Determining the Relative Burden of Childhood Asthma at the Local Level by Surveying School Nurses

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Schools are effective venues for providing pediatric asthma education programs. Resources are limited, however, so ideally, these programs should be provided to schools with the highest prevalence. National and state asthma surveillance data cannot be extrapolated to local geographic areas. The objective of this study was to survey local schools on Long Island to obtain this information. Survey forms were mailed to the school nurses at every school in Nassau and Suffolk Counties, New York, in 2004, 2006, 2008, and 2010 asking for the number of children with asthma and the number who had permission to access rescue medication in the school. School nurses completed and returned the forms. We analyzed data from elementary and high schools separately, as high-school students often carry their medications with them without obtaining permission. Of the 3,327 surveys sent, 2,060 (61.9%) were returned and 1,807 (54.3%) could be included in the analyses. Overall, asthma prevalence increased from 7.6% in 2004 to 8.7% in 2010. This mirrored the New York State and national trends, although the rates we found were generally lower. The rate of asthmatic children with permission to access rescue medication in school was about the same throughout the study period (39.7% in 2004 and only 42.3% in 2010). Both rates were lower in elementary schools in low socioeconomic areas. These methods allowed us to compare the burden of childhood asthma in individual responder schools in a relatively large geographic area.

Introduction

ASTHMA IS ONE of the most common chronic diseases occurring in childhood. It adversely impacts the quality of life of affected children and their families, and is one of the leading causes of school absenteeism.¹ According to the National Heart, Lung and Blood Institute Clinical Guidelines for the Diagnosis, Evaluation, and Management of Adults and Children with Asthma Expert Panel Report-3 (EPR-3), asthma self-management education improves patient outcomes.² Thus, education is important in optimizing asthma patients' health and well-being.

Knowledge of the local prevalence of pediatric asthma is important for public health officials and health care providers to target interventions and resources most efficiently; yet, information below the county level is currently unavailable. National rates for pediatric asthma are determined by the National Health Interview Survey (NHIS),³ and New York State and County rates are determined by the Behavioral Risk Factor Surveillance System (BRFSS).⁴ Unfortunately, sample sizes of these surveys are too small to permit stratified analyses of childhood asthma by region within the state.

The Asthma Coalition of Long Island (ACLI) is funded by a grant from the New York State Department of Health to the American Lung Association and is dedicated to decreasing emergency department visits and hospitalizations due to asthma. Schools have been shown to be effective venues for pediatric asthma management education.⁵ Discussions with members of the School Nurse Committee of the ACLI revealed that most schools on Long Island had access to a school nurse, although New York State does not require a nurse in every school building.⁶ This study presents a sequential analysis of asthma prevalence at the local level based on reports from school nurses in Nassau and Suffolk counties. Our objective was to obtain relative prevalences to prioritize resources and provide asthma education and intervention to schools with high asthma prevalence.

Materials and Methods

The Investigational Review Board of Winthrop University Hospital determined that this study did not constitute research involving human subjects covered by 45 CFR 46.102(f).

Data from this study were presented at abstract presentations at the Metropolitan Association of College and University Biologists Annual Conference, October 29, 2011 and the American Academy of Pediatrics Annual Conference, October 20–23, 2012.

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Survey methods

In February of 2004, 2006, 2008, and 2010, a self-administered questionnaire was mailed to school nurses in schools with grades from pre-K through 12 in the Nassau and Suffolk Counties, New York, to determine the local prevalence. In 2004 and 2006, the questionnaires were sent to all the public schools, and in 2008 and 2010, private schools were added to the list.

The number of schools on Long Island varies from year to year as schools split, consolidate, close, and so forth. To minimize error, the Basic Educational Data System (BEDS) Code assigned to New York State schools by the New York State Department of Education was employed as the unique identifier for each school in the survey. The enrollment, grades, and socioeconomic status (SES) of each school were also obtained from the New York State Department of Education for every survey year.

The proportion of children eligible to receive free or reduced price lunches was used as the measure of SES. Overall, median annual household incomes for the Nassau and Suffolk Counties are among the highest in the nation (\$91,104 and \$81,551, respectively, in 2010⁷). However, there are pockets of poverty within the counties with median household incomes below \$54,000.^{8,9}

Each mailed survey form was accompanied by a self-addressed, stamped envelope and a small incentive. Incentives included a US flag pin, an allergy pillow cover, or other small items. Schools that did not return the survey within 2 months were sent another copy. If information on the returned survey was incomplete or ambiguous, a telephone call was placed to the school nurse for clarification.

