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Frequency and Correlates of Overweight Status in Adolescent Asthma

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Abstract

Background—Debate exists within the literature concerning whether asthma and obesity are linked as comorbid conditions. Further study is required to understand the relationship between asthma and overweight status, and developmental considerations are an important priority area.

Objective—The present study addressed gaps in the existing literature by comparing rates of overweight status among a matched sample of adolescents with and without asthma and by examining correlates of overweight status among youth with asthma.

Methods—Rates and correlates of overweight status were compared among a matched cohort of 103 adolescents with asthma, 75 adolescents with asthma characterized by history of a severe acute event, and 92 normal controls.

Results—Significantly higher rates of overweight status were found among the asthma groups compared to the control group and to population estimates. Significant correlates for overweight status included younger age and earlier age at asthma diagnosis, suggesting that receiving an asthma diagnoses in early childhood may increase the propensity for weight gain.

Conclusion—Asthma and obesity are problematic comorbid conditions, and specialized obesity prevention programs may be particularly necessary at the onset of a new asthma diagnosis.

Clinical Implications—Identifying and addressing the factors that may contribute to the potential for obesity among youth with asthma are key research and clinical practice priorities.

Keywords

asthma; adolescent; overweight; obesity

Introduction

Emerging data demonstrate a complex, poorly understood association between two leading public health challenges: pediatric asthma and overweight status (1,2). Both conditions have a widespread and costly impact, particularly among ethnic minorities, low-income families, and inner-city communities (3,4). Specifically, asthma remains the most common chronic illness presenting in childhood and is a major source of hospitalizations, emergency department visits, and activity restriction for youth (5-9). Moreover, the prevalence of pediatric obesity has risen sharply in recent decades, with rates tripling between 1980 and 2000 (10). Upward of 65% of adults in the United States currently meet criteria for either overweight status or obesity (i.e., Body Mass Index [BMI] greater than or equal to 25) (11), and adult obesity is often rooted in gradual excess weight gain during childhood (12).

Interestingly, a growing body of research has documented a complicated, multifaceted overlap between these escalating health concerns (13-15). A clear explanation for the rising rates and associated risks of pediatric asthma and obesity remains elusive. Numerous studies have reported an association between asthma and obesity in adult and pediatric cohorts (16-19). Sex differences, with stronger associations documented among women, have been observed, although not consistently (16,17). Evidence suggests that obesity complicates the diagnosis, treatment, and course of asthma (20), whereas significant weight loss results in improved pulmonary status (21,22). Finally, excess body weight may precede and precipitate the onset of asthma, with preliminary evidence supporting this finding even in high-birth-weight infants (23,24). A lack of consensus exists in the literature, however, as other studies have not documented such associations (25-27). Some have questioned whether the association between asthma and obesity is largely a result of problematic methodology, such as the reliance of self-reported asthma diagnosis and the lack of objective weight measurement (27).

While epidemiologic data generally support a clinically significant association between asthma and obesity, more research is needed to document this relationship across the lifespan. Importantly, little is known about the developmental and behavioral correlates of overweight status among youth with asthma (28). An earlier report based on a subsample of the present dataset examined pulmonary function variables in relation to BMI, and found support for an association between overweight status and baseline flow limitation, but did not examine other relevant asthma correlates, such as age at asthma diagnosis (29). Understanding the contributions of physiologic and demographic factors in any overlap between asthma and obesity would increase our understanding of this comorbidity and would help guide future intervention and prevention efforts.

In response to gaps in the existing literature, the purpose of the present study is to compare the extent of overweight status between adolescents with varying degrees of asthma severity with a matched group of otherwise healthy controls and with population norms, and to investigate correlates of obesity among the asthma cohort. Based on the existing literature, we expected to find higher rates of overweight status among those with asthma, and a greater propensity for obesity in adolescents with more severe asthma. Additionally, we expected to find significant demographic and physiologic correlates of obesity among our asthma cohort, such as socioeconomic status (SES) (30), ethnic/minority status (31), and the extent of steroid burden (32), which would elucidate potential causal pathways between asthma and obesity. Finally, we anticipated that comorbid asthma and obesity would result in more complicated asthma outcomes.

