (especially those of lower socioeconomic status) are at greater risk of experiencing poorer asthma outcomes. Such children and families are less likely to align with asthma IRs (professional model) associated with better health outcomes (i.e., perceiving asthma as controllable). Moreover, if conditions of obesity and asthma exacerbate one another, then adhering to prescribed rescue and daily medication regimens might truly be less effective for children with both conditions (Desager et al., 2018). Additionally, children with asthma are at greater risk of experiencing mental health comorbidities such as anxiety disorders (Katon et al., 2004; Kewalramani et al., 2008). While the pathophysiology of childhood obesity and asthma remains complex, the combination of conditions seemingly increases the likelihood of poorer asthma outcomes.

Specific Aims and Hypotheses

Specific Aim 1 - *Relationship between obesity and each asthma outcome variable*

Specific Aim 1a: To examine the degree to which obesity is associated with Asthma Control (ACT).

Hypothesis 1a: Children and adolescents with BMIs classified as obese will demonstrate worse Asthma Control (ACT) than children with BMIs classified as majority and overweight.

Figure 1

A Causal Framework for the Effects of Obesity on Various Asthma Outcomes

Specific Aim 1b: To examine the degree to which obesity is associated with Pediatric Asthma Quality of Life (PAQLQ).

Hypothesis 1b: Children and adolescents with BMIs classified as obese will demonstrate worse Pediatric Asthma Quality of Life (PAQLQ) than children with BMIs classified as majority and overweight.

Specific Aim 1c: To examine the degree to which obesity is associated with Quick Relief Medication use.

Hypothesis 1c: Children and adolescents with BMIs classified as obese will be more likely to use their Quick Relief Medication (assessed via electronic monitoring devices) than children with BMIs classified as majority and overweight.

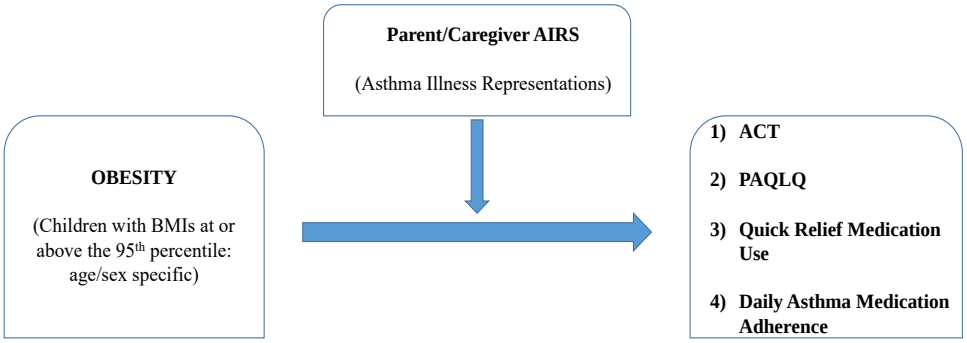
Specific Aim 1d: To examine the degree to which obesity is associated with daily asthma medication adherence.

Hypothesis 1dI: Children and adolescents with BMIs classified as obese will be less adherent to daily inhaled corticosteroids (ICS) medications (assessed via electronic Doser monitoring devices) than children with BMIs classified as majority and overweight.

Hypothesis 1dII: Children and adolescents with BMIs classified as obese will be less adherent to daily Leukotriene Receptor Antagonist (LTRA) medications (assessed via TrackCaps electronic monitoring devices) than children with BMIs classified as majority and overweight.

Figure 2

A Causal Framework for the Moderating Effects of Asthma Illness Representations on Various Asthma Outcomes



<u>Specific Aim 2</u> – *Parent/Caregiver Asthma Illness Representations (P-AIRS) as a moderator of the relationship between obesity and each asthma outcome variable*

Specific Aim 2a: To examine whether the association between obesity and Asthma Control (ACT) is moderated by Parent/Caregiver Asthma Illness Representations (P-AIRS).

Hypothesis 2a: The relationship between obesity and Asthma Control (ACT) will be moderated by Parent/Caregiver Asthma Illness Representations (P-AIRS).

Specific Aim 2b: To examine whether the association between obesity and Pediatric Asthma Quality of Life (PAQLQ) is moderated by Parent/Caregiver Asthma Illness Representations (P-AIRS).

Hypothesis 2b: The relationship between obesity and Pediatric Asthma Quality of Life (PAQLQ) will be moderated by Parent/Caregiver Asthma Illness Representations (P-AIRS).

Specific Aim 2c: To examine whether the association between obesity and Quick Relief Medication use is moderated by Parent/Caregiver Asthma Illness Representations (P-AIRS).

Hypothesis 2c: The relationship between obesity and Quick Relief Medication use will be moderated by Parent/Caregiver Asthma Illness Representations (P-AIRS).

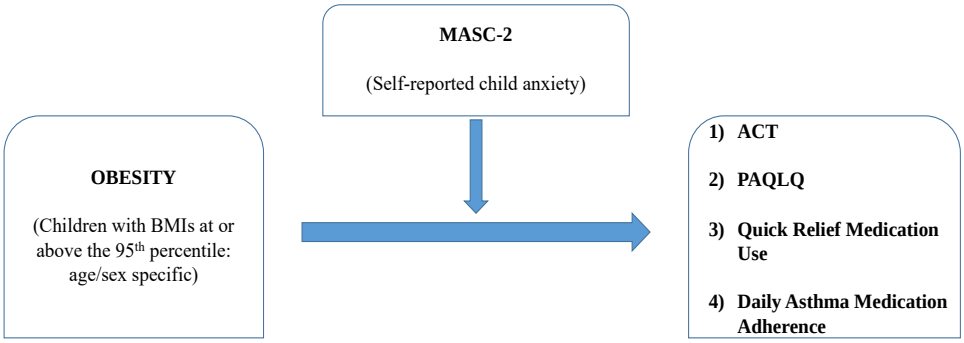
Specific Aim 2d: To examine whether the association between obesity and daily asthma medication adherence is moderated by Parent/Caregiver Asthma Illness Representations (P-AIRS).

Hypothesis 2dI: The relationship between obesity and daily ICS medication adherence will be moderated by Parent/Caregiver Asthma Illness Representations (P-AIRS).

Hypothesis 2dII: The relationship between obesity and daily LTRA medication adherence will be moderated by Parent/Caregiver Asthma Illness Representations (P-AIRS).

Figure 3

A Causal Framework for the Moderating Effects of Child Anxiety on Various Asthma Outcomes



<u>Specific Aim 3</u> - *Self-reported child anxiety (MASC-2) as a moderator of the relationship between Obesity and each asthma outcome variable*

Specific Aim 3a: To examine whether the association between obesity and Asthma Control (ACT) is moderated by self-reported child anxiety (MASC-2).

Hypothesis 3a: The relationship between obesity and Asthma Control (ACT) will be moderated by self-reported child anxiety (MASC-2).

Specific Aim 3b: To examine whether the association between obesity and Pediatric Asthma Quality of Life (PAQLQ) is moderated by self-reported child anxiety (MASC-2).

Hypothesis 3b: The relationship between obesity and Pediatric Asthma Quality of Life (PAQLQ) will be moderated by self-reported child anxiety (MASC-2).

Specific Aim 3c: To examine whether the association between obesity and Quick Relief Medication use is moderated by self-reported child anxiety (MASC-2).

Hypothesis 3c: The relationship between obesity and Quick Relief Medication use will be moderated by self-reported child anxiety (MASC-2).

Specific Aim 3d: To examine whether the association between obesity and daily asthma medication adherence is moderated by self-reported child anxiety (MASC-2).

Hypothesis 3dI: The relationship between obesity and daily ICS medication adherence will be moderated by self-reported child anxiety (MASC-2).

Hypothesis 3dII: The relationship between obesity and daily LTRA medication adherence will be moderated by self-reported child anxiety (MASC-2).

Study Rationale and Innovation

Among pediatric populations, asthma is the most frequently diagnosed chronic illness and its impact on Black-non Latinx and Latinx urban youth remains disproportionate. To date, studies integrating the assessment of asthma outcomes through validated scales (Asthma Control Test [ACT] and Pediatric Asthma Quality of Life [PAQLQ]) and objective measures of asthma management (device monitoring of medication) are limited. Furthermore, research that aims to address facets of mental (child anxiety) and physical health (Body Mass Index; BMI), caregiver IRs, and asthma outcomes may contribute to our understanding of and intervention for such disparities. The current study intended to explore the impact of obesity on pediatric asthma-health management through the moderating influences potentially imposed by certain mechanisms. In particular, the main and moderating effects of caregiver IRs and child anxiety on asthma outcomes. Moreover, the implications of such a model when applied to the exploration of asthma in Black-non Latinx and Latinx youth (10-17 years of age) is yet to be determined. The relationship between

obesity and asthma is marked by complexity. This research sought to unearth essential pathways that determine the manifestation and efficacy of health behavior in vulnerable populations. Such findings may serve to inform patient and family-centered approaches to screening and enhancing interventions that target childhood asthma.

Chapter II: Methods

Overview of Study Design

Data was extracted from Dr. Jonathan Feldman's R01-funded Childhood Asthma Perception Study and intervention (CAPS; R01:HL128260-01). This ongoing parent study and its procedures were approved by the Albert Einstein College of Medicine Institutional Review Board (IRB; 2014-3257). Data from the current study were drawn from the first and second sessions of the larger CAPS study protocol. CAPS is a longitudinal Randomized Controlled Trial (RCT) investigating the efficacy of two different interventions administered over Sessions 2 – 4, encompassing nine total sessions. CAPS is designed to improve measures of symptom perception and peak expiratory flow (PEF) predictions in asthma, clinical ratings of asthma control, medication adherence, illness representations, pulmonary function (spirometry testing) and healthcare utilization in an ethnic-minority population of children residing in the Bronx.

Participant Sample and Recruitment Sources

Black-non Latinx and Latinx children (10-17 years-of-age) and their caregivers were considered a dyad and were recruited for participation through mailings and phone calls. Participants were also approached in-person by lab coordinators and qualified research assistants during routine visits to neighboring asthma and pediatric clinics within Montefiore Medical Center and Jacobi Medical Center. Data collection and participant recruitment for this study concluded on March 20th, 2020. For the parent study CAPS, which began data

collection in 2017, the original target sample size was 260 dyads. Ultimately, inclusion criteria for the study remained the same.

Eligibility

Inclusion Criteria: Criteria for inclusion in the parent study pertained to children or adolescents 10-17 years-of-age with a diagnosis of asthma (by a physician and confirmed via electronic medical records), presence of breathing problems and prescribed controller medication in the past 12 months, self-identification of race/ethnicity as Latinx or Black-non Latinx by child/adolescent and at least one parent, participating parent/caregiver currently maintains primary or at least equal obligation to care for the child for at least past 9 months of the year, participating parent/caregiver must complete the measure of AIRS, and the child's BMI must be assessed along with the completion of MASC and at least 1 measure of asthma outcome, control or medication use/adherence. There were no additional inclusion criteria for the current study.

Asthma Diagnosis: Diagnoses of asthma were reviewed and confirmed through evaluation of electronic medical records (EMR; ICD-9/ICD-10 designation of asthma) by study personnel prior to a subject's participation.

Exclusion Criteria: Criteria for exclusion in the parent study were considered if participants (child/adolescent and/or parent/caregiver) reported a learning or cognitive disability impacting study participation and inability to complete and/or comply with study procedures. Children who participated in other intervention studies for asthma in the last 12 months or who are experiencing significant comorbid and chronic pulmonary conditions were also excluded. There were no additional exclusion criteria for the current study.

Screening and Incentives

Those interested in participation were evaluated by trained personnel and research assistants using an English or Spanish version of the Eligibility Screening Form (ESF) in order to verify criteria for inclusion or exclusion. Various physicians were enlisted for the purpose of distributing information regarding the larger intervention. Signed letters of affiliated physicians were mailed to their patients and accompanied by CAPS flyers describing criteria for participation and study-contact information. Beginning several weeks later, staff and research assistants reached out to such patients to consider their potential interest in participating. In general, $340 was offered to interested child-parent/caregiver dyads for their completion of all study sessions. In regards to the current study, incentives for Sessions 1 and 2 included $30 and $10 respectively.

Informed Consent Procedure

During the process of recruitment and as approved by the IRB, informed consent was obtained for all interested participants via signature prior to detailed explanation of the study protocol and their disclosure/release of medical information. For caregivers and children 13 years of age or older, consent forms were reviewed and signed. Children under the age of 13 were provided more accessible assent forms to sign before participating. By phone, study personnel first obtained oral consent and permission to discuss information protected under HIPPA. In person, staff distributed and reviewed documentation specifying informed consent/assent and HIPPA authorization. Once participants consented and agreed to take part in research, both the caregiver and child were invited to attend Session 1 of the study where they received a detailed explanation and overview of study practices and procedures. They were also asked to sign more in-depth versions of informed consent/assent verifying their

involvement. Copies of such documents were provided to participants for their records in case they had questions or concerns. Following COVID-19, such procedures continued. However, when families participated via telehealth instead of in-person (which was at first mandatory and then later as per preference), consent was obtained remotely.

Ethics

The Institutional Review Board of Albert Einstein College of Medicine continues to maintain its approval for the encompassing CAPS study and intervention. Safety protocols and considerations for working with children, a vulnerable population, are ongoing. Significant attention was allocated towards ensuring accurate and comprehensive understanding of the study protocol for child and parent participants throughout the process of recruitment and enrollment. Informed consents and assents were reviewed together with lab personnel and signed by participants before any distribution of medical information. The experience of adverse events related to their involvement in the study was reported during each session and continually monitored in order to thwart any potential health risks posed by their participation. Families were instructed and reminded of their right to discontinue participation at any time.

Data Management

To ensure patient confidentiality, each dyad was assigned a unique identification number upon enrollment which was used throughout the study to collect personal data. Physical records such as signed payment forms and informed consents were stored away in locked cabinets. Digital information was amassed using computer software (Medialab) in order to administer study interviews and measures. Staff personnel were provided access to software and files on private research databases through Albert Einstein College of

Medicine's virtual private network (VPN). Digital data was password protected with access provided only to study personnel. Such data was backed up daily and reviewed by the study's principal investigator, Dr. Jonathan Feldman. To date, no breaches of confidentiality have occurred.

Measures

Demographics

The age of the child and ethnicity of both the child and parent/caregiver were self-reported through the ESF. Several other demographic variables were collected using the ESF and further assessed at Session 1 with a supplementary questionnaire. Such variables included sex assigned at birth, level of education, race, ethnicity, and history of migration. Table 1 provides a summary of the measures, their phase of administration, and the dyad member undergoing assessment.

BMI

Body mass index (BMI) is a common and accessible method of screening for weight classifications that may indicate risk of health complications (CDC, 2020a, 2020b). For this study, each child's height (using a stadiometer) and weight (using a scale) was recorded at Session 1. In general, BMI is an individual's weight in kilograms divided by the square of their height in meters. For children and teens in particular, the measure is age- and sex-specific (BMI-for-age) (Pasco et al., 2012). While BMI does not directly measure the amount of body fat, it is significantly correlated with such measures (Freedman et al., 2013 Garrow & Webster, 1985; Wohlfahrt-Veje et al., 2014). Child BMI from Session 1 was measured and analyzed as a categorical (dichotomous cutoff; obese vs non-obese) variable. Children with BMIs at or above the 95th percentile (CDC; age/sex specific growth charts) were

Table 1

Predictor, Moderator and Outcome Measures

Measures	Construct	Phase of Administration	Subject
Predictor			
Obesity	Body Mass Index (BMI) *(Children with BMIs at or above the 95th percentile: age/sex specific)*	Session 1	Child
Moderator			
Parent Asthma Illness Representations Scale (P-AIRS)	Parent/Caregiver asthma illness representations	Session 1	Parent/Caregiver
The Multidimensional Anxiety Scale for Children (MASC-2-SR)	Childhood Anxiety: Subjective/Self-reported anxiety	Session 1	Child
Outcome			
Quick Relief (QR) Medication Use	Asthma management: QR Use	Session 2	Child
Inhaled corticosteroid (ICS) Adherence (Primary)	Asthma management: Controller/Daily Medication Adherence	Session 2	Child
Leukotriene Receptor Antagonist LTRA) Adherence (Secondary)	Asthma management: Controller/Daily Medication Adherence	Session 2	Child
Asthma Control Test and Child-Asthma control Test (ACT, C-ACT)	Asthma management: Self-reported asthma control	Session 1	Child
Pediatric Asthma Quality of Life Questionnaire (PAQLQ)	Quality of Life: Self-reported asthma quality of life	Session 1	Child

considered *obese* (Kuczmarski et al., 2002). BMIs considered healthy ($\geq$ 5th percentile and < 85th percentile) and underweight (< 5th percentile) were combined, defined as *majority*, and determined to be of similar character based on preliminary comparisons between asthma outcome variables.