The one-page questionnaire asked 2 main questions: (1) "How many children have a diagnosis of asthma listed on your health concerns list or medical alert for this school year?" and (2) "How many children have written permission to either carry their own inhalers or to use their inhalers in your office?" In addition, we asked for the total enrollment, the distribution of grade levels, and the acknowledgement that the survey was completed by the school nurse.

EPR-3 guidelines for managing asthma recommend that all children with asthma should have an asthma action plan and medication available for both rescue and control.² Written documentation of parental permission to permit their child to have access to rescue inhalers was used as an indicator of the number of children whose asthma was being managed by a health care provider.

School nurses report that high-school students with asthma often carry rescue medication with them without requesting permission from the nurse (personal communication, School Nurse Committee, ACLI). Thus, we expected

that reported inhaler permission rates would be biased downward in the higher grades. Accordingly, schools with valid data were divided into 3 groups: elementary, secondary, or other schools. Schools that included pre-k through 6th grade were placed into the elementary school group; schools that included grades from the 7th through the 12th were placed into the secondary school group; and schools that contained all grades, or whose grades could not be determined were placed in the other group. If a school had both elementary and secondary school grades, the school was placed in the group that encompassed the majority of the school's grades. Analyses were conducted on 3 groups: the elementary and secondary school groups and on the all schools group, which contained all the schools combined (the elementary, secondary, plus the other schools).

Results

Survey response rates

Altogether 3,327 survey forms were mailed, and 2,060 (61.9%) were returned (Table 1). Schools with fewer than 100 children enrolled, and schools whose returned questionnaires contained errors that could not be resolved were excluded from all analyses except for response rates. In the end, 1,807 (54.3% of all the survey forms originally mailed out) could be included in prevalence analyses (Table 2). Interestingly, while the proportion of returns decreased over time (from 68.1% in 2004 to 51.6% in 2010: $\chi^2_3=67.18$, $P<0.001$: Table 1), the proportion of valid returns remained about the same over the course of the study ($\chi^2_3=0.05$, $P>0.05$: Table 1).

A check on possible sources of bias of the sample was conducted for each year using logistic regression. There were no significant differences between the responder and non-responder schools with respect to enrollment, SES, or type of school in any survey year.

Asthma prevalence

Prevalence was calculated as the proportion of children reported with asthma in the school (number of children on health concerns or medical alert list with asthma/total school enrollment that year). Reported asthma rates were about the same in the elementary and in the high schools (tests on probit transformations for 2004, 2006, 2008, and 2010; all $P>0.05$).

Prevalence increased significantly over the course of the study, from 7.2% in 2004 to 8.7% in 2010 among the elementary schools (an increase of 20.8%; probit analysis $F_{1,1177}=20.25$, $P<0.001$), and from 8.0% to 8.6% among the secondary schools (an increase of 7.5%; $F_{1,578}=3.68$,

TABLE 1. THE NUMBER OF ASTHMA PREVALENCE SURVEYS SENT TO SCHOOL NURSES IN NASSAU AND SUFFOLK COUNTIES, NEW YORK, THE NUMBER AND PROPORTION RETURNED, AND THE NUMBER AND PROPORTION OF SURVEYS INCLUDED IN ANALYSES, 2004, 2006, 2008, AND 2010

Year	2004 ^a	2006 ^a	2008 ^b	2010 ^b	Total
Number sent	752	785	902	888	3,327
Number and (%) sent that were returned	512 (68.1%)	538 (68.5%)	552 (61.2%)	458 (51.6%)	2,060 (61.9%)
Number and (%) returned used in analysis	450 (87.9%)	464 (86.3%)	501 (90.8%)	392 (85.6%)	1,807 (87.7%)

^aSurveys were only sent to public schools that year.

^bSurveys were sent to both public and nonpublic schools that year.

TABLE 2. ASTHMA PREVALENCE AND INHALER PERMISSION RATES IN SCHOOL-AGED CHILDREN IN NASSAU AND SUFFOLK COUNTIES, NEW YORK, DETERMINED FROM RESPONSES TO SCHOOL NURSE SURVEY, 2004, 2006, 2008, AND 2010

