

Original article

## Impact of school-based health centers on children with asthma

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### Abstract

**Purpose:** To quantitatively assess the impact of school-based health centers (SBHCs) on hospitalization and emergency department (ED) visits for children with asthma.

**Methods:** The study was conducted at four SBHC intervention school districts and two comparable non-SBHC school districts in Greater Cincinnati, Ohio. A longitudinal quasi-experimental time-series repeated measures design was used with a study period from 1997 to 2003. Children with asthma with at least 2 years of continuous enrollment who had medical claims for asthma diagnosis and antiasthmatic medications were selected. The primary data sources were student enrollment data from the schools and the Ohio Medicaid claims database. Generalized estimating equation (GEE) analysis and analysis of covariance were used to assess the intervention effect before and after the SBHC program.

**Results:** Asthma was one of the major diseases for SBHC encounters. Major prescription drugs that SBHC staff managed for children with asthma included albuterol, montelukast, fluticasone, budesonide, and triamcinolone. Of 273 children (196 in SBHC schools and 77 in non-SBHC schools), 42% were female, 41.7% African-Americans, and the average age was 8.2 years. After the opening of the SBHC, relative risks of hospitalization and ED visits in the SBHC group decreased 2.4-fold and 33.5%, respectively. The cost of hospitalization per child decreased significantly over time for children in SBHC schools ( $F = 4.115$ ,  $p = .044$ ). After SBHCs opened, cost of hospitalization decreased for African-American children ( $F = 5.198$ ,  $p = .023$ ). Costs of ED visits for children in SBHC schools were significantly lower than children in non-SBHC schools ( $F = 19.8$ ,  $p < .0001$ ).

**Conclusions:** The risk of hospitalization and ED visits for children with asthma decreased significantly with SBHC programs. The potential cost-savings for hospitalization was estimated as \$970 per child. © 2005 Society for Adolescent Medicine. All rights reserved.

### Keywords:

School-based health center; Asthma; Hospitalization; Emergency department visit; Medicaid; Cost

School-Based Health Centers (SBHCs) provide essential primary health care for school-age children. SBHCs are designed to overcome many health care access barriers, including transportation, lack of providers, lack of insurance coverage, and inconvenient appointment times for working parents. By the 2001–2002 school year, more than 1500

SBHCs nationwide had been established with support from the federal government, many foundations, Medicaid, and health insurance [1].

Asthma is the most common chronic illness for school-age children with access to the SBHC [2,3]. Asthma affects 7% of children in the United States, or 6.3 million children under age 18 [4,5]. Lifetime prevalence rates for childhood asthma range from 7% to 13% with the peak at ages 5–17 years in the United States [6]. The prevalence rate of asthma in Ohio was estimated as 7.6%, which was slightly higher

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than the national average (7.2%) in 2000 [7]. The annual direct health care costs for asthma treatment in the United States were estimated as \$8.1 billion in 1991, with 43% of hospitalization cost and 8% of emergency department (ED) visits [8]. Forty-six percent and 13% of children with asthma had ED visits and hospitalizations, respectively [9]. Some hospitalizations for patients with asthma are preventable [10].

Numerous studies document that SBHCs effectively overcome health care access barriers and reduce ED visits in adolescent populations [11–14]. In a New York survey study, 46% of children with asthma had ED visits and 13% were hospitalized. The rate of hospitalization for children with asthma was 50% higher among children in schools without an SBHC than among those in schools with an SBHC [9]. Students in an SBHC school had less difficulty obtaining physical health care and less ED visits than students in a comparable non-SBHC school [11,12]. For all children, nonurgent ED visits decreased after the SBHC program, and Medicaid-insured children were more likely to use the ED than privately insured or uninsured children [13]. Whereas the ED costs for all students in SBHC schools decreased compared with students in non-SBHC schools, the hospitalization and prescription costs for children with asthma in SBHC schools also decreased significantly [14].

The objectives of this study were to assess the impact of school-based health centers on risk of hospitalization and ED visits and to estimate the impact on costs for hospitalization and ED visits for children with asthma.

