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PII: S1876-2859(19)30331-6
DOI: <https://doi.org/10.1016/j.acap.2019.07.001>
Reference: ACAP 1381

To appear in: *Academic Pediatrics*

Received date: 15 February 2019
Accepted date: 4 July 2019

Please cite this article as: Staci R. Eisenberg MD , Elissa Jelalian PhD , Michael Farrow MA ,
Sheryl J. Kopel MSc , Nico Vehse MD , Patricia Mitchell MS , Shira Dunsiger PhD ,
Daphne Koinis-Mitchell PhD , Perceptions of asthma and exercise, and associations with
weight status and asthma morbidity in urban children, *Academic Pediatrics* (2019), doi:
<https://doi.org/10.1016/j.acap.2019.07.001>



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Perceptions of asthma and exercise, and associations with weight status and asthma morbidity in urban children

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Author contributions: All authors approved the final version of the submitted draft. Dr. Eisenberg was centrally involved in the conception of the study analysis, in interpretation of the data, and in preparation of the manuscript. Mr. Farrow was a research assistant and assisted with the data collection of this study and in the preparation of this manuscript. Ms. Kopel was the project director, led study data collection and data processing, and reviewed drafts of the manuscript. Dr. Vehse was involved in the design of the study and reviewed drafts of the paper. Ms. Mitchell performed clinical evaluations of all participants and reviewed drafts of the paper. Dr. Dunsiger was involved in the design of the study and analyzed and interpreted data for this manuscript. Drs. Koinis-Mitchell and Jelalian were the study's principal investigators and were centrally involved in the conception, design, and implementation of the study, and in interpretation of the data, and preparation of the manuscript.

Source of support: Eunice Kennedy Shriver National Institute of Child Health and Human Development R01 HD057220; PI, Koinis-Mitchell

Conflicts of Interest: None

Manuscript total word count (excluding the abstract, references, and legends): **3,800**

Abstract word count: **250**

Keywords: asthma, obesity, pediatric, urban, minority, fear, caregiver

Background: Given the high prevalence of asthma and obesity in minority children, there is a need to identify targets for intervention to decrease the impact of these conditions on children's functioning in this high-risk group.

Objective: To examine in urban children with persistent asthma, 1) differences in asthma indicators (e.g., FEV1% predicted) by weight status, and by ethnic group/weight status, 2) caregivers' fears about their child's asthma by weight status, and by ethnic group/weight status, and 3) the proportion of children who qualified for exercise induced bronchospasm (EIB) via exercise challenge test among those whose caregivers endorse exercise as a trigger for asthma.

Methods: In this sample of urban children (aged 7-9; N=147), subjective measures included child/caregiver daily report of asthma symptoms and caregiver fears about their child's asthma. Objective lung function was measured twice daily via handheld spirometer and EIB was confirmed via exercise challenge test.

Results: In the overall sample, a greater proportion of normal-weight children reported asthma symptoms compared to overweight/obese children. Caregiver fears about asthma were more prevalent among Latino caregivers. Non-Latino White children whose caregivers were afraid their child may die when having asthma reported more days with asthma symptoms. Very few children had confirmed EIB compared to the proportion of caregivers who endorsed exercise as a dangerous trigger for asthma.

Conclusion: Caregiver fear about asthma and misperceptions of exercise as a dangerous trigger for asthma should be addressed during health care visits with families of children with asthma and interventions including urban children with asthma.

What's New

Asthma and obesity disproportionately impact urban youth. Caregiver perceptions of children's asthma and physical activity influence asthma management decisions. Caregivers may perceive exercise as a dangerous trigger for asthma. Addressing caregiver fears and misperceptions about asthma may increase physical activity among urban youth.

Introduction

Asthma and obesity are co-morbid, significant, and costly public health issues that disproportionately affect urban minority youth, particularly children from Latino and African-American (AA) backgrounds.^{1,2} Urban children experience poorer asthma outcomes^{1,3} due to multiple factors, including increased exposure to allergens and irritants,^{1,4} to urban stressors (e.g., poverty, neighborhood disadvantage),¹ to stressors related to ethnic background (e.g., acculturative stress, discrimination),¹ and to other individual-level factors (e.g., genetic predisposition,⁵ medication adherence).⁶ These and other multi-level contributing factors also increase risk for overweight or obesity in children with asthma,⁷ including those that are biological in nature (e.g., chronic inflammation⁸), as well as lifestyle factors, such as decreased participation in physical activity.⁹⁻¹³ Moreover, urban children with asthma are more likely to have poorly controlled asthma^{14,15} and may be deconditioned, which may contribute to less engagement in physical activity.¹⁵ Given the burden of asthma and obesity in minority children and the impact of these conditions on daily functioning and long-term health outcomes, there is need to identify modifiable targets for intervention specific to the needs of this high-risk group.

