

OBESITY

Prevalence, Demographics, and Health Outcomes of Comorbid Asthma and Overweight in Urban Children

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Background. Asthma and overweight are epidemic in urban children but the relationship between these conditions is not fully understood. This study presents demographic and risk profiles of comorbidity for overweight asthmatic children, characterizes morbidity by comparing health outcomes among overweight asthmatics and healthy weight asthmatics, and examines socioeconomic factors associated with comorbidity. **Objective.** To construct a demographic profile of overweight asthmatic children in an urban setting and identify factors that contribute to prevalence. **Method.** Cross-sectional study of 5250 children in New York City public elementary schools using a parent-report questionnaire on body mass index, socioeconomic status, asthma, and asthma-related outcomes. **Results.** Prevalence of overweight (body mass index $\geq$ 85th percentile for age and gender) was 50.9%. The prevalence of overweight and ever being diagnosed with asthma was 10.9%. The prevalence of overweight with current asthma was 6.2%. Overweight current asthmatics had more night symptoms, missed school days, and asthma medication use than healthy weight asthmatics. Almost 50% of overweight current asthmatic children reported emergency department visits for asthma compared with 30% of healthy weight asthmatics. Comorbidity was most prevalent among males, Latinos, and children in low-income households, with the highest prevalence among Puerto Ricans. In multivariate analysis stratified by gender, the most significant factors associated with comorbidity among girls were low income and minority race/ethnicity, while among boys significant factors were parental education and parental history of asthma. Interestingly, there were few underweight children (7.8%) but they had high prevalence of asthma (13.8%). **Conclusions.** The comorbidity of overweight and asthma has a large impact on urban populations, causing greater disease burden than asthma alone. Overweight asthmatics show more uncontrolled asthma, evidenced by emergency department visits, quick-relief medication use, and days with asthma symptoms. The relationship between socioeconomic factors and the asthma–obesity comorbidity may vary by gender and requires further study to identify successful interventions to reduce disease in children.

Keywords asthma, child, health status disparities, minority health, obesity, overweight, schools

INTRODUCTION

Asthma and overweight are highly prevalent in children. National estimates from 2007 to 2008 show that 9.1% of American children aged 0–18 years had current asthma (CA), while 31.7% of children aged 2–17 years were overweight or obese (1,2). In urban and minority communities in particular, asthma and overweight have reached near-epidemic proportions. For example, it has been estimated that 43% of New York City school children are overweight and the prevalence of asthma has been reported at 13.0% (3–6). Although there is consensus about the alarmingly high prevalence of asthma and overweight independent of each other, there is debate about how the two conditions are interrelated.

Several pathways have been hypothesized to explain the coexistence of obesity and asthma, including complex biological mechanisms, behavioral, and environmental factors (7–12). It is likely that comorbidity results from interactions involving multiple pathways, rather than one mechanism (10). One compelling hypothesis suggests

an exacerbatory relationship, in which overweight individuals more commonly experience inflammatory reactions that trigger or hasten asthma episodes (13). This is supported by studies that show that overweight asthmatic children experience more frequent and severe asthma exacerbations than healthy weight asthmatics, resulting in more emergency department (ED) visits, missed school days, hospitalizations, and activity limitations (14–18).

Several studies support the hypothesis of a link between asthma and obesity (16,19–22). Cross-sectional analysis of the Third National Health and Nutrition Examination Survey (NHANES III) found that overweight children aged 6–16 years were three times more likely to report having asthma than their healthy weight peers (13). The Children's Health Study of Southern California found that the risk of new asthma diagnosis in a 4-year follow-up period was significantly higher among overweight and obese children than for those at a normal weight (23). However, another 1-year prospective study found no relationship between body mass index (BMI) and measures of asthma severity in children or adults (24). Questions remain regarding the level of asthma morbidity in overweight asthmatic children.