## Methods

Three primary data sources were used for this study: (a) Annual school enrollment databases provided by SBHC and non-SBHC schools from 2000 to 2003. Student names and demographics were documented in each school. (b) The Ohio Medicaid medical claims databases. Because a large number of students (range 37% to 88%, mean 63.5%) enrolled in those schools were receiving a free or discounted school lunch program owing to low family incomes, many of those students were enrolled in Medicaid and/or Children's Health Insurance programs (CHIP). The automated Medicaid claims database included their pharmacy, medical, hospital inpatient, and outpatient institutional claims. (c) Summary data from the SBHC's encounter databases.

### *Design and cohort patient selection*

A longitudinal quasi-experimental time-series repeated measure design was used. All students in SBHC schools had parental written consents for evaluation owing to possible health intervention at schools. Students in comparison schools were not required to have written consent because of non-SBHC intervention. The research was approved by the University of Cincinnati Medical Center Institutional Review Board (IRB).

The target population was school-age children with

asthma who were enrolled in schools in the Cincinnati area and also enrolled in the Ohio Medicaid or state CHIP programs. By 2004, over 15 SBHCs in the Cincinnati area had been funded by The Health Foundation of Greater Cincinnati. The schools with SBHCs were selected because at least 30% of students in those schools received free or reduced lunches owing to their low family incomes. Each SBHC covered one or more schools in its school district and provided services for students in kindergarten through eighth grade. All students were eligible for the SBHC program. SBHCs operated only during the school academic quarters, not in the summer quarter. Each SBHC was open from Monday through Friday. Any medical requests during the weekend were directed to either a neighborhood health center or other primary care physicians. The SBHC staff members included at least one nurse practitioner and one part-time medical doctor.

Of the SBHCs funded by the Health Foundation, we focused on the first *four SBHC intervention* school districts (7 schools) because they were established in September 2000 and had operated through June 2003. *Two comparison (non-SBHC)* school districts (6 schools) were selected to reflect students with similar characteristics to those in SBHC schools based on Ohio census data from local education departments, including information on rural/urban setting, percentage of student body that was nonwhite, and percentage of students eligible for free or reduced lunch. Owing to delays for medical claims processing and severe Health Insurance Portability and Accountability Act (HIPAA) regulation changes, we were unable to utilize or collect the Medicaid claims data from March 2003 to August 2003. Consequently, the study period was from September 1, 1997 to February 28, 2003.

From 9240 students enrolled in SBHC intervention and non-SBHC comparison schools/districts, 5069 children were matched in the Ohio Medicaid database based on children's name, gender, race, date of birth, and county code (Figure 1). A total of 556 (11% of identified children) with asthma were identified because they had at least one medical claim with asthma diagnosis indicated by the International Classification of Disease, Ninth Revision Clinical Modification (ICD-9-CM) codes 493 and at least one pharmacy claim of antiasthmatic medication during the study period. These antiasthmatic medications include the following therapeutic classes:  $\beta_2$  agonists (inhaled or oral tablets), glucocorticoids or corticosteroids (systemic, inhaled), sustained release theophylline, anticholinergics, other anti-inflammatory agents, and leukotriene receptor antagonists [5]. In order to measure the consistent overall impact of the SBHC programs, we excluded 282 children who had only 1-year enrollment in their schools or changed their schools between intervention and comparison group, and one child (in non-SBHC) who had severe asthma and multiple comorbidities and extreme high health care utilization. The final cohort consisted of 273 children who had at least 2 years' continuous enrollment in both their schools and the Ohio

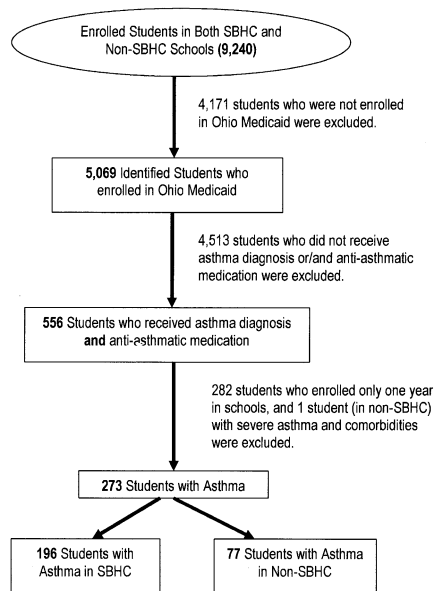


Fig. 1. Flow-chart of selecting cohort students with asthma 1997–2003.

