Asthma Burden in a Citywide, Diverse Sample of Elementary Schoolchildren in Chicago

Madeleine U. Shalowitz, MD, MBA; Laura M. Sadowski, MD, MPH; Rajesh Kumar, MD; Kevin B. Weiss, MD, MPH; John J. Shannon, MD

Objective.—The purposes of this study are to describe and develop preliminary models of the burden of diagnosed asthma and symptoms of possible undiagnosed asthma in a large, citywide, ethnically and socioeconomically diverse sample of Chicago elementary schoolchildren. We hypothesized that considering possible asthma would give a more complete picture of race/ethnic disparities in pediatric asthma.

Methods.—We studied 35 583 students aged 6 to 12 years attending Chicago Public and Archdiocese elementary schools for the Chicago Initiative to Raise Asthma Health Equity (CHIRAH) study. The full enrollments of 105 schools were surveyed for asthma and possible undiagnosed asthma by the Brief Pediatric Asthma Screen Plus (BPAS+) respiratory symptoms. The child had to be 6 to 12 years old, the valid age range for the BPAS+. Questionnaires included the BPAS+, basic demographic information, and household asthma information; they were sent home with each schoolchild for completion by the parent and returned to school for collection and scoring.

Results.—Overall, 13.9% of students had diagnosed asthma. For children aged 6 to 12 years, rates of diagnosed asthma varied from 13.1% to 14.5%, whereas the rates of possible undiagnosed asthma varied from 14.8% to 10.9%. The rate of diagnosed asthma was 21.2% for African Americans, 9.7% for whites, 11.8% for Hispanics, with similar rates of possible undiagnosed asthma. By multinomial logistic regression, African Americans were more than twice as likely and Hispanics were 1.57 times more likely than whites to have diagnosed asthma at all school district income levels and controlling for other household members with asthma, type of school, age of the child, gender, and language preference. The odds of African Americans being diagnosed with asthma rather than having possible asthma were 76% higher and for Hispanics were 46% higher compared with whites, at all school district income levels and controlling for other household members with asthma, type of school, age of the child, gender, and language preference.

Conclusions.—Our study confirms national disparities in diagnosed asthma by race/ethnicity. Respiratory symptoms consistent with possible undiagnosed asthma increase the total potential burden of asthma overall to more than one-quarter of the school enrollees. Among students with respiratory symptoms, African Americans, Hispanics (controlling for language), and families where another person has asthma are more likely to have diagnosed rather than possible asthma. Improved knowledge about asthma, recognition of symptoms, and access to high-quality care are necessary to ascertain how much of the possible undiagnosed asthma represents additional cases of asthma requiring treatment.

KEY WORDS: health disparities; inner city; pediatric asthma; school; underdiagnosis; urban

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Asthma is one of the most common chronic illnesses of childhood. Since the 1970s, its prevalence has risen rapidly[1,2] and unequally, especially for African Americans and Puerto Ricans.[3–12] Mortality due to asthma is associated with race and community socioeconomic status in high-risk urban communities[13]; Chicago is one of the US cities with the highest asthma mortality and the greatest disparities.[14,15] The proportion of residents with diagnosed asthma by Chicago neighborhood is related to social factors[16,17] as well as to traditional environmental triggers.[18] Asthma symptom management in Chicago remains suboptimal despite major efforts over the last decade to increase asthma awareness and education.[19] Little is known about the extent and correlates of asthma underdiagnosis. Here, we present the results of a citywide data collection effort to ascertain diagnosed asthma and possible undiagnosed asthma in elementary schoolchildren.