Asthma Control

The Childhood Asthma Control Test (C-ACT; Liu et al., 2007) was administered to children 10-11 years-of-age (4 items) and parents (3 item) while the Asthma Control Test (ACT; Nathan et al., 2004) was administered to adolescents 12 years and older (5 items). The total score from each participant measure (C-ACT or ACT) was calculated with higher numbers indicating better asthma control and lower numbers indicating worse control. Total scaled scores range from 0-27 with scores 20 and above indicating acceptable to good asthma control (Liu et al., 2007). Scores were further dichotomized using this clinical threshold with participants deemed as either well controlled or poorly controlled. The C-ACT (α = .79) and ACT (α = .84) classify children and adolescents as poorly controlled or well controlled and, as shown by Liu et al. (2007) and Nathan et al. (2004), demonstrate good reliability and cross-sectional validity. Both versions assess asthma's interference with activities, asthma symptoms, and nighttime awakenings. The Spanish ACT exhibits good reliability (α = .84) and validity (Vega et al., 2007) while the larger parent study has assessed the C-ACT for cultural relevancy through the translation/back-translation of the test. This measure was administered at Session 1.

Asthma Quality of Life

The Pediatric Asthma Quality of Life Questionnaire (PAQLQ) is a 23-item self-report measure used to assess the impact of asthma on daily life for children 7-17 years-of-age (Juniper et al., 1996). The PAQLQ consists of 3 domains: Activity Limitation (5 items), Symptoms (10 items), and Emotional Functioning (8 items). Using a 7-point Likert scale that ranges from 1 = *all of the time* to 7 = *none of the time,* children indicate their level of impairment based on how much their asthma symptoms have interfered with their daily

functioning during the past week. An average score is calculated from the mean score across all items of the PAQLQ (scores ranging from 1 – 7), with lower scores representing greater impairment. The PAQLQ is devised with simple language to help facilitate comprehension and demonstrates good responsiveness in distinguishing patient declines or improvements (Juniper et al., 1996). The measures' reproducibility in patients who were stable (ICC = .95) indicates its' strength for discriminating between patients of different impairment levels. Moreover, Lobo et al. (2007) demonstrate very high reliability for individual and overall scale scores for the PAQLQ, ranging from .81 to .96 ($p < .001$). Regarding construct validity, the PAQLQ demonstrated adequate negative correlations with asthma clinical parameters ranging from -0.25 to -0.44. A cross-culturally adapted Spanish form of the PAQLQ has been standardized, demonstrating similar internal consistency, validity, and sensitivity to clinical changes (Tauler et al., 2001). This instrument was administered at Session 1 and the average score was analyzed as a continuous measure.

Asthma Management

QR Medication Use. Electronic Doser devices (Meditrack, Massachusetts, USA) were fitted to all QR medications in Metered Dose Inhaler (MDI) form at Session 1 in order to objectively record daily inhaler use across 30-day periods. All QR medications in MDI form were fitted with a Doser device at Session 1 that will record daily inhaler use across 30-day periods. Data for subjects with more than one QR inhaler were combined (i.e., those with "home" and "school" MDIs for the same medication). The assessment period days between Session 1 and Session 2 varied depending on the coordination of their appointment dates. For any value on a given day exceeding 12 puffs, that day's total puffs were truncated down to 12 puffs. The final value across a 30-day period was determined by subtracting the number of

extra puffs (exceeding 12) from the sum total number of puffs taken across each day. Data was retroactively downloaded at Session 2 to reflect the child's frequency of MDI use 30 days prior. Dyads were encouraged to report changes in medication by providers so that any modification in terms of use were accounted for. Dosers demonstrate greater reliability for tracking medication use than pharmacy record or self-report (Jentzsch et al., 2009). This information was reported in a database for further examination.

Daily Asthma Medication Adherence. Electronic Doser devices (Meditrack, Massachusetts, USA) were fitted to all ICS medications in MDI form at Session 1 in order to objectively record daily inhaler use across 30-day periods. Data was retroactively downloaded at Session 2 to reflect the child's frequency of MDI use 30 days prior. Once downloaded, the percentage of adherence was calculated as the total number of daily doses taken by a child divided by the number of doses prescribed daily across the period of monitoring. Dyads were encouraged to report changes in medication by providers so that any modification in terms of adherence were considered. Incidental recordings of doses or dumping of medication between sessions were accounted for by data reduction: any day with dose recordings greater (> 100%) than the prescribed dosage was curtailed to 100%. Dosers demonstrate greater reliability for tracking medication adherence than pharmacy record or self-report (Jentzsch et al., 2009).

Smartinhaler/Smartdisk were used to monitor ICS medication adherence for certain MDI and Dry Powder Inhalers (DPI) with design features that aren't compatible with Dosers. Smartinhalers' were fitted to medications at Session 1 and their data retroactively downloaded at Session 2. The Smartinhalers' battery life lasts up to 3 months before recharging is necessary and can record up to 6,000 actuations while Smartdisks record up to

1,400 actuations. The reliability of both devices for real world medication monitoring has been established (Patel et al., 2013).

MEMS-6 TrackCap for oral medications were used to monitor the use of Leukotriene Receptor Antagonist (LTRA) medications for asthma (e.g., Singulair). TrackCaps' were fitted to medications at Session 1 and their data retroactively downloaded at Session 2. It is the most commonly used electronic adherence monitoring (Rapoff, 2010; Riekert & Rand, 2002) device and reports of failure are rare. The TrackCap stores time-stamped recordings each time the medication vial is opened and closed. Data are easy to download and battery life can last up to 36 months.

Parent Asthma Illness Representations

The Asthma Illness Representation Scale (P-AIRS) is a 37-item measure that was used to assess parent/caregiver asthma illness beliefs and their association with lay or professional models (Sidora-Arcoleo et al., 2010a). The P-AIRS is comprised of 5 subscales used to identify barriers and risk factors for poor adherence to controller medications. The subscales include Treatment Expectations (8 items), Attitudes Towards Medication Use (8 items), Facts Regarding Asthma (11 items), The Nature of Asthma Symptoms (5 items), and Emotional Aspects of Medication Use (5 items). Items are scored on a five-point Likert scale that ranges from 1 = *strongly agree* to 5 = *strongly disagree*. The average score is the mean score across all items of the P-AIRS measure (37 items) and ranges from 1 – 5. In regards to asthma management, greater average scores demonstrate closer alignment with the professional model, in lieu of the lay model. Initial data comparing white and African American samples in Rochester to a latter and primarily inner-city, ethnic-minority sample from the Bronx, New York extends validation of the AIRS. The AIRS has been validated in

both English (α = 0.82) and Spanish (α = 0.77) and has shown acceptable internal reliability (Sidora-Arcoleo et al., 2010b). Therefore, this measure was administered at Session 1 (English or Spanish) and the average score was analyzed.

Childhood Anxiety

The Multidimensional Anxiety Scale for Children 2nd Edition–Self-Report (MASC-2-SR) is a 50-item measure based on the original form (MASC; March et al., 1997) that was used to assess anxiety for children ranging from 8-19 years-of-age for this study (March, 2013). The MASC-2-SR is composed of 6 scales (some with overlapping items) and 4 subscales examining key facets of anxiety in youth: Separation Anxiety/Phobias (9 items), Generalized Anxiety Disorder (GAD; 10 items), Social Anxiety (Total SA, Humiliation/Rejection and Performance Fears subscales (9 items), Obsessions and Compulsions (10 items), Physical Symptoms (Total PS; Panic and Tense/Restless subscales; 12 items), and Harm Avoidance (8 items). Certain scales are also merged to determine five indices: Separation/Panic Index, Social Anxiety Index, Obsessive-Compulsive Index, Physical Symptoms Index, and Hard Avoidance Index. There is also an inconsistency index. Respondents are asked to rate their experience of symptomology "in the last while" for each item on a 4-point Likert scale: ranging from *never true about me* (1) to *often true about me* (4). Total scores, T-scores, and anxiety probability are then generated. Total MASC-2-SR scores range from 0 - 150 and are the sum of all items with higher scores indicating greater severity of anxiety symptoms.

The original measure (MASC) demonstrated good internal reliability (Baldwin & Dadds, 2007; Dierker et al., 2001) and high test-retest reliability (March & Sullivan, 1999) as well as strong convergent and divergent validity (March et al., 1997). Moreover, the MASC

has exhibited promising predictive validity for identifying children and adolescents with anxiety disorders (van Gastel & Ferdinand, 2008; Wei et al., 2014). The more relevant and revised form, the MASC-2-SR (Fraccaro et al., 2015), has also yielded acceptable internal reliability ($\alpha = .92$) and high test-retest reliability with corrected correlation values ranging from .80 to .94 ($p < .001$). Of note, Caucasian youth tended to score significantly higher than Hispanic/Latino and African American youth on several of the scales/subscales as well as on the Total Score. To assess anxiety in subjects who prefer Spanish, a process of translation, back-translation, and cross-cultural equivalence was employed (Canino & Bravo, 1994) together with a translation service (Einstein-Montefiore Institute for Clinical and Translational Research; 5UL-1TR001073-02). For this study, T-scores were analyzed as a continuous measure (categorical cutoffs: scores 0 – 40; Average, 55 – 59; High Average, 60 – 64; Slightly Elevated, 65 – 69; Elevated, 70 – 90; Very Elevated). This measure was administered at Session 1.

Procedure

The proposed study amassed and analyzed data from Session 1 (asthma outcome data) and Session 2 (medication use and adherence data when first available), prior to the administration and effects of intervention. The time frame between Sessions 1 and 2 was at least 4 weeks due to the longitudinal nature of the larger study that intends to gather symptom perception data prior to the intervention. The assessment of obesity, P-AIRS, MASC-2, C-ACT/ACT and PAQLQ occurred at Session 1. Distribution and attachment of electronic devices to monitor QR and ICS/LTRA medications took place at Session 1 with initial data collection at Session 2. The cross-sectional nature of the proposed study is necessary to understand the associations between such measures prior to the impact of the

intervention. Due to the extenuating circumstances caused by the COVID-19 pandemic and suspension of in-person visits, direct measures of height, weight and ultimately BMI were inaccessible. Thus, the cutoff for data collection occurred on March 20th, 2020.

Data Collection, Analysis, and Interpretation

Statistical Approach

Analytical modeling and testing of aims were carried out by IBM SPSS Statistical Software version 28.0 (Armonk, New York). Descriptive statistics were used to summarize patterns in the data and examine the distribution of categorical and continuous variables' total scaled scores. BMI was originally analyzed as a continuous variable. After further consideration, it was determined that obesity would be analyzed as a three-group categorical variable (obese, overweight, and majority), in which underweight participants were subsumed into the majority group. Analyses presented below only pertain to obesity as a categorical variable. Data cleaning, dichotomizing of the asthma control variable, and devising percentages of the medication adherence variables was also conducted. First, one-way analyses of variance (ANOVAs) were conducted to determine if BMI class was associated with any of the outcome variables in bivariate analyses. Then, potential covariates such as age, sex, ethnicity, race, and level of education were examined using a variety of statistics including independent samples *t*-tests, chi squares, and ANOVAs. Such variables were controlled for when found to be associated with the outcome variables and were considered adjusted analyses. Hypotheses were tested using a variety of regression techniques based on the distribution of those variables.

Specific Aim 1

To examine the degree to which obesity was associated with asthma control (ACT; 1a), self-reported quality of life specific to asthma (PAQLQ; 1b), children's use of quick relief medication (QR; 1c), and adherence to daily asthma medication (ICS and/or LTRA; 1dI and 1dII) in a sample of urban youth with asthma.

Hypothesis 1a: This hypothesis was tested using a hierarchical logistic regression analysis, with asthma control (dichotomous) as the criterion and obesity as the predictor, as well as one covariate (child sex assigned at birth). The three-category obesity variable was represented using two dummy variables using contrast coding which compared (a) the obese group to the majority group (named MvOB, coded obese = -1, majority = 1, and overweight = 0), and (b) the obese to overweight group (named OWvOb, coded obese = -1, majority = 0, and overweight = 1). Together, these two variables represent all three BMI classes, and allowed for planned comparisons of (a) majority and obese groups, and (b) overweight and obese groups.

Hypothesis 1b: This hypothesis was tested using a hierarchical multiple linear regression analysis, with asthma quality of life as the criterion and obesity as the predictor, as well as one covariate (child sex assigned at birth). The three-category obesity variable was represented using two dummy variables.

Hypothesis 1c: This hypothesis was tested using a hierarchical logistic regression analysis, with quick relief medication use (dichotomous) as the criterion and obesity as the predictor. The three-category obesity variable was represented using two dummy variables.

Hypothesis 1dI and 1dII: This hypothesis was tested using a hierarchical multiple linear regression analysis, with percent adherence to daily asthma medication (ICS and/or LTRA) as the criterion and obesity as the predictor. The three-category obesity variable was represented using two dummy variables.

Specific Aim 2

To examine the degree to which obesity, Parent/Caregiver Asthma Illness Representations (P-AIRS), and the interaction between the two, predicted asthma control (ACT; 2a), self-reported quality of life specific to asthma (PAQLQ; 2b), children's use of quick relief medication (QR; 2c), and adherence to daily asthma medication (ICS and/or LTRA; 2dI and 2dII) in a sample of urban youth with asthma.

Hypothesis 2a: This hypothesis was tested using a hierarchical logistic regression analysis, with asthma control (dichotomous) as the criterion and obesity (using the two dummy variables described earlier to represent the three-group variable), P-AIRS, and the interaction of P-AIRS and the two dummy variables as predictors, as well as one covariate (child sex assigned at birth). The two interaction effects were computed by multiplying each of the dummy variables (MvOW, OWvOb), which have been coded -1, 1, or 0 as described in Hypothesis 1A by the P-AIRS mean score. This resulted in an interaction effect score for each subject. A significant interaction effect in the hierarchical regression analysis indicated significant moderation.

Hypothesis 2b: This hypothesis was tested using a hierarchical multiple linear regression predicting asthma quality of life. One covariate was entered in the first step (child sex assigned at birth), main effects of dummy variables: obesity vs overweight, obesity vs majority, and P-AIRS entered in the second step, and finally, the

interaction of the obesity dummy variables by P-AIRS in the third step to test the moderation effect.

Hypothesis 2c: This hypothesis was tested using a hierarchical logistic regression predicting use of quick relief medication (dichotomous). The main effects of obesity dummy variables and P-AIRS were entered in the first step while the interaction of obesity dummy variables x P-AIRS were entered in the second step to test the moderation effect. A statistically significant interaction effect of the obesity dummy variables x P-AIRS indicated significant moderation.

Hypothesis 2dI and 2dII: This hypothesis was tested using a hierarchical multiple linear regression predicting percent adherence to daily asthma medication. The main effects of dummy variables: obesity vs majority, obesity vs overweight, and P-AIRS were entered in the first step while the interaction of the obesity dummy variables by P-AIRS were entered in the second step to test the moderation effect.

Specific Aim 3

To examine the degree to which obesity, self-reported child anxiety (MASC-2), and the interaction between the two, predicted asthma control (ACT; 3a), self-reported quality of life specific to asthma (PAQLQ; 3b), children's use of quick relief medication (QR; 3c), and adherence to daily asthma medication (ICS and/or LTRA; 3dI and 3dII) in a sample of urban youth with asthma.

Hypothesis 3a: This hypothesis was tested using a hierarchical logistic regression analysis, with asthma control (dichotomous) as the criterion and obesity dummy variables, MASC-2 and their interaction as predictors, as well as one covariate (child sex assigned at birth). The two interaction effects were computed by multiplying the

MASC-2 total scores by each of the dummy variables (MvOW, OWvOb) as described in Hypothesis 2A. A statistically significant interaction effect of the obesity dummy variables x MASC-2 indicated significant moderation.

Hypothesis 3b: This hypothesis was tested using a hierarchical multiple linear regression predicting asthma quality of life. One covariate was entered in the first step (child sex assigned at birth), with main effects of dummy variables: obesity vs overweight, obesity vs majority, and MASC-2 entered in the second step, and finally, the interaction of the obesity dummy variables by MASC-2 in the third step to test the moderation effect.

Hypothesis 3c: This hypothesis was tested using a logistic regression predicting use of quick relief medication (dichotomous). The main effects of obesity dummy variables x MASC-2 were entered in the first step while the interaction of obesity x MASC-2 were entered in the second step to test the moderation effect. A statistically significant interaction effect of the obesity dummy variables x MASC-2 indicated significant moderation.

