

Burden of Asthma in Inner-city Elementary Schoolchildren

Do School-Based Health Centers Make a Difference?

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Background: About 1400 school-based health centers (SBHCs) provide care to 1.1 million children. However, it is unknown if access to on-site services is associated with a better outcome.

Objective: To compare outcomes including hospitalizations, emergency department visits, and school absenteeism in elementary schoolchildren with asthma who were grouped according to their enrollment at schools that have or do not have SBHCs.

Setting: Six elementary schools in The Bronx, NY (4 schools with and 2 without SBHCs).

Participants: Nine hundred forty-nine inner-city schoolchildren with asthma.

Design: To collect baseline data for a longitudinal study, we surveyed parents to identify children with asthma, and to obtain information about symptoms and the use of health services in the last 12 months. Participating schools provided absenteeism information.

Results: Of 6433 parents surveyed, 74% completed the questionnaires. The prevalence of asthma was 19.9% and the morbidity was high—during the previous year, 46.2% had been treated for asthma in an emergency department; 12.6% had been hospitalized. Emergency department use was not associated with SBHCs. However, in univariate and multivariate analyses, the rate of hospitalization was higher among children enrolled at schools without an SBHC (rate ratio, 1.5; 95% confidence interval, 1.1-1.9). In addition, schoolchildren with asthma enrolled in the schools without an SBHC missed more days of school than those enrolled in schools with an SBHC (mean [SD], 21.3 [15.4] vs 18.2 [13.0], respectively; $P = .02$).

Conclusion: Access to SBHCs was associated with a reduction in the rate of hospitalization and a gain of 3 days of school for schoolchildren who have asthma.

Arch Pediatr Adolesc Med. 2003;157:125-129

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IN THE PAST DECADE, the number of school-based health centers (SBHCs) nationwide has increased from 150 to about 1400, offering health care to approximately 1.1 million children.¹ The SBHCs are designed to provide primary, preventive, and acute care for school-aged children, and are equipped to treat chronic conditions and educate both parents and children about health concerns.² Despite the intuitive appeal of putting children's health services where the children are, questions remain about the fundamental mission of SBHCs. If the sole mission of SBHCs is to improve access to health care, there is no doubt that SBHCs succeed.³ However, in this era of evidence-based medicine, for SBHCs to survive financially, they must demonstrate that improved access is accompanied by improved outcomes. Previous studies of SBHCs have primarily focused either on ac-

cess or on cost-effectiveness, demonstrating better coverage for vaccination programs,^{4,5} an increase in the number of students using reproductive and mental health services,^{6,7} and the cost-effectiveness of school-based tobacco control programs.⁸ Fewer evaluative studies have been published and, to our knowledge, none using a quasi-experimental design to assess the effect of SBHCs on the health and well-being of elementary school children.

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During the 1999-2000 school year, we undertook a 3-year project to evaluate whether the availability of SBHCs measurably affected the health and school performance of children with asthma attending 6 Bronx, NY, elementary schools. We selected asthma as our indicator condition because

it is the most common chronic illness affecting US children,⁹ and is costly: children with asthma struggle with adherence to strict medication regimens¹⁰ and frequent hospital and emergency department (ED) visits. Asthma is also the leading medical cause of school absenteeism,¹¹ which may have educational and social consequences,⁹ especially in inner-city children.

This study reports asthma symptoms and illness-related burden and examines differences in ED visits; hospitalizations; medication use by sex, race, or ethnicity; health insurance coverage; and availability of SBHCs. School absenteeism according to availability of SBHCs is also reported.

METHODS

Data were obtained from surveys completed by the parents or guardians of kindergartners through fifth graders attending 6 elementary schools in The Bronx. Four of the schools have SBHCs in which, on average, 86% of children are enrolled. These SBHCs provide comprehensive services by a pediatrician or a nurse practitioner during the school day with backup services after hours provided by 2 community health centers affiliated with Montefiore Medical Center in The Bronx. Two of the schools ("comparison schools") do not provide comprehensive services, but provide some acute care via the services of a traditional school nurse. The comparison schools were selected based on the cooperation of the school principals and the demographic and socioeconomic similarities to students attending schools with SBHCs. For example, 86% and 90% of students at the 2 comparison schools were eligible for the free lunch program compared with 82%, 84%, 97%, and 99% at the 4 schools with SBHCs.¹²

During the 1999-2000 school year, bilingual Spanish and English surveys were sent home with the children. At least 3 attempts were made to obtain responses from parents by distributing the surveys to children during different weeks. Small prizes (pencils or stickers) were given on return of completed surveys. Survey information included the following: demographic information (with race or ethnicity noted as optional), asking if the child has asthma, and asking about the presence of specific asthmatic symptoms in the last year. In addition, we collected information on ED visits, hospitalizations, and medication use during the last year. Additional details of the survey are described elsewhere.¹³

DEFINITION

The present analysis is based on information from children we identified as having "probable asthma" from the parent survey. Criteria for probable asthma were checking off "yes" to the question inquiring if the child has ever had asthma and reporting that 1 or more of the following was true during the past 12 months: (1) that he or she had taken asthma medication; (2) that he or she had experienced sleep disturbance due to wheezing, coughing, or tightness in the chest; (3) that he or she coughed after or during exercise when he or she did not have a cold; (4) that he or she had weather-related breathing problems; or, (5) that he or she wheezed in the presence of pets, mold, strong odors, or cigarette smoke.