Mortality data and other statistics are based on hospital-generated claims underestimate the asthma burden because they require a known diagnosis of asthma. Similarly, representative national surveys rely on parent report of whether a child has "ever been diagnosed with asthma by a doctor or nurse." Such estimates are likely subject to bias as a result of unequal access to health care,[20,21] diagnostic uncertainty during the first several years of life,[22,23] and, theoretically, recall bias, although

From the Section for Child and Family Health Studies, Evanston Northwestern Healthcare and Northwestern University, Feinberg School of Medicine, Evanston, Ill (Dr Shalowitz); Collaborative Research Unit of the Departments of Medicine, John H. Stroger Jr Hospital of Cook County and Rush Medical University, Chicago, Ill (Dr Sadowski); Division of Allergy and Immunology, Children's Memorial Hospital and Northwestern University, Feinberg School of Medicine, Chicago, Ill (Dr Kumar); Institute for Healthcare Studies and Division of General Internal Medicine, Northwestern University Feinberg School of Medicine, Center for Management of Complex Chronic Care, Hines VA Hospital, Chicago, Ill (Dr Weiss); and Division of Pulmonary and Critical Care Medicine, Department of Medicine, John H. Stroger Jr Hospital of Cook County, Chicago, Ill (Dr Shannon).

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Address correspondence to Madeleine U. Shalowitz, MD, MBA, Evanston Northwestern Health Care Research Institute, 1001 University Place, Evanston, IL 60201 (e-mail: m-shalowitz@northwestern.edu).

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parent recall of asthma symptoms may be relatively accurate.[24]

Diagnostic accuracy is best achieved with a full clinical evaluation and testing, but it is logistically challenging and costly for large samples. Written surveys completed by parents or students[13,25–28] are more common, but results may not be valid if the sensitivity and specificity in English and in translation have not been established.[28]

Studies of asthma prevalence in Chicago have been limited to relatively small samples[29] or larger samples that do not accurately represent Chicago's population of children.[28] The current study advances previous work with a new sample that is large; broadly representative of schoolchildren throughout Chicago's neighborhoods; and racially, ethnically, and socioeconomically heterogeneous. We used a validated asthma survey for previously diagnosed asthma and possible undiagnosed asthma. We then evaluated whether distinguishing "possible asthma" from "no asthma" provided further insight into the observed disparities.

METHODS

Study Overview

This cross-sectional asthma survey, conducted in 2003–2005 at 105 Chicago Public and Archdiocese elementary schools, reports information on 35 587 children. This was the first stage in a recruitment strategy to establish a longitudinal cohort of urban children and adults with asthma for the Chicago Initiative to Raise Asthma Health Equity (CHIRAH), a study of how biological, psychosocial, and environmental stressors affect asthma morbidity. The school survey also provided information to the schools about rates of diagnosed asthma and possible undiagnosed asthma; and to parents with information on their children's asthma status, and suggested resources for care. The study was approved by the institutional review boards of all the participating institutions.

School Selection

In 2004, Chicago public schools (CPS) consisted of 486 elementary schools with 320 557 students. Overall (including secondary students), CPS students were 50% African American, 38% Hispanic, and 9% white. Eighty-five percent of CPS students were considered low income, defined as coming from families who are receiving public aid, living in institutions for neglected or delinquent children, being supported in foster homes with public funds, or being eligible to receive free or reduced-price lunches. In 2004, the Archdiocese of Chicago had 37 333 students in 126 elementary schools. Archdiocese students were 14% African American, 17% Hispanic, and 62% white. Twenty-four percent of Archdiocese students were low-income (includes Chicago and suburbs; Chicago-only estimates are higher). It was not feasible to approach private, non-Archdiocese schools for participation because of their small size. Their total enrollment is approximately one-third of the Archdiocese enrollment.

Schools were eligible if they had not participated in on-site asthma screening within the previous 2 years. Although schools can only estimate the percent of their enrollment that comes from outside their district, we eliminated schools whose enrollment was reported by school administration to be more than 50% from outside.

The school selection strategy was based on the ultimate goal of enrolling the longitudinal sample neighborhood by neighborhood (with school districts as proxy). The schools were first stratified by percentage of African American race and then by income group so that 4 school sampling groups were created. The "high African American" (high AA) schools had enrollments of more than 50% African American students. The "low-income" schools had enrollments in which more than 70% of students received subsidized or free school lunch. Ninety-two schools were identified by population proportionate sampling methods within each of the 4 race-income sampling groups (high AA/low income, high AA/midincome, low AA/low income and low AA/high income).[30]

Five randomly selected schools in each race-income sampling group were selected to represent larger neighborhood areas. The 2 geographically closest cluster schools to each of these schools were selected, adding 40 additional schools. Of these 132 schools, 27 refused to participate, and 1 of the selected cluster schools was a duplicate selection, yielding a final sample of 105 schools that were widely dispersed throughout the city. Reasons for refusal generally related to competing academic priorities for the principal's attention and unwillingness to distract classes from their lessons. All children in grades K through 8 were eligible to be surveyed in the selected schools.