	Number of schools analyzed	Asthma prevalence			Inhaler permission rates			
		School enrollment	Number of cases	Rate	95% confidence intervals	Number of cases	Rate	95% confidence intervals
2004								
All schools	450	320,796	24,337	7.6	7.3–7.9	8,897	39.7	37.6–41.7
Elementary	287	150,215	10,886	7.2	6.9–7.6	4,654	46.2	43.7–48.7
Secondary	151	166,186	13,214	8.0	7.4–8.5	4,102	33.2	30.0–36.3
US overall, 5–17 ^a				9.6				
2006								
All schools	464	324,264	24,589	7.6	7.3–7.9	10,689	43.8	41.8–45.8
Elementary	298	145,094	10,668	7.4	7.0–7.7	5,494	50.5	48.3–52.7
Secondary	154	174,675	13,540	7.8	7.2–8.3	5,006	38.1	34.5–41.6
US overall, 5–17 ^a				10.6				
2008								
All Schools	501	330,519	27,524	8.3	8.0–8.7	11,062	44.8	42.5–47.2
Elementary	328	156,176	12,654	8.1	7.7–8.5	5,889	52.4	49.2–55.6
Secondary	155	167,195	14,238	8.5	7.9–9.1	4,844	37.3	33.6–40.9
US overall, 5–17 ^a				10.8				
2010								
All schools	392	253,442	22,017	8.7	8.3–9.1	8,601	42.3	40.6–44.8
Elementary	266	123,615	10,762	8.7	8.2–9.2	4,657	47.1	44.8–49.4
Secondary	118	126,143	10,849	8.6	8.0–9.2	3,778	38.4	34.3–42.5
US overall, 5–17 ^a				10.9 ^b				

^aSource: American Lung Association.¹⁸

^bRate reported for 2009; 2010 not yet available.

$P=0.055$). Most importantly, the increase from 7.6% to 8.7% in all schools combined was significant (an increase of 14.5%; $F_{1,1805}=28.32$, $P<0.001$, Table 2).

Inhaler permission rates

Inhaler permission rates were calculated as the proportion of children with asthma that had permission to have their asthma medication in school. Total inhaler permission rates were weighted by school enrollment.

Inhaler permission rates were consistently and significantly higher in elementary than in secondary schools. In 2004, inhaler permission rates were 39.2% higher in elementary schools than in secondary schools (46.2% versus 33.2%, respectively). In 2006, they were 32.6% higher (50.5% versus 38.1%, respectively); in 2008, the difference was 40.5% (52.4% versus 37.3%); and in 2010, elementary schools were 22.7% higher (47.1% versus 38.4%, respectively: tests on probit transformations for all survey years; $P<0.001$, Table 2)

In 2010, only about 42.3% of the children diagnosed with asthma had permission to use their medication in school (Table 2). Inhaler permission rates remained about the same in all 3 groups during the study period (probit regression analyses in elementary, secondary, and all schools combined: $P>0.05$ for each survey year).

Prevalence and SES

There was a significant correlation between prevalence and SES in every survey year in the elementary schools: the more financially disadvantaged the school population, the higher the rate of asthma (regression analyses for elementary schools each survey year; all $P<0.001$). In contrast, this relationship was not significant for the secondary schools in

any year (regression analyses for the secondary schools for each survey year; all $P>0.05$).

Inhaler permission rates and SES

There was a highly significant correlation between inhaler permission rates and SES in every survey year in elementary schools. Inhaler permission rates increased as SES increased (regression analyses for the elementary schools, all years; $P<0.01$). So, in the elementary schools, not only were low-income children more likely to be diagnosed with asthma, but they were also less likely to have permission to have a rescue inhaler in school.

In contrast, inhaler permission rates in the secondary schools were not significantly correlated with SES (regression analyses for the secondary schools, all years; $P>0.05$).

Discussion

The main objective of this study was to determine the relative rates of asthma in individual schools on Long Island to assist in targeting education or other programs to schools at highest risk. Schools have been effective venues for gaining a better understanding of the prevalence of childhood asthma, for determining the extent to which asthma is managed, and for providing services to reduce the burden of the disease for the children and their families. To obtain a more accurate measure of the prevalence of childhood asthma, Bryant-Stephens et al. screened children in schools in disadvantaged neighborhoods,¹⁰ Gerald et al. used a 3-stage asthma case-detection procedure in elementary schools,¹¹ and Wheeler and Boyle developed an asthma case identification system.¹²

The degree to which asthma cases are properly managed in schools were examined by Zuniga et al.,¹³ who

investigated the extent to which schools had a policy regarding the requirement for asthma action plans; Marshik et al.,¹⁴ who determined the extent to which children had access to their asthma medications during school hours; and Gerald et al.,¹⁵ who investigated the existence and completeness of individual asthma action plans on file and the availability of asthma medications in the school. All the investigators concluded that more effort should be devoted to managing the childrens' asthma in school.

These studies yielded more accurate information about asthma prevalence and management in individual schools than the present study, but would have been prohibitively costly to employ across the approximately 900 schools we included in our survey. Instead, we attempted to learn the relative rates of asthma and the relative extent to which rescue medications were available to the children in the schools.