Medicaid program, including 196 children in SBHC schools and 77 children in non-SBHC schools.

#### Definitions and outcome measures

Four outcome measures (dependent variables) were used for this study. (a) *Rate of hospitalization per child* was defined as the total number of hospital admissions divided by the total number of enrolled months for a child. (b) *Rate of emergency department (ED) visits per child* was defined as the total number of ED visits divided by the total number of enrolled months for a child. (c) *Cost of hospitalization per child* was defined as the total dollar amount that Medicaid paid for hospital accommodation, medical therapy service, physician encounter, and radiological diagnosis during the children's hospitalization period. (d) *Cost of ED visits per child* was defined as the total dollar amounts that Medicaid paid for ED service, medical treatment, physician encounter, and radiology during the ED visit period. All four dependent variables were measured before and after the SBHC September 2000 intervention.

For each Medicaid claim reimbursement from 1997 to 2003, costs of hospitalization and ED visits were adjusted using the medical component of the Consumer Price Index (MCPI) as the dollar value in 2002 based on data from the Bureau of Labor Statistics. The inflation-adjusted discount rate was calculated using a 3% discount rate and each annual MCPI rate for this study [15]. The annual MCPI rates of change were found to be 4.6% in 2002, 4.7% in 2001, 4.2% in 2000, 3.7% in 1999, 3.4% in 1998, and 2.8% in 1997 [16,17].

The description of covariates is as follows: Age was defined as age on September 30, 2000. Gender was defined as a dichotomous variable (male = 1 and female = 0). Race was defined as a dichotomous variable (African-American

= 1, white and other races = 0) because of predominant Hispanic White in other race categories. The number of enrollment months was defined for each child enrolled in the Medicaid program during the study period. The enrollment category included (a) disabled/blind enrollment program, (b) Aid to Families with Dependent Children (AFDC) for low-income children from birth through age 18 and pregnant women, (c) Children's Health Insurance Plan (CHIP), which covered low-income children up to 150% poverty and who are often also included in the AFDC program, and (d) Managed Care Organizations (MCOs), which included children enrolled in private MCOs and supported by the Ohio Medicaid program. Because recipients could have been in multiple programs during the study period, the recipient's aid category was defined by the percentage of enrollment months for which the recipient was enrolled in each program.

In order to compare baseline characteristics, children's comorbid medical illnesses before September 2000 were compared for the SBHC intervention group and the non-SBHC comparison group [6,18–21]. These comorbidities included:

- obesity (ICD9 code 278, 278.0x),
- allergies (ICD9 codes 477.xx),
- sinusitis (ICD9 codes 461.xx, 473.xx),
- gastroesophageal reflux disease (ICD9 code 530.81),
- depression (ICD9 codes 296.2x, 296.3x, 311.xx), and
- attention deficit hyperactive disorder (ADHD) (ICD9 code 314.xx)

Because depression and ADHD among school-age children had been major chronic illnesses in recent literature, we included these diseases in the list in order to compare the baseline differences between SBHC and non-SBHC groups.

#### Data analysis

The demographic characteristics and comorbidity frequencies were compared between the SBHC intervention group and the comparison non-SBHC group using Chi-square tests and Student's *t*-tests. If one or more cells had an expected count less than 5, Yate's continuity adjusted Chi-square tests were conducted. In order to measure the probability of hospitalization and ED visits, a *generalized estimating equations (GEE) analysis of repeated measures Poisson regression* was used to assess the time-related intervention effect before and after the SBHC program. A *repeated measures analysis of covariance (ANCOVA)* was performed to evaluate the differences in the hospitalization and ED costs before and after the SBHC program. After controlling the covariates, the primary factor of interest in the repeated measures ANCOVA was the interaction term, SBHC \* TIME, because this term is a measure of the difference in change over time between two groups. Covariates included age, gender, race, SBHC group, time (before and after), and Medicaid enrollment categories, e.g., Children's Health Insurance Program (CHIP), disabled, and