Survey Instrument

The 1-page survey instrument had 4 primary components: social-demographic characteristics of the child and caregiver, an asthma screening tool, a question to identify asthma among household members, and a question box to express the household's interest in being contacted for secondary screening for possible enrollment onto the longitudinal cohort. One side of the page was in English and the other in Spanish.

Social Demographic Measures

The survey assessed characteristics of the child (age in years, gender, and race/ethnicity). Race/ethnicity was coded as "any Hispanic," "African American, non-Hispanic," "white, non–African American and non-Hispanic," and "Other." Other variables included whether the child attended a public or Archdiocese school and the language in which the caregiver completed the survey (Spanish or English). Neighborhood poverty was approximated by using the percentage of students receiving free or subsidized school lunch (referred to as "percent low income") and included families up to 185% of the poverty level.[31] Percent low income was assumed to reflect neighborhood resources. We created 4 categories representing neighborhood low income by quartiles, including the lowest percentage of low income (<25%); the highest percentage of low income (>75%), and the 2 quartiles in between.

Household Member With Asthma

"Household member with asthma" was a "yes" or "no" variable based on a composite of the caregiver's asthma status and the report of other household members with asthma. Because the latter variable did not account for household size or the relationship of the household member with asthma to the child, it may represent household familiarity with asthma and asthma symptoms rather than family history per se.

Administration of Asthma Screening Questionnaire

The Brief Pediatric Asthma Screen Plus (BPAS+, asthma questions only) is a parent-report questionnaire that identifies children ages 6 to 12 years with diagnosed asthma and children who need evaluation for possible undiagnosed asthma.[32,33] The instrument has been validated in English and Spanish in various populations by comparing the questionnaire results to a medical history and physical examination by a pediatric asthma specialist.[32,33] Similar to the National Health Interview Survey, the BPAS+ asks the caregiver, "Has a doctor or nurse ever told you that your child has asthma?" Four respiratory symptom questions follow. The sensitivity and specificity of the BPAS+ are for the detection of "possible undiagnosed asthma" and are based on a positive response to any one of the symptom questions. The English BPAS+ had 73% sensitivity and 74% specificity for African Americans and 61% sensitivity and 83% specificity for Hispanics. The Spanish BPAS+ had 74% sensitivity and 86% specificity for possible undiagnosed asthma. The reading level in English is less than second grade.

Survey Administration and Follow-up Protocols

The study team distributed the survey in each classroom on a single day and answered students' questions. Students took the form home for completion by parents/caregivers and brought the completed form back to their teachers. Teachers batched the forms for pickup by the research staff the next week. All classrooms had a party for completing the survey. Those with high participation rates received pizza; the others received cookies.[28] Our overall response rates by school ranged from 39.6% to 99.4%. The response rate was 79% overall.

Analysis

All analyses were completed by STATA 9.2.[34] As a service to the school, all children were surveyed (n = 62 005); however, this report includes only the sample of children in the age range valid for the BPAS+ (6–12 years) (n = 35 583). Descriptive statistics and bivariate analyses (χ^2) were used to calculate the potential total burden of asthma symptoms, the sum of diagnosed asthma, and possible undiagnosed asthma as a whole and by the children's race/ethnicity, age, and the school's percent low income. Multiple logistic regression analysis was used to develop a predictive model for diagnosed asthma. The likelihood of having previously diagnosed asthma was initially compared with the combination of no asthma and possible undiagnosed asthma. This was considered the traditional analysis because in most previous work, anyone with "possible asthma" is embedded in the "no asthma" group. We then used multinomial logistic regression to develop predictive models for the 3 asthma status groups (no asthma, possible asthma, and diagnosed asthma). Multinomial logistic regression is similar to multiple logistic regression. It is used when the dependent variable consists of more than 2 categories. Briefly, the procedure first selects one of the categories as a reference (eg, no asthma); then it conducts logistic regressions of the dependent variable categories 2 at a time—that is, diagnosed vs no asthma, and possible undiagnosed vs no asthma. Parameter estimates for the comparison between diagnosed and possible undiagnosed asthma can be obtained from estimates of the model parameters.