INDEPENDENT VARIABLES

Parents classified the race or ethnicity of the schoolchildren as Puerto Rican, other Latino, African American, White, Asian, Arabic, mixed, or "other" ethnic group. Respondents could check off as many categories as they chose, and children with 2 or

more selections were considered mixed. Analyses combined children of White, Asian, Arabic, other, and mixed race or ethnicity into a single group labeled "other" because of the small number of study participants. Analyses by race or ethnicity excluded 69 children whose parents did not specify one. We used the proportion of children eligible for the free lunch program in each school (range, 82%-99%) as our proxy measure of socioeconomic status (SES). Individual data on SES or free lunch eligibility were unavailable.

All schools, with the exception of 1 comparison school, provided absenteeism data. Analyses of absenteeism records excluded children who had attended this comparison school, as well as children who attended any of the participating schools for fewer than 90 days of the 180-day school year. As per school policy, no information on school attendance was available for children who were discharged or transferred, or left school for any reason before the end of the school year. In addition, once children were graduated, their attendance records were removed from the system.

The study was approved by the institutional review board of Montefiore Medical Center for schools with an on-site Montefiore-affiliated SBHC and by the Office for Protection from Research Risks, now known as the Office for Human Research Protections for schools with no on-site services.

DATA ANALYSIS

Univariate analyses were performed using rate ratios (RRs) with 95% confidence intervals (CIs) to assess the association between ED use, hospitalization, and other categorical variables. We used the *t* test to assess differences in the mean number of school days missed by children attending schools with SBHCs, compared with a comparison school. $P < .05$ was considered statistically significant. Multivariate analyses were conducted using Poisson regression (SAS statistical software, Version 8.1; SAS Institute Inc, Cary, NC) to examine the effect of SBHCs on hospitalization. We created 2 dummy variables, one for SES by grouping schools by the proportion of children eligible for the free lunch program, either 80% to 90% (high SES) or $>90\%$ (low SES). The other represented the presence or absence of an SBHC. We started with a full model including sex, age (in years), and race or ethnicity as potential confounders. Variables with $P > .10$ or those having less than a 10% effect on parameter estimates of variables already in the model were removed from the model. Interaction between the covariates was tested using the same criteria.

RESULTS

Of the 6433 families surveyed, 74.2% (4775/6433) returned completed questionnaires. The response rate for schools with and without SBHCs was 72.6% (3419/4709) and 78.7% (1356/1724), respectively. We identified 949 children (19.9%) as having probable asthma as previously defined. The prevalence of asthma was 18.9% at schools with an SBHC and 22.4% at schools without an SBHC. Characteristics of children with asthma by school type are given in **Table 1**.

ASTHMA SYMPTOMS AND MEDICATION USE

Table 2 lists the percentages of children whose parents answered the questions and reported the symptoms targeted by the survey. Only 34 children (3.6%) had no symptoms within the past year. When we asked parents about the frequency of symptoms, specifically how of-

Table 1. Characteristics of 949 Asthmatic Children at Schools With and Without School-Based Health Centers (SBHCs)*

Variable	4 Schools With an SBHC (n = 645)	2 Schools Without an SBHC (n = 304)
Sex		
Male	343 (53.2)	166 (54.6)
Female	302 (46.8)	137 (45.1)
Not specified	...	1 (<1)
Age group, y†		
<5	16 (2.5)	6 (2.0)
5-9	515 (79.8)	240 (78.9)
≥10	112 (17.4)	52 (17.1)
Not specified	2 (0.1)	6 (0.1)
Race or ethnicity		
Puerto Rican	266 (41.2)	132 (43.4)
Other Latino	117 (18.1)	48 (15.8)
African American	109 (16.9)	60 (19.7)
Other‡	101 (15.7)	47 (15.5)
Not specified	52 (8.1)	17 (5.6)
ED visits in the last year		
≥1	303 (47.0)	135 (44.4)
Hospitalizations in the last year		
≥1	68 (10.5)	52 (17.1)
Health insurance coverage		
Yes	565 (87.6)	265 (87.2)
No	60 (9.3)	26 (8.6)
Not specified	20 (3.1)	13 (4.3)

Abbreviation: ED, emergency department.