Table 1  
Baseline characteristics for children with asthma in SBHC and non-SBHC schools (n = 273)

Variable	SBHC (n = 196)	Non-SBHC (n = 77)	p Value <sup>a</sup>
Mean age (SD) <sup>b</sup> , yrs	8.3 (2.3)	8.2 (2.3)	.7851
Female, %	38.3	52.0	.0543
Race			
White, %	59.2	48.1	.0954
African-American, %	40.3	45.4	.4376
Other, %	0.5	6.5	.0024
Mean months enrolled (SD) <sup>b</sup>	58.9 (12.2)	60.1 (11.3)	.5078
Months enrolled before SBHC (SD) <sup>b</sup>	26.4 (11.1)	26.7 (10.7)	.6160
Months enrolled after SBHC (SD) <sup>b</sup>	28.4 (4.2)	28.9 (3.4)	.1940
Enrollment categories <sup>c</sup> , %			
Disabled	6.2	8.8	.3883
Families/dependent children (AFDC)	92.2	89.3	.3729
Child health insurance plan (CHIP)	37.0	30.3	.1416
Managed care organization (MCO)	20.1	9.8	.0005
Asthma Comorbidity <sup>d</sup> , %			
Obesity	1.1	2.6	.3291
Depression	4.6	5.2	.8333
Allergies	24.5	13.0	.0365
Sinusitis	15.3	10.4	.2909
Gastro-esophageal reflux disease (GERD)	1.1	1.3	.8427
Attention deficit hyperactive disorder (ADHD)	12.8	18.2	.2489

<sup>a</sup> Children in SBHC schools compared to children in non-SBHC using Student's *t*-test for age and months enrolled, and chi-square test for other variables.

<sup>b</sup> SD = standard deviation.

<sup>c</sup> The percentage of enrollment months that a child enrolled in each category. Children could have been in multiple programs during the study period.

<sup>d</sup> Diagnosis of comorbidity was based on primary diagnoses for each child before the SBHC intervention (before September 2000).

MCO. CHIP enrollment is specifically for children, and most of the children enrolled in CHIP were also partially enrolled in the AFDC programs. Therefore, AFDC was not included in the regression models in order to minimize multicollinearity. The statistical power is greater than .80 with alpha level .05 and a medium effect size of .15 [22]. All statistical analyses were conducted using both SPSS for Windows 10.0 (SPSS Inc., Chicago, IL) and SAS for Windows, version 8.1 (SAS Institute Inc., Cary, NC).

## Results

There was a total of 7572 encounters in four SBHCs. On average, 37% (range 20% to 81%) of the children who received treatment in these four SBHCs were Medicaid recipients during the study period. Asthma was one of the major diseases for SBHC encounters, along with mental health disorders, otitis media, urinary tract infection, and respiratory disorder. The percentage of SBHC encounters for children with asthma ranged from 2% to 11% in different schools and academic years. Primary prescriptions that SBHC staff members managed for asthmatic children included albuterol, montelukast, fluticasone, budesonide, and triamcinolone.

Of 273 children with asthma in this cohort, 42.1% were female, 41.7% were African-American, and the average age

was 8.2 years (SD 2.3). The baseline characteristics for SBHC and non-SBHC groups were quite similar in terms of demographics, enrollment, and asthma comorbidity (Table 1). Compared with the SBHC intervention group, the non-SBHC group had a significantly higher percentage of females and other race children, but significantly less MCO enrollment and less allergy comorbidity.