In addition to biological and medical factors, obesity and asthma appear to be strongly influenced by

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socioeconomic factors. Studies consistently show that asthma morbidity and mortality vary by household income, with adverse outcomes increasing with decreasing income (25–27). Latinos and African-Americans have higher prevalence of asthma compared with Whites, even in studies that control for income (25–30). A recent study by Victorino and Gauthier (27) found greater odds of asthma in children from households with a single female parent but the odds of asthma decreased as the number of children in the household increased (31). Exposure to environmental tobacco smoke (ETS) is differential among children with asthma, with parental income and education as mediating factors (32,33). Similar relationships have been found between overweight/obesity and race/ethnicity, income, and education (34,35). These findings suggest that factors like race/ethnicity, education, socioeconomic level, and household structure must also be considered when assessing disparities in asthma and obesity.

The significance of past findings regarding the relationship between overweight and asthma is tempered by inconsistent findings and variations among different populations (36–39). Prevalence estimates indicate disparities in the distribution of comorbidity in the general population, with males, African-Americans, and Latinos exhibiting the greatest prevalence (20,23,40). Several studies have focused on homogeneous populations without comparison with others (20,21). A review of the asthma–obesity link suggested that weak associations may result from a “dilution effect,” whereby the subgroup for which the asthma–overweight association is strongest is absent or poorly represented in the sample (41). In addition, many studies do not differentiate between Latino subgroups such as Mexican or Puerto Rican, two populations that exhibit very different asthma prevalence (4). Rather, studies often recruit subjects from only one or two Latino subgroups only (5,42,43) or group all Latinos into one category (called “Hispanic” or “Latino”) (5,23,44,45), losing the opportunity to make important distinctions in health outcomes between subgroups. In the case of comorbid asthma and overweight, subpopulation analysis can be especially important in identifying at-risk populations and accurately assessing morbidity.

The objectives of this study were to (1) measure the prevalence of concomitant asthma and overweight in schoolchildren of different socioeconomic status (SES); (2) compare asthma-related outcomes between weight groups; and (3) identify how SES factors may be associated with comorbid asthma and overweight. This study adds to the literature by comparing demographics and health outcomes of children with *both* asthma and overweight with healthy weight children in a large multiethnic sample from diverse urban communities.

METHODS

Data were collected as part of a cross-sectional study of asthma prevalence. The study was approved by Mount Sinai Institutional Review Board, the Mount Sinai Health

Insurance Portability and Accountability Act Office, and the New York City (NYC) Department of Education’s Division of Assessment and Accountability.

Study Design

Methodology for selecting the participating schools has been published elsewhere (46). Briefly, schools were randomly selected for inclusion based on the asthma hospitalization rate for children aged 5–12 years in each neighborhood, as reported by local hospitals to the New York State Statistics Planning and Area-wide Research Council database. ZIP codes were ranked and grouped according to their childhood asthma hospitalization rate. Schools from the highest, median, and lowest hospitalization groups were eligible for the study. Using the SAS Surveyselect Procedure (SAS Institute Inc., Cary, NC, USA), one school from each ZIP code was selected with probability proportional to size. Twenty-six schools were selected, 8 from the low and median groups and 10 from the high group to compensate for lower expected asthma prevalence. Questionnaires were distributed in two randomly selected K-5 classrooms per grade level and up to two special education classrooms. Children brought the questionnaire home to their parent/guardian and returned the completed forms. Children and teachers were offered nominal incentives for participation.

