



Association of exercise-induced wheeze and other asthma symptoms with emergency department visits and hospitalizations in a large cohort of urban adolescents

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ABSTRACT

Objective: Exercise-induced wheeze (EIW) has been found to be associated with asthma-related urgent care in school-aged children. Despite asthma's high prevalence and morbidity among adolescents, this association has not been examined in adolescents. We tested the association of EIW and other asthma symptoms to asthma-related ED visits and hospitalizations in urban adolescents with probable asthma. We hypothesized that EIW would be associated with urgent care.

Methods: In this cross-sectional study 30,467 high school students (mean age = 16.0) from 49 NYC schools completed two brief validated measures, one assessing probable asthma and the other the frequency of six asthma symptoms over the past year. Adolescents also reported if in the past year they had an asthma-related ED visit or hospitalization. Analyses presented here included students with probable asthma (n = 9149). Using logistic regression, we modeled each asthma symptom as a function of ED visits and hospitalizations adjusting for sex, age, race/ethnicity and asthma severity. Multivariable models included all symptoms to account for the potential interaction between symptoms.

Results: Among adolescents with probable asthma, EIW was associated with ED visits and hospitalizations. In multivariable models wheeze without a cold, chest tightness, night waking, but not EIW, were significantly associated with both ED visits and hospitalizations.

Conclusions: Unlike findings with younger children, EIW does not appear to be associated with ED visits and hospitalizations among urban adolescents with probable asthma. Instead, symptoms, such as chest tightness and night waking, appear to be important at identifying adolescents at risk for asthma-related urgent care.

1. Introduction

In the United States, relative to elementary school aged children, adolescents suffer from a higher prevalence of asthma [1–4], more frequent asthma exacerbations [5], and have a higher mortality rate due to asthma [2,5]. Asthma exacerbations can be dangerous and costly, with one exacerbation potentially increasing annual costs threefold [6–8]. As such, exacerbations impose a significant burden on children, their families, and the health care system. A major challenge for asthma management is to develop effective methods for identifying risk factors that predict asthma exacerbations, which will allow us to intervene to prevent these exacerbations.

Epidemiologic research has clearly shown that socio-economic

status, race, access to preventive medical care and geography are good overall predictors of the risk of exacerbation and emergency treatment [9]. Urban areas have a disproportionate burden of the disease [10,11]. In New York City (NYC), children living in lower income neighborhoods are up to 17 times more likely to be admitted into the emergency department (ED) or hospitalized for an asthma-related incident than those living in wealthy neighborhoods [12]. These socioeconomic predictors, however, are not very useful for predicting risk for exacerbation in individual children.

While increased symptom frequency, resulting both from poor asthma control and more severe disease is a clear indicator of risk for ED visits and hospitalizations, there is also evidence that certain asthma phenotypes have an increased likelihood of these morbidities [13].

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Identifying specific asthma symptoms that could indicate increased risk for ED visits and hospitalizations, independent of increased symptom frequency, could be useful in the clinic, as well as for public health interventions. In two cohort studies of NYC elementary school age children, we found that children with asthma reporting exercise-induced wheeze (EIW) were more likely to have urgent medical visits for asthma than children with asthma without a report of EIW [14,15]. Strikingly, these associations were independent of other indicators of asthma severity (e.g., frequency of symptoms, lung function) and other asthma symptoms. We also observed that EIW was more common for children with asthma living in neighborhoods with a higher burden of ED visits than among those children in neighborhoods where ED visits were less common [14].

While these findings suggest that asking about EIW may be a useful tool for identifying elementary school age children who are at increased risk for asthma-related urgent medical visits, the relevance to high school age children with asthma, whose asthma morbidity and asthma care differ from elementary school aged children [1–5,16,17], has not been investigated. Among a cohort of NYC high school students with asthma, we hypothesized that EIW would be associated with asthma-related emergency department visits and overnight hospitalizations, independent of other indicators of asthma control.

2. Methods

2.1. Data collection procedures

In this cross-sectional study 30,468 high school students (mean age = 15.98) from 49 NYC public high schools housed in 19 school buildings were screened for eligibility for a randomized control trial (RCT) to test the efficacy of an asthma intervention for high school students [18]. Schools were selected to participate in the RCT if they served those most at risk for asthma, namely, lower income (i.e., at least 50% of the student body received free or reduced lunch) and primarily African-American and/or Hispanic students.

To identify eligible students for the larger study from which the data for this study is drawn, students in each school completed a case detection survey in class during the fall semester each year for four consecutive years; this study utilizes the case detection data from Study Years 2–4 (2009–2011). The institutional review boards of New York University School of Medicine, Columbia University College of Physicians and Surgeons, and the New York City Department of Education (DOE) approved all study procedures, including a waiver of parental consent for the case detection survey.