Caregivers play an integral role in managing their children's asthma.^{19,20} Their perceptions regarding their children's asthma and engagement in physical activity can influence day-to-day asthma management decisions. The small number of existing studies that have examined these perceptions found that caregivers restrict their children's participation in physical activity because of fear related to their child's asthma.^{9-11,16} A qualitative study indicated that caregivers were fearful that their children do not always recognize their asthma symptoms.¹⁶ Yet, caregivers often rely on their observations and on their child's report of symptoms when making asthma management decisions. We have shown that children's perceptual accuracy of their asthma symptoms can affect their

morbidity and healthcare utilization,¹⁷ and Latino children may be more prone to over-magnification of symptoms.¹⁷ Understanding how caregivers' fears about their child's asthma and exercise influence management decisions can inform the development of tailored interventions for overweight/obese urban children with asthma.

The overall goals of this study involve the examination of child asthma outcomes in normal and overweight children, and caregivers' fears in the context of these outcomes. We first examined differences in indicators of asthma [e.g. FEV1% predicted, forced vital capacity (FVC), asthma control, and asthma symptoms] by weight status in the overall sample, and by ethnic group and weight status. We expected that minority children who are overweight or obese would have the poorest asthma outcomes.^{18,19}

Secondly, we examined caregivers' fears about their child's asthma in the overall sample, by children's weight status, and by ethnic group and weight status. Based on our prior work, and given higher asthma-obesity comorbidity in Latino children, we expected that Latino caregivers would report higher levels of fear of asthma than their AA and NLW counterparts.^{20,21} Although not specifically examined in prior research, we also expected that caregivers of overweight/obese children would be more likely to report fear of asthma in general or while their child is exercising, due to the potential for the children to misperceive deconditioning as symptoms of asthma.^{22,23} We expected that caregivers' fear in general about their child's asthma, and more specifically, fear of their child dying from an asthma, and fear of their child dying from an asthma while exercising, would be higher in Latino caregivers of overweight/obese children, given morbidity is highest in this group.

A third study question involved examining the associations between each caregiver fear indicator and each child asthma outcome. We expected that for each fear indicator, increased caregiver fear would be associated with poorer asthma outcomes, and that these associations would be more robust among minority children with overweight/obesity.

Our final question involved examining the proportion of caregivers who perceive that exercise is a trigger for their child's asthma and comparing this information to the proportion of their children who actually qualified for a diagnosis of exercise induced bronchospasm (EIB) via an exercise challenge test. Based on prior results suggesting that caregivers limit their children's physical activity due to fear of asthma,^{12,13,15,24,25} we expected a low proportion of children qualifying for EIB in comparison to the proportion of caregivers who endorsed exercise as a trigger for their child's asthma. We expected this to be higher among Latinos, given the higher prevalence of asthma and obesity and poorer perceptual accuracy in this group,¹⁷ and high prevalence of somatization among Latino children with asthma and their caregivers.²⁶

Methods

Data for the current study were collected as part of a larger five-year observational study that assessed asthma and physical activity as well as cultural and contextual factors among a sample of urban elementary school-age children with persistent asthma across one year.²⁷ The procedures and methods of the larger study, which include data for the current report, are summarized below.

Participants were recruited from hospital-based ambulatory pediatric clinics and from the four largest and adjacent urban school districts in a Northeast U.S. city. Eligible participants were between 7 and 9 years old, attended public school in one of the

four targeted urban school districts, had caregiver reported-physician-diagnosed asthma or breathing problems in the previous 12 months, and had a caregiver willing to participate who self-identified as Latino (Dominican or Puerto Rican), Black/African American (AA), or non-Latino White (NLW). Children were classified as having persistent asthma by caregiver report and/or a report of a current prescription for an asthma controller medication, and/or caregivers' report of recurrent daytime or nighttime symptoms, caregivers' report of their child's activity limitation, rescue medication use, or 2 or more oral steroid bursts the prior 12 months.²⁸ Diagnosis of persistent asthma was later confirmed at a study clinic visit (see below). Exclusion criteria included moderate to severe cognitive impairment, another pulmonary or chronic health condition, use of stimulant medication for ADHD, or a diagnosed sleep disorder (e.g., restless leg syndrome, chronic insomnia) that would confound the assessment of the main study questions of the larger study.

Data included in this report were collected during the fall and winter of each study year. Demographic information and information regarding asthma medication use were collected via caregiver and child questionnaires at the initial study visit at the participants' home. At this visit, full consent was obtained from the child and primary caregiver prior to interview-based questionnaires being administered to assess caregivers' fears about asthma and perception of exercise as a trigger for asthma. The second study visit occurred at our hospital-based asthma and allergy clinic at least two weeks later. As part of their participation in the study, at this visit, study clinicians evaluated children's asthma diagnosis and severity, confirmed asthma medication use, and assessed height and weight using standardized procedures. Immediately after this visit, as part of the study protocol, children and caregivers participated in a 4-week home-monitoring period, during which the child used a portable spirometry device twice daily to assess lung

function. Participants also completed a daily diary of information relevant for processing and scoring objective asthma data. Children and caregivers received standardized training on the use of the portable asthma monitor and instructions for completing entries in the daily diary (see below) and encouraged protocol adherence.^{17,29} Midway through the monitoring period, study staff visited the home to collect information on asthma control and download lung function data.