Survey Instrument

The questionnaire, available in English, Spanish, and Chinese, contained standardized questions on demographics, household environment, and asthma symptoms adapted from the International Study of Asthma and Allergies in Childhood (47) as follows: parents reported race/ethnicity of their child using six categories or an “Other” category. “Ever asthma (EA)” was defined as a positive response to: “Have you or your child ever been told by a doctor or a nurse that he/she has asthma?” Current asthma (CA) was defined as a positive response to both the previous question and “In the last 12 months, has your child had wheezing in the chest?” Parents/guardians of asthmatic children completed questions on asthma-related Emergency Department (ED) visits, hospitalizations, asthma episodes, sleep disturbances in the previous 12 months, missed school days in the previous 2 weeks, and number of days during the previous 2 weeks their child had experienced the following symptoms: cough, wheeze, shortness of breath, chest pain, or sleep disturbances. To assess patterns of medication use, parents were asked to specify which medications their child used in the previous 2 weeks (options: short-acting β -agonists and prednisone) as well as frequency of use (when having symptoms only, when having an asthma attack only, or regularly—even when not having symptoms). Regular use of short-acting β -agonists or prednisone, even when not having symptoms, was considered as an indicator of poor asthma control (48).

Data Analysis

Gender/age-adjusted BMI was calculated from parent report of the child's age, gender, height, and weight. A publicly available SAS computer program from the Centers of Disease Control and Prevention (CDC) was used to calculate BMI, adjusted for age and gender, based on 2000 CDC growth charts (49). To conform to the World Health Organization's limits for acceptable data, the SAS program calculates modified *z*-scores for each observation, flags modified *z*-scores greater than 5.0 or less than -5.0 as "biologically implausible," and excludes them from analysis.

After BMI percentiles were calculated, children were grouped into three categories according to CDC-established cutoffs: (1) underweight—below the 5th percentile; (2) healthy weight—at or above the 5th and below the 85th percentile; (3) overweight—at or above the 85th percentile. In this study, as in others (5,6,50–52), the overweight category condenses two CDC-defined categories: "Overweight"—between 85th and 95th percentile and "Obese"—at or above 95th percentile to maximize analytical power.

Data were weighted to represent the number of children attending public elementary schools within their respective ZIP codes. Prevalence for CA and EA by BMI group was calculated in SAS v9.1 using the Surveyfreq procedure. Chi-square tests were performed to explore the associations between overall demographic variables and the different outcomes of interest. Prevalence estimates for health outcomes, medication use, and demographic characteristics were calculated by BMI group using SAS' Surveyfreq and Surveymeans procedures. Because the association between CA and weight status differed by gender, separate logistic regression models were constructed using the SAS Surveylogistic procedure. The dependent outcome was the presence or absence of comorbid CA and overweight. The independent variables of interest were parent education, household income, single-parent household, number of children in the household, and race/ethnicity. Exposure to ETS and parent with asthma were included in the model as control variables as they are environmental and biological factors associated with the outcome (comorbid asthma and overweight) and several independent variables. All analytic procedures account for the sampling design of clustering by school and stratification by neighborhood asthma hospitalization rate.

RESULTS

Characteristics of the Sample

The overall response rate, adjusted for the average absence rate for each school, was 76.9% ($n = 5250$). Height, weight, age, and gender data were obtained from 3077 (58.6%) respondents. Applying the CDC program resulted in the exclusion of 184 respondents who provided height or weight data that produced biologically implausible age-adjusted BMI values [29 too high (0.9%),

155 too low (5.0%)]. Therefore, the total number of respondents with usable BMI data was 2893 (55.1%). Children with valid BMI data were more likely than those without valid BMI data to be Asian, live in high-income households, and have parents with a college degree. Importantly, there was no significant difference in the prevalence of asthma between respondents with or without usable BMI data.

Prevalence of Overweight and SES Factors

Less than one-tenth of respondents were underweight (7.8%) and 41.3% were at a healthy weight. More than one-third of respondents (34.2%) had age-adjusted BMI at or above the 95th percentile, indicating obesity. Another 16.7% fell between the 85th and 95th percentile. Combined, this population showed that over half of respondents (50.9%) were overweight or obese (Table 1). After we performed chi-square tests of the associations between the demographic variables and being overweight, we observed that overweight children were significantly more likely to be male (54.4%), Puerto Ricans (62.5%), and come from low-income households (53.9%). Other ethnic groups with high prevalence of overweight were Dominicans (57.4%) and other Latinos (58.6%). Prevalence of underweight was highest among Mexicans (11.3%), Whites (9.5%), and Asians (8.4%).