Hypothesis 3d: This hypothesis was tested using a hierarchical multiple linear regression predicting percent adherence to daily asthma medication. The main effects of dummy variables: obesity vs overweight, obesity vs majority, and MASC-2 were entered in the first step, while the interaction of the obesity dummy variables by MASC-2 were entered in the second step to test the moderation effect.

Power Analysis

Power analyses were conducted using G*Power software, version 3.1.9.4. Assumptions of the power analysis were alpha = .05, power = 80%, with an estimated 3

covariates. Power analyses for Aim 1 included 1 main effect. Those for Aims 2 and 3 included 2 main effects, and 1 interaction entered into the regression. All power analyses were conducted estimating the effect size of either the main effect (Aim 1) or the interaction (Aims 2 and 3), which could be significantly detected given the obtained sample size of 303, the alpha level (.05), and power of 80%. Given the various types of analysis being proposed, a sample of 303 subjects would give 80% or power of detecting significant effects in the small range (e.g., OR = 1.67, f = .02).

Logistic Regression

The power analysis was conducted for a z-test for a logistic multiple regression. The power analysis (Table 2) conducted was to determine the size of effect that would be detectable given the obtained sample size (303), alpha, and power. Assuming 3 covariates, it was determined that with 303 subjects, the analyses would have 80% power to detect a main effect (Aim 1) of OR 1.50 or greater, or an interaction (Aims 2 and 3) with the effect size of OR = 1.50 or greater and similar to previous literature (Koster, Wijga, et al., 2011).

Table 2

Effect Sizes for Logistic Multiple Regression

Effect Size (OR)	Power	Effect Size	Sample Size
1.5	.74	Small	303
2.5	.90	Medium	303
4.3	.96	Large	303

Hierarchical Linear Multiple Regression

The power analyses were conducted for an F-test for a linear multiple regression with fixed model, R^2 increase. The power analysis (see Table 3) conducted was to determine the size of effect that would be detectable given the obtained sample size (303), alpha, and power. At an alpha value of 0.05, an estimated 3 covariates are expected, with either a main effect (Aim 1) or 2 main effect predictors and an interaction (Aims 2 and 3). Using G*Power software, it was determined that with 303 subjects, the analysis would have 80% power to detect a main effect with effect size of $f^2 = .02$ (Aim 1) or an interaction with the effect size of f = .02 or greater and similar to previous literature (Yoos et al., 2007; Koster, Raaijmakers et al., 2011).

Table 3

Effect Sizes for Hierarchical Linear Multiple Regression

Effect Size (f) of interaction effect)	Power	Effect Size	Sample Size
.01	.74	Small	303
.03	.90	Medium	303
.05	.96	Large	303

Previous Research for Power Analysis

Specific Aim 1

Hypothesis 1a. Previous research linking obesity and worse asthma control has yielded large to very large effect sizes (Lavoie et al., 2006; Maalej et al., 2012). Translating

results into common effect size statistics results in f = 1.361 (consistent with d = 3.33; Lavoie et al., 2007), odds ratio = 20.0 (Maleej et al., 2012), and *r* = .52 (consistent with d = 1.22; Maalej et al., 2012). Thus, a similarly large effect of the main effect, obesity on asthma control, is expected to be found in the current study.

Proposed Analysis. This hypothesis was tested using a hierarchical logistic regression analysis, with asthma control (dichotomous) as the criterion and obesity dummy variables (obesity vs majority; obesity vs overweight) as predictors, as well as an estimated three possible covariates. See Power Analysis section above on Logistic Regression.

Hypothesis 1b. Several studies have found that overweight status is associated with poorer quality of life and these studies found large to very large effect sizes (f = .771; Lavoie et al., 2006; f = 1.104; Maalej et al., 2012). Therefore, of similar magnitude (large-very large), a main effect of obesity on adherence is expected to be found in the current study. The power analysis was conducted to determine what effect size would be detectable at 80% power with the obtained sample of 303 subjects for the addition of the interaction to the model.

Proposed Analysis. This hypothesis was tested using a hierarchical multiple regression predicting asthma quality of life. An estimated three covariates were entered in the first step, followed by obesity dummy variables (obesity vs majority; obesity vs overweight) in Step 2. See Power Analysis section above on Hierarchical Linear Multiple Regression.

Hypothesis 1c. Previous research analyzing child BMI continuously and categorically found that being overweight or obese was associated with greater use of quick relief medication (Quinto et al., 2011). This study found small effect sizes with Odds Ratios between 1.15 to 1.28 depending on the medication assessed and the BMI classification

utilized. Similar small effect sizes for the main effects of BMI on PRN medication use are expected. However, no research is available to estimate the expected effect of the interaction proposed (obesity x P-AIRS). Again, without previous literature on relevant interaction effects, the power analysis was conducted to determine what effect size would be detectable at 80% power with the obtained sample of 303 subjects for the addition of the interaction to the model was used to obtain a range of estimates for the sample size needed.

Proposed Analysis. This hypothesis was tested using a logistic regression predicting quick relief medication use. An estimated three covariates were entered in the first step, with the main effect of obesity dummy variables (obesity vs majority; obesity vs overweight) entered in the second step. See Power Analysis section above on Logistic Regression.

Hypothesis 1d . No research was found on the relationship between weight/obesity and adherence to asthma daily medication (ICS/LTRA). However, BMI as a continuous variable was found to be associated with adherence to diabetes meds, with a small-medium effect size found (r = .20; Farhat et al., 2019).

Proposed Analysis. This hypothesis was tested using a hierarchical multiple linear regression predicting ICS/LTRA medication adherence. An estimated three covariates were entered in the first step, with the main effect of obesity dummy variables (obesity vs majority; obesity vs overweight) entered in the second step. See Power Analysis section above on Hierarchical Linear Multiple Regression.

Specific Aim 2

Hypothesis 2a. Research has also found that parental medication beliefs are associated with asthma control with small-medium effect size (Risk Ratio = 1.6; Koster, Wijga, et al., 2011). Without previous literature on relevant interaction effects, the power

analysis was conducted to determine what effect size would be detectable at 80% power with the obtained sample of 303 subjects.

Proposed Analysis. This hypothesis was tested using a hierarchical logistic regression analysis, with asthma control (dichotomous) as the criterion and obesity dummy variables (obesity vs majority; obesity vs overweight), P-AIRS and their interaction as predictors, as well as an estimated three possible covariates. A statistically significant effect of the obesity dummy variables x P-AIRS interaction indicated significant moderation. See Power Analysis section above on Logistic Regression.

Hypothesis 2b. No literature was available to estimate the expected effect of the interaction proposed. Thus, the power analysis was conducted to determine what effect size would be detectable at 80% power with the obtained sample of 303 subjects for the addition of the interaction to the model.

Proposed Analysis. This hypothesis was tested using a hierarchical multiple linear regression predicting asthma quality of life. An estimated three covariates were entered in the first step, main effects of obesity dummy variables (obesity vs majority; obesity vs overweight) and P-AIRS entered in the second step, and finally, the interaction of obesity dummy variables x P-AIRS in the third step to test the moderation effect. See Power Analysis section above on Hierarchical Linear Multiple Regression.

Hypothesis 2c. Similarly, no research was available to estimate the expected effect of the interaction proposed. Thus, the power analysis was conducted to determine what effect size would be detectable at 80% power with the obtained sample of 303 subjects for the addition of the interaction to the model.

Proposed Analysis. This hypothesis was tested using a logistic regression predicting quick relief medication use. An estimated three covariates were entered in the first step, main effects of obesity dummy variables (obesity vs majority; obesity vs overweight) and P-AIRS entered in the second step, and finally, the interaction of obesity dummy variables x P-AIRS in the third step to test the moderation effect. See Power Analysis section above on Logistic Regression.

Hypothesis 2d. Previous work indicates that parental illness beliefs or representations are associated with adherence to daily controller medication (Koster, Raaijmakers et al., 2011; Yoos et al., 2007). These studies found small-medium (OR = 2.32) to medium (β = -.285, equivalent to r = -.335) effect sizes. Another study of diabetes medication adherence in adults found a small-medium sized effect (r = -.18) of illness beliefs on adherence (Farhat et al., 2019). Therefore, it was expected that of similar magnitude (small-medium), a main effect of parental illness representations on medication adherence would be found in the proposed study. While no studies were available to estimate the expected effect of the interaction proposed (obesity x P-AIRS), the power analysis was conducted to determine what effect size would be detectable at 80% power with the obtained sample of 303 subjects for the addition of the interaction to the model.

Proposed Analysis. This hypothesis was tested using a hierarchical multiple linear regression predicting ICS/LTRA medication adherence. An estimated three covariates were entered in the first step, main effects of obesity dummy variables (obesity vs majority; obesity vs overweight) and P-AIRS entered in the second step, and finally, the interaction of obesity dummy variables x P-AIRS in the third step to test the moderation effect. See Power Analysis section above on Hierarchical Linear Multiple Regression.

Specific Aim 3

Hypothesis 3a. Research among anxiety and asthma control has demonstrated mixed findings. Large effects of anxiety on asthma control (r = - .517, r = .55) have been found in some studies (Fernandes et al., 2010; Shams et al., 2018), while no effect was found in others (OR = 1.00; Feldman et al., 2013). No research was available to estimate the expected effect of the interaction proposed (obesity x Anxiety). Thus, the power analysis was conducted to determine what effect size would be detectable at 80% power with the obtained sample of 303 subjects for the addition of the interaction to the model.

Proposed Analysis. This hypothesis was tested using a logistic regression analysis, with asthma control (dichotomous) as the criterion and obesity dummy variables (obesity vs majority; obesity vs overweight), MASC-2, and their interaction as predictors, as well as an estimated three possible covariates. A statistically significant effect of the obesity dummy variables x MASC-2 interaction indicated significant moderation. See Power Analysis section above on Logistic Regression.

Hypothesis 3b. Anxiety also seems to demonstrate an association to poorer quality of life for asthmatics, with medium to large effect sizes (r = -.48; Feldman et al., 2009; standardized beta ranging from -.255 to -.561; Kullowatz et al., 2007; and d ranging from .5 to 1.0; Shams et al., 2018). Therefore, it was expected that the main effect of anxiety on quality of life would be in the medium to large range. However, no studies were available to estimate the expected effect of the interaction proposed. Thus, the power analysis was conducted to determine what effect size would be detectable at 80% power with the obtained sample of 303 subjects for the addition of the interaction to the model.

Proposed Analysis. This hypothesis was tested using a hierarchical multiple linear regression predicting asthma quality of life. An estimated three covariates were entered in the first step, main effects of obesity dummy variables (obesity vs majority; obesity vs overweight) and MASC-2 entered in the second step, and finally, the interaction of obesity dummy variables x MASC-2 in the third step to test the moderation effect. See Power Analysis section above on Hierarchical Linear Multiple Regression.

Hypothesis 3c. Research examining the effect of anxiety on the use QR medication found that greater anxiety was associated with greater use of quick relief medication, with medium effect sizes (r = .34; Feldman et al., 2009; standardized beta = .29, Feldman et al., 2013). It is therefore expected that the main effects of MASC-2 will show medium effect sizes in the current research. However, no studies were available to estimate the expected effect of the interaction proposed (obesity x MASC-2). Thus, the power analysis was conducted to determine what effect size would be detectable at 80% power with the obtained sample of 303 subjects for the addition of the interaction to the model.

Proposed Analysis. This hypothesis was tested using a logistic regression predicting quick relief medication use. An estimated three covariates were entered in the first step, main effects of obesity dummy variables (obesity vs majority; obesity vs overweight) and MASC-2 entered in the second step, and finally, the interaction of obesity dummy variables x MASC-2 in the third step to test the moderation effect. See Power Analysis section above on Logistic Regression.

Hypothesis 3d. No literature could be found on the relationship between anxiety and medication adherence. Likewise, no studies were available to estimate the expected effect of the interaction proposed (obesity x MASC-2). Thus, the power analysis was conducted to

determine what effect size would be detectable at 80% power with the obtained sample of 303 subjects for the addition of the interaction to the model.

Proposed Analysis. This hypothesis was tested using a hierarchical multiple linear regression predicting ICS/LTRA medication adherence. An estimated three covariates were entered in the first step, main effects of obesity dummy variables (obesity vs majority; obesity vs overweight) and MASC-2 entered in the second step, and finally, the interaction of obesity dummy variables x MASC-2 in the third step to test the moderation effect. See Power Analysis section above on Hierarchical Linear Multiple Regression.

Chapter III: Results

Refusal Data

Refusal data from both in-person recruitment and mailing-related phone calls were analyzed from the parent study, CAPS, in order to examine possible differences between individuals who chose to participate and individuals who were not interested in participation. Data were available for 1037 dyads who underwent an initial eligibility screening to participate in CAPS. Of those screened, 354 (34.1%) dyads were enrolled in the study, 339 (32.7%) were deemed ineligible, and 344 (33.2%) were either lost to outreach and/or no longer interested. For the 339 dyads who were deemed ineligible, reasons attributed were as follows: no controller medication (89.7%), mental health and/or cognitive impairments (6.8%), other (i.e., no asthma symptoms in the past 12 months, sibling already enrolled/completed; 2.0%) and other pulmonary condition (1.5%). Therefore, 303 participants were included in this study as data were collected and analyzed prior to the completion of the larger RCT (Figure 4).

Participant Characteristics

This study's sample included 303 parent-child dyads (see Table 4). Children were predominately male (53.8%) and caregivers were primarily female (94.1%). The average age of children was 13 years-of-age (M = 13.2, SD = 2.22) while the average age of caregivers was 42 years-of-age (M = 42.44, SD = 8.11). Children mainly identified as either Puerto Rican (32.7%) or Black-non Latinx (32.7%) while caregivers predominately identified as Puerto Rican (31.7%). For this sample at baseline, children tended to have moderate-

persistent asthma (43.5%). In regards to level of education, most female (70.6%) and male (84.4%) heads of household had at least some high school education. Finally, the majority of families were living below the poverty threshold (71.9%).

Obesity

All 303 children participating had their height and weight measured at Session 1. Body Mass Indexes (BMIs) were calculated based on such measures and children with BMIs at or above the 95th percentile compared to similar peers (age and sex specific), were classified as obese (40.3%) (see Table 5). Children with BMIs greater than or equal to the 85th percentile and less than the 95th percentile (age and sex specific) were classified as overweight (17.1%). Lastly, children with BMIs less than the 85th percentile were classified as majority (42.6%), which for the purpose of analyses, included six children who would otherwise be characterized as underweight. As indicated by Table 6, the mean across all child BMIs was 24.84 (*SD* = 7.54) with values that ranged from 12.1 – 74.6. The data were somewhat kurtotic (kurtosis = 6.22).