### Risk of hospitalization and ED visits

Based on results from the GEE analysis of repeated measure Poisson regression, the relative risks of hospitalization decreased 2.4-fold (i.e.,  $3.403 - 1.0 = 2.4$ ), and relative risks of ED visits decreased 33.5% (i.e.,  $1.335 - 1.00 = .335$ ) after the SBHCs opened for intervention students (Table 2). The risk of ED visits for children in SBHC schools after the SBHC program was 43% (i.e.,  $1.43 - 1.00 = .43$ ) lower than children in non-SBHC schools. In addition, the risk of ED visits for children enrolled in the MCO plan and CHIP were 5.7% (i.e.,  $1.00 - .943 = .057$ ) and 24% (i.e.,  $1.00 - .76 = .24$ ), respectively, lower than children enrolled in other Medicaid programs.

We conducted additional categorical data analyses to investigate the primary diagnoses for hospitalization and ED visits before and after the SBHCs opened. Table 3 indicates that the number of hospitalizations decreased from 36 to 12 in the SBHC group (Table 3). Hospitalizations for

Table 2  
Relative risks of hospitalization and emergency department visits for children with asthma in SBHC and non-SBHC schools (n = 273)

Variable	Relative risk (95% CI) <sup>a</sup>	
	Hospitalization	ED Visits
Non-SBHC vs. SBHC	1.960 (0.631–5.884)	1.430 <sup>b</sup> (1.0924–1.865)
Non-SBHC * TIME (before) <sup>c</sup>	1.146 (0.368–3.631)	1.221 (0.909–1.637)
SBHC * TIME (before) <sup>c</sup>	3.403 <sup>b</sup> (1.536–8.473)	1.335 <sup>b</sup> (1.059–1.684)
Sex (male = 1)	1.782 (0.924–3.646)	1.084 (0.901–1.308)
Age (yrs)	1.040 (0.906–1.194)	0.970 (0.931–1.010)
Race (African-American = 1)	1.551 (0.774–3.140)	0.916 (0.738–1.133)
Disabled <sup>c</sup>	2.165 (0.768–5.575)	0.693 (0.459–1.016)
Managed care organization <sup>c</sup>	0.962 (0.913–1.007)	0.943 <sup>b</sup> (0.927–0.959)
Children health insurance plan <sup>c</sup>	0.915 (0.355–2.239)	0.764 <sup>b</sup> (0.591–0.982)
Model fit	Scaled deviance = 0.626, Log likelihood = –116.23	Scaled deviance = 0.985, Log likelihood = –75.09

<sup>a</sup> 95% confidence interval.

<sup>b</sup> *p* value < .05.

<sup>c</sup> TIME refers to before and after the SBHC intervention. Enrollment categories of Disabled, MCO, and CHIP are time-dependent covariates.

asthma, mental health disorders, sinusitis, bronchitis, and pneumonia decreased significantly for children with asthma in intervention schools after the SBHC opened, whereas those hospitalizations remained at the same level for children with asthma in the comparison schools. The total number of ED visits for all diagnoses decreased from 344 to 307 in the intervention group after the SBHCs opened, whereas the total number of ED visits increased from 200 to 210 in the comparison group (Table 3). The decrease in ED visits for otitis media (ear infections) was statistically significant in the intervention group, although the ED visits for other specific diagnoses had no significant difference.

#### Costs of hospitalization and ED visits

Table 4 summarizes the costs of hospitalization and ED visits for children with asthma before and after the SBHCs opened. Based on results from the repeated measure ANCOVA, there was a significant interaction effect (TIME \* SBHC,  $F = 4.115$ ,  $p = .044$ ) for the hospitalization cost before and after the SBHC opened (Table 5). Figure 2 demonstrates this interaction effect. Although the cost of hospitalization per child decreased from \$1150 to \$180 per child after controlling covariates in the intervention group, the cost of hospitalization per child was relatively unchanged from \$583 to \$606 per child in the comparison group before and after the SBHCs opened. In addition, African-American children with asthma had significantly decreased costs of hospitalization (TIME \* RACE,  $F = 5.198$ ,  $p = .023$ ) after the SBHCs opened. Disabled children with asthma had significantly higher costs of hospitalization than other children with asthma ( $F = 4.70$ ,  $p = .031$ ).