Prevalence of overweight differed between income and parental educational attainment. Over half of the children from households in the lowest (less than \$20,000 a year) and medium (\$40,000–\$74,999) income groups were overweight, while the highest earning households had the fewest overweight children. Overweight was also highest (54%) among children whose parents had the lowest educational attainment (less than high school) but did not vary greatly between parental attainment groups.

Prevalence of Asthma is Greater in Overweight Children

Overall, the prevalence of ever having been diagnosed with EA was 18.9% (Table 1). The prevalence of EA in overweight children (21.4%) was significantly greater than EA in healthy weight children (16.1%) (Figure 1). BMI was significantly associated with EA, with unadjusted odds of EA in overweight children, compared with healthy weight children of 1.4 (95% CI: 1.2–1.6).

The prevalence of CA was 10.6%. The prevalence of CA in overweight (12.2%) and underweight (13.8%) children was significantly greater than CA in healthy weight children (8.1%) (Figure 1). The unadjusted odds of CA in overweight children, compared with healthy weight children, were 1.6 (95% CI: 1.2–2.1). Among boys, the association between BMI group and CA was significant.

Some respondents reported wheezing in the past 12 months, but had never been diagnosed with asthma ($n = 77$). There was a significant association between wheeze (without asthma diagnosis) and BMI. Of those

TABLE 1.—Prevalence (in percentages) of overweight, ever asthma (EA), overweight with EA, current asthma (CA), and overweight with CA by demographic characteristics ($n = 2893$).

	Overweight $n = 1472$	EA $n = 478$	CA $n = 276$	Overweight with EA $n = 264$	Overweight with CA $n = 155$
Overall	50.9	18.9	10.6	10.9	6.2
Gender	***	***	**	***	***
Males	54.4	23.5	14.8	13.7	8.4
Females	47.8	17.5	10.0	8.3	4.2
Ethnicity	***	***	***	***	***
African-American	56.1	26.0	17.2	13.3	6.6
Asian	36.2	9.5	4.6	3.1	1.5
Latinos	58.5	24.1	13.7	17.2	10.3
Puerto Rican	62.5	36.7	21.2	23.4	15.5
Dominican	57.4	24.5	13.2	18.0	8.0
Mexican	51.0	10.1	7.4	10.2	8.8
Other Latino	58.6	19.3	10.0	12.6	6.7
White	44.5	10.9	6.6	5.7	3.2
Other	49.7	20.9	14.4	8.5	6.2
Household income	**	***	**	***	*
<\$20,000	53.9	22.7	14.0	13.1	7.6
\$20,000–\$39,999	48.1	21.4	12.2	11.9	6.6
\$40,000–\$74,999	51.0	15.8	10.2	8.3	4.8
\$75,000 and more	42.1	12.7	4.9	4.2	1.4
Parental education			**	*	*
<High school	54.0	23.2	14.1	15.8	9.6
High school diploma/GED	51.5	22.2	13.7	11.6	7.1
Some college	53.1	19.7	12.9	10.2	6.0
College degree	47.4	16.6	8.2	8.5	3.6

Notes: Chi-square tests of association between overall demographic characteristics and overweight, EA, CA, or the overweight/asthma comorbidities.

P-values: * $p < .05$, ** $p < .01$, *** $p < .001$.