Some of the variables used in the logistic regressions are school-level, not individual-level, data. Students are not randomly distributed across schools; rather, students are clustered within schools. Accordingly, the standard errors of the coefficients were adjusted for clustering by school by a random-intercept model approach. The random-intercept induces within-school correlations and represents the combined effect of school-specific covariates, or unobserved heterogeneity across schools. Thus, adjusting for clustering permitted the school-level data to be interpreted as individual characteristics that were shared by students in the same school. In addition, adjusting for clustering partially compensated for the variation in questionnaire return rates by school.

RESULTS

Sample Characteristics

Of 35 583 students aged 6 to 12, a total of 17 352 (50%) were girls and 17 924 (48%) were boys. African Americans comprised 29% of the student sample (n = 10 216), 42% were "any Hispanic" (n = 15 090), 21% were "any white, non-Hispanic, non–African American (n = 7325), and 7% were "other ethnicities" (n = 2455). One percent (n = 497) were missing ethnicity data. Forty percent (n = 6049) of the Hispanic children's caregivers completed the questionnaire in Spanish.

School Characteristics

Of 105 elementary schools surveyed, 74% were public and 26% were Archdiocese (Catholic). Overall, on the basis of the 2002 estimated data obtained from CPS and the Archdiocese on the enrolled schools, African American mean percentage of enrollment was 39%, Hispanic 30%, and white 25%, and mean percent low income was 65.4% (median, 74.6%; SD, 31.2). Within-school diversity was more limited. Each school tended to include primarily 1 or 2 minority groups. Lack of race/ethnic heterogeneity within schools reflected the segregation in Chicago neighborhoods.

Diagnosed and Possible Undiagnosed Asthma in Schools

Overall, 13.9% of students had diagnosed asthma, with similar rates in public (14.1) and Catholic Archdiocese (12.8%) schools. Table 1 shows that rates of diagnosed

Table 1. Relationship of Asthma Status to the Percentage of School Enrollment That Is Low Income

Low-Income School Enrollment, %	Diagnosed Asthma* (n = 4952)	Possible Undiagnosed Asthma** (n = 4403)
<25%	12.0%	13.9%
25%–50%	13.3%	11.7%
50%–75%	13.3%	11.3%
75%–100%	14.7%	12.5%
Weighted average rate	13.9%	12.4%

*Cochran-Mantel-Haenszel test for trend: $\chi^2(1) = 26.846$, $P < .0001$.
**Cochran-Mantel-Haenszel test for trend: $\chi^2(1) = 1.630$, $P = .20$.

asthma rise with the percentage of low-income families in the school. The rates of possible undiagnosed asthma do not show a similar trend. Therefore, the potential total burden of asthma (defined by all children with diagnosed asthma and possible undiagnosed asthma) does not increase with the percentage of low-income families in the school (26% vs 27%).

Diagnosed and Possible Undiagnosed Asthma in Schoolchildren

Diagnosed asthma and possible undiagnosed asthma rates by individual child characteristics are listed in Table 2. From ages 6 to 12 years (multiple cross sections), diagnosed asthma varied from 13.1% to 14.5%, whereas possible undiagnosed asthma varied from 14.8% to 10.9%. The total potential asthma burden (actual plus possible asthma) varied from 27.9% to 25.4%. Diagnosed asthma among African Americans (21.2%) was more than twice that of whites and almost twice that of Hispanics (11.8%), but possible undiagnosed asthma was similar (13.3% for African Americans, 12.3% for whites, and 12.6% for Hispanics). Boys had diagnosed asthma much more frequently than girls (16.2% vs 11.8%), but levels of possible undiagnosed asthma was similar.