Although there was no significant interaction effect on the cost of ED visits for all children before and after the SBHCs opened (TIME \* SBHC,  $F = .507$ ,  $p = .477$ ) (see Table 5), the costs of ED visits for children with asthma in comparison schools were significantly higher than for chil-

dren with asthma in intervention schools ( $F = 19.8$ ,  $p < .0001$ ) after the SBHCs opened. Figure 3 shows that the costs of ED visits per child were \$303 in both the intervention and comparison groups before the SBHCs opened, then decreased to \$275 per child in the intervention group and increased to \$331 per child in the comparison group after the SBHCs opened.

#### Discussion

Hospitalization and emergency department (ED) visits are the most costly medical services in Medicaid programs, accounting for 23% to 30% of the total annual Ohio Medicaid expenditures from 1995 to 2000. The present study is a longitudinal quasi-experimental cohort study to quantitatively assess the impact of SBHCs on hospitalization and ED visits for children with asthma based on multiple SBHC schools and non-SBHC comparison schools. After the SBHCs opened, the relative risk of hospitalization decreased 2.4-fold and the risk of ED visits decreased 34% for students with asthma. Because we found there was a significant interaction effect for the cost of hospitalization before and after the SBHCs opened, the potential cost-savings for hospitalization was estimated as \$970 per child with asthma (i.e., \$1150 – \$180 = \$970) (see Figure 2). This indicates that the SBHC program provided valuable primary care, such as prescription drugs for children with asthma, which may have resulted in lower hospitalization rates and ED visits. The initial higher hospitalization cost in SBHC schools than the comparison group might be owing to the higher rate of allergy comorbidity. Although we cannot control the students' asthma severity, we found that the pattern of hospitalization for students in intervention schools changed after the SBHCs opened, i.e., hospitalizations for asthma, mental health disorders, sinusitis, bronchitis, and pneumonia decreased for children in the interven-

Table 3  
Frequency of hospitalization and emergency department visits for children with asthma in SBHC and non-SBHC schools (n = 273)

ICD9 code	Description of disease	Before SBHC	After SBHC	p Value <sup>a</sup>
<b>Hospitalization</b>				
Children in SBHC Schools (n = 196)				
n		36	12	
493	Asthma	14	4	.0027
290–314	Mental disorders	13	3	.0015
460–519	Sinusitis, bronchitis, pneumonia	5	1	.083
280–289	Blood diseases	2	1	1.000
800–999	Injury and poisoning	2	1	1.000
656, 754	Pregnancy labor abnormalities, congenital musculoskeletal deformities	0	2	—
Children in Non-SBHC Schools (n = 77)				
n		11	10	
493	Asthma	3	3	1.000
290–314	Mental disorders	2	2	1.000
280–289	Blood diseases	2	3	1.000
460–519	Sinusitis, bronchitis, pneumonia	2	1	1.000
800–999	Injury and poisoning	2	1	1.000
<b>Emergency Department Visits</b>				
Children in SBHC Schools (n = 196)				
n		344	307	
493	Asthma	47	40	.2885
800–999	Injury and poisoning	95	85	.2918
460–519	Sinusitis, bronchitis, other respiratory diseases	61	46	.0403
780–799	Chest and abdomen symptoms	27	34	.2050
380–382	Otitis media	21	11	.0124
009–079	Infectious diseases	18	20	.6464
290–314	Mental disorders	11	10	1.000
—	Other diseases	64	61	.7043
Children in non-SBHC schools (n = 77)				
n		200	210	
493	Asthma	23	30	.1739
800–999	Injury and poisoning	44	42	.7604
460–519	Sinusitis, bronchitis, other respiratory diseases	36	27	.1088
780–799	Chest and abdomen symptoms	61	69	.3211
380–382	Otitis media	13	15	.5930
009–079	Infectious diseases	3	6	.1573
290–314	Mental disorders	2	5	.1088
—	Other disease	18	16	.6276

<sup>a</sup> Yate Continuity Adjusted Chi-square tests were used to compare the frequency of hospitalization before and after the SBHC intervention in either SBHC or non-SBHC schools.

tion group. No such pattern was found in the non-SBHC comparison group. In general, this finding is consistent with previously published SBHC evaluations in Georgia and New York [12,14]. In addition, the results in the present

study indicate that children enrolled in Medicaid MCOs or in CHIP also had lower risks of ED visits than children enrolled in other programs, such as a Medicaid blind or disabled program. This reflects the fact that children en-