All assessments were administered verbally in Spanish or English by research staff fluent in both languages and according to participants' language preference. All instruments were translated using standardized procedure.³⁰ Participants received compensation for each session completed. The study was approved by the local Institutional Review Board.

Measures

Demographic and Descriptive Information. Primary caregivers provided demographic information (Table 1). Poverty status was computed as a dichotomous variable by comparing each family's annual income to the US per capita poverty threshold for the year of study participation.³¹

Physician Query. Children's primary care providers as well as asthma/allergy specialists (if applicable) completed a query detailing the date of child's last office visit, asthma diagnosis, past medical history, and current asthma treatment. The study clinician used this information as background to evaluate the child's asthma and allergy status as below.²⁹

Asthma Diagnosis and Classification of Asthma Severity. The clinic study visit included a medical history, physical examination, including child height and weight, and pulmonary function testing. Study clinicians used standard NHLBI EPR-3 guidelines to confirm asthma diagnosis and persistent severity classification.²⁸ Caregiver reports of children's asthma medication use and adherence

were noted. Lung function measurements (FEV1, FVC, etc.) were obtained with the Koko incentive spirometer (nSpireHealth, Longmont, CO) before and after administration of a short-acting beta agonist.³²

Asthma Outcomes: Asthma Control. Caregivers and children both completed the Asthma Control Test³³ a well-validated questionnaire of asthma-related impairment, at the clinic visit and at the end of the 4-week monitoring period. Continuous asthma control scores (higher scores = better control) were maintained for selected analyses, an approach used in prior research.²⁹

Asthma Symptoms. During the clinic visit, children and caregivers were oriented to use of a paper-based diary to record daily reports of asthma symptoms across the 4-week fall monitoring period. Data were summarized as a proportion of days with symptoms across the monitoring period using standard procedures.²⁹

Lung Function: FEV1% predicted, FVC. During the 4-week home monitoring period, children's lung function measurements were assessed twice daily (morning and evening) using a hand-held computerized spirometer (Jaeger AM2+; VIASYS Healthcare; Yorba Linda, CA). Research assistants instructed the caregiver and child in proper device use, including how to perform a forced, sustained expiration into the device, using standard procedures.³⁴ Participants were instructed to complete three "blows" each morning and evening prior to use of any asthma or allergy medications. The best of three blows (i.e., the highest FEV1% predicted value) was retained for each morning and evening trial. Details regarding data cleaning and data reduction procedures have been published previously,³⁴ including normative values used for FEV1 based on children's age.³⁵

Caregiver Perceptions: Fear of Asthma and Perception of Exercise as a Trigger for Asthma.

A questionnaire validated in our prior work assessed the extent to which caregivers are

fearful of asthma.²⁷ Using a 1-5 Likert scale, caregivers rated how often they felt afraid because of their child's asthma, with higher scores indicating more frequent fear. Fear was then further dichotomized (afraid because of child's asthma frequently or all the time vs. afraid never, rarely or sometimes) to ensure consistency in the scales of all caregiver perception variables. Caregivers were also asked whether or not they are afraid that their child will die when they are having an asthma attack and whether or not they are afraid that their child will die when they are having an asthma attack during exercise.

Weight Status: *Body Mass Index* (BMI) was computed from the children's clinic visit height and weight measurements using normative data. Using a standard CDC algorithm, children $\geq$ 85th percentile of BMI were classified as overweight/obese; those $<85\%$ were classified as normal weight, after omitting those classified as underweight (BMI percentile $< 5\%$).

Exercise Challenge Test: Among a subset of patients ($n= 39$), exercise-induced bronchospasm (EIB) was assessed through standardized exercise challenge testing.³⁶ Flow/volume curves and spirometry were performed at baseline and again at standard intervals after treadmill stress testing using a ramp protocol. EIB was diagnosed if FEV1% predicted decreased by $\geq 10\%$ from baseline after exercise.³⁷

Analysis Plan

As a preliminary step, differences by weight and race/ethnicity in baseline demographics, clinical characteristics, diary-reported asthma symptoms, asthma-related lung function and caregiver fear and perceptions of asthma and exercise were examined using chi-squared tests (for categorical variables) and analysis of variance (for continuous variables). We present these as unadjusted differences (Tables 1 and 2). Correlation analysis was used to identify potential confounders (e.g., asthma severity, poverty, age, and

gender). A variable was considered a confounder if it was associated ($p < .10$) with the predictor (fear, perception of exercise as trigger) and outcome (asthma outcome). Only asthma severity was associated with both the predictors (fears about asthma, perception of exercise as a trigger) and asthma outcomes at the 0.10 level and thus was included as a confounder in the adjusted analyses.

