The Relationship between Asthma and Overweight in Urban Minority Children

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Background: This study was performed to determine the relationship between overweight [body mass index (BMI) ≥85th percentile] and asthma as determined by spirometry.

Method: Spirometry was performed according to the American Thoracic Society guidelines, and BMI was calculated. Asthma was defined as a forced expiratory volume in 1 second (FEV_1) <80% predicted and FEV_1/forced vital capacity (FVC) >5% lower than predicted for age and sex.

Results: One-hundred-nine children (age 14.7 ± 1.6 years) were enrolled. Eighty children (73%) were African-American, and 29 children (27%) were white. Fifty-eight (53%) children were overweight. Twelve (11%) children, of whom nine (75%) were overweight, met the criteria for asthma. Baseline FEV_1 percent predicted (87 ± 6% vs. 83 ± 7%, p=0.03), FEV_1/FVC (93 ± 6 vs. 87 ± 8, p<0.001), and FEV_1 percent predicted following albuterol administration (94 ± 7 vs. 89 ± 7%, p=0.03) were all lower in overweight children. Children with asthma were almost 1.5 times more likely to be overweight compared with children without asthma (relative risk: 1.49, 95% confidence interval: 1.015–2.17).

Conclusions: Inner-city children are more likely to be overweight compared to the general population. Asthma is a risk factor for overweight in these children.

Key words: asthma ■ children ■ obesity ■ spirometry

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INTRODUCTION

Asthma is the principal cause of chronic illness and school absenteeism in children.[1,2] Asthma imposes a disproportionate burden on ethnic and racial minorities and poor inner-city children.[3,4] Obesity in children is another major public health concern.[5-8] The rise in obesity has been attributed to lifestyle changes that have resulted in decreased energy expenditure, whereas the increase in asthma prevalence remains unexplained.[2,6] Because the increases in asthma and obesity appear to have coincided, it has been suggested that they may be causally related. Results of studies on the association between overweight/obesity and asthma in children have been inconsistent, and the exact nature of the relationship remains unclear.[9-16]

The diagnosis of asthma in previous studies relied on physician-diagnosed asthma, parental report of asthma symptoms or use of asthma medications.[9-16] In economically disadvantaged inner-city children, the diagnosis of asthma is dependent not only on patient's perception of symptoms but also on the availability and access to healthcare.[17] Objective measures of lung function would minimize difficulties in diagnosing cases of asthma in these children.[2] Furthermore, standard body mass index (BMI) reference values were not available for the studies on this subject that were conducted before 1991.[18]

The focus of this study was to describe the proportion of inner-city children who are overweight (BMI ≥85th percentile) and to study the relationship between being overweight and having asthma as determined by objective measures of airway obstruction using spirometry.

METHODS

This study gathered information on weight, height, BMI and the spirometry findings of children enrolled in public seventh-to-12th grades in one secondary school in Flint, MI, from March 1, 2004, to May 31, 2004. The school is located 2 miles from a

highway and had 483 students enrolled for the above academic year. Children with recent upper or lower respiratory diseases, chest or skeletal deformities, and immunodeficiency were excluded from the study. Informed consent was obtained from parents. An assent was obtained when appropriate. The institutional review board of Hurley Medical Center approved the study.

The questionnaires used in this study to elicit symptoms of asthma are shown in Table 1. Children were instructed to respond "yes" to each question if symptoms had occurred at least once in the last year. The questionnaire was developed specifically for this study by the investigators and research team. All children were measured and weighed in a private area to maintain confidentiality. Height was measured with the child barefoot and erect against a wall-mounted scale (Accustat-Stadiometer; Genentech, San Francisco, CA) and recorded to the last 0.5 cm. Children were weighed in underpants, and the weight was recorded (Health-O-Meter; Continental Scale Corp, Chicago, IL) to the last complete 100 g. BMI was calculated as weight in kilograms divided by squared height in meters. Weight status was defined by using age- and gender-specific BMI percentiles from the 2000 revised Centers for Disease Control and Prevention/National Center for Health Statistics growth charts for the United States.[19] Overweight was defined as a BMI ≥85th percentile for age and sex.[20,21]