*Data are given as the number (percentage) of schoolchildren. Ellipses indicate not applicable.

†Other includes children of white, Asian, Arabic, mixed, and other specified races or ethnicities.

ten their child wheezed, coughed excessively, or felt tightness in his or her chest in the past year, 15.8% (134/847) reported that their child wheezed at least once per week, and only 10.7% (91/847) reported no wheezing at all. Most of the frequent wheezers (64.1% [84/131]) were taking daily medications, compared with 27.7% (191/689) of the less frequent and nonwheezing groups (RR, 3.5; 95% CI, 2.6-4.9). There were no statistically significant differences in symptom frequency by sex, race or ethnicity, or health insurance coverage. Children attending comparison schools were less likely to report wheezing symptoms (ie, to answer that they experience no symptoms at all) than children attending schools with an SBHC (14.0% [38/271] vs 9.2% [53/576], respectively; RR, 1.5; 95% CI, 1.0-2.3). No statistically significant associations were noted between daily medication use and sex, health insurance coverage, or availability of a SBHC, but African American children were more likely than others to take daily asthma medications (43.4% [72/166] vs 30.7% [209/680], respectively; RR, 1.4; 95% CI, 1.1-1.7).

ACTIVITY LIMITATION

Parents were asked how much asthma limits their child's activities and were given response options of "not at all," "a little," "moderately," and "a lot." Eight hundred six-five (91.1%) of the 949 respondents answered this question. Two hundred thirty-four (27.1%) of the 865 re-

Table 2. Percentage of Children Reporting Asthmatic Symptoms by Attendance at Schools With and Without School-Based Health Centers (SBHCs)

Variable	4 Schools With an SBHC (n = 645)	2 Schools Without an SBHC (n = 304)
In the last 12 months, has your child's sleep been disturbed due to wheezing, coughing, or tightness in the chest?	80.2	76.8
In the last 12 months, has your child coughed during or after exercise when she or he did not have a cold?	67.5	66.2
In the last 12 months, did a change in the weather cause your child to have difficulty breathing?	73.1	81.1
In the last 12 months, did your child wheeze, cough, or feel tight in the chest after being near cigarette smoke, pets, mold, or strong odors?	63.5	66.4

spondents reported at least a moderate amount of limitation, while 293 (33.9%) of the same respondents reported that their child did not experience any limitation in activity. No statistically significant differences were noted in activity limitation by sex, race or ethnicity, health insurance coverage, or availability of an SBHC.

HOSPITALIZATION

One hundred twenty (12.6%) of the 949 children had been hospitalized for asthma at least once in the past year. In bivariate analyses, children attending the comparison schools were more likely than those in schools with SBHCs to have been hospitalized for asthma (17.1% [52/304] vs 10.5% [68/645], respectively; RR, 1.6; 95% CI, 1.2-2.3). No statistically significant associations were noted between hospitalization and sex, race or ethnicity, and health insurance coverage.

EMERGENCY DEPARTMENT

Four hundred thirty-eight (46.2%) of the 949 parents responded that their child had been treated in the ED at least once for asthma in the past year. No statistically significant differences were noted in ED use by sex, race or ethnicity, health insurance coverage, or availability of an SBHC.

ABSENTEEISM

Absenteeism data were available for 602 (63.4%) of the 949 asthmatic children and 2305 (60.2%) of the 3826 non-asthmatic children. Of the 602 asthmatic children with available absenteeism data, 25.1% (151/602) attended a comparison school and 74.9% (451/602) attended schools with an SBHC. Overall, students in the comparison school missed more days of school than those with an SBHC (mean [SD] 16.4 [12.9] days vs 14.5 [11.2] days, respectively; $P < .001$). This difference appears partly because

of the asthmatic children. Among asthmatic children, those attending the comparison school missed, on average, 3 more school days than those attending schools with an SBHC (ie, mean [SD] days absent, 21.3 [15.4] vs 18.2 [13.0], respectively; $P = .02$).

MULTIVARIATE ANALYSES

The final Poisson regression model identified attendance at schools without an SBHC as the only statistically significant factor associated with hospitalization for asthma in the last year (RR, 1.5; 95% CI, 1.1-1.9). Sex, race or ethnicity, age (in years), and our SES indicator (proportion of children receiving a free lunch) failed to remain in the final model.