To assess the extent to which child weight was associated with asthma symptoms, asthma control, and lung function (FEV1% predicted, FVC), a series of generalized linear models (GLMs) were used in which asthma outcomes were regressed on weight (overweight/obese vs. normal weight) and confounders of the association. As a subsequent step, we explored whether the associations between weight and asthma outcomes were moderated by race/ethnicity using a similar analytic approach. Specifically, GLMs were used that included main effects of race/ethnicity and weight status as well as the interaction between them. Models also included potential confounders of the association. GLMs use a likelihood-based approach to estimation and thus make use of all available data without directly imputing missing outcomes.

Using a series of GLMs, we tested the associations between caregiver perceptions of asthma (fears about asthma and perception that exercise is a trigger for asthma) and asthma outcomes. As a subsequent step, weight and race/ethnicity were explored as potential moderators of the association between perceptions of asthma and asthma outcomes, using a similar approach. Models included the main effects of perceptions, the potential moderator, and the interaction between them.

Finally, among those who considered exercise as a trigger for asthma, we examined proportions of children with actual diagnosis of exercise induced bronchospasm through exercise challenge tests.

Analyses were carried out using SAS 9.3³⁸ with significance level set at $\alpha = .05$ a priori.

Results

Preliminary Results: The study consisted of 147 children with persistent asthma. Sociocontextual and clinical characteristics participants appear in Table 1. Mean age of participants was 8.18 years ($SD=0.91$), 56% were male, and 28% had poorly controlled asthma. Seventy-one percent of household's incomes were at or below the poverty threshold. Half of the sample (50.3%) had a BMI in the overweight/obese range.

Ethnic differences in Participant Characteristics: Our sample included 58% Latino participants, 27% African-Americans (AA), and 15.6% Non-Latino Whites (NLW). Between (ethnic) group differences are presented in Table 2. There were no significant differences between ethnic groups for age, child gender, or poverty status (Table 2).

Differences in asthma indicators by weight status in the overall sample. Unadjusted differences between (weight) groups are presented in Table 1. In the overall sample, we found a significant difference in self-reported asthma symptoms in normal weight vs. overweight/obese children, with a greater proportion of normal-weight children reporting asthma symptoms (0.17 vs. 0.11, $p<0.05$). This represents a 6% difference in the proportion of children reporting symptoms by weight status. This association remained significant after controlling for asthma severity ($b=0.14$, $SE=0.07$, $p=0.05$).

Differences in asthma indicators by weight status and ethnic group. Unadjusted differences in asthma indicators and perceptions of caregiver fear by race/ethnicity are presented in Table 2. Of note were significant between group differences with respect to FEV1 (AA>NLW>Latino) and FVC (AA>NLW>Latino). Adjusted findings among AAs mirrored the overall sample, with normal-weight children reporting a greater proportion of days with asthma symptoms ($b=.14$, $SE=.07$, $p=.05$) compared to

overweight/obese AA children. There were no significant associations between weight and asthma outcomes among Latino or NLW children.

Caregiver fears about asthma in the overall sample. As shown in Figure 1, 37.9% of caregivers reported feeling frequently or always afraid because of their child's asthma, with an even higher percentage (41%) feeling afraid that their child may die when having asthma. Roughly one-third (31.1%) reported fear that their child may die from asthma during exercise.

Caregiver fears by weight and race/ethnicity. There were no differences in fear between caregivers of normal weight vs. overweight/obese children (Table 1). Latino caregivers were most likely to report fears about child's asthma than AA and NLW children. The same pattern was observed for caregiver fear of their child dying when having asthma and dying of asthma while exercising.

Associations between caregiver fears related to their child's asthma and children's asthma outcomes. After adjusting for severity, there was a trend in the association between caregiver fear that their child may die when having asthma and a greater proportion of days of child asthma symptoms ($b=.06$, $SE=.03$, $p=.07$). Specifically, caregivers who feared their child may die when having an asthma attack had children who reported a greater proportion of days with asthma symptoms. There were no other associations between fear of asthma and asthma indicators in the overall sample.

Association between caregiver fear of their child's asthma and asthma indicators by weight status. Analysis by weight status showed no significant associations between caregiver fear and asthma outcomes. However, among overweight/obese children, there

was a trend such that children whose caregivers feared their child may die from asthma while exercising had a greater proportion of days with symptoms ($b=.07$, $SE=.04$, $p=.07$).

Association between caregiver fear of their child's asthma and asthma indicators by race/ethnicity: NLW children whose caregivers were frequently/always afraid of their child's asthma had higher lung function (FEV1) ($b=15.67$, $SE=6.80$, $p=.03$). Moreover, NLW children whose caregivers were afraid their child may die when having asthma had children who reported more frequent asthma symptoms ($b=.28$, $SE=.08$, $p=.01$), as did those who were afraid their child may die from asthma when exercising ($b=.28$, $SE=.08$, $p=.01$). There were no associations between fear and asthma indicators among AA caregivers and children.