Methods

Procedures

The study involved a multisite investigation of asthma symptom perception among adolescents conducted at Brown University (Providence, Rhode Island, USA), National Jewish Medical and Research Center (Denver, Colorado, USA), and the University of Texas in Tyler. Institutional review boards at each site approved the study, and informed consent and assent were obtained from all participants. The study recruited three groups: (1) adolescents with a serious asthma exacerbation (SAE) characterized by at least one of the following after the age of five years: intensive care unit admission, intubation, intravenous terbutaline or continuous nebulizer treatment for greater than 12 hours, seizure or loss of consciousness, or hypoxia while receiving supplemental oxygen; (2) adolescents with asthma requiring at least one daily controller medication that had not been marked by an acute severe event serving as asthma controls (ACs); and (3) otherwise healthy adolescent normal controls (NCs). Recruitment was conducted to achieve groups with comparable distributions of age (± 12 months), sex, and ethnic minority status. Exclusionary criteria included any other pulmonary or cardiac conditions, any nonatopic chronic illness requiring medication, non-English speaking, IQ less than 70, or pregnancy. Participation was delayed in any participant with asthma reporting a course of systemic corticosteroids within the past two weeks and/or a FEV1 below 70% predicted. Data collection occurred over two days at one of the three study centers and included various measures of anthropometric status (objectively measured using calibrated equipment), symptom perception, and relevant psychosocial characteristics (29).

Participants

A total of 274 adolescents participated in the study, and the present analyses included 270 adolescents with ages 12 to 19 years, with four subjects excluded due to missing data. The final sample was comprised of 103 asthma controls (38%), 92 normal controls (34%), and 75 children with asthma characterized by history of a SAE (28%). Ethnic-minority youth represented 40% of the sample (19% African American, 12% Hispanic, and 9% biracial or other background), and 60% were Caucasian. Most participants were recruited and tested at the National Jewish Medical and Research Center ($n = 116$; 43%), with the remainder from Brown Medical School ($n = 93$; 34%) and the University of Texas at Tyler ($n = 61$; 23%).

Measures

Body Weight—Anthropometric measurements of height and weight were made with calibrated equipment. Age- and sex-specific BMI percentiles were calculated based on raw height and weight per current guidelines using the Centers for Disease Control's (CDC's) published SAS syntax (cdc.gov/nccdphp/dnpa/growthcharts/sas.htm) (33). According to CDC criteria, participants with a BMI below the 85th percentile were coded as "normal weight" and at or above the 85th percentile were coded as "at risk for overweight or overweight." For categorical analyses, underweight individuals below the 5th percentile were excluded ($n = 2$).

Demographic and Asthma Variables—Descriptive demographic and asthma background data were collected from parent reports. The National Opinion Research Council's (NORC's) coding system for occupational prestige was used as an indicator of SES (34). Asthma-related functional morbidity was assessed using the Rosier Functional Asthma Severity Scale on a four point scale (35). Asthma severity was calculated based on the Global Initiative for Asthma (GINA) guidelines, using an algorithm representing medication dosing, FEV1, medication adherence, and symptom levels (36,37).

Data Analysis

All analyses were conducted using SPSS (Chicago, IL, USA) for Windows software (38). Descriptive statistics were employed to examine the distribution of BMI data across the sample. Correlational and chi-square statistics were used to examine correlates of BMI. BMI was examined as a continuous variable (i.e., BMI percentile) or a categorical variable (e.g., normal weight vs. at risk for overweight or overweight), depending on the characteristics of the predictor being examined.