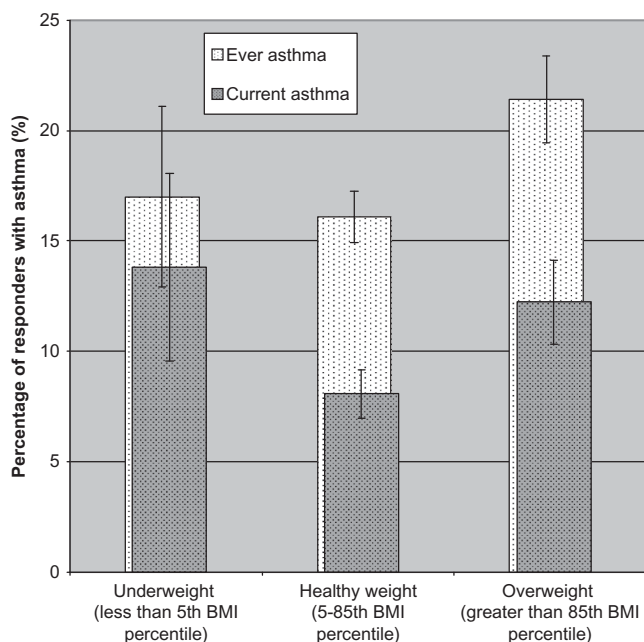


FIGURE 1.—Prevalence of ever asthma (EA) and current asthma (CA) among asthmatics by body mass index (BMI) group.

children experiencing wheeze with no asthma diagnosis, over two-thirds (67.1%) were overweight (results not shown).

Demographic Characteristics of Overweight Asthmatic Children

Overweight ever asthmatics (children who had ever received a doctor's diagnosis of asthma in their lifetime) accounted for 10.9% of the sample. Overweight children with CA (doctor-diagnosed asthma and wheezing in the past year) was 6.2% of the sample (Table 1). The remaining children (109 overweight ever asthmatics who had not experienced wheezing in the previous year) did not differ from overweight current asthmatics with regard to sociodemographic characteristics—gender, race/ethnicity, household income, and parental education.

The prevalence of comorbidity varied significantly by socioeconomic factors. The prevalence of comorbid CA and overweight among males was double that found in females. Compared with other race/ethnic groups, Latinos had the highest prevalence (10.3%) followed by African-Americans (6.6%) and Asians (1.5%). Among Latinos, Puerto Ricans far exceeded the prevalence of comorbidity with 15.5%, followed by Dominicans and Mexicans (8.8% and 8.0%, respectively). The prevalence of comorbidity showed an inverse relationship with household income and parental educational attainment, specifically, comorbidity steadily decreased as household income and parental educational attainment increased.

Overweight Children with Asthma Reported Poor Asthma Control

To evaluate asthma-related health outcomes between weight groups, we restricted our analysis to current asthmatics (Table 2). Among current asthmatics, we found higher prevalence of asthma-related health outcomes among those who were overweight (Table 2). Overweight asthmatic children were more likely to report using the ED and had been hospitalized for asthma care in the previous 12 months, when compared with healthy weight asthmatics ($p < .05$ for both comparisons). This was significantly higher than the proportion of ED visits and hospitalizations in healthy weight asthmatic children (although the prevalence for hospitalizations was highest among underweight asthmatics). In addition, overweight asthmatic children were more likely than healthy weight asthmatics to report other indicators of poorly controlled asthma, including sleep disturbance due to asthma, 12 or more asthma attacks in the previous 12 months, and using quick-relief medication regularly even without symptoms, although these differences were not statistically significant. Similarly, overweight asthmatics reported the highest prevalence of prednisone use. Underweight asthmatics were more likely than healthy weight asthmatics to report adverse outcomes, and often had higher prevalences of outcomes than overweight asthmatics; however, their sample size was relatively small ($n = 22$).

Factors Independently Associated with Comorbidity Differ by Gender

When evaluated overall in a logistic regression model, gender and ethnicity were the strongest factors associated with having comorbid asthma and overweight (Table 3). Males were 2.4 times more likely to have comorbid asthma and overweight than females after controlling for income, education, ethnicity, family history of asthma, number of siblings in the home, single-parent households, and ETS exposure. Parental income and parental history of asthma were also significant factors for comorbidity. In addition, children whose parents had

less than high school education had 2.29 times the odds of reporting comorbidity than children of college-educated parents.

