Racial and Ethnic Disparities in Diagnosed and Possible Undiagnosed Asthma Among Public-School Children in Chicago

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Asthma is one of the most common chronic illnesses of childhood. It is also unequally distributed among children of different races and ethnicities. Recent national survey data indicate an overall asthma prevalence of 12.2% for children younger than 18 years.[1] These data reveal dramatic differences in the prevalence of lifetime asthma by racial/ethnic group: among Hispanics, Puerto Ricans have the highest lifetime asthma prevalence (19.6%), more than 3 times the prevalence for Mexicans (6.1%). These prevalences bound those for non-Hispanic Blacks (13.8%) and non-Hispanic Whites (11.1%).[2]

As alarming as these proportions are, they likely underestimate the prevalence of asthma among racial/ethnic subpopulations, as asthma appears to be highly prevalent among those segments of the population—for example, in minority children of low socioeconomic status living in urban areas[1,3–14]—in which symptomatic children often go undiagnosed.[4–7,10–12,14–16] This problem of underdiagnosis has limited the ability of administrative and other secondary data analyses (such as those using Medicaid or Medicare data, or the National Health Interview Survey) to yield accurate subpopulation estimates.

Recent primary data collection efforts have tried to address this problem and have attempted to estimate the total potential burden of asthma by surveying respondents about asthma-related respiratory symptoms in addition to diagnosed asthma.[4,5,7,8,10,11] However, methodological inconsistencies among studies have produced varying prevalence estimates. This is to be expected given the considerable challenges faced by any study of an underdiagnosed condition, which include minimizing bias in the sample selected for study, using survey-based measures that have been validated against physician evaluations, translating and revalidating measures for use

with non–English-speaking populations, and imposing consistent definitions of racial and ethnic subgroup membership.

We report the prevalence findings of an ongoing research project examining both the prevalence and correlates of asthma among Chicago public-school children. We examined racial and ethnic disparities in the total potential burden of asthma, including possible undiagnosed asthma, by surveying the caretakers of children in 14 low-income, racially/ethnically heterogeneous Chicago neighborhood public elementary schools. School-based surveys such as this have been shown to be a feasible means of ascertaining childhood asthma cases.[7,10,12,17–24] Our study has multiple strengths: (1) We employed a population-based sampling strategy that minimizes sample bias within the schools and neighborhoods selected; (2) We surveyed a large number of children across all elementary school grades in 14 neighborhoods; (3) We achieved a high response prevalence; and (4) We employed English- and Spanish-language survey

Objectives. We examined racial and ethnic disparities in the total potential burden of asthma in low-income, racially/ethnically heterogeneous Chicago schools.

Methods. We used the Brief Pediatric Asthma Screen Plus (BPAS+) and the Spanish BPAS+, validated, caregiver-completed respiratory questionnaires, to identify asthma and possible asthma among students in 14 racially/ethnically diverse public elementary schools.

Results. Among 11 490 children, we demonstrated a high lifetime prevalence (12.2%) as well as racial and ethnic disparities in diagnosed asthma, but no disparities in prevalences of possible undiagnosed asthma. Possible asthma cases boost the total potential burden of asthma to more than 1 in 3 non-Hispanic Black and Puerto Rican children.

Conclusions. There are significant racial and ethnic disparities in diagnosed asthma among inner-city schoolchildren in Chicago. However, possible undiagnosed asthma appears to have similar prevalences across racial/ethnic groups and contributes to a high total potential asthma burden in each group studied. A better understanding of underdiagnosis is needed to address gaps in asthma care and intervention for low-income communities. (*Am J Public Health.* 2006;96:1599–1603. doi:10.2105/AJPH.2005.071514)

measures of symptomatology that were validated against a professional medical evaluation. Our research design allowed us to accurately estimate the prevalence of asthma in specific racial/ethnic subgroups of children, as well as to estimate the total potential burden of asthma, in a medically vulnerable population of predominantly low-income, urban-dwelling children of diverse ethnicities.