Results

Preliminary Analyses

Preliminary analyses were conducted to ensure comparability between groups to confirm the matched characteristics of our sample. As shown in Table 1, groups were equivalent in terms of child age, sex, and ethnic/minority background, consistent with our intended matched design. Parental education levels and NORC ratings levels were both comparable between the groups. Additionally, study sites were comparable across sample characteristics, and site data were pooled for all subsequent analyses.

Group Differences in BMI

As predicted, adolescents with either level of asthma were more likely to be overweight than healthy counterparts. As displayed in Table 2, this finding was consistent whether examining differences in raw BMI, age- and sex-specific BMI percentile, or BMI category grouping. While we had anticipated higher rates of being overweight among the SAE group compared with the AC group, the extent of obesity as measured in any manner was comparable between the two asthma cohorts. This allowed for a combination of both asthma groups in subsequent analyses (see Table 3). Combining asthma cohorts underscored the disproportionate extent of obesity among those with asthma, evidencing an average raw BMI of 24.8 (standard deviation [SD] 5.9) and BMI percentile of 74.4 (SD = 25.5) compared with an average raw BMI of 22.4 (SD = 4.6) [$t(268) = 3.57$; $p < .001$] and BMI percentile of 61.5 (SD = 27.4) [$t(268) = 3.76$; $p < .001$] in the healthy cohort. Moreover, 46% of participants with either level of asthma were at or above the 85th percentile for BMI, compared to 29% of the healthy cohort ($\chi^2 = 6.6$; $p < .01$).

Comparison with Population Estimates

In order to provide a more thorough understanding of the extent of overweight status within our sample, we conducted comparisons with the general population based on the National Health and Nutrition Examination Survey (NHANES) 1999-2000 data (33). As displayed in Table 4, 40% of our sample was at or above the 85th percentile, compared to 30.4% of the general pediatric population ($p < .001$). Further examination by group status confirmed that this difference was attributed to the asthma cohort, as rates of overweight were comparable between the healthy cohort and population estimates. Conversely, rates of at-risk for overweight and overweight status (45.5% vs. 30.4%; 26.4% vs. 15.5%) were significantly greater among the asthma group compared to general population ($p < .0001$ for both weight classifications).

Correlates of BMI

Demographic Correlates—No significant relationships were found between child sex, ethnic/minority background, parental education, SES, or parent marital status and body weight when examined as either a continuous variable (e.g., BMI percentile) or a dichotomous variable (e.g., 85th percentile as a cut-off distinguishing normal weight versus at-risk for overweight or overweight status) among the healthy cohort. Among the asthma cohort, age was the only

significant demographic correlate, with younger children evidencing a greater propensity for obesity. A significant negative association was found between age and BMI percentile ($R = -.24$, $p < .01$), and at-risk for overweight or overweight children were younger, on average ($X = 14.61$, $SD = 1.62$) than normal-weight children with asthma ($X = 15.26$, $SD = 1.83$) [$t(176) = 2.46$; $p < .01$].

Correlates of Overweight Status among Asthma Cohorts

Asthma History Correlates—We analyzed the relationship between BMI and asthma variables in an attempt to identify whether specific asthma characteristics were predictive of overweight status (see Table 5). Historical asthma factors, including oral steroid use, hospitalizations, and emergency department visits in the previous year were unrelated to BMI percentile or classification ($<$ or $>$ 85th percentile). Age of diagnosis was the only significant correlate. A trend showed a negative association between age of diagnosis and BMI percentile ($r = -.15$, $p = .05$), and children at or above the 85th percentile were diagnosed with asthma at younger ages ($n = 73$, $X = 3.3$ years, $SD = 3.4$) than normal weight children ($n = 94$, $X = 4.4$ years, $SD = 3.7$) [$t(165) = 1.94$; $p < .05$].