COMMENT

This study reports a strikingly lower asthma-related hospitalization rate in children who attend schools with SBHCs compared with those attending comparison schools. In addition to reduced hospitalization rates, we also document a gain of 3 days of school for asthmatic children attending schools with an SBHC compared with asthmatic children attending a comparison school. These findings, from different data sources, reinforce and support each other: it is logical that fewer hospitalizations among asthmatic children would result in fewer missed days of school. Since hospitalizations account for a high proportion of the direct costs of asthma,^{14,15} and school absenteeism a high proportion of the indirect costs, our data suggest that SBHCs may reduce asthma-associated costs while increasing access to health care. Further, while schools have an obvious interest in reducing barriers to learning, high absenteeism presents them with a double burden: it is harder for students to keep up with the pace of learning if they miss a lot of school, and New York City and other urban districts provide incentives to schools based, in part, on good student attendance (D.K.A., oral communication, February 26, 2002).

While we documented 2 outcomes in which SBHCs make important contributions to the health and well-being of inner-city schoolchildren, significant challenges remain. For example, we did not find an influence of SBHCs on ED use. Our findings are consistent with a study from an SBHC serving elementary schoolchildren in Minneapolis, Minn, which also documented reduced hospitalization but unchanged rates of ED use after a brief asthma intervention.¹⁶ The lack of effect on ED use in both of these studies underscores the importance of improving asthma management skills in parents of young children. Working with families of children with asthma to improve knowledge, compliance with preventive medications, and early detection and response to symptoms promises benefit in both health and cost outcomes.

Recognition of our findings that access to school-based services contributes toward improved outcomes in asthmatic children is dependent on evidence that children attending comparison schools are otherwise comparable. We acknowledge that different schools and children are never strictly comparable, and note that SBHCs

and comparison schools differed somewhat in survey response rates and in the prevalence of asthma. However, we offer the following as support. First, Bronx parents do not select an elementary school for their child to attend. Rather, children are assigned to schools based on their home address. Second, the racial or ethnic composition of schools with an SBHC and comparison schools is similar, and, using eligibility for the free lunch program as a marker of SES, our 2 comparison schools ranked exactly midrange (ranks 3 and 4) of the 6 schools studied. Third, the higher frequency of symptoms we reported among children attending schools with SBHCs would argue against the theory that children attending schools with SBHCs have less severe disease. Fourth, in contrast with others,¹⁷ we found that health insurance coverage was similar and high among asthmatic children in all schools. Fifth, one motivation we had for constructing a regression model of factors related to hospitalization was to assess whether the observed bivariate association between schools with SBHCs and reduced hospitalization could be explained by SES or other potential confounders. We found that the variable for SES was not statistically significant, while the protective relation between schools with SBHCs and hospitalization for asthma was undiminished. Thus, we suggest that our findings are not explainable by better family or financial resources in schools with SBHCs, but were likely due, at least in part, to improved access to asthma care.

On an additional methodological note, we compared outcomes in *all* asthmatic children in schools with and without SBHCs to assess the effect of school-based services.¹⁸ We chose this comparison as opposed to comparing outcomes in SBHC users to outcomes in children attending comparison schools because we expect that students with moderate to severe asthma might be more likely to use SBHCs than children with milder disease. Therefore, children using the SBHCs might overrepresent children with more serious asthma relative to the population of all children with asthma. To avoid this potential bias, we compared outcomes in all asthmatic children with and without SBHCs to estimate the effect of on-site health services. Utilization analyses attest to frequent SBHC use for asthma. During the period under study, 13.5% (2816/20902) of all visits at the 4 schools with SBHCs were for asthma care, with a mean annual frequency of 4.9 visits per child. In addition, half of the asthmatic children (320/645) identified by the parent survey in this study used the SBHCs for asthma care during this 1-year period.

As a final note, the analyses presented were carried out on baseline data collected before our intervention to better engage students and their families. The asthma services provided were predominantly focused on treatment of acute exacerbations with rescue medications and short-course steroid treatment. Daily nebulizer treatments were given if prescribed by a community medical provider. It remains to be demonstrated whether the outreach and intervention strategy we are using can further affect the health and well-being of these families. In either case, our findings support the efficacy of SBHCs for inner-city schoolchildren with asthma and have implications for access to and funding of school-based primary care.¹⁸

What This Study Adds

School-based health centers offer a practical response to the limited access to health care experienced by poor and uninsured children. During the 1999-2000 school year, we undertook a 3-year project to evaluate whether the availability of SBHC services measurably affected the health and school performance of asthmatic children attending 6 Bronx elementary schools. We selected asthma as our indicator condition because it is the most common chronic illness affecting US children and is costly. Our results demonstrate a reduction in asthma-related hospitalizations and improved school attendance equal to 3 days in asthmatic children attending a school with an SBHC compared with a comparison school without an SBHC. These findings support the efficacy of SBHCs for inner-city children with asthma and have implications for access to school-based primary care.

Accepted for publication August 8, 2002.

This study was supported by grant R18 HS10136 from the Agency for Health Care Research and Quality, Rockville, Md (Dr Webber).

We thank Peter Gergen, MD, for helpful comments on an earlier draft of the manuscript.

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