METHODS

Chicago Public Elementary Schools

In 2004, Chicago Public Schools (CPS) consisted of 486 elementary schools with a total enrollment of 320 557 students. Overall (including secondary students), CPS students are 38% Hispanic, 50% Black, and 9% White. Eighty-five percent of CPS students are considered low-income, defined as coming from families that 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.[25]

School selection. To identify low-income, racially/ethnically heterogeneous schools whose enrollment we would survey, we used student demographic information from the CPS Web site.[25] We considered a school to be low-income if more than 75% of its students qualified as low-income. Because of the segregated nature of Chicago neighborhoods, we considered a school to be racially/ethnically heterogeneous if no single racial/ethnic group comprised more than two-thirds of its enrollment. Effectively, most schools were either predominantly Black and Hispanic or White and Hispanic.

To control for community factors that may be correlated with asthma, we chose schools whose enrollment came from the local community (rather than magnet schools) so that children of different races/ethnicities within a school were living in similar neighborhoods. We enrolled the first 14 eligible schools that agreed to participate and surveyed the full school census for asthma and respiratory symptoms.

Measures

Brief Pediatric Asthma Screen Plus (BPAS+) and the Spanish version of the BPAS+. We surveyed students in the 14 schools with the BPAS+ and the Spanish version of the BPAS+.[22,23] These parent-report questionnaires are useful for identifying children with diagnosed asthma as well as children who are in need of evaluation for possible undiagnosed asthma. The instruments have been validated with various low-income populations by comparing the questionnaire results to the findings of a medical history and physical examination by a pediatric asthma specialist.[22,23]

Similar to the National Health Interview Survey, the BPAS+ asks the caregiver the following question, "Has a doctor or nurse ever told you that your child has asthma?" Then the caregiver is asked to respond to 4 respiratory symptom questions. The sensitivity and specificity of the BPAS+ are on the basis of the performance of the symptom questions. The optimal scoring for "further evaluation for possible undiagnosed asthma" is a positive response to 1 or more of 4 items: wheeze, persistent cough, night cough, and breathing problem with temperature change. 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.[22,23]

Responses to the BPAS+ items were used to classify each child into 1 of 3 categories: (1) child shows no symptoms and has no diagnosis of asthma; (2) child shows symptoms of asthma but has no diagnosis (possible undiagnosed asthma); and (3) child has a previous professional diagnosis of asthma. To estimate the total potential burden of asthma, we constructed numerators for each racial/ethnic subgroup equal to the sum of the number of children who had received a previous diagnosis of asthma and the number of children with possible undiagnosed asthma.

Demographics

Additional information on this 1-page survey was limited to the child's race, ethnicity, age, and gender and the respondent's relationship to the child. We observed language choice for completion of the survey. Respondents provided addresses so that we could provide the results of the screen, and telephone numbers so that we could recruit interested, eligible families into a longitudinal study.

Procedures

Students delivered the BPAS+ with cover letter home to their caregivers and returned the completed questionnaires to their teachers. The questionnaire and cover letter were printed in English on one side and in Spanish on the other side; caregivers chose which side to complete. To encourage participation, research assistants visited classrooms and briefly discussed the importance of asthma awareness and informed students of the incentive: Classrooms that returned completed questionnaires from 85% or more of students over the course of 1 week received a pizza party for their participation; others received cookies. Thus, each class had a party after questionnaires were collected.

All caregivers who completed a BPAS+ and provided their mailing addresses received a letter informing them of their children's results. The letters encouraged caregivers to seek medical care for their children who showed symptoms of asthma or who had diagnosed asthma. Each letter included asthma

information and community-specific health resources for additional information and care.

We returned aggregate information to each school and the questionnaire results for individual children whose caregivers indicated that they wished to share results with the school nurse. The CPS administration received the results for all 14 schools.

Analysis

We present results of bivariate analyses (χ^2 tests of significance) of BPAS+ category by child subgroup using data for 81% of the screened population. This subsample (n= 11 490) includes only children aged 4 to 13 years for comparability to the age range of the BPAS+ validation studies, though we surveyed the entire school enrollment at the schools' request. Additional cases were excluded because the BPAS+ has not been validated in Polish. (The BPAS+ was translated into Polish to accommodate schools with significant numbers of Polish-speaking families.) We excluded a total of 2681 cases from analyses.

RESULTS

Sample Description

The overall questionnaire return prevalence for the 14 schools was 90% (n=14 171). Questionnaire respondent and child demographic characteristics for the subsample (n=11 490) are shown in Table 1. The average age of the children was 9.4 years (range, 4.0–13.9) and 51% were boys. Nearly three fourths of respondents completed the English survey whereas one quarter completed the Spanish version. Most (87%) of the questionnaire respondents were parents; two thirds gave permission to share their child's questionnaire results with the school nurse; and 53% indicated interest in participating in the follow-up longitudinal study.