Proportion of children with confirmed exercise induced bronchospasm among those whose caregivers endorse exercise as trigger for asthma. Overall, out of the entire sample, two-thirds of caregivers agreed that exercise is dangerous for children with asthma. This perception did not differ by weight status or race/ethnicity; however, NLW children whose caregivers considered exercise as a trigger for asthma had poorer asthma control ($b=-5.10$, $SE=1.62$, $p=.01$). Of the 63 caregivers who endorsed exercise as a dangerous trigger for asthma, only three of those children had confirmed exercise induced bronchospasm.

Discussion

This study sought to shed further light on the association between caregiver perceptions of asthma and exercise and child asthma outcomes, and how these associations differed by race/ethnicity and weight status. In addition, exercise challenge testing

allowed us to examine the prevalence of EIB in this high-risk sample and to evaluate caregiver perceptions about asthma and exercise in the context of these data.

We found that child weight status was not associated with objective lung function (i.e. FEV1%) whereas self-reported asthma symptoms did vary by weight status. Normal weight AA and NLW children reported more days with symptoms compared to overweight/obese children. The literature has been mixed regarding the impact of excess weight on objective lung function. Symptom perception can be affected by a variety of factors, including asthma morbidity, which we have shown to be associated with inaccurate symptom perception.⁴⁰ It may be that obese children are less sensitive to changes in lung function or asthma symptoms, though this needs to be studied further. Alternatively, it may be that normal weight children are more active and this may affect their perceived or actual symptoms.

As expected, we found high levels of caregiver fears about asthma in our sample. There were no differences in fear between caregivers of normal weight vs. overweight/obese children, perhaps due to high levels of fear at baseline. However, there were differences by race/ethnicity; Latino caregivers reported higher levels of fear of asthma, and fear of their child dying from asthma or while exercising, than caregivers from AA and NLW backgrounds. Multi-level factors may contribute to these differences, such as: lack of knowledge about asthma symptom prevention and/or how to respond to symptoms prior to and during exercise; urban and family stresses contributing to increased caregiver fears of asthma; or increased frequency of observing family members struggle due to asthma. Future studies need to explore factors that impact caregiver fear and the ways in which these fears contribute to day to day management of asthma.

There were significant associations between caregiver fears and asthma outcomes by race/ethnicity. Contrary to expectation, the strongest associations were observed in the non-Latino white group; NLW caregivers who reported fear of their child dying from asthma (either in general or while exercising) had children who reported more days with asthma symptoms. As we have previously shown higher perceptual accuracy of symptoms among NLW children,³⁰ it is possible that children who are aware of symptoms are more vocal about them resulting in increased caregiver fear. This may also help explain the trend we observed toward better lung function among NLW children whose caregivers reported fears about their child's asthma. Among families with fewer competing stressors, increased caregiver fear levels may contribute to more monitoring on the caregiver's part, or may otherwise affect management decisions that can impact lung function. More research is needed to examine how specific caregiver fears may affect specific management behaviors.

Finally, among children whose caregivers endorse exercise as trigger for asthma, we sought to determine the proportion who qualified for EIB via exercise challenge test. Approximately two-thirds of caregivers agreed that exercise is dangerous for children with asthma, with no differences by weight status or race/ethnicity. This is consistent with the small³⁹ number of prior studies which have shown that caregiver fear is associated with restriction of children's activities.^{11,39}

Notably however, of the subsample who underwent exercise challenge testing, a very small proportion had confirmed EIB. This finding represents a potential opportunity for education and intervention to improve management of asthma, caregiver perceptions of exercise, and, ultimately, children's participation in physical activity.

Several limitations of our study should be noted. More studies with larger samples of urban children are needed to validate our results and account for the number of variables examined. Our analysis also does not allow us to determine causality between weight status, asthma outcomes, and caregiver fears. Finally, as caregiver fear was just one factor examined in this larger study of urban children with asthma, we had a limited number of questions assessing caregiver fear. Mixed methods studies (e.g., qualitative approaches) are needed to disentangle factors that impact caregiver fear and identify opportunities to intervene in the development of caregiver perceptions that impact asthma management and physical activity. Future studies should also explore whether exercise challenge testing could be helpful to confirm or rule out EIB to reinforce the safety and benefit of physical activity when children's asthma is well controlled.

We found high levels of caregiver fear about asthma in general and inaccurate caregiver perception of exercise as a trigger for asthma in our sample of children. Our findings highlight opportunities for intervention. At the family level, further caregiver education regarding asthma management, particularly how to prevent and address asthma symptoms during exercise, is needed. Health care providers are encouraged to ask caregivers directly about perceptions and fears related to asthma and explore how their perceptions may guide daily decisions about asthma management and health care utilization. Thus, culturally informed, patient and family-centered education regarding the safety and importance of exercise for children with asthma is necessary. Such tailored interventions may ultimately decrease the prevalence and impact of asthma and obesity in urban children, and improve daily quality of life for this group.