Asthma Morbidity and Overweight Status—Relationships between indices of asthma morbidity and the presence of obesity were examined to determine whether the course of asthma may be further complicated by overweight status. As expected, comorbid asthma and overweight status appeared to result in a “dual burden” and a more complicated asthma course, aside from the presence or absence of a previous severe acute event. BMI percentile was significantly associated with the Rosier asthma functional morbidity score ($R = .33$; $p < .01$), with higher BMI scores correlating with higher morbidity values. Individuals at or above the 85th percentile evidenced higher functional morbidity levels ($X = 2.35$, $SD = .93$) than those below the 85th percentile ($X = 1.74$, $SD = .87$) ($t = -4.37$; $p < .001$). Moreover, individuals at or above the 85th percentile for BMI demonstrated higher severity scores generated based on GINA guidelines ($X = 3.21$, $SD = 1.04$) than those at normal weight ($X = 2.88$, $SD = 1.11$) [$t(171) = -2.06$; $p < .05$]. Groups were comparable on physiologic measures of severity, including FEV1 and PD20.

Discussion

Our study found significantly higher rates of obesity among adolescents with asthma compared to a matched cohort of otherwise healthy youth and compared to population estimates. The extent of obesity was equivalent between asthma controls and subjects with asthma marked by a previous severe acute event. These findings are consistent with other published studies documenting an overlap between asthma and overweight status (39,40), including similar case-control designs (41). Interestingly, disproportionately higher rates of overweight status were found consistently across males and females, while others have found sex differences in the relationship between asthma and obesity across different ages (42,43). Moreover, this is one of the first studies to report differences in obesity rates in a matched cohort design controlling for key demographic variables, such as sex, age, and racial/ethnic background. Our findings lend additional empirical support to the emerging evidence that asthma and obesity may represent an intricate comorbidity requiring further exploration and understanding.

The lack of consistency concerning the relationship between asthma and obesity within the larger literature (44) underscores the need to examine correlates of overweight status among asthmatics. Identification of specific asthma-related correlates of overweight status, such as age at asthma diagnosis, would lend preliminary support to the notion that the presence of asthma leads, in some manner, to the development of obesity. Surprisingly, we found little support for physiologic or demographic correlates of obesity among our asthma groups. Illness

characteristics, such as history of a severe acute event, previous oral steroid use, and past health care utilization, were unrelated to overweight status. While others have found preliminary support for the contribution of oral steroid use toward the development of excess body weight, (32,45), we did not see such an association, although only 47% of our participants with asthma had received an oral steroid burst in the past year, and further study among those with steroid-dependant asthma is needed to more definitively answer this question. Additionally, we did not find associations between overweight status and demographic variables among youth with asthma that are typically found with obesity in the general population, such as SES or ethnic minority background (46). Due to the greater propensity for asthma among lower income families and ethnic minority youth, this lends additional credence to the higher rates of obesity among youth with asthma.

The only significant correlates included child age and age at initial asthma diagnosis. Specifically, younger children, and those with an earlier age at asthma diagnosis, were more likely to be overweight, suggesting that developmental factors may be involved in the relationship between asthma and obesity. The typical precipitating course of obesity is often marked by small, yet steady, weight gain over childhood (12). Accordingly, having asthma may result in seemingly minor behavior changes, such as diminished enthusiasm for physical activity, that influence weight trajectories and increase the risk of developing obesity. If sedentary behaviors and physical activity avoidance contribute to the relationship between asthma and obesity, age at diagnosis could be an important factor. Recent studies have found that physical activity patterns are adopted at younger ages than initially thought, with the preschool years proving instrumental in establishing long-term physical activity attitudes and behaviors (47). If physical inactivity is responsible for the increased propensity for obesity among those with asthma, receiving an asthma diagnosis at a younger age could result in more entrenched sedentary patterns than those who were able to adopt healthy activity patterns prior to an asthma diagnosis.