Caregivers reported child race/ethnicity as Hispanic (52%); non-Hispanic Black (26%); non-Hispanic White (14%); and other/ unidentified (9%). Most of the Hispanics were of Mexican (77%) or Puerto Rican (10%) ancestry. Hispanic subgroup data were missing for 4 schools. These percentages differ from the entire CPS enrollment because we recruited racially/ethnically heterogeneous schools. The percentage of low-income

TABLE 1—Demographic Characteristics of Respiratory Questionnaire Respondents and Their Children (n = 11 490)

Characteristic	n (%)
Questionnaire language used	
English	8525 (74.2)
Spanish	2965 (25.8)
Relationship of respondent to child	
Mother/father	9969 (86.8)
Grandparent	356 (3.0)
Aunt/uncle	179 (1.6)
Other/unreported	986 (8.6)
Child's gender[a]	
Boy	5844 (51.0)
Girl	5608 (49.0)
Child's race/ethnicity	
White non-Hispanic	1560 (13.6)
Black non-Hispanic	2938 (25.6)
Hispanic	6002 (52.2)
Other/unreported	990 (8.6)
Child Hispanic subgroup[b]	
Mexican	3823 (77.3)
Puerto Rican	473 (9.6)
Mexican and Puerto Rican	130 (2.6)
Other Hispanic	521 (10.5)

[a]Gender not reported for 38 cases.
[b]n = 4947; Hispanic subgroup data are missing for 4 schools.

TABLE 2—Diagnosed Asthma, Possible Asthma, and Total Potential Asthma Burden Among Chicago Public Elementary-School Students (n = 11 490)

	Diagnosed Asthma n (%)	P	Signs of Possible Asthma n (%)	P	Total Potential Asthma Burden (Diagnosed + Possible) n (%)	P	No Diagnosis and No Signs of Asthma n (%)	P
Overall 14 schools	1409 (12.2)		1670 (14.5)		3079 (26.8)		8411 (73.2)	
Child race/ethnicity		<.001		.125		<.001		<.001
White non-Hispanic	153 (9.8)		207 (13.3)		360 (23.1)		1200 (76.9)	
Black non-Hispanic	537 (18.3)		461 (15.7)		998 (34.0)		1940 (66.0)	
Hispanic	610 (10.3)		866 (14.4)		1476 (24.6)		4526 (75.4)	
Other/unidentified	109 (11.0)		136 (13.7)		245 (24.7)		745 (75.3)	
Child Hispanic subgroup[a]		<.001		.911		<.001		<.001
Mexican	317 (8.3)		538 (14.1)		855 (22.4)		2968 (77.6)	
Puerto Rican	102 (21.6)		72 (15.2)		174 (36.8)		299 (63.2)	
Mexican and Puerto Rican	22 (16.9)		19 (14.6)		41 (31.5)		89 (68.5)	
Other Hispanic	50 (9.6)		72 (13.8)		122 (23.4)		399 (76.6)	
Child gender[b]		<.001		.079		<.001		<.001
Boy	834 (14.3)		817 (14.0)		1651 (28.3)		4193 (71.7)	
Girl	570 (10.2)		849 (15.1)		1419 (25.3)		4189 (74.7)	
Child age, y		.632		.111		.698		.698
4	30 (10.9)		49 (17.8)		79 (28.6)		197 (71.4)	
5	103 (12.0)		125 (14.5)		228 (26.5)		633 (73.5)	
6	143 (10.8)		216 (16.3)		359 (27.1)		967 (72.9)	
7	186 (13.6)		205 (15.0)		391 (28.6)		974 (71.4)	
8	166 (12.1)		202 (14.8)		368 (26.9)		1000 (73.1)	
9	170 (12.5)		196 (14.4)		366 (26.9)		996 (73.1)	
10	173 (12.7)		169 (12.4)		342 (25.1)		1022 (74.9)	
11	163 (13.1)		177 (14.3)		340 (27.4)		900 (72.6)	
12	136 (11.2)		188 (15.4)		324 (26.6)		893 (73.4)	
13	139 (12.5)		143 (12.9)		282 (25.4)		829 (74.6)	

[a]n = 4947; Hispanic subgroup data are missing for 4 schools.
[b]n = 11 452; 38 cases missing gender data.

families in the 14 study schools ranged from 77% to 98%.