When stratifying the regression analysis by gender, findings showed differences in variables associated with comorbid asthma and overweight (Table 3).

Among girls, income and ethnicity were the factors most strongly associated with comorbid asthma and overweight. Girls in the lowest income households were almost six times more likely to report comorbidity than girls in the highest income households. Similarly, Puerto Rican girls were 5.89 times more likely to report comorbidity than their White counterparts. Asians were less likely than all respondents, including Whites, to report comorbidity. When controlling for all other SES, environmental, and parental history of asthma, parental education, single-parent household, and number of children in the household were not significant social determinants associated with comorbidity in girls.

Among boys, having a parent with asthma remained the factor most strongly associated with comorbidity (OR: 2.91, 95% CI: 1.24–6.86). The impact of education remained significant when comparing children of parents who had not completed high school with children of parents with a college degree (OR: 3.5, 95% CI: 1.15–10.6). When controlling for other factors income, race/ethnicity, single-parent household, and the number of children in the household were not significant social determinants associated with comorbidity in boys.

DISCUSSION

This study found a 6.2% prevalence of the comorbidity of CA and overweight in a sample of New York City schoolchildren of varied SES. Among boys, significant factors associated with comorbid asthma and overweight were low parental educational attainment and having a parent with asthma. Among girls significant factors were low household income and race/ethnicity. These results showed a strong association even when controlling for social and environmental determinants of health such as single-parent households and ETS.

TABLE 2.—Prevalence of asthma-related health outcomes and medication use among current asthmatics by body mass index (BMI) group.

Outcome	Underweight (%) ($n = 22$)	Healthy weight (%) ($n = 99$)	Overweight (%) ($n = 155$)
ED visit in previous 12 months*	36.3	30.5	49.2
Hospitalization in previous 12 months*	24.7	4.9	6.8
> 12 attacks in previous 12 months	13.2	4.3	6.2
Sleep disturbed once or more per week in previous 12 months	24.1	18.1	22.6
Missed school in previous 2 weeks	30.7	20.1	24.8
Used quick-reliever medication regularly, even when not having symptoms	13.2	7.6	14.4
Used prednisone in previous 2 weeks	13.9	10.8	15.4

Note: Chi-square test between outcome and weight status variable. ED, emergency department.
P-value: * $p < .05$.

TABLE 3.—Adjusted prevalence odds ratio (OR) of comorbid current asthma (CA) and overweight, overall and by gender.^a

	OR [95% confidence interval (CI)]		
	Overall	Girls	Boys
N ^b	2336	1211	1125
Gender			
Male	2.40 (1.50, 3.81)		
Female	Reference		
P-value	<.001		
Income			
<\$20,000	2.47 (1.03, 5.96)	5.91 (1.17, 29.8)	1.41 (0.38, 5.21)
\$20,001–\$39,999	2.31 (1.26, 4.23)	5.20 (1.16, 23.2)	1.47 (0.64, 3.38)
\$40,000–\$74,999	2.18 (1.30, 3.65)	2.47 (0.47, 12.9)	1.94 (0.84, 4.45)
\$75,000 or more	Reference	Reference	Reference
P-value	.01	.03	>.05
Education			
Less than high school	2.29 (1.03, 5.09)	1.06 (0.23, 3.77)	3.49 (1.15, 10.6)
High school diploma/GED	2.07 (0.84, 5.13)	1.12 (0.37, 3.34)	2.91 (0.86, 9.92)
Some college	1.52 (0.80, 2.88)	1.11 (0.37, 3.30)	1.75 (0.76, 4.01)
College degree or higher	Reference	Reference	Reference
P-value	>.05	.05	>.05
Ethnicity			
Asian	0.42 (0.16, 1.12)	0.09 (0.01, 0.66)	0.63 (0.20, 1.96)
African-American	1.45 (0.49, 4.32)	0.43 (0.06, 3.22)	2.20 (0.72, 6.72)
Dominican	2.16 (0.67, 6.97)	1.88 (0.34, 10.5)	2.63 (0.76, 9.04)
Mexican	1.70 (0.64, 4.54)	1.46 (0.38, 5.57)	2.03 (0.62, 6.70)
Puerto Rican	3.18 (1.06, 9.50)	5.89 (1.23, 28.3)	2.30 (0.81, 6.55)
Other Latino	1.54 (0.74, 3.20)	3.65 (0.98, 13.7)	0.56 (0.51, 1.55)
Other/multi-racial	1.38 (0.47, 1.08)	1.87 (0.34, 10.4)	1.35 (0.38, 4.60)
White	Reference	Reference	Reference
P-value	<.0001	<.0001	.0472
Parent with asthma	2.55 (1.35, 4.82)	1.90 (0.73, 4.99)	2.91 (1.24, 6.86)
P-value	.004	>.05	.01