Spirometry

Spirometry (pre- and postbronchodilator) was assessed using a flow-sensitive spirometer (Renaissance II; Puritann-Bennett, Carlsbad, CA). A respiratory therapist who was experienced in performing spirometry in children conducted all tests, and all tests conformed to the criteria of the American Thoracic Society.[22-24] All tests were performed between 10 a.m. and 2 p.m. The following parameters were measured: forced vital capacity (FVC), forced expiratory volume in 1 second (FEV_1) and forced expiratory flow at midlung volume (FEF_{25-75}). The ratio of FEV_1 to FVC (FEV_1/FVC) was calculated. All values were adjusted for body temperature and barometric pressure. Percent predicted values for FVC, FEV_1 and FEF_{25-75} were calculated from reference values based on the Harvard six-cities study.[23] Subjects were asked to refrain from use of asthma medications for 24 hours before testing. Before use of an inhaled bronchodilator, the best three of five forced expiratory maneuvers were recorded. Acute bronchodilatation was achieved with inhalation of two puffs (90 μgm each) of albuterol metered-dose inhaler (Ventoline; GlaxoSmithKline, Research Triangle Park, NC) delivered via a spacer (Optichamber Advantage; Respironics, Cedar Grove, NJ). Ten minutes later, spirometry was repeated, with no more than five attempts made to obtain three acceptable forced expiratory maneuvers. All maneuvers were done in the standing position, with a nose clip in place. A single observer for the quality of the FEV_1 and FVC reviewed all studies. Asthma was defined as FEV_1 <80% predicted and FEV_1/FVC >5% lower than predicted for age and sex.

Values are presented as mean ± standard deviation. Chi-squared analysis was used for nominal data, and unpaired t-tests were used for continuous data. Statistical significance was assumed when the p value was ≤0.05.

Table 1. Questionnaires used to elicit symptoms of asthma

- Wheezing at any time
- Wheezing with exercise
- Wheezing while sleeping
- Cough at night
- A severe attack of wheezing requiring emergency department visit

RESULTS

One-hundred-nine children were included in the study. Eleven children were excluded because of unacceptable pulmonary function tests. The demographics and other characteristics are shown in Table 2. Overall, 58 children (53%) were overweight (BMI ≥85th percentile). Girls were more likely to be overweight (35/61, 57%) compared with boys (24/48, 50%); however, this difference was not statistically significant (p=0.46). Eighteen (17%) children were diagnosed with asthma by a physician, but spirometry parameters were consistent with a diagnosis of asthma in only two of these 18 children. There was not a statistically significant difference between the overweight (8/58, 14%) and lean children (9/51, 18%) with regard to a physician diagnosis of asthma

Table 2. Demographics and clinical characteristics of the study population

Age (years, mean ± SD)	14.7 ± 1.6
Gender (male/female)	48/61
Body mass index	26 ± 7.8
Body mass index percentile	77 ± 23
Weight (kg)	73 ± 22
Height (cm)	147 ± 22
Ethnic Group (n, %)	
African Americans	80 (74%)
Whites	29 (26%)

(p=0.412), nor was there a statistically significant association between asthma symptoms and the diagnosis of asthma based on spirometry.

Twelve children (11%) met the criteria for asthma based on objective measures of lung functions by spirometry. Of these 12 children, nine (75%) were overweight. All 12 children demonstrated a significant response to albuterol, defined as an increase in FEV_1 of ≥12%. There was no statistically significant difference between male and female [seven (15%) vs. five (8%), p=0.2] with regard to the diagnosis of asthma on the basis of spirometry. Children with asthma were almost 1.5 times more likely to be overweight compared with children without asthma (relative risk: 1.49, 95% confidence interval: 1.015–2.17). When overweight was considered as the risk factor and asthma as the outcome, results were not statistically significant.

Table 3 presents a comparison of overweight and lean children with regard to symptoms of asthma and the spirometry parameters. A positive response indicates that the symptom of asthma has occurred at least once in the last year. Baseline FEV_1, FEV_1/FVC and FEV_1 following administration of albuterol were each lower in children who were overweight compared with children who were not overweight. Three children with a physician diagnosis of asthma reported use of albuterol metered-dose inhaler (MDI) in the last week. None of these children met the criteria for asthma based on spirometry. Five children with a physician diagnosis of asthma reported use of albuterol MDI in the past month. Two of these children met the criteria for asthma on the basis of spirometry. However, overall, there was not a statistically significant association between use of albuterol MDI and a diagnosis of asthma by spirometry.

DISCUSSION

This study, which consisted predominantly of African-American children, demonstrated that inner-city children are more likely to be overweight compared with other children.[11] Fifty-three percent of children in this study were overweight, which is much higher than the prevalence of overweight in the general pediatric population (15%) in the United States.[11] It also demonstrated that overweight inner-city children are more likely to have spirometry parameters that are consistent with asthma compared to the spirometry parameters among lean children.