Figure 4

Flow Chart: Participant Enrollment and Screening

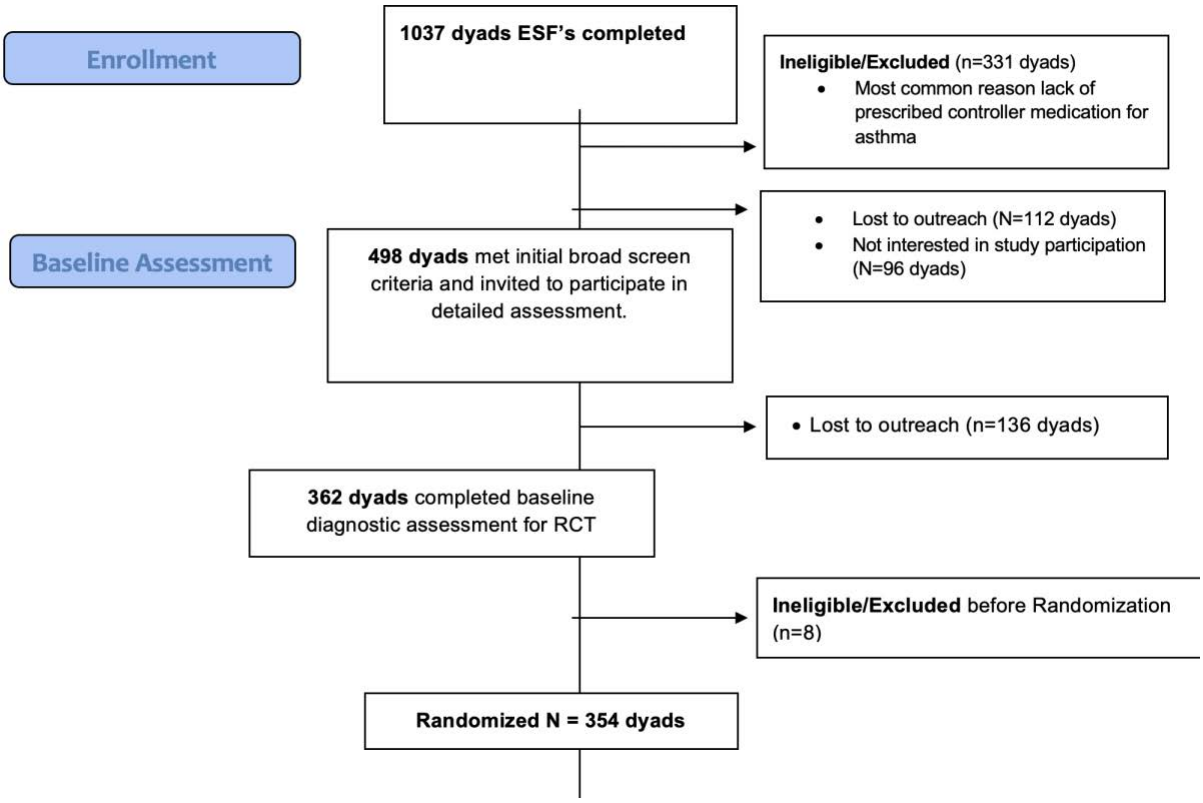


Table 4

Participant Characteristics By BMI Class

Variable	Majority (*n* = 129)	Overweight (*n* = 52)	Obese (*n* = 122)	Total Sample (*N* = 303)	*p*
Child Age (*M* (*SD*))	13.01 (2.18)	13.53 (2.25)	13.26 (2.26)	13.2 (2.22)	.33
Caregiver Age (*M* (*SD*))	41.54 (7.51)	42.52 (9.18)	43.38 (8.21)	42.44 (8.11)	.20
Child Sex (*N* (%))					.02*
Female	61 (47.3)	32 (61.5)	47 (38.5)	140 (46.2)	
Male	68 (52.7)	20 (38.5)	75 (61.5)	163 (53.8)	
Caregiver Sex (*N* (%))					.37
Female	121 (93.8)	51 (98.1)	113 (92.6)	285 (94.1)	
Male	8 (6.2)	1 (1.9)	9 (7.4)	18 (5.9)	
Child Ethnicity (*N* (%))					.48
Puerto Rican	46 (35.7)	12 (23.1)	41 (33.6)	99 (32.7)	
Black-non Latinx	45 (34.9)	16 (30.8)	38 (31.1)	99 (32.7)	
Dominican	16 (12.4)	8 (15.4)	18 (14.8)	42.(13.9)	
Other Latino	17 (13.2)	11 (21.2)	21 (17.2)	49 (16.2)	
Other	5 (3.9)	5 (9.6)	4 (3.3)	14 (4.5)	
Caregiver Ethnicity (*N* (%))	46 (35.7)	13 (25.0)	37 (30.3)	96 (31.7)	.62
Puerto Rican					
Black-non Latinx	32 (24.8)	12 (23.1)	31 (25.4	75 (24.8)	
Dominican	16 (12.4)	8 (15.4)	17 (13.9)	41 (13.5)	
Other Latino	17 (13.2)	11 (21.2)	26 (21.3)	54 (17.8)	
Other	18 (14.0)	8 (15.4)	11 (9.0)	37 (12.2)	

Table 4 (Continued)

Variable	Majority (n = 129)	Overweight (n = 52)	Obese (n = 122)	Total Sample (N = 303)	p
Education – Female Head of Household (N (%))				N = 296	.01*
Less than High School	27 (21.6)	13 (25.5)	47 (39.2)	87 (29.4)	
High School	25 (20.0)	15 (29.4)	25 (20.8)	65 (22.0)	
More than High School	73 (58.4)	23 (45.1)	48 (40.0)	144 (48.6)	
Education – Male Head of Household (N (%))				N = 154	.19
Less than High School	19 (27.5)	9 (39.1)	27 (43.5)	24 (15.6)	
High School	19 (27.5)	7 (30.4)	19 (30.6)	76 (49.4)	
More than High School	31 (44.9)	7 (30.4)	16 (25.8)	54 (35.0)	
Poverty Threshold, Binary (N (%))					.74
Below Threshold	90 (69.8)	39 (75.0)	89 (73.0)	218 (71.9)	
Above Threshold	39 (30.2)	13 (25.0)	33 (27.0)	85 (28.1)	
Household Income, Binary (N (%))					.15
Below 1000/month	39 (30.2)	17 (32.7)	51 (41.8)	107 (35.3)	
Above 1000/month	90 (69.8)	35 (67.3)	71 (58.2)	196 (64.7)	
Child Asthma Severity (N (%))					.31
Intermittent	8 (6.2)	5 (9.6)	6 (4.9)	19 (6.3)	
Mild-persistent	21 (16.3)	11 (21.2)	20 (16.4)	52 (17.2)	
Moderate-persistent	65 (50.4)	19 (36.5)	48 (39.3)	132 (43.5)	
Severe-persistent	35 (27.1)	17 (32.7)	48 (39.3)	100 (33.0)	

Note. "Other Latino" includes Mexican, Latino Central American, Latino South American, and "Other" category includes Jamaican, Black-Caribbean, and African. BMI Classes: Majority; < 85th percentile, Overweight; ≥ 85th and < 95th percentile, Obese; ≥ 95th percentile.

Table 5

Frequencies for Standard BMI Classifications

BMI Class	*N*	Percent (%)
Obese	122	40.3
Overweight	52	17.1
Majority	123	40.6
Underweight	6	2.0
Total	303	100.0

Note. Child Age and Sex specific.

Asthma Control Test / Child-Asthma Control Test

All 303 participants reported their subjective experience of asthma control at Session 1, as measured by the ACT (n = 192) and C-ACT (n = 111) (see Table 6). Cronbach's alpha was used to assess the reliability for ACT (α = .801) and C-ACT (α = .763) and both measures had acceptable reliability. For ACT, the mean total score was 18.75 (SD = 4.39). For C-ACT, the mean total score was 18.69 (SD = 4.71). The data were normally distributed. Total scores for ACT ranged from 6 - 25 and for C-ACT, 4 - 27. The asthma control measure was dichotomized into 2 groups: 147 (48.5%) participants demonstrated well controlled asthma and 156 (51.5%) participants demonstrated poorly controlled.

Table 6

Descriptive Statistics By Variable

Variable	*N*	Mean	*SD*	Min	Max	Kurtosis	Skewness
Body Mass Index	303	24.84	7.54	12.10	74.60	6.218	1.577
(Child) C-ACT	111	18.69	4.71	4.00	27.00	0.184	-0.644
(Adolescent) ACT	192	18.75	4.39	6.00	25.00	-0.019	-0.684
PAQLQ	303	5.28	1.26	1.48	7.00	-0.210	-0.779
QR Use	217	20.84	24.23	0.00	100.00	1.604	1.471
ICS Adherence	173	37.95	28.47	0.00	99.17	-0.988	0.434
LTRA Adherence	118	47.89	32.13	0.00	100.00	-1.385	0.000
P-AIRS	303	3.11	0.31	2.11	3.96	0.194	-0.158
MASC-2	303	56.28	10.80	40.00	84.00	-0.676	0.311

Note. Body Mass Index – Age/Sex specific. ACT: Subjective Asthma Control – Asthma Control Test – Child: C-ACT (10-11 years of age) (Liu et al., 2007); Adolescent: ACT (12-17 years of age) (Nathan et al., 2004); PAQLQ*:* Pediatric Asthma Quality of Life Questionnaire (Juniper et al., 1996); QR Use*:* Quick Relief Medication Use - Mean Percent Frequency of Days per Week; ICS Adherence: Inhaled Corticosteroid Medication Adherence – Percent Frequency; LTRA Adherence: Leukotriene Receptor Antagonist Medication Adherence – Percent Frequency; P-AIRS: Caregiver Asthma Illness Representations (Sidora-Arcoleo, 2010a); MASC-2: Multidimensional Anxiety Scale for Children (2nd ed.) (March et al., 2013) T-Scores.

For analyses with dichotomized variables of asthma control, independent sample *t*-tests revealed that there were no differences between well controlled and poorly controlled groups in child age (t [301] = 0.679, p = .50) and caregiver age (t [300] = -1.528, p = .13). Chi-square tests revealed that child sex was associated with asthma control ($\chi^2 = 5.23$, p =

.02), with male children (54.6%; $n = 89$) more likely to be well controlled than female children (41.4%; $n = 58$). Chi-square tests for caregiver ethnicity ($\chi^2 = 7.74$, $p = .10$) indicated no association with asthma control. Furthermore, Spearman's correlation demonstrated that caregiver education was not significantly associated with asthma control ($\rho = .01$, $p = .83$). In light of such findings, child sex was applied as a covariate to further analyses of asthma control.

Pediatric Asthma Quality of Life Questionnaire

All 303 participants reported their subjective experience of quality of life in relation to asthma at Session 1, as measured by the PAQLQ. For PAQLQ, the mean of average scores was 5.28 ($SD = 1.26$) (see Table 6), with scores closer to 7 indicating no impairment and scores closer to 1 indicating significant impairment. The data were normally distributed. Average total scores for PAQLQ ranged from 1.48 – 7.00.

Pearson's correlation demonstrated that PAQLQ was not associated with child age ($r = .04$, $p = .51$) or caregiver age ($r = .07$, $p = .20$). However, independent sample t-tests revealed that there was a significant association between child sex and quality of life (t [301] = 3.38, $p = .046$), with male children more likely to report greater PAQLQ than female children. Tests using ANOVA indicated that caregiver ethnicity (F [4, 298] = 2.183, $p = .07$) revealed no association with PAQLQ. Finally, Spearman's correlation demonstrated that caregiver education was not significantly associated with quality of life ($\rho = .06$, $p = .30$). Therefore, child sex was applied as a covariate to further analyses of quality of life.

Quick Relief Medication Use

A total of 217 participants provided QR use data through electronic Doser monitoring devices. Missing data for the other 86 participants were attributed to them not bringing back

devices for download at Session 2, not attaching devices to refilled medications, device failure or participants losing devices. For those with QR use data available across approximately 30 days, the mean percent frequency of days per week use was 20.84 (*SD* = 24.23); indicating overall that participants used their QR medication less than 21% of the time or less then 1.5 days per week (see Table 6). In regards to QR medication use across the sample, 26.7% (*n* = 58) of participants were persistent in their use (> 2 days per week) while 73.3% (*n* = 159) were intermittent in their use (≤ 2 days per week). Therefore, based on clinical guidelines determining asthma severity, participants' asthma did not generally cause impairment because on average, they did not use their QR medications more than 2 days each week (NHLBI, 2007). While values of skewness and kurtosis were within acceptable range, QR use was not normally distributed (based on its asymmetrical form; positively skewed). See Table 8 for further categorization of QR use by BMI class and control.

For analyses with the dichotomized variable of QR use, independent sample *t*-tests revealed that there were no differences between intermittent use (well controlled) and persistent use (poorly controlled) groups in child age (t [215] = 0.74, p = .46) and caregiver age (t [214] = -1.05, p = .30. Chi-square tests revealed that caregiver ethnicity (χ^2 = 8.31, p = .08), child gender (χ^2 = 0.02, p = .90) and caregiver education (χ^2 = 9.91, p = .45) were not significantly associated with QR use. Ultimately, none of the demographic variables tested were associated with QR use. Therefore, no covariates were applied to further analyses of QR use.

ICS Medication Adherence

A total of 173 participants provided ICS adherence data through electronic monitoring devices (Doser and/or Smartinhaler/Smartdisk). A total of 94 participants were

not prescribed ICS medication at Session 2. Missing data for the other 36 participants were attributed to them not bringing back devices for download at Session 2, not attaching devices to refilled medications, device failure or participants losing devices. For ICS adherence across the monitoring period, the mean percent frequency of daily doses taken (divided by the number of doses prescribed daily) was 37.95 (*SD* = 28.47); indicating that participants' adherence to ICS medication was less than 38% overall across the monitoring period (see Table 6). While values of skewness and kurtosis were within acceptable range, ICS adherence was not normally distributed (based on its asymmetrical form; positively skewed).

Pearson's correlation demonstrated that ICS medication adherence was not associated with child age (r = -.09, p = .23) or caregiver age (r = -.09, p = .27). Independent samples t-tests revealed that child sex was also not significantly associated with ICS adherence (t [171] = -1.70, p = .30). Tests using ANOVA demonstrated that caregiver ethnicity (F [4, 168] = 1.46, p = .22) revealed no association with ICS adherence. Finally, Spearman's correlation indicated that caregiver education was not significantly associated with ICS adherence (ρ = -.11, p = .16). Ultimately, none of the demographic variables tested were associated with ICS adherence. Therefore, no covariates were applied to further analyses of ICS adherence.

LTRA Medication Adherence

A total of 118 participants provided LTRA adherence data through electronic monitoring devices (TrackCaps device). A total of 151 participants were not prescribed LTRA medication at Session 2. Missing data for the other 34 participants were attributed to them not bringing back devices for download at Session 2, not attaching devices to refilled medications, device failure or participants losing devices. For LTRA adherence across the monitoring period, the mean percent frequency of daily doses taken (divided by the number

of doses prescribed daily) was 47.89 (*SD* = 32.13); demonstrating that participants adherence to LTRA medication was less than 48% overall (see Table 6). The data were normally distributed and the values of skewness and kurtosis were within acceptable range.

Pearson's correlation indicated that LTRA medication adherence was not associated with child age (r = -.12, p = .20) or caregiver age (r = .06, p = .50). Independent samples *t*-tests revealed that child sex was also not significantly associated with LTRA adherence (t [116] = -0.69, p = .81). Tests using ANOVA indicated that caregiver ethnicity (F [4, 113] = 1.23, p = .30) revealed no association with LTRA adherence. Lastly, Spearman's correlation indicated that caregiver education was not significantly associated with LTRA adherence (ρ = -.004, p = .97). Ultimately, none of the demographic variables tested were associated with LTRA adherence. Therefore, no covariates were applied to further analyses of LTRA adherence.

Caregiver Asthma Illness Representations

All 303 caregivers participating completed the P-AIRS at Session 1. As indicated by Table 6, the mean of average scores across all items of caregiver P-AIRS was 3.11 (*SD* = 0.31) with values that ranged from 2.11 – 3.96. Greater average scores demonstrated closer alignment with the professional model (5 = fully aligned), in lieu of the lay model (1 = fully aligned). The data were normally distributed.

Subjective Child Anxiety

All 303 child participants completed the MASC-2 at Session 1. As indicated by Table 6, the mean of T-scores for all children on MASC-2 was 56.28 (*SD* = 10.8) with values that ranged from 40.0 – 84.0. The mean was considered High Average (T-scores; 55 – 59) and the data were normally distributed.

Unadjusted Analyses

One-way analyses of variance were conducted to determine if BMI class was associated with any of the outcome variables in bivariate analyses. None of the ANOVAs showed significant differences between the BMI classes (see Table 7 and Table 8). Therefore, obesity was not directly associated with any of the asthma outcome variables prior to controlling for covariates.

Table 7

Means and Standard Deviations of Asthma Outcome Variables by BMI Class

Variable	Majority			Overweight			Obese			
	n	*M*	*SD*	*n*	*M*	*SD*	*N*	*M*	*SD*	*p*
ACT (ages 12-17)	78	18.91	4.44	37	19.54	4.35	77	18.21	4.32	.28
CACT (ages 10-11)	51	19.12	4.43	15	18.33	4.59	45	18.33	5.11	.69
CPAQLQ	129	5.36	1.20	52	5.25	1.25	122	5.20	1.32	.60
ICS Adherence	81	38.22	28.06	25	43.63	29.23	67	35.50	28.80	.18
LTRA Adherence	55	44.25	31.39	18	41.82	31.61	45	54.78	32.70	.40

Note. ACT: Subjective Asthma Control – Asthma Control Test – Child: C-ACT (10-11 years of age) (Liu et al., 2007); Adolescent: ACT (12-17 years of age (Nathan et al., 2004); PAQLQ*:* Pediatric Asthma Quality of Life Questionnaire – Average Total Scores (Juniper et al., 1996); ICS Adherence: Inhaled Corticosteroid Medication Adherence – Mean Percent Frequency; LTRA Adherence: Leukotriene Receptor Antagonist Medication Adherence – Mean Percent Frequency.