Table 2. Relationship of Asthma Status to Children's Age, to Race/Ethnicity, to Gender, and to Language

Characteristic	Diagnosed Asthma (n = 4952)	Possible Undiagnosed Asthma (n = 4403)
Children's age, y		
6	13.1%	14.8%
7	13.7%	13.5%
8	13.1%	12.4%
9	14.7%	11.5%
10	14.3%	12.2%
11	14.3%	11.0%
12	14.5%	10.9%
Statistical significance, Cochran-Mantel-Haenszel test for trend	$P < .05$	$P < .0001$
Children's race/ethnicity		
Black	21.2%	13.3%
White	9.7%	12.3%
Hispanic	11.8%	12.6%
Other	9.8%	8.3%
Statistical significance, Hispanic vs white	$P < .0001$	NS
Statistical significance, black vs white	$P < .0001$	NS
Children's gender		
Female	11.8%	12.3%
Male	16.2%	12.4%
Statistical significance	$P < .0001$	NS
Language		
English	15.2%	12.1%
Spanish	7.9%	13.7%
Statistical significance	$P < .0001$	$P < .001$

Table 3. Traditional Model of Diagnosed Asthma and Its Relationship to Child and School Characteristics†

Characteristic	Odds Ratio (95% CI) for Diagnosed Asthma vs All Other (n = 31 909)
Child	
Black, non-Hispanic	2.15*** (1.89, 2.45)
Hispanic	1.57*** (1.38, 1.79)
Female gender	.66*** (.62,.71)
Age, y	1.01 (.99, 1.03)
Another household member with asthma	4.07*** (3.76, 4.42)
Spanish	.60*** (.534, .663)
School	
Low-income school enrollment at 25%–50%	1.01 (.84, 1.23)
Low-income school enrollment at 50%–75%	.96 (.78, 1.19)
Low-income school enrollment at >75%	.88 (.71, 1.08)
Archdiocese	1.03 (.87, 1.21)

*$P < .05$.
**$P < .01$.
***$P < .001$.
†Standard errors robust for clustering by school. 95% CI indicates 95% confidence interval.

Multivariate Models to Predict Diagnosed and Possible Undiagnosed Asthma in Schoolchildren

Table 3 shows the traditional predictive model for health disparities in a sample (n = 31 909) restricted to whites, African Americans, and Hispanics, in order to draw comparisons to national data on disparities. Children with diagnosed asthma were compared with all other children. The bivariate relationships of diagnosed asthma to neighborhood income and to children's age are no longer significant in the traditional multivariate model. Compared with white children, African Americans are more than twice as likely and Hispanics 1.57 times more likely to have diagnosed asthma at all school district income levels, controlling for other household members with asthma, type of school, age of the child, gender, and language preference. Male sex is associated with an increased likelihood of diagnosed asthma. Having another household member with asthma is associated with a 4-fold increase in diagnosed asthma. Choosing Spanish rather than English decreases the odds of diagnosed asthma by 40%.

Table 4 shows the predictive models for the asthma status categories compared 2 at a time. For children with diagnosed asthma compared with those with no asthma (children with possible asthma excluded), the predictive model is similar to the traditional predictive model (Table 3). A different picture is evident for the comparison of