Eighteen children (17%) reported that a physician had diagnosed them with asthma without performing objective tests of lung function. This percentage is consistent with previous reports.[25] Twelve children met the definition of asthma based on objective measures of lung functions by spirometry. This is consistent with the national estimate of 11.3% for children 0–16 years of age reported by the National Health and Nutrition Examination Survey III.[16]

Studies on the association between asthma and overweight in children have produced conflicting results.[9-16] The definition of asthma is a concern in most previous studies, which relied on asthma questionnaires or a clinical diagnosis of asthma made by a physician without objective measures of lung functions.[9-16] A clinical diagnosis of asthma is dependent on the patient's perception of symptoms in terms of frequency and severity, access to healthcare and the physician's diagnostic habits in the locale.[17] These factors can lead to variations in the diagnosis of asthma. Compared to past studies, our study has some advantages in verifying the relationship between overweight and asthma in children because the definition of asthma was based on objective measures of lung function using spirometry.[10-16]

This study supports previous findings demonstrating that children with asthma are more likely to be overweight,[12,26] and it has been suggested that overweight is a plausible etiological component for asthma.[12,26] However, it is also possible that reduced energy expenditure resulting from low levels of physical activity in children with asthma may predispose to overweight and obesity.[27,28] It has been demonstrated

Table 3. Comparison of overweight [body mass index (BMI) ≥85th percentile] and lean children (BMI <85th percentile) with regard to asthma symptoms and spirometry parameters

Symptom/Variable	BMI		P
	≥85th Percentile (n=58)	<85th Percentile (n=51)	
Wheezing any time*	10/58 (17%)	9/51 (17%)	0.56
Wheezing with exercise*	22/58 (37%)	17/51(33%)	0.36
Wheezing while sleeping*	9/58 (16%)	7/51 (12%)	0.40
Cough at night*	17/58 (29%)	9/51 (17%)	0.11
A severe attack of wheezing*	3/58 (5%)	2/51 (4%)	0.50
FEV_1 (L) percentage of predicted at baseline**	83 ± 7	87 ± 6	0.03
FEV_1/FVC (%) baseline***	87 ± 8	93 ± 6	<0.001
FEV_1 (L) percentage of predicted after albuterol	89 ± 7	94 ± 7	0.03

* Occurred at least once in the last year; ** FEV_1: forced expiratory volume in the first second of exhalation; *** FVC: forced vital capacity

that caloric intake is similar in children with or without asthma but that children with asthma are more likely to have exercise-induced bronchospasm. The latter is related to the amount of subcutaneous fat in the bodies of asthmatic children.[27,28] Exercise-induced bronchospasm may lead to an aversion to exercise, with subsequent risk of overweight and obesity. This is despite the fact that resting energy expenditure, which makes up the largest contribution to total energy expenditure, is greater in children with asthma when compared with children without asthma.[27] These data indicate that increases in overweight and obesity in children with asthma may be related to decreases in physical activity.[27,28]

Initiation of preventive measures, such as dietary and physical activity measures, are critical for children who are at risk for overweight,[29-31] which includes children who have obese parents or obese older siblings and children who begin to show large increases in BMI for their age.[29] It may also be helpful to consider lifestyle modifications that involve the entire family and that can be incorporated into the family's daily routine.[30-32]

LIMITATIONS

This study is limited in part by the small number of inner-city children studied at one secondary school in the midwestern part of the United States. Participation was voluntary and based on the willingness of children and their parents to consent for enrollment into the study. This may introduce selection bias into the results of the study. Another critical issue is the definition of overweight in children and adolescents. A child who is physically active may have a high BMI but an acceptable level of body fat. Some studies have suggested that BMI may be a poor indicator of adiposity in an individual child.[33,34] The sum of triceps and subscapular skinfold thickness (sum of skinfolds) is another measure of obesity that has been used to evaluate the association between asthma and obesity in children.[13] However, Figueroa-Munoz et al. found that BMI was more consistently associated with asthma than the sum of skinfolds in children 4–11 years of age.[13] We selected BMI instead of sum of skinfolds because caliper measurements are somewhat less reproducible than weight and height measurements and because Pietrobelli et al.[35] validated the use of BMI as a measure of adiposity in children.

Another difficulty is related to the definition of asthma. Even when a single definition is accepted, there are no established rules about how to make a diagnosis of asthma in an individual child. From a clinical standpoint, a diagnosis of asthma often is made over a period of time based on the history, physical examination and respiratory function tests, as well as exclusion of other diagnoses that might mimic another disease, such as gastroesophogeal reflux. The variability of the condition means that evidence of it may or may not be present on the day or at the time the child is assessed.

In conclusion, within the limitations of this study, inner-city children who have asthma are more likely to be overweight. Longitudinal studies may shed light on the temporal association between asthma and overweight in these children because determining the temporal sequence is a key aspect of defining a causal relationship between asthma and overweight. Further studies should explore the possibility of a causal relationship between asthma and overweight; this study provides some framework for the objective measurements of asthma, while examining the relationship between asthma and overweight.

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