Notes: ^aAll models are adjusted for number of children in the household, single-parent household (yes/no), and environmental tobacco smoke (ETS) (yes/no).

^bN is the number of respondents with complete data for each model.

In our study population, the prevalence of asthma (10.6%) is slightly higher than the national average (9.1%) (2) and the New York City average (9.1%) (53). The prevalence of overweight was found to be greater than the 2008 national average (31.7%) based on NHANES data (1). Our study results are similar to others which have found that urban areas have a high prevalence of overweight children, especially among low-income, minority children (5,54).

The bivariate relationships observed in this study between BMI and asthma are consistent with some studies (15,35,55) but differ from results in others (20,56,57). Previous studies have found subgroup differences such as significant associations between asthma and overweight among non-allergic children only (23) and gender differences in prevalence of asthma and overweight (56,58), the latter consistent with our findings. In the present sample, different prevalence in the comorbidity by gender, racial/ethnic, income, and education groups highlight distinct disease burdens among Puerto Ricans (59), Dominicans, Mexicans, African-Americans, and households with low parental education or low income. Other urban studies on asthma or overweight either do not recruit such diverse samples or group Latinos together as Hispanic missing important differences among subgroups (60–62).

We found that overweight asthmatics experienced ED visits and hospitalizations in greater numbers and with greater frequency than healthy weight asthmatics. This is consistent with findings from several studies assessing asthma burden experienced by overweight children compared with their healthy weight counterparts (14,17,18,63,64). Our study sought to further investigate whether overweight asthmatics experienced more adverse asthma-related outcomes compared with healthy weight asthmatic children using measures of disease severity. Overall, asthmatic and overweight children had more asthma-related healthcare utilization and ED visits compared with asthmatic children with healthy weight, which is indicative of greater severity and poorer asthma control.

There is strong evidence for the roles of physical activity and fitness in asthma control (65,66). Non-asthmatic children with high measures of body fat and low activity levels can exhibit airway inflammation similar to asthmatics after minimal exercise or physical activity (67). A review of NHANES data from 2001 to 2004 by researchers at Duke University showed that elevated BMI as well as elevated serum C-reactive protein levels, a marker of obesity-induced inflammation, are both associated with severe asthma (68). In addition, the same data showed that low activity levels were more

common in children who were overweight (69). The predominance of poor control and severity of symptoms among overweight asthmatics suggest that interventions encouraging physical activity would benefit children with asthma. However, proponents of this approach must be mindful about subjects' inflammatory and allergic sensitivities as well as their asthma control measures in order to promote physical activity interventions (70–72).