Table 8

Combined Self-reported Asthma Control (ACT and C-ACT) and Frequency of Quick Relief Medication Use (Days per Week) by BMI Class – Well vs Poorly Controlled

Variable	Majority		Overweight		Obese		
	Poor Control *n* (%)	Well Control *n* (%)	Poor Control *n* (%)	Well Control *n* (%)	Poor Control *n* (%)	Well Control *n* (%)	*p*
Asthma Control	62 (48.1)	67 (51.9)	23 (44.2)	52 (55.8)	71 (58.2)	51 (41.8)	.14
QR Medication Use	24 (24.2)	75 (75.8)	8 (25.8)	23 (74.2)	26 (29.9)	61 (70.1)	.68

Note: QR Medication Use: Well Control = intermittent use; Poor Control = persistent use

Adjusted Analyses by Aim

Specific Aim 1

Associations between BMI classifications and the following asthma outcome variables were examined: asthma control as measured by the Asthma Control Test (ACT/C-ACT), asthma quality of life as measured by the Pediatric Asthma Quality of Life Questionnaire (PAQLQ), device monitored quick relief medication use (QR use), and device monitored daily asthma medication adherence (ICS and/or LTRA).

Hypothesis 1a. A hierarchical logistic regression was applied to assess a model that examines ACT (see Table 9). Preliminary analyses demonstrated that child sex was significantly associated with ACT, and thus, it was entered as a covariate in Step 1 of the regression. The Omnibus test of model coefficients revealed that Step 1 was significant (χ^2 = 5.25, p = .02, Nagelkerke R^2 = .023) with male children more likely to be well controlled. The predictor obesity dummy variables were added at Step 2. At Step 2, the Omnibus test of model coefficients revealed that obesity dummy variables explained additional variability (χ^2

= 5.63, p = .06, Nagelkerke R^2 = .047). The Nagelkerke statistic increased by .024, indicating that the model including the obesity dummy variables showed a nearly significant increase in fit over the model with only child sex (see Table 9). Results indicated no association between obesity dummy variables and ACT; therefore, obesity was not associated with asthma control. Planned comparisons did not show significant differences between obese and majority classes (B = 0.75; p = .65; OR = 1.08, 95% CI: [0.78, 1.49]) and between obese and overweight classes (B = 0.32; p = .12; OR = 1.38, 95% CI: [0.92, 2.09]). The hypothesis was not supported.

Table 9

Hierarchical Logistic Regression Analysis for Association Between Obesity Dummy Variables and Asthma Control (N = 303)

		Coefficient							
Step	Variable	*B*	*SE*	Wald	df	Odds-Ratio	95% CI Lower	95% CI Upper	*p*
2[a]	(Constant)	-0.326	0.176	3.42	1	0.72			.06
	Child Sex	0.627	0.240	6.84	1	1.87	1.17	2.995	.01
	MvOB	0.750	0.164	0.21	1	1.08	0.78	1.486	.65
	OWvOB	0.324	0.210	2.38	1	1.38	0.92	2.085	.12

Note. Coding: Female = 0, Male = 1; Poorly Controlled = 0, Well Controlled = 1; MvOB: Majority = 1, Obese = -1; OWvOB: Overweight = 1, Obese = -1.
[a]Nagelkerke R^2 = .047

Hypothesis 1b. A hierarchical linear regression was applied to assess a model examining PAQLQ (see Table 10). Preliminary analyses demonstrated that child sex was significantly associated with PAQLQ, and thus, it was entered as a covariate in Step 1 of the regression. On average, boys demonstrated greater quality of life (PAQLQ average total scores) than girls (β = -0.20, p = .001). Sex explained 3.7% of the variance (R^2_{change} = .037, F [1, 301] = 11.42, p = .001). The predictor obesity dummy variables were added at Step 2. The full model explained 4.2% of the variance (R^2_{change} = .042, F [3, 299] = 4.40, p = .005). A 0.6% change in explained variance occurred from Step 1 to Step 2 (R^2_{change} = .006, p = .41); thus, obesity dummy variables were not associated with a significant amount of variance in PAQLQ (see Table 10). Therefore, obesity was not associated with pediatric asthma quality of life. The hypothesis was not supported.

Table 10

Hierarchical Linear Regression Analysis for Association Between Obesity Dummy Variables and Pediatric Asthma Quality of Life (N = 303)

		Coefficients					
Step	Variable	*B*	*SEB*	β	*t*	*Semi-partial r* r_{sp}	*p*
2[b]	(Constant)	6.022	0.229		26.28		<.001
	Child Sex[a]	-0.504	0.145	-0.200	-3.49	-.20	.001
	MvOB	-0.078	0.100	-0.057	-0.79	-.04	.43
	OWvOB	-0.046	0.127	-0.026	-0.36	-.02	.72

Note. Coding: Female = 0, Male = 1; MvOB: Majority = -1, Obese = 1; OWvOB: Overweight = -1, Obese = 1.

[a] R^2_{change} due to Child sex = .037;

[b] F_{change} (2, 299) = 0.89, p = .41

Hypothesis 1c. A hierarchical logistic regression was applied to assess a model that examines QR use (see Table 11). Preliminary analyses demonstrated that no covariates were significantly associated with QR use, and thus, the predictor obesity dummy variables were entered in Step 1 of the regression. The Omnibus test of model coefficients revealed that BMI class did not explain significant variability ($\chi^2 = 0.77$, $p = .68$, Nagelkerke $R^2 = .005$). Results indicated no association between obesity dummy variables and QR use; therefore, obesity was not associated with QR use. In planned comparisons (see Table 11), odds of being well controlled was equivalent for Majority as compared to Obese (OR = 1.13, 95% CI: [0.73, 1.75]) and when comparing Overweight to Obese (OR = 1.04, 95% CI: [0.58, 1.86]). The hypothesis was not supported.

Table 11

Hierarchical Logistic Regression Analysis for Association Between Obesity Dummy Variables and Quick Relief Medication Use (N = 217)

Variable	*B*	*SE*	Wald	df	Odds-Ratio	95% CI Lower	95% CI Upper	*p*
(Constant)	1.016	0.176	33.38	1	2.76			<.001
MvOB	0.123	0.222	0.31	1	1.13	0.73	1.78	.58
OWvOB	0.040	0.295	0.02	1	1.04	0.58	1.86	.89

Note. Nagelkerke $R^2 = .005$. Coding: Poorly Controlled = 0, Well Controlled = 1; MvOB: Majority = 1, Obese = -1; OWvOB: Overweight = 1, Obese = -1.

Hypothesis 1dI. A hierarchical linear regression was applied to assess a model examining daily asthma medication adherence to ICS (Doser and/or Smart device monitoring) (see Table 12). Preliminary analyses demonstrated that no covariates were

significantly associated with ICS adherence, and thus, predictors, obesity dummy variables were entered in Step 1 of the regression. The model after Step 1 explained 0.9% of the variance (R^2_{change} = .009, F [2, 170] = 0.75, p = .48). Obesity dummy variables were not associated with a significant change in variance for ICS adherence (see Table 12). Therefore, obesity was not associated with ICS medication adherence and the hypothesis was not supported.

Table 12

Hierarchical Linear Regression Analysis for Association Between Obesity Dummy Variables and Inhaled Corticosteroid Medication Adherence (N = 173)

Variable	*B*	*SEB*	β	*t*	*Semi-partial r* r_{sp}	*p*
(Constant)	39.116	2.465		15.87		<.001
MvOB	0.899	3.07	0.029	0.29	.02	.77
OWvOB	-4.51	4.113	-0.109	-1.10	-.08	.27

Note. F_{change} (2, 170) = 0.75, p = .48. Coding: MvOB: Majority = -1, Obese = 1; OWvOB: Overweight = -1, Obese = 1.

Hypothesis 1dII. A hierarchical linear regression applied to assess a model that examines daily asthma medication adherence to LTRA (TrackCaps device monitoring) (see Table 13). Preliminary analyses demonstrated that no covariates were significantly associated with LTRA adherence, and thus, the predictor, obesity dummy variables were entered in Step 1 of the regression. The model after Step 1 explained 2.9% of the variance (R^2_{change} = .029, F [2, 115] = 1.729, p = .18). Obesity dummy variables were not associated with a significant

change in variance for LTRA medication adherence (see Table 13). Therefore, obesity was not associated with LTRA medication adherence and the hypothesis was not supported.

Table 13

Hierarchical Linear Regression Analysis for Association Between Obesity Dummy Variables and Leukotriene Receptor Antagonist Medication Adherence (N = 118)

Variable	*B*	*SEB*	β	*t*	*Semi-partial r* r_{sp}	*p*
(Constant)	46.948	3.297		14.24		<.001
MvOB	2.701	4.129	0.077	0.65	.60	.51
OWvOB	5.126	5.454	0.111	0.94	.09	.35

Note. F_{change} (2, 115) = 1.73, p = .18. Coding: MvOB: Majority = -1, Obese = 1; OWvOB: Overweight = -1, Obese = 1.

Specific Aim 2

Parents' illness representations about their child's asthma as measured by the Parent Asthma Illness Representations Scale (P-AIRS) were examined as a moderator of the relationship between BMI class (associated obesity dummy variables) and children's asthma control as measured by the Asthma Control Test (ACT/C-ACT), asthma quality of life as measured by the Pediatric Asthma Quality of Life Questionnaire (PAQLQ), device monitored quick relief medication use (QR use), and device monitored daily asthma medication adherence (ICS and/or LTRA).

Hypothesis 2a. A hierarchical logistic regression was applied to assess a model using P-AIRS (average total scores) as a moderator of the relationship between obesity

dummy variables and ACT (see Table 14). After controlling for child sex in Step 1, the main effects of obesity dummy variables and P-AIRS were added at Step 2. At Step 2, the Omnibus test of model coefficients revealed that BMI class explained additional but not significant variance ($\chi^2 = 7.23$, $p = .07$, Nagelkerke $R^2 = .054$). The increase in the Nagelkerke statistic from Step 1 of .031 indicates that the fit of the model increased, but not to a statistically significant degree ($p = .06$). At Step 3, the interaction of P-AIRS and obesity dummy variables were entered and were not significantly associated with ACT ($\chi^2 = 2.48$, $p = .29$, change in Nagelkerke $R^2 = .01$.) Individually, only sex was significantly associated with ACT: male children had nearly twice the odds of being well controlled than females (see Table 14). The hypothesis was not supported.

Table 14

Hierarchical Logistic Regression Analysis for the Moderation of Caregiver Illness Representations on the Relationship Between Obesity Dummy Variables and Asthma Control (N = 303)

		Coefficient							
Step	Variable	*B*	*SE*	Wald	df	Odds-Ratio	95% CI Lower	95% CI Upper	*p*
3	(Constant)	-1.986	1.322	2.22	1	0.14			.14
	Child Sex	0.677	0.245	7.67	1	1.97	1.22	3.18	.006
	MvOB	2.299	1.725	1.78	1	9.97	0.34	292.94	.18
	OWvOB	0.088	2.092	0.00	1	1.09	0.02	65.86	.97
	P-AIRS	0.526	0.418	1.58	1	1.69	0.75	3.84	.21

MvOB*P-AIRS	-0.718	0.548	1.72	1	0.49	0.17	1.43	.19
OWvOB* P-AIRS	0.071	0.669	0.01	1	1.07	0.29	3.99	.92

Note. Nagelkerke $R^2 = 0.064$. Coding: Female = 0, Male = 1; Poorly Controlled = 0, Well Controlled = 1; MvOB: Majority = 1, Obese = -1; OWvOB: Overweight = 1, Obese = -1. P-AIRS = Parent Asthma Illness Representations (Sidora-Arcoleo et al,, 2010a).

Hypothesis 2b. A hierarchical linear regression was applied to assess a model using P-AIRS as a moderator of the relationship between obesity dummy variables and PAQLQ (see Table 15). The interaction effects of obesity vs majority x P-AIRS (β = -0.206, p = .78) and obesity vs overweight x P-AIRS (β = -0.014, p = .98) were not significant, indicating that parents' illness representations about their child's asthma was not a significant moderator of the relationship between obesity and quality of life. The interactions accounted for 0% of the variance in PAQLQ average total scores (R^2_{change} = .000, F [2, 296] = 0.07, p = .93). While the moderator was not significant, child sex was significantly associated with PAQLQ (β = -0.199, p = .001). Lastly, caregiver illness representations more aligned with the professional model were associated with better quality of life reported by children (β = 0.229, p < .001). However, neither obesity dummy variable was a significant predictor of quality of life (see Table 15). Ultimately, the hypothesis was not supported.

Table 15

Hierarchical Linear Regression Analysis for the Moderation of Caregiver Illness Representations on the Relationship Between Obesity Dummy Variables and Pediatric Asthma Quality of Life (N = 303)

Step	Variable	*B*	*SEB*	β	*t*	*Semi-partial r* r_{sp}	*p*
3 [a]	(Constant)	3.119	0.787		3.97		<.001
	Child Sex	-0.503	0.143	-0.199	-3.52	-.20	.001
	MvOB	0.250	1.015	0.181	0.25	.01	.81
	OWvOB	-0.017	1.238	-0.010	-0.01	-.00	.99
	P-AIRS	0.932	0.245	0.229	3.80	.21	<.001
	MvOB*P-AIRS	-0.091	0.323	-0.206	-0.28	-.02	.78
	OWvOB*P-AIRS	-0.008	0.396	-0.014	-0.02	-.00	.98

Note. Coding: Female = 2, Male = 1; MvOB: Majority = -1, Obese = 1; OWvOB: Overweight = -1, Obese = 1. P-AIRS = Parent Asthma Illness Representations (Sidora-Arcoleo, Feldman, Serebrisky & Spray, 2010a).
[a] F_{change} (2, 296) = 0.07, p = .93.

Hypothesis 2c. A hierarchical logistic regression was applied to assess a model using P-AIRS as a moderator of the relationship between obesity dummy variables and QR use (see Table 16). Preliminary analyses demonstrated that no covariates were significantly associated with QR use, and thus, the main effects of the predictor obesity dummy variables and P-AIRS were added at Step 1. The Omnibus test of model coefficients revealed that obesity dummy variables did not explain significant variability (χ^2 = 0.93, p = .82, Nagelkerke R^2 = .06). At Step 2, the interaction of obesity dummy variables and P-AIRS were entered and

were not significantly associated with QR use ($\chi^2 = 0.69$, $p = .71$, Nagelkerke $R^2 = .011$). The change in the Nagelkerke statistic indicates that the addition of the interaction did not significantly improve the fit of the model. No other variables were significantly associated with QR use and ultimately (see Table 16), the hypothesis was not supported.

Table 16

Hierarchical Logistic Regression Analysis for the Moderation of Caregiver Illness Representations on the Relationship Between Obesity Dummy Variables and Quick Relief Medication Use (N = 217)

		Coefficients							
Step	Variable	*B*	*SE*	Wald	df	Odds-Ratio	95% CI Lower	95% CI Upper	*p*
2	(Constant)	1.118	1.781	0.39	1	3.06			.53
	MvOB	-0.721	2.215	0.11	1	0.49	0.01	37.31	.75
	OWvOB	2.414	3.037	0.63	1	11.18	0.03	4300.31	.43
	P-AIRS	-0.025	0.562	0.00	1	0.98	0.32	2.93	.96
	MvOB*P-AIRS	0.261	0.699	0.14	1	1.30	0.33	5.10	.71
	OWvOB*P-AIRS	-0.754	0.950	0.63	1	0.47	0.07	3.03	.43

Note. Nagelkerke $R^2 = 0.011$. Coding: Poorly Controlled = 0, Well Controlled = 1; MvOB: Majority = 1, Obese = -1; OWvOB: Overweight = 1, Obese = -1. P-AIRS = Parent Asthma Illness Representations (Sidora-Arcoleo et al., 2010a).

Hypothesis 2dI. A hierarchical linear regression was applied to assess a model using P-AIRS as a moderator of the relationship between obesity dummy variables and daily asthma medication adherence to ICS (see Table 17). The interaction effects of obesity vs

majority x P-AIRS (β = -0.412, p = .68) and obesity vs overweight x P-AIRS (β = 1.10, p = .27) were not significant, indicating that parents' illness representations about their child's asthma was not a significant moderator of the relationship between obesity dummy variables and daily asthma medication adherence to ICS. The interactions accounted for 0.8% of the variance in daily ICS adherence (R^2_{change} = .008, F [2, 167] = 0.72, p = .49). Neither the moderator nor obesity dummy variables were a significant predictor of daily ICS adherence (see Table 17). Thus, the hypothesis was not supported.