References:

- 1 Koinis-Mitchell D, McQuaid EL, Seifer R, Kopel SJ, Esteban C, Canino G, Garcia-Coll C, Klein R, Fritz GK. Multiple urban and asthma-related risks and their association with asthma morbidity in children. *Journal of Pediatric Psychology* 2007; doi:10.1093/jpepsy/jsl050
- 2 Lang JE. Obesity, Nutrition, and Asthma in Children. *Pediatric Allergy Immunology Pulmonology* 2012; 25: 64-75.doi: 10.1089/ped.2011.0137
- 3 Akinbami LJ, Moorman JE, Bailey C, Zahran HS, King M, Johnson CA, Liu X. Trends in asthma prevalence, health care use, and mortality in the United States, 2001-2010. *NCHS Data Brief* 2012: 1-8.
- 4 Kattan M, Mitchell H, Eggleston P, Gergen P, Crain E, Redline S, Weiss K, Evans III R, Kaslow R, Kerckmar C. Characteristics of inner- city children with asthma: the National Cooperative Inner- City Asthma Study. *Pediatric Pulmonology* 1997; 24: 253-262.
- 5 Hanson B, McGue M, Roitman-Johnson B, Segal NL, Bouchard TJ, Jr., Blumenthal MN. Atopic disease and immunoglobulin E in twins reared apart and together. *American Journal of Human Genetics* 1991; 48: 873-879.
- 6 McQuaid EL, Everhart RS, Seifer R, Kopel SJ, Mitchell DK, Klein RB, Esteban CA, Fritz GK, Canino G. Medication adherence among Latino and non-Latino white children with asthma. *Pediatrics* 2012; peds. 2011-1391.

- 7 Gennuso J, Epstein LH, Paluch RA, Cerny F. The relationship between asthma and obesity in urban minority children and adolescents. *Archives of Pediatrics & Adolescent Medicine* 1998; 152: 1197-1200.
- 8 Donma M, Karasu E, Ozdilek B, Turgut B, Topcu B, Nalbantoglu B, Donma O. CD4+, CD25+, FOXP3+ T regulatory cell levels in obese, asthmatic, asthmatic obese, and healthy children. *Inflammation* 2015; 38: 1473-1478. doi:10.1007/s10753-015-0122-4
- 9 Glazebrook C, McPherson AC, Macdonald IA, Swift JA, Ramsay C, Newbould R, Smyth A. Asthma as a barrier to children's physical activity: Implications for body mass index and mental health. *Pediatrics* 2006; 118: 2443-2449.
- 10 Holderness H, Chin N, Ossip DJ, Fagnano M, Reznik M, Halterman JS. Physical activity, restrictions in activity, and body mass index among urban children with persistent asthma. *Annals of Allergy, Asthma & Immunology* 2017; 118: 433-438.
- 11 Lang D, Butz A, Duggan K, Serwint J. Physical activity in urban school-aged children with asthma. *Pediatrics* 2004; 113: 341-346. doi:10.1542/peds.113.4.e341
- 12 Leinaar E, Alamian A, Wang L. A systematic review of the relationship between asthma, overweight, and the effects of physical activity in youth. *Annals of Epidemiology* 2016; 26: 504-510.
- 13 Williams B, Powell A, Hoskins G, Neville R. Exploring and explaining low participation in physical activity among children and young people with asthma: a review. *BMC Family Practice* 2008; 9: 40.
- 14 Wiesenthal EN, Fagnano M, Cook S, Halterman JS. Asthma and overweight/obese: double trouble for urban children. *Journal of Asthma* 2016; 53: 485-491. doi:10.3109/02770903.2015.1108435

- 15 Lang DM, Butz AM, Duggan AK, Serwint JR. Physical activity in urban school-aged children with asthma. *Pediatrics* 2004;
113: 341-346.
- 16 Kornblit A, Cain A, Bauman LJ, Brown N, Reznik M. Barriers to physical activity in urban school children with asthma:
parental perspective. *Academic Pediatrics* 2018.
- 17 Fritz GK, McQuaid EL, Kopel SJ, Seifer R, Klein RB, Mitchell DK, Esteban CA, Rodriguez-Santana J, Colon A, Alvarez M.
Ethnic differences in perception of lung function: a factor in pediatric asthma disparities? *American journal of respiratory and
critical care medicine* 2010; 182: 12-18.
- 18 Vijayakanthi N, Grealley JM, Rastogi D. Pediatric Obesity-Related Asthma: The Role of Metabolic Dysregulation. *Pediatrics*
2016; 137. doi: 10.1542/peds.2015-0812
- 19 Forno E, Lescher R, Strunk R, Weiss S, Fuhlbrigge A, Celedón JC. Decreased response to inhaled steroids in overweight and
obese asthmatic children. *JACI* 2011; 127: 741-749. doi: 10.1016/j.jaci.2010.12.010
- 20 Stingone JA, Ramirez OF, Svensson K, Claudio L. Prevalence, Demographics, and Health Outcomes of Comorbid Asthma and
Overweight in Urban Children. *Journal of Asthma* 2011; 48: 876-885. doi:10.3109/02770903.2011.616615
- 21 Vo P, Makker K, Matta-Arroyo E, Hall CB, Arens R, Rastogi D. The association of overweight and obesity with spirometric
values in minority children referred for asthma evaluation. *Journal of Asthma* 2013; 50: 56-63. doi:
10.3109/02770903.2012.744035