Underweight asthmatics reported poor asthma-related health outcomes too, often poorer than overweight asthmatics. There is little research that has investigated the potential relationship between underweight and asthma (20). Kwon et al. (20) hypothesized that early life nutritional and growth restriction could contribute to both underweight and the development of asthma. Future longitudinal studies of children's health would be needed to explore this possibility. The number of underweight asthmatics in our sample was small, and it is difficult to draw conclusions on these results. It is possible that there are health effects of underweight that are not captured in our study.

Multivariate analysis found different significant factors associated with comorbidity of asthma and overweight for boys and girls. Males were more than twice as likely as females to have comorbid asthma and overweight, which is consistent with results from two previous studies (23,63). Other studies have found a higher association among girls, particularly when the children are post-puberty, which is older than the sample of children included in our study. However, two reviews of the asthma–obesity relationship in childhood showed that some studies have found gender differences in the relationship, while others have not, with no clear consensus emerging from the literature (41,73).

There is scarce data presenting asthma and obesity comorbidity; however, present knowledge of asthma's etiology and prevalence between genders suggests that asthma is more common in boys than in girls during early childhood and the trend gradually reverses by adulthood (74,75). In addition, data from NHANES consistently show slightly higher prevalence of overweight among boys than girls (1,51). Family history of asthma has been shown to be a strong predictor of asthma and overweight in both genders and is consistent with our results (76,77). It is possible that SES has a stronger impact in relation to overweight or asthma by gender. Some potential differences between boys and girls that could influence obesity rates between genders have been studied elsewhere (78,79). For example, a lack of resources in lower income households may constitute disparate burdens between children of different genders resulting in poor preventive care or mismanagement of nutrition and/or asthma symptoms. In the future, prospective studies will be needed to determine what contributes to gender differences in the relationship between asthma and obesity, and whether this relationship changes through the life course.

In considering our findings, potential limitations were identified. While response to the survey was high (76.9%), 55.1% of respondents provided usable BMI data. This could affect the representativeness of the sample, but two main findings give credence to the reliability of our data. First, no significant differences in CA or EA were observed when comparing those who provided valid BMI data with those who did not. Second, children with valid BMI data were generally more likely to be from sociodemographic populations with low prevalences of both asthma and overweight (Asians, high-income households, parent with a college degree) (4,43,80,81). The sociodemographic profile of the comorbidity provided by this study, then, likely consists of conservative estimates of the true population with the comorbidity.

Another potential limitation is that BMI values were calculated using parent-reported height and weight of each child, which could be subject to recall bias for individual children. However, the validity of using parent-report data to determine population-based prevalence of overweight among school-aged children has been established in studies showing that parent-reported height and weight are reliably comparable with measured values (82,83). Due to the cross-sectional nature of this study, we could not assess the directionality of the association between asthma and obesity. It is possible that children with poorly controlled asthma may be overweight because of activity limitations due to their asthma.

This study has particular strengths worth noting. The sampling design allowed us to achieve a representative sample of public school children. In addition, the specification of Latino ethnicity provided important intra-ethnicity differentiation for all analyses. Finally, to our knowledge, this is the first study to offer a prevalence estimate of comorbid asthma and overweight in a multiethnic, urban sample from communities of varying SES. The study of comorbidities, rather than singular diseases is both useful and practical. Such an approach, which acknowledges multiple stressors and the dynamics of multiple health conditions, has the potential to yield important clues about disease mechanisms and effective interventions.

CONCLUSIONS

Children with overweight and asthma comorbidity show a greater disease burden than those children who have asthma alone, as reflected by increased number of missed school days, more night symptoms, more asthma medication use and a higher number of overweight children who had ED visits due to asthma. Comorbidity was most frequently found among males, Latinos (particularly Puerto Ricans), and children living in low-income households. The relationship between socioeconomic factors and the asthma–obesity comorbidity may vary by gender and requires further study to identify successful interventions to reduce disease in children.

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DECLARATION OF INTEREST

The authors report no conflicts of interest and have no financial disclosure to declare. The authors alone are responsible for the content and writing of the paper.

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