Table 17

Hierarchical Linear Regression Analysis for the Moderation of Caregiver Illness Representations on the Relationship Between Obesity Dummy Variables and Inhaled Corticosteroid Medication Adherence (N = 173)

Step	Variable	*B*	*SEB*	β	*t*	*Semi-partial r* r_{sp}	*p*
2[a]	(Constant)	62.154	24.668		2.52		.01
	MvOB	13.581	31.354	0.441	0.43	.03	.67
	OWvOB	-50.346	41.613	-1.219	-1.21	-.09	.23
	P-AIRS	-7.362	7.918	-0.084	-0.93	-.07	.35
	MvOB*P-AIRS	-4.091	9.986	-0.412	-0.41	-.03	.68
	OWvOB*P-AIRS	14.814	13.341	1.100	1.11	.09	.27

Note. Coding: MvOB: Majority = -1, Obese = 1; OWvOB: Overweight = -1, Obese = 1. P-AIRS = Parent Asthma Illness Representations (Sidora-Arcole et al., 2010a).
[a] F_{change} (2, 167) = 0.72, p = .49

Hypothesis 2dII. A hierarchical linear regression was applied to assess a model using P-AIRS as a moderator of the relationship between obesity dummy variables and daily asthma medication adherence to LTRA (see Table 18). The interaction effects of obesity vs majority x P-AIRS (β = -0.239, p = .84) and obesity vs overweight x P-AIRS (β = 0.722, p = .52) were not significant, indicating that parents' illness representations about their child's asthma was not a significant moderator of the relationship between obesity dummy variables and daily asthma medication adherence to LTRA. The interaction accounted for only 0.4% of the variability in LTRA adherence (R^2_{change} = .004, F [2, 112] = 0.24, p = .79). Neither the moderator nor obesity dummy variables were a significant predictor of daily LTRA adherence (see Table 18). Ultimately, the hypothesis was not supported.

Table 18

Hierarchical Linear Regression Analysis for the Moderation of Caregiver Illness Representations on the Relationship Between Obesity Dummy Variables and Leukotriene Receptor Antagonist Medication Adherence (N = 118)

Step	Variable	*B*	*SEB*	β	*t*	*Semi-partial r* r_{sp}	*p*
2[a]	(Constant)	56.007	32.337		1.73		.09
	MvOB	11.168	41.927	0.320	0.27	.03	.79
	OWvOB	-28.456	52.865	-0.617	-0.54	-.05	.59
	P-AIRS	-2.868	10.408	-0.029	-0.28	-.03	.78
	MvOB*P-AIRS	-2.682	13.34	-0.239	-0.20	-.02	.84
	OWvOB*P-AIRS	10.915	17.001	0.722	0.64	.06	.52

Note. Coding: MvOB: Majority = -1, Obese = 1; OWvOB: Overweight = -1, Obese = 1.

P-AIRS = Parent Asthma Illness Representations (Sidora-Arcoleo et al., 2010a).
[a] F_{change} (2, 112) = 0.24, p = .79

Specific Aim 3

Children's subjective experiences of anxiety as measured by the Multidimensional Anxiety Scale for Children (2nd Edition–Self-Report; MASC-2) were examined as a moderator of the relationship between BMI class (associated obesity dummy variables) and children's asthma control as measured by the Asthma Control Test (ACT/C-ACT), asthma quality of life as measured by the Pediatric Asthma Quality of Life Questionnaire (PAQLQ), device monitored quick relief medication use (QR use), and device monitored daily asthma medication adherence (ICS and/or LTRA).

Hypothesis 3a. A hierarchical logistic regression was applied to assess a model using MASC-2 (T-scores) as a moderator of the relationship between obesity dummy variables and ACT (see Table 19). After controlling for child sex in Step 1, the main effects of obesity dummy variables and MASC-2 were added at Step 2. At Step 2, the Omnibus test of model coefficients revealed that obesity dummy variables explained additional and significant variance (χ^2 = 14.96, p = .002, Nagelkerke R^2 = .086). MASC-2 was negatively associated with ACT; higher anxiety was correlated with lower asthma control. At Step 3, the interaction of MASC-2 and obesity dummy variables were entered and were not significantly associated with ACT (χ^2 = 2.61, p = .27, Nagelkerke R^2 = .097). The change in the Nagelkerke statistic indicates that the addition of the interaction did not significantly improve model fit. Individually, sex was significantly associated with ACT: male children had greater odds (OR = 1.79 [CI: 1.10, 2.90]) of being well controlled compared to females. MASC-2

was also significantly associated with ACT: as subjectively reported anxiety increased, asthma control decreased (see Table 19). Ultimately, the hypothesis was not supported.

Table 19

Hierarchical Logistic Regression Analysis for the Moderation of Child Anxiety on the Relationship Between Obesity Dummy Variables and Asthma Control (N = 303)

		Coefficient							
Step	Variable	*B*	*SE*	Wald	df	Odds-Ratio	95% CI Lower	95%CI Upper	*p*
3[a]	(Constant)	1.305	0.702	3.454	1	3.69			.06
	Child Sex	0.579	0.248	5.478	1	1.79	1.10	2.90	.02
	MvOB	0.144	0.903	0.025	1	1.15	0.20	6.78	.87
	OWvOB	-1.164	1.120	1.080	1	0.31	0.04	2.81	.30
	MASC-2	-0.029	0.012	5.394	1	0.97	0.95	1.00	.02
	MvOB*MASC-2	-0.001	0.016	0.003	1	1.00	0.97	1.03	.96
	OWvOB*MASC-2	0.026	0.020	1.794	1	1.03	0.99	1.07	.18

Note. Coding: Female = 0, Male = 1; Poorly Controlled = 0, Well Controlled = 1; MvOB: Majority = 1, Obese = -1; OWvOB: Overweight = 1, Obese = -1. MASC-2 = Multidimensional Anxiety Scale for Children (2nd ed.) (March et al., 2013).
[a]Nagelkerke R^2 = .097

Hypothesis 3b. A hierarchical linear regression was applied to assess a model using MASC-2 as a moderator of the relationship between obesity dummy variables and PAQLQ (see Table 20). The interaction effects of obesity vs majority x MASC-2 (β = -0.321, p = .37) and obesity vs overweight x MASC-2 (β = 0.073, p = .84) were not significant,

indicating that self-reported experience of anxiety by children was not a significant moderator of the relationship between obesity and quality of life. The interactions accounted for 0.3% of the variance in PAQLQ ($R^2_{change} = .003$, F [2, 296] = 0.50, $p = .61$). While the moderator was not significant, child sex was significantly associated with PAQLQ ($\beta = -0.184$, $p = .001$); indicating that male children reported greater quality of life. MASC-2 was also a significant predictor of quality of life ($\beta = -0.391$, $p < .001$); as self-reported anxiety increased, self-reported quality of life decreased. However, neither obesity dummy variable was a significant predictor of quality of life (see Table 20). Ultimately, the hypothesis was not supported.

Table 20

Hierarchical Linear Regression Analysis for the Moderation of Child Anxiety on the Relationship Between Obesity Dummy Variables and Pediatric Asthma Quality of Life (N = 303)

Step	Variable	*B*	*SEB*	β	*t*	*Semi-partial r* r_{sp}	*p*
3 [a]	(Constant)	8.521	0.434		19.61		<.001
	Child Sex	-0.464	0.136	-0.184	-3.43	-.18	.001
	MvOB	0.339	0.494	0.245	0.69	.04	.49
	OWvOB	-0.138	0.623	-0.079	-0.22	-.01	.83
	MASC-2	-0.046	0.007	-0.391	-6.84	-.36	<.001
	MvOB*MASC-2	-0.008	0.009	-0.321	-0.90	-.05	.37

OWvOB*MASC-2	0.002	0.011	0.073	0.20	.01	.84

Note. Coding: Female = 2, Male = 1; MvOB: Majority = -1, Obese = 1; OWvOB: Overweight = -1, Obese = 1. MASC-2 = Multidimensional Anxiety Scale for Children (2nd ed.) (March et al., 2013).
[a] F_{change} (2, 296) = 0.50, p = .61

Hypothesis 3c. A hierarchical logistic regression was applied to assess a model using MASC-2 as a moderator of the relationship between obesity dummy variables and QR use (see Table 21). Preliminary analyses demonstrated that no covariates were significantly associated with QR use, and thus, the main effects of the predictor obesity dummy variables and MASC-2 were added at Step 1. The Omnibus test of model coefficients revealed that obesity dummy variables did not explain significant variability (χ^2 = 1.06, p = .79, Nagelkerke R^2 = .007). At Step 2, the interaction of obesity dummy variables and MASC-2 were entered and were not significantly associated with QR use (χ^2 = 1.52, p = .47, Nagelkerke R^2 = .017%). The change in the Nagelkerke statistic indicates that the addition of the interaction did not significantly improve model fit. No other variables were significantly associated with QR use (see Table 21) and ultimately, the hypothesis was not supported.

Table 21

Hierarchical Logistic Regression Analysis for the Moderation of Child Anxiety on the Relationship Between Obesity Dummy Variables and Quick Relief Medication Use (N = 217)

Step	Variable	*B*	*SE*	Wald	df	Odds-Ratio	95% CI Lower	95% CI Upper	*p*
2[a]	(Constant)	1.426	0.95	2.255	1	4.16			.13

MvOB	-0.906	1.202	0.569	1	0.40	0.04	4.26	.45
OWvOB	-0.084	1.582	0.003	1	0.92	0.04	20.45	.96
MASC_2	-0.007	0.017	0.193	1	0.99	0.96	1.03	.66
MvOB*MASC-2	0.018	0.021	0.759	1	1.02	0.98	1.06	.38
OWvOB*MASC-2	0.002	0.028	0.006	1	1.00	0.95	1.06	.94

Note. Coding: Poorly Controlled = 0, Well Controlled = 1; MvOB: Majority = 1, Obese = -1; OWvOB: Overweight = 1, Obese = -1. MASC-2 = Multidimensional Anxiety Scale for Children (2nd ed.) (March et al., 2013).
[a] Nagelkerke $R^2 = .017$

Hypothesis 3dI. A hierarchical linear regression was applied to assess a model using MASC-2 as a moderator of the relationship between obesity dummy variables and daily asthma medication adherence to ICS (see Table 22). The interaction effects of obesity vs majority x MASC-2 ($\beta = -0.05$, $p = .93$) and obesity vs overweight x MASC-2 ($\beta = 0.104$, $p = .86$) were not significant, indicating that self-reported experience of anxiety by children was not a significant moderator of the relationship between obesity dummy variables and daily asthma medication adherence to ICS. The interactions accounted for 0% of the variance in daily ICS adherence ($R^2_{change} = .00$, F [2, 167] = 0.02, $p = .98$). Neither the moderator nor obesity dummy variables were a significant predictor of daily ICS adherence (see Table 22). Thus, the hypothesis was not supported.

Table 22

Hierarchical Linear Regression Analysis for the Moderation of Child Anxiety on the Relationship Between Obesity Dummy Variables and Inhaled Corticosteroid Medication Adherence (N = 173)

Step	Variable	*B*	*SEB*	β	*t*	*Semi-partial r* r_{sp}	*P*
2 [a]	(Constant)	48.374	13.814		3.50		.001
	MvOB	2.305	17.063	0.075	0.14	.01	.89
	OWvOB	- 8.546	23.216	-0.207	-0.37	-.03	.71
	MASC-2	- 0.164	0.241	-0.061	-0.68	-.05	.50
	MvOB*MASC-2	- 0.027	0.296	-0.050	-0.09	-.01	.93
	OWvOB*MASC-2	0.075	0.408	0.104	0.18	.01	.86

Note. Coding: MvOB: Majority = -1, Obese = 1; OWvOB: Overweight = -1, Obese = 1. MASC-2 = Multidimensional Anxiety Scale for Children (2nd ed.) (March et al., 2013).
[a] F_{change} (2, 167) = 0.02, p = .98

Hypothesis 3dII. A hierarchical linear regression was applied to assess a model using MASC-2 as a moderator of the relationship between obesity dummy variables and daily asthma medication adherence to LTRA (see Table 23). The interaction effects of obesity vs majority x MASC-2 (β = -0.25, p = .69) and obesity vs overweight x MASC-2 (β = 0.166, p = .79) were not significant, indicating that self-reported experience of anxiety by children was not a significant moderator of the relationship between obesity dummy variables and daily asthma medication adherence to LTRA. The interactions accounted for 0.1% of the variance in daily ICS adherence (R^2_{change} = .001, F [2, 112] = 0.08, p = .92). Neither the

moderator nor obesity dummy variables were a significant predictor of daily LTRA adherence (see Table 23). Ultimately, the hypothesis was not supported.

Table 23

Hierarchical Linear Regression Analysis for the Moderation of Child Anxiety on the Relationship Between Obesity Dummy Variables and Leukotriene Receptor Antagonist Medication Adherence (N = 118)

Step	Variable	*B*	*SEB*	β	*t*	*Semi-partial r* r_{sp}	*P*
2 [a]	(Constant)	57.413	17.078		3.36		.001
	MvOB	11.344	21.959	0.325	0.52	.05	.61
	OWvOB	-2.274	27.923	-0.049	-0.08	-.01	.94
	MASC-2	-0.181	0.290	-0.063	-0.62	-.06	.54
	MvOB*MASC-2	-0.149	0.376	-0.250	-0.40	-.04	.69
	OWvOB*MASC-2	0.129	0.474	0.166	0.27	.03	.79

Note. Coding: MvOB: Majority = -1, Obese = 1; OWvOB: Overweight = -1, Obese = 1. MASC-2 = Multidimensional Anxiety Scale for Children (2nd ed.) (March et al., 2013).
[a] F_{change} (2, 112) = 0.08, p = .92

Chapter IV: Discussion

Summary of Findings

This study was designed to consider the degree to which childhood obesity and the moderating role of caregiver illness representations of asthma and child anxiety were related to essential markers of disease outcome (i.e., asthma control, management, and quality of life). Associations between childhood obesity as measured by BMI and various asthma outcome variables were considered, through potential main and moderating effects of caregiver asthma-related illness representations, using the P-AIRS, and self-reported child anxiety, via the MASC-2-SR. Overall, when compared to majority and overweight groups, the obese group was not significantly different across any of the asthma outcome variables: ACT, PAQLQ, QR use nor ICS/LTRA adherence (Hypothesis 1a - 1dII). Furthermore, no interactions between obesity and P-AIRS were found, and thus, failed to moderate the relationship with ACT, PAQLQ, QR use or ICS/LTRA adherence (Hypothesis 2a - 2dII). In addition, no interactions between obesity and MASC-2 were found, and thus, failed to moderate the relationship with ACT, PAQLQ, QR use or ICS/LTRA adherence (Hypothesis 3a - 3dII). Therefore, none of the hypotheses were supported.

This study's findings for the proposed hypotheses were not significant. Interestingly, the rate of obesity overall was markedly higher for this sample of children and adolescents when compared to national averages. Results indicated that caregiver illness representations more aligned with professional models of understanding were associated with greater child

self-reported quality of life. Moreover, higher rates of child self-reported anxiety were associated with lower self-reported asthma control and quality of life.

Across the sample, children tended to demonstrate poor asthma control, modestly positive reports of quality of life related to asthma, intermittent use of QR medications (most did not use their QR medications more than 2 days each week), and inconsistent adherence to daily ICS and LTRA asthma medication. Overall, caregiver illness representations were slightly more allied with the professional model of asthma and reports of child anxiety were considered High Average.

Analyses of covariates demonstrated several associations of significance: (1) child sex and asthma control and (2) child sex and quality of life. These relationships revealed that male children were more likely to be well controlled than female children. Furthermore, male children were more likely to report greater quality of life as related to asthma than female children. However, no other demographic variables tested including age, caregiver sex, child ethnicity, caregiver ethnicity, and education (female and male - head of household), were associated with the asthma outcome variables, and therefore, no other covariates were applied to the analyses.

Interpretation

In the present study, Body Mass Index (BMI) was calculated based on each child's height and weight and as compared to similar peers (age and sex specific). Child BMIs at or above the 95th percentile were classified as obese (40.3%), those between the 85th and 95th percentile were classified as overweight (17.1%), and children with BMIs less than the 85th percentile were classified as majority (42.6%). Six children who would otherwise be classified as underweight (below the 5th percentile), were not considered statistically different

from other groups and were merged with the majority group. Notably and compared to demographics of the US population, obesity in this sample of children (10 to 17 years-of-age) was significantly more prevalent: 40.3% compared to 16.2% (NHANES, 2022). The New York City Department of Health attributes such incongruences to a dearth in accessible and affordable foods, along with other factors that algin with high rates of poverty: income, housing, race, ethnicity, healthy eating habits and environmental exposure (New York City Department of Health, 2019). Similarly, disparities in racial and ethnic groups exist and while this sample only assessed Black and Latinx children and adolescents, obesity was considerably more prevalent for these vulnerable groups compared to the general population: Latinx (42.1%) and Black-non Latinx (31.1%) compared to 25.8% and 22.0%, respectively (Hales et al., 2017). While obesity was particularly overrepresented in male children (61.5%) as compared to female children (38.5%) (p = .02), national data finds no significant differences in prevalence between boys and girls (NHANES, 2018). Therefore, in terms of BMI status, the current sample is not demographically representative of national averages and further, highlights the pervasiveness of obesity in the Bronx.