Diagnosed Asthma Prevalence Estimates

Overall, 12.2% (1409 of 11490) of the caregivers reported a previous diagnosis of asthma for their child (Table 2). By major race/ethnicity group, non-Hispanic Black children had the highest percentage of diagnosed asthma (18.3%), roughly twice the prevalence for non-Hispanic Whites (9.8%) and Hispanics (10.3%) (P<.001). In analyses of Hispanics for whom we elicited country of origin subgroup data, children of Puerto Rican ancestry had the highest percentage of diagnosed asthma (21.6%). This is the highest percentage of diagnosed asthma of any group in this study, more than 2.5 times the percentage for children of Mexican ancestry (8.3%; P<.001). It is interesting to note that the percentage of diagnosed asthma for children of mixed Mexican and Puerto Rican ancestry (16.9%) is between the prevalences for Mexicans and Puerto Ricans, although the number in this mixed group is small (n=130). Boys had a higher percentage of diagnosed asthma (14.3%) than girls (10.2%; P<.001). We did not find a statistically significant difference or an obvious trend in diagnosed asthma by age.

We excluded cases from statistical analyses because the BPAS+ validity has not been determined in certain age ranges and in Polish; however, we note that the percentages of diagnosed asthma by subgroup for the full screening population are not statistically different from those of the subsample: overall (12.0%), non-Hispanic Blacks (18.4%), non-Hispanic Whites (8.6%), Hispanics (10.1%), Puerto Ricans (20.7%), Mexicans (8.4%), boys (13.8%), and girls (10.1%).

Possible Asthma and Total Potential Asthma Burden

More children (14.5%, n=1670) had respiratory symptoms consistent with possible asthma, even though they had never been diagnosed with asthma, than had diagnosed asthma (Table 2). The proportion of possible asthma was high across all racial/ethnic groups and was not statistically different by group, ranging from 13.3% for non-Hispanic Whites to 15.7% for non-Hispanic Blacks.

We did not find a significant difference between the possible asthma prevalence for girls

and boys. Likewise, we did not find a significant difference or obvious trend by age.

Because the proportion of possible undiagnosed asthma is similar in each racial/ethnic group, when this proportion is added to the proportion of children in each group who are diagnosed with asthma, we observe that the differences between groups in total potential asthma burden are similar to those observed for diagnosed asthma. The total potential asthma burden (diagnosed asthma plus possible asthma) for the subsample was 26.8%. By major race/ethnicity group, non-Hispanic Black children had the highest total potential asthma burden (34.0%; $P<$ .001), and the percentages were comparable for Hispanics (24.6%) and non-Hispanic Whites (23.1%).

In analyses of Hispanics for whom we elicited Hispanic subgroup data, Puerto Rican children had a significantly higher total potential asthma burden (36.8%; $P<$.001). Again, the total potential burden for children of mixed Mexican and Puerto Rican ancestry (31.5%) is between that of Mexicans (22.4%) and Puerto Ricans, although the number in this group is small (n=130). Girls had less total potential asthma burden than boys (25.3% vs 28.3%; $P<$.001). We did not find a significant difference or an obvious trend by age in total potential asthma.

DISCUSSION

We observed a racial and ethnic disparity in lifetime prevalence of diagnosed asthma, on the basis of parent report, using a school-based ascertainment procedure. Our average prevalence of diagnosed asthma across race/ethnicity was identical to the 2002 National Health Interview Survey prevalence for children younger than 18 years and nearly the same as that of children aged 5 to 11 years (which overlaps closely with our study population).[1] By race/ethnicity, non-Hispanic Blacks had roughly twice the average prevalence of lifetime asthma as non-Hispanic Whites and Hispanics. In our sample of Hispanics of predominantly Mexican origin, this average Hispanic prevalence obscured the highest prevalence of lifetime asthma, that is, for Puerto Ricans.

As in other studies of the elementary-school years, boys were more likely to have diagnosed asthma than girls.[1,7,26] When we considered the children with possible undiagnosed asthma, the gender differences in the possible asthma group were reversed; girls were slightly more likely to have possible asthma than boys, thus closing the gap in total potential burden by gender.