The rates of return in the present study varied from 51.6% to 68.5%. Hager et al.¹⁶ review the question of what constitutes an adequate rate of return for mailed questionnaires distributed by nonprofit organizations. They report that while opinions vary, acceptable rates of return range from 50% to 75%.

Our asthma prevalence rates were consistently lower than rates measured in national and state-wide surveys. For example, in 2008, we found an overall rate of 8.3%. During 2006–2008, 14.3% of 5–9-year olds, 12.5% of 10–14-year olds, and 9.5% of 15–17-year olds in New York State currently had asthma,¹⁷ and NHIS data show that in 2008, 10.7% of children between 5 and 17 in the United States currently had asthma¹⁸ (Table 2).

The differences in these rates may be attributable to the different methods used. Our survey was conducted through the mail. New York State data were obtained through the BRFSS survey, coordinated by the Centers for Disease Control. It is a state-based telephone interview, and the current prevalence of childhood asthma is reported by an adult in the family. National asthma prevalence data were obtained through the NHIS program, a "multistage probability sample survey designed to solicit health and demographic information about the population. It is conducted annually with face-to-face interviews in a nationally representative sample of households".¹⁹ In addition, our rates came from school health forms, a secondary source, and may be less accurate due to reporting errors such as misdiagnoses, parents' failures to report that their child has asthma, or other issues.

Asthma prevalence increased steadily over the course of our study. This corresponds to national trends. Akinbami et al. found that rates increased in the United States from 2001 to 2010, and were at their highest level in 2010 (9.5% of all U.S. children between 0 and 17 had asthma in 2010).²⁰ Among school-aged children (5–17 years) in the United States, rates increased from 9.6% in 2004 to 10.8% in 2008 (an increase of 12.5%).¹⁸ In comparison, the prevalence rates for all schools combined in the present study increased from 7.6% to 8.3% in the same time period (an increase of 9.2%, Table 2).

This study sheds light on the extent to which rescue medication is available to asthmatic children in school. We found that in 2010, only about 42.3% of all the children diagnosed with asthma had permission to use asthma medication in school (Table 2). Further, permission rates were about the same during the 10-year study period. Although our results showed that inhaler permission rates were consistently higher in elementary schools than in secondary

schools (Table 2), rescue medications may be more available in secondary schools than the permission rates imply. Based on discussions with school nurses, older children are more likely to carry rescue medications without notifying the nurse. Thus, while the actual proportion of asthmatic children who have medication in school is undoubtedly higher than we observed here, altogether, the data support other investigators' conclusions that there is an important gap in asthma management that should be addressed.

We found asthma prevalence was higher and access to medication lower in elementary schools in low socioeconomic areas, findings similar to those reported in the past.^{21,22} One possible explanation for this is that asthmatic children in low income families lack medical insurance and so lack medication in school.

Somewhat surprisingly, our data showed no significant relationship between SES and either prevalence or permissions to access asthma medications in the secondary schools. It seems likely that the burden of asthma is greater in older children in low SES communities as well, but high schools draw students from larger geographic areas than elementary schools, so they are likely to include families with a wider range of incomes; in addition, we suspect that older children simply do not report these matters to the school nurse, regardless of SES.

Conclusions

The results suggest a significant burden of asthma on Long Island. Applying our 2010 prevalence rate to the 2010 census, we estimate that there are at least about 44,000 children between 5 and 17 on Long Island diagnosed with asthma. In addition, as is true for the New York State and the United States, we found that childhood asthma is increasing, and that at least among the younger children, asthma is higher in low SES communities.

The data we obtained about permission to access asthma medications in school are also important. They suggest that too few children have immediate access to rescue inhalers in school, especially if their families have low incomes, a finding similar to Gerald et al.¹⁵

Thus, the methods employed in this study provide a practical, relatively inexpensive way to determine the relative rates of childhood asthma at the local level in hundreds of schools. Identifying schools and the communities they serve that are at greatest risk is useful to public health departments and health care providers in many ways. Specifically, school-based asthma management programs can assist in achieving good asthma control (reviewed by Wheeler et al.⁵)

This work supports earlier workers' observations (e.g., Taylor-Fishwick et al.²³) of the power of community coalitions to bring interested parties together and create partnerships that work to improve the health of the community. The ACLI has already employed these grass root data to prioritize interventions and has partnered with community groups to provide it. For example, we sent each participating school nurse a letter containing the prevalence calculated for their school that year compared with all the schools in that group on Long Island to use to encourage administrators to allocate time for asthma education programs. In addition, we used the data to offer schools the opportunity to participate in the American Lung Association's "Open Airways for

Schools@” program.²⁴ We plan to continue to work with targeted schools and to offer additional programs designed to reduce the burden of this disease.

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