Trained study personnel distributed to the students letters describing case detection purpose and procedures. Students were asked to bring the letters home to caregivers who could call the investigators with questions. Several days later, students were asked to complete the case detection survey in class with the assistance of trained study personnel who visited each class a second time to allow absent students to complete the survey. For this study, we analyzed responses from those students who reported signs and symptoms of probable asthma, resulting in a sample size of 9149.

2.2. Measures

2.2.1. Asthma status and severity

Students reported if they were ever diagnosed with asthma. The case detections survey included a brief validated measure assessing *probable asthma* [19]. Students first indicated how often they experienced (0 = Never, 1 = Sometimes, 2 = A lot) seven signs and symptoms of asthma: (1) noisy or wheezy breathing, (2) difficulty taking a deep breath, (3) difficulty stopping coughing, (4) chest tightness or chest pain after running or exercising, (5) night waking due to coughing, (6) night waking due to trouble breathing, and (7) coughing when running, climbing stairs or exercising. Those who

Table 1

Descriptive statistics of study participants by asthma characteristics.

	Full Sample ^a (N = 9149) % (n) ^a	Asthma-related ED Visit (N = 1253) % (n) ^a	Asthma-related Hospitalizations (N = 613) % (n) ^a
Sex			
Male	33.2% (3038)	28.0% (352)	30.5% (187)
Female	59.4% (5440)	64.7% (811)	62.8% (385)
Age, mean (SD)	15.94 (1.31)	15.88 (1.35)	15.97 (1.45)
Grade			
9	31.1% (2847)	33.2% (416)	32.5% (199)
10	30.5% (2789)	28.8% (361)	29.5% (181)
11	26.9% (2459)	26.0% (326)	25.6% (157)
12	8.7% (794)	9.3% (117)	9.6% (59)
Ever diagnosed with Asthma			
Yes	40.3% (3685)	81.0% (1015)	82.1% (503)
No	58.5% (5350)	17.9% (224)	17.0% (104)
Asthma Severity^b			
Mild	31.3% (2869)	14.4% (181)	13.5% (83)
Medium	38.0% (3477)	28.6% (358)	26.8% (164)
High	25.2% (2302)	50.3% (630)	53.0% (325)
Asthma-related ED Visit			
Yes	13.7% (1253)	100% (1253)	74.7% (458)
No	81.6% (7466)		24.0% (147)
Asthma-related Hospitalization			
Yes	6.7% (613)	36.6% (458)	100% (613)
No	88.7% (8117)	62.3% (780)	
Race/Ethnicity			
African/African American/ Black/Caribbean Black, not Latino	31.0% (2835)	33.1% (415)	36.1% (221)
Asian/Asian American/ Pacific Islander	5.5% (499)	2.8% (35)	2.9% (18)
Hispanic/Latino	41.2% (3766)	41.4% (519)	40.3% (247)
White/Caucasian/ European American, not Latino	3.8% (348)	2.6% (32)	2.0% (12)
Other	7.8% (717)	7.2% (90)	7.0% (43)
Multi race/ ethnicity	9.2% (842)	12.5% (156)	11.7% (72)

^aThe full sample of those with probable asthma, defined as reporting three or more signs and symptoms of asthma.

^a Percentages may not add to 100% because of missing data.

^b Tertiles determined by total asthma probability score, where: 0 = fewer than 3, 1 = 3, 2 = 4 and 5, and 3 = 6+.

Table 2

Asthma symptom frequencies by probable asthma and asthma-related ED visits and hospitalizations.

Symptom in Past Year (yes/ no)	Probable Asthma ^a (n = 9149)	Asthma-related ED Visit (n = 1253)	Asthma-related Hospitalization (n = 613)
Persistent Cough	53.9% (4933)	68.5% (859)	69.3% (425)
Wheeze No Cold	36.4% (3331)	62.2% (780)	64.1% (393)
Exercise Wheeze	58.3% (5334)	75.0% (940)	74.0% (454)
Exercise Cough	61.9% (5669)	73.5% (922)	73.0% (448)
Chest, Tight, Heavy	66.9% (6123)	86.4% (1083)	86.7% (532)
Wake up cough	38.6% (3535)	64.4% (808)	68.6% (421)

^a Probable asthma is defined as citing three or more probable asthma symptoms.

reported at least three symptoms were classified as having probable asthma. Endorsement of three or more symptoms was found to have a sensitivity of 80% and specificity of 70% against clinical data [19]. An *asthma severity* score was computed by summing each of the seven

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