Our data mirror those of other investigators in Chicago, though others have not necessarily selected communities systematically or attempted to disentangle the effects of race/ethnicity and low-income status. The additional group of possible asthma cases boosts the total potential burden of asthma to more than 1 in 3 non-Hispanic Black and Puerto Rican children. Whitman et al. found prevalences of diagnosed plus possible asthma to be as high as 34% for Puerto Rican children (13% possible undiagnosed) whereas Mexican children had the lowest prevalences (14% overall with only 5% possible undiagnosed) among Hispanics, Blacks, and Whites.[8] In 2 separate studies of inner-city Chicago Black schoolchildren, Wolf et al. found high percentages of diagnosed (19% and 20%) and possible (10% and 16%) asthma.[18,22] Grant et al. found 30% of inner-city kindergarteners in Chicago to have asthma-related symptoms but no diagnosis.[11] Our data build on this body of information by demonstrating the disparities in shared low-income neighborhoods.

We might expect that the percentage of children with possible asthma in the later elementary-school years would be lower, as children would get medical evaluations over time that would move them to the "no asthma" or "diagnosed asthma" groups. Our data do not support this hypothesis, suggesting that either (1) there is a balance between new children developing respiratory symptoms and movement of other children out of the "possible asthma" category or (2) that "possible asthma" is a static group that is not systematically evaluated over time. Both of these explanations are plausible and may co-exist in populations with suboptimal access to care and education.

Although we asked whether the child had *ever* been diagnosed with asthma, some respondents may have answered "no" because they believed their child had "outgrown" his or her asthma. Children with diagnosed asthma may have fewer symptoms as they grow older because of the physics of larger airways, and may seek care less often. Their perception, but probably not their asthma status, may change over time. This could result in an underreport of diagnosed asthma, which, if balanced by an equal number of children with possible asthma who subsequently receive a diagnosis, would explain why we do not see a statistically significant change in percentage of diagnosed asthma by child age.

Although using a questionnaire to identify diagnosed and possible asthma in schools is feasible, efficient, and valid,[7,10,12,17,18,20,22,24,27,28] several limitations must be noted. The schools that we surveyed met specific criteria; that is, all had enrollments that were substantially low-income and racially/ethnically heterogeneous. Although our sample was quite large, the schools were not randomly selected and do not represent the full range of Chicago neighborhoods. We cannot verify that the person who completed the questionnaire was the best reporter of the child's diagnosed asthma and/or respiratory symptoms. One might predict that an uninformed respondent might underreport this information, but we are unable to test this hypothesis. The many elementary-school children who attend parochial or other private schools were not included in our study. The findings cannot be generalized as representative of the city of Chicago but rather represent the influence of ethnicity in a diverse group of children living and attending school in the same neighborhoods.

Despite these limitations, this is the first report of a large, school-based ascertainment study of racial/ethnic disparities among low-income children who live in the same neighborhoods, attend the same schools, and likely have access to similar neighborhood resources. A particular strength of the study is the extremely high survey response prevalence (90%), which insures the external validity of our estimated morbidity prevalences. (For example, sensitivity analysis suggests that, if the asthma prevalence among nonrespondents were as low as zero, or as much as twice that of respondents, our overall estimate of the diagnosed asthma prevalence would be within 1.2 percentage points of the population prevalence.)

Another strength of this study is that we provide estimates of total potential asthma burden on the basis of respiratory symptoms

consistent with undiagnosed asthma using an instrument with known sensitivity and specificity. Hypothetically, although those children with symptoms but no diagnosis may represent a group with milder symptoms, it is unknown to what degree this group contributes to later asthma morbidity and mortality. Longitudinal follow-up of children with possible asthma is necessary to clarify this issue.

Racial and ethnic disparities were not demonstrated in prevalences of "possible asthma." Our findings indicate that much needs to be done to address gaps in asthma care and intervention for low-income communities across racial and ethnic groups. The potential asthma burden is substantial, which suggests that partnering with organizations such as elementary schools to facilitate asthma care might reduce asthma morbidity and improve students' readiness to learn. Although our data should be verified in a citywide representative sample and on a national scale, the actual burden of asthma is likely much higher than that reported in national figures—an "epidemic" of enormous proportions. ■

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This article was accepted July 17, 2005.

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