Factors to Consider Regarding Non-Significant Findings

In this study, analyses revealed findings that were not significant between obesity and its direct association with asthma outcome variables (asthma control, quality of life, asthma management), and further, through mechanisms (illness representations and child anxiety) that could potentially moderate those relationships. Fundamentally, extraneous and/or confounding variables within this study uncovering the true impact obesity had on asthma outcomes may have been overlooked. Additionally, the hypotheses themselves suggesting the presence of meaningful differences in asthma management and outcomes between children

with obesity and without may have been incorrect to begin with. Alternatively, the sample in this study may have been uncharacteristic in subtle yet substantial ways as to have nullified the potential for such relationships.

While much research tends to demonstrate the negative impact of obesity on disease outcomes generally (Ahmadizar et al., 2016; Aragona et al., 2016; Lang et al., 2012; Lavoie et al., 2006, 2011; Maalej et al., 2012; Rastogi et al., 2015), such work often relies on BMI as the primary construct to measure body fat. Other work suggests that body fat can be assessed more effectively using BMI in combination with other measures, or with other more precise techniques, in light of the tremendous variability that exists across human body types (Burkhauser & Cawley, 2008; Ross et al., 2020; Rothman, 2008; Shah & Braverman, 2012). Moreover, obesity and groups categorized by BMI, are determined and assessed in a variety of ways. Some research defines obesity in terms of child age/sex specific (like this study) while other work with children has utilized classifications based on adult parameters. Research designs also span the gamut in how many BMI classes they compare and how or if they combine groups (i.e., combining children of obese and overweight groups or keeping them separate). Therefore, the relationship between obesity and various asthma outcomes in this study may have been compromised by the way the BMI classes were structured.

Obesity and Asthma Control

Obesity was not associated with subjective asthma control, as measured by ACT/C-ACT. In contrast to Hypothesis 1a, when the obese group was compared to majority and overweight groups, group differences in self-reported asthma control were not observed. In particular, children with obesity did not report significantly less asthma control. The proportion of well controlled and poorly controlled asthma was nearly even across all ages.

Evidently, levels of reported asthma control for both children and adolescents separately (C-ACT: 10-11; ACT: 12-17), and combined, were not statistically different.

Child sex was significantly associated with asthma control. As self-reported, male children were more likely to be well controlled than female children ($p = .01$). This relationship is consistent with previous work indicating that adult females are more likely to report greater experiences of dyspnea and worse breathing control (Chhabra & Chhabra, 2011), demonstrating that females may report poorer control than males more frequently. Despite reports of greater airway obstruction by females in the prior study, no differences were found between males and females regarding asthma control. While this research assessed asthma control in adults, such findings remain pertinent to consideration of sex differences among asthma control in children. Further assessment of asthma control and potential sex differences among children with obesity might compare self-reported asthma control to objective measures of pulmonary function (i.e., Forced Expiratory Volume in 1 second).

The current study's findings tend to be inconsistent with literature demonstrating links between obesity and worse asthma control (Lavoie et al., 2006). In one RCT with children 8-17 years-of-age (Jensen et al., 2013), a weight-loss intervention improved asthma control scores in a similar measure: Asthma Control Questionnaire (ACQ). Other weight-loss interventions for children demonstrate improvements in asthma control using the ACQ (Holguin, 2013). While this measure is somewhat different than the ACT/C-ACT used in the current study, meta-analytic research (Ahmadizar et al., 2016) and reviews (Juel & Ulrik, 2013) further indicate a link between obesity and worse asthma control using ACT/C-ACT and other related measures (i.e., ACQ).

Discrepant findings in prior literature may be attributable to several factors. Asthma prevalence is particularly high in the Bronx. This vulnerable yet resilient sample where the prevalence of obesity was also high may have underreported experiences of asthma-related distress. Some children may have disregarded asthma-related symptoms due to a fundamental lack of knowledge of their disease which could have led to misperceiving signs of poor asthma control and inflated perceptions of health (Feldman et al., 2013; Pradel et al., 2001). Moreover, measuring asthma control cross-sectionally via self-report may not have been sufficient to capture days or periods in which the child was more symptomatic. Finally, and unlike subjective self-reports of experience (ACT/C-ACT), determination of the obesity construct and other BMI classes involve the computation and interpretation of quantitative data. Ultimately, these non-significant findings seem to reflect a more nuanced and complex portrayal of obesity, asthma, and subjective asthma control.

Obesity and Pediatric Asthma Quality of Life

Obesity was not associated with subjective quality of life, as measured by the PAQLQ. In contrast to Hypothesis 1b, obese children reported comparable, rather than lower levels of quality of life as conjectured. Thus, no statistically significant differences were found in quality of life between the obese group when compared to overweight and majority groups.

Child sex was found to be significantly associated with asthma-related quality of life. Male children were more likely to report greater quality of life than female children. This relationship is consistent with previous research (Alvim et al., 2009) indicating sex differences in self-reported quality of life using the PAQLQ, in which, female adolescents (14-16 years-of-age) were more likely to report worse quality of life. Likewise, additional

research on asthma and quality of life suggests that female children were more likely to report lower health-related quality of life, with significantly lower values for activity and emotion-domain sub-scales (Shi et al., 2021). Therefore, the current study tends to be consistent with some work, and divergent with other research accounting for differences in child sex and self-reported quality of life.

In the current study, no significant differences in quality of life were found between BMI classes. These findings are in contrast to some cross-sectional research with children (Kupkina et al., 2020) indicating significant differences in quality-of-life reports between BMI classes as measured by the PAQLQ, with obese children demonstrating lower quality of life than those of majority BMI. More specific differences can be seen when comparing domain-specific scores of the PAQLQ (i.e., activity and symptoms), where children of majority BMI reported greater sub-scale scores (less impairment) than those of overweight and obese groups. Other cross-sectional research in children (van Gent et al., 2007) and adults (Maalej et al., 2012) demonstrates associations between lower self-reported quality of life and obesity and/or excessive BMI. Yet, in the aforementioned RCT by Jensen et al. (2013), clinically significant improvements in quality of life for children following a weight-loss intervention were only observed in the emotion domain of the PAQLQ but not overall. However, the present study did not assess differences between quality of life subscales and BMI classes. Ultimately, no such relationship between overall self-reported quality of life and obesity was discovered.

Findings in the current study did not provide evidence demonstrating that children with obesity would be more likely to report lower quality of life when compared to children with heathier BMI. Several factors may have hindered the true nature of this relationship.

Other comparable studies seem to employ a variety of methodologies in their research design that could meaningfully impact the relationship between obesity and quality of life, such as: how obesity and/or BMI is categorized, cross-sectional research versus interventional or longitudinal work, and in the makeup of their participant samples. Other disparities seem to reveal significant differences in certain sub-scale scores (i.e., activity limitation, emotion, and symptoms) without demonstrating total-score differences in quality of life between obese children and others. Therefore, in light of the current study's focus on total-scores, more subtle differences in quality of life sub-scales for children with obesity may have been overlooked.

Obesity and Asthma Management

QR Medication Use. Obesity was not associated with objective measures of quick relief medication use, as measured by electronic monitoring devices. Contrary to Hypothesis 1c, when compared to majority and overweight groups, obese children exhibited comparable rates of QR use (not significantly more, as postulated). While it was postulated that children with obesity would use their QR medication more frequently, differences in use were not statistically significant.

No associations were found between QR use and any of the demographic variables tested in this study. Some literature indicates differences between male and female adults, in which women tend to exhibit greater asthma severity along with greater use of QR medication (Sinclair & Tolsma, 2006). However, other work more aligned with the current study (urban children) demonstrates that male and female children do not significantly differ in their use of QR medication (Stingone et al., 2011). Thus, the current findings seem to be

more consistent with research examining boys and girls, demonstrating no differences in their QR medication use.

In the present study, findings were not significant and the literature remains somewhat unclear concerning the nature of the relationship between asthma, obesity, and QR use. Some previous longitudinal work demonstrates that comorbid asthma and obesity (high BMIs and/or overweight) is associated with greater use of self-reported QR medication in children (Black et al., 2013; Quinto et al., 2011). In other work using a cross-sectional approach (Lang et al., 2015), and despite similarities in ED visits, pulmonary function, and controller medication adherence, overweight/obese children 10-17 years-of-age reported more than three times the rate of QR use than lean children (BMIs between 20th to 60th percentiles). Dias-Júnior et al. (2014) provides further support from a RCT study demonstrating improvements in adults with obesity in which weight reduction was associated with less QR use. However, none of these studies utilized objective measures of assessment (electronic monitoring) when analyzing QR medication use and instead, draw from electronic medical records or self-report assessments. While it was proposed that obese children with asthma would demonstrate an over-reliance on QR medication because of various concurrent factors (i.e., less responsive to standard treatments and misperception of symptoms), no such pattern was found. Therefore, results from the present study may serve to undermine proposed differences in QR medication use for children with obesity and asthma when objectively assessed in a sample of urban children seeking care.

Contrary findings in the current study may be attributable to a variety of factors. While a number of studies attest to the relationship between obesity, asthma, and increased reliance and/or use of QR medication, much of, if not all such links found have been via self-

report data or electronic medical records. These relationships, unlike in this study, are predicated on subjective assessments of medication use behavior and thus, are potentially quite vulnerable to misrepresentation or distortion. In contrast, missing data in the current study attributed to misplaced or forgotten return of devices at the time data was to be downloaded may have distorted or nullified potentially significant differences between BMI classes. Moreover, electronic monitoring of medication only records instances of administration, not consumption. Besides, even when accounting for racial/ethnic disparities in socioeconomic status, the prevalence of living below the poverty threshold is considerably greater for this sample of urban families (below poverty threshold; 71.9%). Thus, decreased access to (i.e., unable to afford refills or delayed treatment) and trust in healthcare, psychosocial stressors and lack of disease knowledge, may all play a role in decreased use or reliance on QR medication even for children in need (Arcoleo et al., 2019; McQuaid, 2018; McQuaid & Landier, 2018). Ultimately, these findings suggest that children with comorbid obesity and asthma adhere to daily asthma medication in a manner akin to peers of varying BMI classes.

ICS/LTRA Adherence. Obesity was not associated with objective measures of ICS/LTRA medication adherence, as measured by electronic monitoring devices. Contrary to hypotheses (1dI/dII), when compared to majority and overweight groups, obese children exhibited comparable rates of ICS/LTRA adherence (not significantly less, as posited). Mean rates were consistent with previous research concerning adherence to daily controller medication within similar populations (Arcoleo et al., 2019; Walders et al., 2005). Yet, differences in ICS/LTRA adherence between BMI classes were ultimately negligible and statistically non-significant.

No associations were found between ICS/LTRA adherence and any of the demographic variables tested in this study. However, previous work in illness self-management of diabetes (Anderson et al., 1990) demonstrated that female children assumed more responsibility than male children in adhering to daily controller medications. Later research (Orrell-Valente et al., 2008) on daily controller medication adherence for asthma with children 4 to 19 years-of-age, likewise, indicates that female children were more likely to be adherent. Interestingly, while daily controller medication responsibility increased with the child's age, greater reports of adherence specifically came from parents with younger children. Such outcomes may speak to parents' ability to better manage and monitor their child's treatment but other work suggests that parental self-reported adherence is often inflated (Bender et al., 2000). In the current study, no demographic variables of interest were associated with ICS/LTRA adherence overall and by BMI class, which may demonstrate that the sample itself is too uniform to draw such distinctions from.

The present study revealed an absence of group differences in ICS/LTRA adherence when comparing children with obesity to other BMI classes. Recent cross-sectional literature (Orriëns et al., 2021) on children with asthma 4 – 13 years-of-age and of healthy or excess BMI (BMIs $\geq 85^{th}$ percentile), suggests that high BMI is associated with nonadherence in subjective (parent-report) and objective (pharmacy records) measures of ICS/LTRA adherence. Other research (Longo et al., 2020) demonstrates links to high BMI and increased risk of nonadherence in children initiating or increasing daily prescribed ICS medication regimens. Some work however, with adolescents and/or adults is consistent with the present study's findings indicating that adherence to daily asthma medication does not differ significantly between BMI classes (Bildstrup et al., 2015; Gamble et al., 2009). While it was

hypothesized that obese children would be less adherent to daily ICS/LTRA medication (i.e., less responsive to standard treatments), no such relationship was found. Thus, this study may serve to challenge the notion that children with obesity and asthma are more likely to be less adherent to daily asthma medication when objectively assessed.

The somewhat conflicting nature of this study's findings are potentially attributable to a number of factors. Unlike this study, most research drawing associations between BMI class and ICS/LTRA medication adherence for asthma in children and adults relies heavily on subjective measures. Therefore, such work may unintentionally discount or distort the true nature of adherence behavior in children with obesity and asthma. While this study relied on more objective measures of medication adherence, electronic device monitoring in itself is vulnerable to misrepresentation. Approximately 17% of ICS and 22% of LTRA device tracking data in this study was missing due to device failure, participant failure to return or attach device prior to Session 2, and participants losing their devices. Furthermore, some of these children were prescribed such medications later on and/or provided adherence data at following sessions. The assessment of medication adherence in this study, then, may not be as comprehensive or exacting in its portrayal of such behavior. Again, electronic monitoring of medication only accounts for administration, not consumption. Thus, findings should be interpreted with caution. One strategy employed in future work to minimize missing data could be to increase routine check-ins with participants (i.e., phone calls) to monitor and provide support with devices as well as providing extra devices if resources allow. As mentioned above with QR use, socioeconomic (i.e., significantly higher rates of families living below the poverty line) factors like affordability of refilling prescriptions (insurance coverage) or access to healthcare may have served as environmental barriers to more

consistent medication adherence behavior for some families in this sample. Lastly, these findings seem to indicate that children with comorbid obesity and asthma demonstrate no difference in the way they adhere to daily asthma medication when compared to peers of varying BMI classes and/or, that such behavior is confounded by other factors or mechanisms, warranting further investigation with objective approaches.

Obesity and Parent Asthma Illness Representations

None of the relationships between obesity and asthma outcome variables were moderated by caregiver asthma illness representations. Contrary to hypotheses (2a-2dII), when compared to majority weight and overweight groups, no interactions were observed through P-AIRS and across asthma outcomes, indicating that obese children did not differ significantly from other BMI classes. The average total score for all children was 3.11, with scores ranging from 2.11 to 3.96, demonstrating some variability. This mean score replicates findings from the validation study (Sidora-Arcoleo et al., 2010a) that also reported a mean score of 3.11 with a Bronx sample akin to the current study. Ultimately, no significant interaction by P-AIRS was found between obesity and the outcome variables assessed.

In this study, caregiver asthma illness representations were also not associated with any of the demographic variables. However, research from the validation study (Sidora-Arcoleo et al., 2010a) shows that P-AIRS scores are associated with parent education and household income: parents indicating greater education and/or household income also report higher total P-AIRS scores. This is consistent with other literature demonstrating that less caregiver education is associated with IRs that align more closely to lay person models (Yoos et al., 2007). The validation study (Sidora-Arcoleo et al., 2010a) also shows that White parents conveyed higher AIRS scores, aligning more closely to the professional model,

compared to predominately inner-city, ethnic subgroups (i.e., Puerto Rican and Black-non Latinx). Other work seems to support similar and significant sociodemographic differences in IRs between ethnic groups, especially among Black-non Latinx, Puerto Rican, and White caregivers (Sidora-Arcoleo et al., 2012). Such ethnic and educational differences could not truly be assessed within this more homogenous sample of families, the majority of which had low SES. Further research may expand on current findings by incorporating heterogenous samples in order to better understand how sociodemographic and cultural differences influence BMI, caregiver asthma illness representations and associated health outcomes.

Overall, caregiver asthma illness representations did not significantly moderate the relationship between obesity and various asthma outcomes. To date, no other study has attempted to analyze the moderating role of caregiver asthma illness representations on children with comorbid asthma and obesity, and its relationship to the following: asthma control, quality of life, QR use or daily medication adherence. However, multifaceted work on obesity and asthma seems to highlight various mechanisms by which caregiver perceptions of illness and approaches to managing their child's asthma may be negatively impacted. A systematic review of psychological and physical factors in adult asthma demonstrates that BMI is frequently associated with poorer quality of life, risk of additional comorbid health ailments, and further activity restriction and limitation (Stanescu et al., 2019). In this study notably, and consistent with prior work, caregiver asthma illness representations more aligned with the professional model were positively associated with higher self-reported quality of life in children. Therefore, if caregivers of obese children perceive asthma as more severe, episodic, unresponsive to treatment, and less controllable (lay person model), then such children will experience greater disease burden (i.e.,

hopelessness and less willing to follow treatment protocols or take medication that could work if adhered to consistently).