Table 4. Comparing Models for Individual Asthma Status Groups 2 at a Time†

Characteristic	Odds Ratio (95% CI)		
	Diagnosed Asthma vs No Asthma (n = 27 870)	Possible Asthma vs No Asthma (n = 27 341)	Diagnosed Asthma vs Possible Asthma (n = 8607)
Child			
Black, non-Hispanic	2.24*** (2.00, 2.51)	1.34*** (1.17, 1.52)	1.76*** (1.46, 2.12)
Hispanic	1.59*** (1.42, 1.78)	1.09 (.96, 1.23)	1.46*** (1.23, 1.74)
Female gender	.65*** (.61,.70)	.92* (.86,.99)	.70*** (.64,.77)
Age, y	1.00 (.98, 1.02)	.94*** (.92,.96)	1.06*** (1.03, 1.08)
Another household member with asthma	4.49*** (4.19, 4.81)	1.76*** (1.61, 1.91)	2.56*** (2.32, 2.82)
Spanish	.61*** (.54, .69)	1.17* (1.01, 1.35)	.53*** (.46, .62)
School			
Low-income school enrollment at 25%–50%	1.00 (.85, 1.16)	.91 (.74, 1.11)	1.12 (.92, 1.37)
Low-income school enrollment at 50%–75%	.94 (.80, 1.11)	.88 (.72, 1.08)	1.07 (.84, 1.36)
Low-income school enrollment at > 75%	.86 (.73, 1.01)	.87 (.71, 1.08)	.99 (.78, 1.26)
Archdiocese	1.05 (.92, 1.19)	1.17 (.99, 1.39)	.90 (.76, 1.08)

*$P < .05$.
**$P < .01$.
***$P < .001$.
†Standard errors robust for clustering by school. 95% CI indicates 95% confidence interval.

possible undiagnosed asthma to no asthma (children with diagnosed asthma excluded). In contrast to the traditional model, when comparing children with possible asthma to those without respiratory symptoms, the race/ethnicity, gender, and "household member with asthma" effects are diminished, whereas older age reemerges as a correlate of having possible asthma. The language effect is reversed.

Last, we evaluated the odds of having a diagnosis of asthma compared with possible undiagnosed asthma (children with no asthma excluded). Thus, the sample for this regression comprised children with reports of respiratory symptoms. In contrast to the traditional model, when comparing diagnosed asthma to possible asthma, the race/ethnicity and gender effects are similar. The "household member with asthma" effect is diminished. The language effect is the strongest in this model and indicates decreased likelihood of diagnosed asthma (despite symptoms). Although age is a correlate of having possible asthma, it is in the opposite direction from the comparison of possible to no asthma. This result, as expected, suggests that the decrease in possible asthma seen in groups of children of increasing age may result from movement out of the "possible asthma" group to both the "diagnosed" and the "no asthma" groups.

DISCUSSION

The findings from this large, citywide, racially, ethnically, and socioeconomically diverse sample by using a validated survey instrument indicate that the rates of diagnosed asthma in elementary school-aged children are considerable. Recent national statistics indicate an overall asthma prevalence of 12.2% for children younger than 18 years old.[1] Previous research found that Puerto Rican American children had a lifetime prevalence of asthma of 26%, followed by African American children (16%), non-Hispanic whites (13%), and Mexican Americans (10%).[35] We confirm these well-recognized disparities by race/ethnicity in diagnosed asthma, although our rates were higher than national estimates for African American children and lower for whites.[35] We could not differentiate country or territory of origin in our sample. Our rate of diagnosed asthma in Hispanics (11.8%) is probably consistent with the national data, given that most Hispanics in Chicago are of Mexican origin and Puerto Ricans are a significant minority. In addition, respiratory symptoms consistent with possible undiagnosed asthma increase the total potential burden of asthma overall to more than one-quarter of the sample children. The total asthma burden for girls is less than for boys, consistent with literature noting more asthma in boys during the elementary school years. In multiple cross sections by increasing age, there is a trend toward increasing diagnosed asthma and decreasing possible undiagnosed asthma.

Subjectivity, even in true diagnostic assessment of patients of different backgrounds, may lead to a variety of potential interpretations or misinterpretations of symptoms, and over- or underdiagnosis.[36] The rates of possible undiagnosed asthma are similar to other surveys that attempted to gather information about respiratory symptoms as well as a previous diagnosis of asthma,[13,25,28,37,38] with one study estimating that 50% of all people with asthma between ages 14 and 40 remain undiagnosed.[38] Although it is possible that children with respiratory symptoms but without diagnosed asthma have milder disease, insufficient information is available about their health to confirm this hypothesis. In one study of seventh- and eighth-grade students in North Carolina, students with possible undiagnosed asthma reported significant morbidity due to respiratory illness, in particular missing school, activity limitation, and sleep disturbance.[39] We know that the costs to family and society for diagnosed pediatric asthma morbidity are substantial, including lost productivity at work for the parent[40,41] and at school for the child.[42,43] Estimates of lost productivity and other indirect costs ranged from $1.9 to $6.2 billion per year.[40,41] We can only speculate about the extent

to which these costs would be magnified if morbidity from possible undiagnosed asthma were included.