- 22 Rastogi D, Khan UI, Isasi CR, Coupey SM. Associations of Obesity and Asthma with Functional Exercise Capacity in Urban
Minority Adolescents. *Pediatric Pulmonology* 2012; 47: 1061-1069. doi:10.1002/ppul.22547
- 23 Pianosi PT, Davis HS. Determinants of physical fitness in children with asthma. *Pediatrics* 2004; 113: 225-229.
- 24 Dantas FM, Correia MA, Jr., Silva AR, Peixoto DM, Sarinho ES, Rizzo JA. Mothers impose physical activity restrictions on
their asthmatic children and adolescents: an analytical cross-sectional study. *BMC Public Health* 2014; 14: 287.
doi:10.1186/1471-2458-14-287
- 25 Mansour M, Lanphear B, DeWitt T. Barriers to asthma in urban children: parent perspectives. *Pediatrics* 2000; 106: 512-519.
- 26 Vasquez JC, Fritz GK, Kopel SJ, Seifer R, McQuaid EL, Canino G. Ethnic differences in somatic symptom reporting in
children with asthma and their parents. *Journal of the American Academy of Child & Adolescent Psychiatry* 2009; 48: 855-
863.
- 27 Koinis-Mitchell D. Cultural and Contextual Mechanisms Relevant to Asthma and Physical Activity in Urban Children.
American Journal of Respiratory And Critical Care Medicine 2018; 197.
- 28 National Heart Lung and Blood Institute. Guidelines for the Diagnosis and Management of Asthma. Bethesda, MD: National
Institutes of Health; 1997 No. NIH Publication 3997-4051.
- 29 Koinis-Mitchell D, Kopel SJ, Boergers J, McQuaid EL, Esteban CA, Seifer R, Fritz GK, Beltran AJ, Klein RB, LeBourgeois
M. Good sleep health in urban children with asthma: A risk and resilience approach. *Journal of Pediatric Psychology* 2015;
40: 888-903. doi:10.1093/jpepsy/jsv046

- 30 Canino G, Bravo M. The adaptation and testing of diagnostic and outcome measures for cross-cultural research. *International Review of Psychiatry* 1994; 6: 281-286. doi:10.3109/09540269409023267
- 31 U.S. Department of Health and Human Services. The 2005 HHS Poverty Guidelines. Washington, DC: U.S. Department of Health and Human Services; 2005.
- 32 American Thoracic Society, European Thoracic Society. ATS/ERS recommendations for standardized procedures for online and offline measurement of exhaled lower respiratory nitric oxide and nasal nitric oxide. *American Journal of Respiratory and Critical Care Medicine* 2005; 171: 912-930. doi:10.1164/rccm.200406-710ST
- 33 Schatz M, Sorkness CA, Li JT, Marcus P, Murray JJ, Nathan RA, Kosinski M, Pendergraft TB, Jhingran P. Asthma Control Test: reliability, validity, and responsiveness in patients not previously followed by asthma specialists. *Journal of Allergy and Clinical Immunology* 2006; 117: 549-556. doi: 10.1016/j.jaci.2006.01.011
- 34 Fritz GK, McQuaid EL, Kopel SJ, Seifer R, Klein RB, Koinis-Mitchell DK, Esteban CA, Rodriguez-Santana J, Colon A, Alvarez M, Canino G. Ethnic differences in perception of lung function: A factor in pediatric asthma disparities? *American Journal of Respiratory and Critical Care Medicine* 2010; 182: 12-18. doi:10.1164/rccm.200906-0836OC
- 35 Wang X, Dockery DW, Wypij D, Fay ME, Ferris BG, Jr. Pulmonary function between 6 and 18 years of age. *Pediatric Pulmonology* 1993; 15: 75-88. doi:10.1002/ppul.1950150204
- 36 American Thoracic Society. Guidelines for methacholine and exercise challenge testing-1999. *American Journal Of Respiratory And Critical Care Medicine* 2000; 161: 309-329.