Conclusion

Our findings were limited by the retrospective nature of our data and the lack of historical growth velocity information. Prospective studies would contribute more definitive results. Additionally, we did not collect any objective or self-report data on physical activity levels, and this information would have elucidated whether activity patterns contribute to the obesity and asthma overlap. While our results only offer preliminary consideration of potential casual pathways between asthma and obesity, they underscore the fact that comorbid asthma and obesity results in more complicated functional outcomes. Overweight youth with asthma demonstrated more functional impairment and higher severity scores than their normal-weight counterparts. More research is needed to determine whether maintaining a healthy body weight helps avoid asthma complications and whether establishing optimal asthma control helps to prevent obesity.

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Table 1

Study demographics by group

Variable	Group			F/ χ^2
	SAE (n = 75)	AC (n = 103)	NC (n = 92)	
Age	15.11 (1.6)	14.85 (1.9)	15.09 (1.7)	1.8 , ns
Sex (%)				
Male	31.3	38.2	30.6	2.4 , ns
Female	23.8	38.1	38.1	
Race/ethnicity (%)				
White	54.7	58.3	67.4	4.8 , ns
Hispanic	10.7	14.6	10.9	
Black	22.6	19.4	15.2	
Biracial/other	12.0	7.7	6.5	
Parent education	2.3 (.61)	2.4 (.55)	2.4 (.56)	1.4 , ns
NORC rating	46.4 (12.4)	49.7 (14.4)	52.1 (15.3)	2.79, ns

SAE, serious asthma exacerbation; AC, asthma control; NC, normal control; NORC, The National Opinion Research Council; ns, not significant.

Table 2

Group differences in body mass index (BMI)

BMI variable	Group			F/χ^2
	SAE (n = 75) X (SD)	AC (n = 103) X (SD)	NC (n = 92) X (SD)	
Raw BMI	25.6 (6.5)	24.2 (5.5)	22.4 (4.6)	6.74 **
BMI percentile	76.1 (25.2)	73.2 (25.8)	61.5 (27.4)	7.55 **
BMI $\geq$ 85th	49.3%	42.7%	29.3%	7.40 *

SAE, serious asthma exacerbation; AC, asthma control; NC, normal control; SD, standard deviation.

*
p < .05**
p < .001.

Table 3

Differences in body mass index (BMI) by illness status.

BMI variable	Group		F/ χ^2
	Asthma (n =178) X (SD)	Healthy (n = 92) X (SD)	
Raw BMI	25.6 (6.5)	22.4 (4.6)	6.74 **
BMI percentile	76.1 (25.2)	61.5 (27.4)	7.55 **
BMI >85th	n = 81 (45.5%)	n = 27 (29.3%)	6.60 *

SD, standard deviation.

*
p < .01**
p < .001.

Table 4
Overweight frequency compared with general population^a

	BMI group	N	%	Prevalence from general population	p-value for comparison (chi-square test)
All participants (N = 270)	At or above 85th	108	40.0	30.4	0.0003
	At or above 95th	61	22.6	15.5	0.0006
Asthma cohort (N = 178)	At or above 85th	81	45.5	30.4	<.0001
	At or above 95th	47	26.4	15.5	<.0001
Healthy cohort (N = 92)	At or above 85th	27	29.3	30.4	0.5867
	At or above 95th	14	15.2	15.22	0.5296

BMI, body mass index.

^aGeneral population prevalence figures were calculated from 1999-2000 National Health and Nutrition Examination Survey data (Ogden et al.'s, JAMA, 2002, Vol. 288, pp. 1728-1732).

Table 5

Differences in illness variables by weight status

Asthma variable	Group		t
	Normal weight (n = 97) X (SD)	At-risk or overweight (n = 81) X (SD)	
Age at diagnosis	4.4 years (3.7)	3.3 years (3.4)	1.94 [*]
Functional morbidity score	1.74 (.87)	2.35 (.93)	-4.37 ^{**}
GINA severity score	2.88 (1.11)	3.21 (1.04)	-2.06 [*]
FEV1 composite score	1.52 (.91)	1.57 (.95)	ns
PD20	8.27 (10.5)	7.13 (10.0)	ns

SD, standard deviation; GINA, Global Initiative for Asthma.

*
p < .05**
p < .001.