Disparities by race and ethnicity in both diagnosed and undiagnosed asthma persist despite controls for the child's age and gender, the caregiver's language preference, and the large effect of the presence of other household members with asthma. Among children with respiratory symptoms, caregivers choosing Spanish or female sex of the schoolchild reported that the children were less likely to have a formal diagnosis of asthma diagnosis (despite symptoms). Caregivers' interpretation of these respiratory symptoms in their children and whether or not they seek care for these symptoms may vary on the basis of cultural attitudes toward illness, education, experience, and the ability to communicate in English, or if they have girls rather than boys. Finally, there may be bias toward underestimating the significance of respiratory symptoms by health care providers when evaluating children whose parents do not speak English or when evaluating girls.

In the elementary school years, financial and institutional barriers to health care with limited access to high-quality, culturally and linguistically competent providers are key health system deterrents to diagnosis and treatment for asthma. Previous studies have shown that lack of health insurance is associated with a higher likelihood of respiratory symptoms without an asthma diagnosis, and although we did not ask about insurance status, it is possible that our students whose parents chose to answer the survey in Spanish did not have the financial resources to access regular medical care.[27]

Information about the income of the school district and type of school was not significant in any of the multivariate analyses. Thus, with the limited information available, individual characteristics were stronger predictors of asthma status than school-level variables. We identified a trend toward increasing rates of diagnosed asthma and decreasing possible asthma in groups of children of increasing age. In contrast, Quinn et al[28] did not identify this trend, but that study only included low-income school districts. The apparent movement from possible undiagnosed asthma to diagnosed asthma associated with groups of children of increasing age in the current sample may reflect the cumulative opportunities for diagnosis through health encounters over time, particularly for those middle-class families with better access to care and information.[37]

This study has several limitations. We used a self-administered survey completed by the caregiver at home rather than a clinical assessment of the children to estimate the burden of asthma. We cannot verify the accuracy of these reports, nor can we be completely certain who filled out the survey. We share these limitations with similar studies. The gold standard for asthma diagnosis remains a clinical history and physical examination supplemented by lung function and allergy testing,[44] but as the BPAS+ has known sensitivity and specificity in English and Spanish, it allows for reasonable confidence in the reported estimates.

A survey administered in schools must be straightforward and brief. An individual measure of socioeconomic status, such as family income and assets, may be preferable, but was not feasible. We based neighborhood income on information from the school Web site about the percentage of its enrollment eligible for federally subsidized school lunches. Although these school-level data are related to neighborhood income levels, they are not a true measure of neighborhood incomes because parents may not accurately report income to the school for school lunch eligibility. The data also exclude families without elementary school-aged children or those whose children do not attend the surveyed school.

Although we achieved a high response rate overall (79%), we cannot describe the characteristics of the those who did not respond. Because the response rate for Hispanics was a bit higher than for African Americans, estimates of Hispanic asthma burden are more reliable. Although we know some of the reasons for the varying response rates by school (eg, in some schools, many caregivers spoke languages other than English or Spanish), the full range of reasons are not known. Schools were selected systematically to assure a cross section of Chicago schools with strong minority representation and some diversity in income. Had we been able to include private, nonparochial schools, we would have been able to evaluate a larger income range.

In conclusion, this is one of the largest and likely population-representative surveys that attempts to accurately account for possible undiagnosed asthma in schoolchildren. The findings highlight the importance of increasing cultural and linguistic competency among health care providers and their staffs in order to identify, evaluate, and appropriately treat respiratory symptoms in diverse populations. Data from studies such as this strengthen arguments for increased funding to identify and care for children with asthma, perhaps through their schools. Universal screening for asthma may be warranted in urban areas, but it must be linked with an adequate care-delivery system for those identified. Efforts to increase awareness in the community about common signs and symptoms of asthma are likely necessary to improve asthma detection.

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