Caregivers have also been known to limit a child's engagement in activities and exercise shown to improve overall health (Oudjedi & Aissa, 2020; Wanrooij et al., 2014). Perhaps, and based on such beliefs, excessive restriction of health-promoting behavior grounded in misunderstanding, induces even worse asthma outcomes. Furthermore, caregiver IRs may be distorted by their child's tendency for lower symptom accuracy and higher symptom magnification, evident in some children with obesity and asthma (Kopel et al., 2010). Despite findings that were not significant in this study, the misperception of illness burden by parents and children seems to be a continuing cause for concern. Abundant research has tended to link obesity and asthma with a variety of adverse outcomes; higher rates of ED visits (Aragona et al., 2016), worse asthma control (Lavoie et al., 2006; Maalej et al., 2012), greater use of quick relief medication (Quinto et al., 2011), poorer quality of life (van Gent et al., 2007; Maalej et al., 2012), diminished response to asthma treatment (Rastogi et al., 2015; Vinding et al., 2016), increased risk of exacerbations, and worse disease-related outcomes (Ahmadizar et al., 2016; Eising et al., 2014; Lang et al., 2012; Okubo et al., 2016). Thus, a deeper exploration of caregiver asthma IRs and their potential impact on childhood asthma outcomes is called for. Future investigation may focus on asthma IRs of caregivers that considerably misalign with professional models, examining possible differences that emerge for their children with comorbid obesity and asthma.

Obesity and The Multidimensional Anxiety Scale for Children

None of the relationships between obesity and asthma outcome variables were moderated by self-reported child anxiety. Contrary to hypotheses (3a-3dII), when compared

to majority and overweight groups, no interactions were observed through MASC-2 and across asthma outcomes, indicating that obese children did not differ significantly from other BMI classes. The mean T-score across the sample was 56.28; considered High Average, with scores ranging from 40.0 to 84.0. This degree of clinically significant anxiety is consistent with mean scores (M = 55.80) from previous research on inner-city children with asthma from the Bronx (Feldman et al., 2013; Goodwin et al., 2017). Feldman et al. (2013) demonstrated that Black-non Latinx and Latinx children 7 to 11 years-of-age reported notable and comparable rates of anxiety using the MASC (M = 55.80). Subsequent work from Goodwin et al. (2017) found similar degrees of anxiety among children in the Bronx presenting with asthma and comorbid food allergies (M = 56.73). While this study embraces a non-clinical sample, elevations in anxiety might be more reflective of socioeconomic and psychosocial stressors endured by low-income, urban, ethnic-minority children and families (Goodwin et al., 2017). Ultimately, no significant interaction by MASC-2 (child anxiety) was found between obesity and the asthma outcome variables assessed.

In this study, self-reported child anxiety was not associated with any of the demographic variables. Previous work however (Feldman et al., 2013), demonstrates that self-reported anxiety in younger children 7 to 11 years-of-age, was associated with the over-perception of asthma symptoms and greater use of their QR medication. Adverse outcomes for Black-non Latinx inner-city children such as poorer asthma control, impaired quality of life, and insomnia have also been shown (Shams et al., 2018). Further research indicates that older white children (12 to 17 years-of-age) with obesity and asthma demonstrate less optimal symptom perception (lower accuracy and greater magnification/exaggeration) compared to non-obese peers (Kopel et al., 2010). While group differences between obese

children and other BMI classes were not found in this study, child anxiety was negatively correlated with both asthma control and quality of life. Thus, higher anxiety was associated with lower asthma control and quality of life reported by children, replicating some previous work (Shams et al., 2018).

Ultimately, self-reported child anxiety did not significantly moderate the relationship between obesity and various asthma outcomes. To date, this is the first study to analyze the moderating role of self-reported child anxiety in children with comorbid asthma and obesity, and their relationship to the following: asthma control, quality of life, QR use or daily medication adherence. Nevertheless, prior work has established notable and consistent associations regarding asthma, obesity and/or anxiety. Some literature tends to demonstrate that children with anxiety (Aktar et al., 2017) are at greater risk of misinterpreting threats in the environment. Accordingly, children with anxiety and comorbid asthma seem more prone to magnifying or overperceiving asthma symptoms (Feldman et al., 2013; Sicouri et al., 2017). Similarly, they are more likely to report limitations to activity, poorer asthma control and lower quality of life (Feldman et al., 2009; Feldman et al., 2013; Shams et al., 2018). Moreover, children with asthma and anxiety demonstrate greater use of their QR medication (Feldman et al., 2013), similar to children with obesity (Quinto et al., 2011). Overestimation and poor perception of symptoms in those with asthma have been linked with recurrent hospitalizations and excessive reliance on QR medications (Davis et al., 2009; Dirks & Schraa, 1983; Main et al., 2003). The overuse of QR (i.e., short-acting beta-2 agonists; SABA) medication is also associated with elevated risk of adverse effects, worse asthma control, poorer adherence to daily asthma medication, and the overutilization of acute care services (Cole et al., 2013; Kaplan et al., 2020). Future research may explore the

directionality of such proposed relationships, whether asthma and/or anxiety drive obesity in children. While this study was unable to establish child anxiety as a moderator in such relationships, further examination of these often comorbid mental and physical health conditions is necessary to better understand their underlying mechanisms and their interrelation to each other.

Sample Characteristics

The findings above are drawn from a sample of Black-non Latinx and Latinx children with asthma, and their caregivers who were mainly female. Interpretation of these results should be understood in the context of these participants and their demographic character. Few associations were found between demographic variables and asthma outcome measures. QR use and ICS/LTRA medication adherence were not significantly associated with any of the demographic variables examined in this study. Nonetheless, past research provides a template to consider and interpret findings that were ultimately not significant.

Asthma control in the current study was moderate and similar across BMI classes, with roughly half the sample considered to be well-controlled. This was consistent with previous research on inner-city ethnic minority children (Feldman et al., 2013), but inconsistent with other work highlighting significantly lower asthma control in adults with higher BMIs (Lavoie et al., 2006; Maalej et al., 2012). A validation study using ACT to measure asthma control (Liu et al., 2007) found children 4-11 years-of-age to be over two-thirds well-controlled, however, that sample was predominantly White/Caucasian. Quality of life for this sample was also moderate and on par with previous work examining low income and ethnic-minority communities (Alvim et al., 2009; Erickson et al., 2002). While no differences between children with obesity and other BMI classes were observed in this study,

other research demonstrates that high BMI in children 7-10 years-of-age is associated with lower quality of life (van Gent et al., 2007). Children in this sample were predominantly intermittent in their QR use (demonstrating healthy maintenance) and those with obesity were similar in terms of their QR medication use to other BMI classes. However, research demonstrating contrary findings comparing overweight and obese children to other groups is mixed; indicating associations to both, greater QR use (Black et al., 2013; Quinto et al., 2011; Stingone et al., 2011) and lesser QR use in others (Lang et al., 2015). ICS/LTRA medication adherence was generally low yet consistent with prior literature demonstrating underuse of ICS adherence in ethnic minority children. Some barriers to adherence highlighted by this previous work include logistical challenges (i.e., presciption receipt, initiation, and use), individual factors (i.e., medication beliefs, depressive symptoms or perceived discrimination), provider communciation (i.e., liminted consideration of complementary and alternative medicine use, difficulties communicating with caregivers of limited English proficiency, and implicit cultural biases), and systemic issues (i.e., insurance cost and status, psychosocial stressors in the community) (Arcoleo et al., 2019; McQuaid, 2018; McQuaid & Landier, 2018).

Clinical Implications

While obesity was not significantly correlated with any of the asthma outcome variables alone or via moderation in the current study, notable findings stem from a positive association between caregiver asthma illness representations and quality of life. IRs more aligned with professional models of understanding were associated with greater child self-reported quality of life. Generally, if caregivers are open to learning and abiding by professional models of understanding and treatment for asthma in childhood, then

improvements in their child's health-related well-being seem imminent. While asthma manifests itself uniquely across each child, providers who demonstrate concern and a willingness to collaborate with caregivers and children to meet individual needs, will be most effective in disseminating illness education and recommended treatments supported by current research and medical expertise in the field. While obesity was not associated with IRs or quality of life in this study, such disease comorbidities in childhood asthma should still be considered in order to assess the complexities of these coinciding medical conditions.

Another significant result was the relationship between child anxiety, asthma control, and quality of life. Greater anxiety in children was associated with lesser degrees of self-reported asthma control and quality of life. These findings align with current knowledge and intuition, reinforcing the mutuality of mental and physical health. Children experiencing anxiety symptoms seem more vulnerable to overlapping physiological responses and potential exacerbations in daily symptom management. Children presenting with obesity, anxiety and asthma together, seem at greater risk for harm. Misperceiving symptoms of one condition may lead to chronic mistreatment and neglect in emergency situations. For example, overusing QR medication when confused over being out of breath due to issues with physical endurance or anxiety rather than a true asthma exacerbation. Alternatively, misattributing breathing difficulties and failing to intercede with rescue medication during a panic attack may have dire consequences. The potential for medication misuse and feeling overburdened by the blending of mental and physical symptoms associated with these conditions is of concern. Therefore, assessing children comprehensively while providing psychoeducation on concurrent medical and psychological conditions may improve the efficacy of treatment and preclude chronic or acute presentations of asthma that become

amplified by co-occurring conditions. Interventions geared towards understanding illness representations and concurrent manifestations of asthma, anxiety, and obesity, will serve to reinforce psychoeducation and collaboration with providers. Well-informed children and caregivers will be better able to manage these conditions, likely decreasing the burden of psychosocial factors on children and increasing the control and quality of life they experience with their asthma.

Finally, notable sex differences between male and female children were apparent. Male children with asthma are more likely to be well controlled and more likely to report greater quality of life than female children. These sex differences in the current sample may speak to broader trends in the presentation of adolescent asthma. If female children and adolescents experience worse asthma control and report lower quality of life more generally, deeper consideration and insight into these disparities is necessary in order to address and refine existing interventions. Moreover, consistently lower asthma control and quality of life in female children may indicate the application of less effective treatments that fail to address sex differences in disease perception or response style. Thus, greater examination of such treatments is necessary for the development of more efficacious asthma interventions for female children and adolescents.

Limitations

The current study was limited in various ways. Data were drawn from a larger RCT with a comprehensive yet aspirational data collection design. Participants may have responded with less consideration than desired due to the breadth of assessment. However, participants were provided monetary compensation for their contribution and all efforts were made to streamline study demands in order to prevent undue burdens. This particular sample

consisted of Black-non Latinx and Latinx children 10-17 years-of-age and their caregivers, English and Spanish speakers seeking treatment and compensation. Therefore, results may not generalize to the broader population of individuals with asthma across the country or world. Additionally, children classified as obese (BMI) are overrepresented in this sample (but still in line with health-related disparities in vulnerable populations) when compared with nationwide rates. Nevertheless, asthma prevalence is particularly high for children living in the Bronx, NY, and this sample is representative of such.

The scope of data organization and analyses for current study were cross-sectional in nature and limited to single timepoints (Session 1 or 2) in order to reduce data processing challenges and maintain feasibility of scale. However, including data from two different sessions may serve to obscure the interpretation of findings or the outcomes themselves. There may have been factors that went unaccounted for from one session to the next, potentially impacting the integrity of the data. Furthermore, the inclusion of data across two timepoints may have contributed to instances of missing data that ensued with child medication use (QR) and adherence (ICS/LTRA). A number of participants misplaced or forgot to return with their electronic monitoring devices at specified visits, which led considerably to the incidence of missing data. However, all measures being assessed were gathered prior to the intervention phase in order to minimize the impact of treatment on the results. Yet, such data and their interpretation should be considered with caution.

Additional limitations of this work include its sole reliance on measures of BMI to determine body fat and associated health risks linked to chronic diseases such as asthma. While BMI remains the most widely used and fundamental measure of body fat, an ever-growing compilation of research asserts that more precise and efficacious measurements

exist and that assessing BMI in combination with other measures offers a better understanding of body fat (Burkhauser & Cawley, 2008; Ross et al., 2020; Rothman, 2008; Shah & Braverman, 2012). Furthermore, the theoretical foundation built around IRs and anxiety as moderators to obesity, asthma, and the relevant asthma outcomes examined in this study, may have been unfounded to begin with. Another drawback of this study was its reliance on various self-report measures, which may introduce selection bias on behalf of the participants while diminishing the validity and reliability of these measures. These treatment-seeking families were selected to participate in an intervention that was geared towards improving asthma outcomes, which may have predisposed them to overreport or underreport their experiences when assessed on these measures. Future work that focuses on more objective measures of asthma outcomes may provide a better understanding of chronic disease and co-occurring physical and mental conditions. Alternatively, children may have lost or gained significant amounts of weight prior to or following their participation (and weigh-in) in this study, rendering the cross-sectional categorization of their BMI unreliable. Forthcoming research using other measures of body-fat or those combined with BMI (at more than one time point) to garner more accurate depictions of their status, may better serve to deepen our understanding of body fat, chronic disease and health-related behavior change.

Future Directions

Findings from this work provide a path forward for deeper investigation of childhood asthma management and care. While children with obesity in this sample did not meaningfully differ from children of other BMI classes, there is evidence that obesity can broadly and adversely impact various systems of the body, and presumably, confound efforts to manage and treat childhood asthma. Therefore, future research related to obesity, asthma

outcomes/health behavior, illness representations and mental health should incorporate further RCTs, longitudinal study designs and more diverse participant samples. Such work may provide greater understanding of the factors that influence asthma outcomes and disparities while paving the way for more precise diagnoses of concurrent psychological and physical health conditions. Targeted interventions that emphasize psychoeducation, cultivate family-provider relationships, and tailor treatments to meet individual needs will serve to empower children and their caregivers, and ultimately, provide them the tools to manage asthma more effectively. Promoting sustained health behavior change in childhood asthma requires holistic approaches that consider all facets of physical health and psychological well-being.

Conclusions

Overall, this study's findings were not significant for the associations that were postulated. When obese children were compared to groups of majority and overweight children, negligible differences were found between asthma control, quality of life, QR use, and medication adherence. Furthermore, the moderation of those relationships between obesity and aforementioned asthma outcome variables (asthma control, quality of life, QR use, and medication adherence) via caregiver asthma illness representations and child anxiety, were also found to be non-significant. While evidence for such relationships can be found in other research, findings generally appear mixed.

Nevertheless, this study yielded several significant associations. Caregiver asthma illness representations more directly aligned with the professional model were positively associated with quality of life; in that greater alignment of IRs was correlated with higher self-reported quality of life. Another association was demonstrated between child anxiety,

asthma control, and quality of life. Greater levels of self-reported anxiety in children were linked to lower levels of self-reported asthma control and quality of life. Lastly, meaningful differences between male and female children were evident. Male children were more likely to be well controlled and to report greater quality of life than female children with asthma. However, these relationships did not provide support for any of the principal hypotheses suggesting that children with obesity and asthma would differ from children without obesity.

Ultimately, the results of this study speak to the complex nature of physical and psychological comorbidities, illness representations and the mechanisms by which these factors may influence childhood asthma management. For this sample of urban-minority children and caregivers, living predominantly under the poverty threshold, results demonstrate that obesity was not associated asthma outcomes. While considerable research seems indicative of the added and detrimental impact that obesity can have on asthma health and management in children and adolescents, some literature suggests a more complex relationship prompting greater consideration. In light of this sample's vulnerability to a variety of psychosocial stressors, obesity's detriment to asthma outcomes may have been substantially mitigated for children and families accustomed to overcoming adversity in its many forms. Further investigation of childhood obesity and asthma may focus on alternative pathways that have also been previously linked to asthma outcomes such as symptom perception, asthma severity, health care utilization, and objective measures of pulmonary function. Despite results that were not significant, this study extends our understanding of obesity, childhood asthma, disease management, and illness disparities, providing some basis for clinical intervention of vulnerable populations presenting with concurrent medical conditions.

For children of urban-minority communities with low SES, limited access to healthcare, and notably high rates of obesity, the link between comorbid asthma and worse outcomes remains a concern. Caregivers experiencing greater social, financial, and systemic burden may have less opportunity to learn about their child's illness, potentially jeopardizing quality of life related to asthma. Therefore, greater consideration of caregiver illness representations and their impact on childhood asthma care may provide further opportunities to improve disease outcomes and clinical intervention. In families and communities more vulnerable to mental illness, children with anxiety are at greater risk of experiencing worse asthma control and quality of life. Thus, a deeper understanding of the interdependence of physical and psychological conditions that manifest in childhood and influence asthma management is necessary. As childhood obesity continues to prevail in this country, attention to cooccurring and chronic conditions may pave the way for more effective approaches to treatment and care.

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