- 37 Pasnick SD, Carlos Iii WG, Arunachalam A, Celestin FM, Parsons JP, Hallstrand TS, Anderson SD, Wilson KC, Thomson CC. Exercise-induced bronchoconstriction. *Annals of the American Thoracic Society* 2014; 11: 1651-1652. 10.1513/AnnalsATS.201409-427OT
- 38 SAS Institute Inc. SAS 9.3 Help and Documentation. Cary, NC: SAS Institute Inc., 2002-2004.
- 39 Carroll-Scott A, Gilstad-Hayden K, Rosenthal L, Peters SM, McCaslin C, Joyce R, Ickovics JR. Disentangling neighborhood contextual associations with child body mass index, diet, and physical activity: The role of built, socioeconomic, and social environments. *Social Science & Medicine* 2013; 95: 106-114. doi:10.1016/j.socscimed.2013.04.003

Table 1: Participant characteristics (demographics, asthma status, lung function and caregiver fear): Full sample and by weight status, N=147

	Sample	Normal Weight (< 85 th percentile of BMI)	Obese/Overweight (≥ 85 th percentile of BMI)	Weight differences (p-value)	Effect sizes[†]
%	147	59%	41%	n/a	n/a
Age, mean(std)	8.16 (0.91)	8.10(.90)	8.21(.93)	.48	-.01
Gender, % male	55.8	56.3	55.4	.92	.01
RACE/ETHNICITY (%)					
Latino	55.8	50	61.5	.19	.12
African-American/Black	28.7	34.4	23.1	.16	-.13
Non-Latino White	15.5	15.6	15.4	.97	<-.01
At or Below Poverty Threshold, %	69.5	72.1	66.7	.52	.06
Body Mass Index (BMI)	19.07(3.92)	16.23(1.21)	21.83(3.65)	<.01	.25
ASTHMA STATUS					
Mild Intermittent, %	4.1	5.0	3.3	.63	-.04
Mild Persistent, %	49.6	50.0	50.8	.93	.01
Moderate Persistent, %	27.3	28.3	26.2	.80	-.02
Severe Persistent, %	18.2	16.7	19.7	.67	.04
FEV1 % Predicted, mean(std)	84.58(12.80)	84.75(12.90)	84.39(12.79)	.88	-.01
FVC, mean(std)	84.00(17.68)	84.48(16.08)	83.48(19.43)	.76	.05
Diary Reported Symptoms, mean(std)	0.13(0.16)	.16(.18)	.10(.14)	.06	.35
Asthma Control (continuous), mean(std)	21.17(3.75)	20.92(3.92)	21.44(3.59)	.45	-.19
EIB Status	9.0	13.3	4.5	.15	.15
CAREGIVER FEAR OF ASTHMA, %					
Frequently/Always Afraid Because of Child's Asthma	38.1	35.4	40.8	.45	.19
Afraid Child may Die when having asthma attack	41.2	45.8	36.7	.36	-.09
Afraid Child May Die from Asthma Attack during Exercise	29.9	29.2	30.6	.88	.02
Reported exercise as a dangerous trigger for children with asthma	66.7	69.8	64.0	.56	-.06

† Effect size is a d for continuous variables and a phi for categorical variables. STD=standard deviation. FEV1=Maximal amount of air forced in one second. FVC=Forced expiratory vital capacity. Data aggregated across the sample is presented in column 2. Data for normal weight and overweight/obese participants are presented in columns 3 and 4.

Table 2 Demographics, Asthma indicators and Fear by race/ethnicity, N=147

	Latino	African American	Non-Latino White	Ethnic differences (p-value)	Effect sizes†
Age, mean(std)	8.18(.93)	8.09(.92)	8.36(.86)	.56	.01
Gender,				.11	.17
% male	62.4	51.3	39.1		
%female	37.6	48.7	60.9		
Weight Status				.33	.13
Obese/Overweight, %	55.6	40.5	50		
Normal Weight, %	44.4	59.5	50.0		
At or Below Poverty Threshold, %	72.4	68.6	66.7	.84	.05
ASTHMA STATUS					
FEV1 % Predicted*, mean(std)	81.43(12.01)	89.26(13.49)	86.87(11.18)	<.01	.08
FVC, * mean(std)	79.37(14.24)	91.63(22.02)	84.84(15.48)	<.01	.09
Diary Reported Symptoms, mean(std)	.13(.15)	.15(.19)	.14(.18)	.77	<.01
Asthma Control (continuous), mean(std)	21.78(3.35)	20.18(3.56)	21.05(3.56)	.13	.01
EIB Status	11.5	12.5	11.1	.99	.02
CAREGIVER FEAR OF ASTHMA, %					
Frequently/Always Afraid Because of Child's Asthma*, %	48.2	30	17.6	.41	.28
Afraid Child may Die when having asthma attack*, %	57.1	26.7	17.6	<.01	.35
Afraid Child May Die from Asthma Attack during Exercise*, %	42.9	16.7	17.6	.02	.28

Reported exercise as a dangerous trigger for children with asthma, %	67.3	66.7	66.7	.99	.01
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† Effect sizes are eta squared for continuous variables and phi for categorical variables. STD=standard deviation. FEV1=Maximal amount of air forced in one second. FVC=Forced expiratory vital capacity.

Figure 1. Caregivers' fear because of their child's asthma