Table 4  
Costs of hospitalization and emergency department visits for children with asthma in SBHC and non-SBHC schools (n = 273)

Group	Hospitalization			Emergency Department visits		
	Costs of hospitalization	Number of hospitalizations	Cost per hospitalization	Costs of ED visits	Number of ED visits	Cost per ED visit
<b>SBHC (n = 196)</b>						
Before SBHC	\$203,981	36	\$5,666	\$56,269	344	\$164
After SBHC	\$48,140	12	\$4,012	\$52,734	307	\$172
<b>Non-SBHC (n = 77)</b>						
Before SBHC	\$49,997	11	\$4,545	\$26,178	200	\$131
After SBHC	\$46,374	10	\$4,637	\$27,765	210	\$132

Table 5  
Repeated measures ANCOVA of hospitalization and emergency department visit costs for children with asthma (n = 273)

Effect	df	Mean square	F	p Value
<b>Hospitalization cost model<sup>a</sup></b>				
Tests of within-subjects effects <sup>b</sup>				
TIME	1	1,198	0.000	.989
TIME * SBHC	1	24,582,457	4.115	.044
TIME * RACE	1	31,053,663	5.198	.023
TIME * SEX	1	401,806	0.067	.796
TIME * AGE	1	4,273,766	0.715	.398
TIME * DISABLED	1	2,225,216	0.372	.542
TIME * CHIP	1	287,181	0.048	.827
TIME * MCO	1	12,103,163	2.026	.156
Tests of between-subjects effects				
SBHC	1	501,780	0.049	.824
RACE (African-American = 1)	1	16,483,642	1.622	.204
SEX (male = 1)	1	16,579,852	1.631	.203
AGE (years)	1	2,495,794	0.246	.621
Disabled	1	47,773,083	4.701	.031
CHIP	1	93	0.000	.998
MCO	1	3,565,471	0.351	.554
<b>Emergency Department visit cost model<sup>c</sup></b>				
Tests of within-subjects effects <sup>b</sup>				
TIME	1	4,446	0.029	.865
TIME * SBHC	1	77,669	0.507	.477
TIME * SEX	1	106,908	0.697	.404
TIME * RACE	1	1,372	0.009	.925
TIME * AGE	1	42,808	0.279	.598
TIME * DISABLED	1	377,671	2.463	.118
TIME * CHIP	1	166,423	1.085	.298
TIME * MCO	1	35,875	0.234	.629
Tests of between-subjects effects				
SBHC	1	4,678,895	19.848	.000
SEX (male = 1)	1	75,797	0.322	0.571
RACE (African-American = 1)	1	529,306	2.245	0.135
AGE (yrs)	1	151,626	0.643	0.423
Disabled	1	16,585	0.070	0.791
CHIP	1	553	0.002	0.961
MCO	1	378,073	1.604	0.206

<sup>a</sup> Measure: hospitalization cost.

<sup>b</sup> Design: Intercept+SBHC+RACE+SEX+AGE+DISABLED+CHIP+MCO. Within-subjects design: TIME.

<sup>c</sup> Measure: Emergency Department visit cost.

rolled in Medicaid MCOs or CHIP are healthier than children enrolled in the disabled or AFDC program.

If an SBHC is present in their school, children with asthma are assured better access to health care services and may increase school attendance and performance. Parents might reduce inconvenient appointment times that cause lost time from work or increased travel costs. Owing to the decreased hospitalization and ED visits, children with asthma, families, and the Ohio Medicaid program may benefit from the SBHCs. This present study also has relevance to broader health policy issues. Both the Office of the Inspector General (OIG) in December 1993 and the General Accounting Office (GAO) in 1994 reported that the school-based health centers (SBHCs) provided important primary care for children. They also made recommendations to federal and state governments for improving coordination between the SBHCs and state Medicaid programs [23–27]. Schools with SBHCs in Greater Cincinnati have a large

proportion of children who are African-American and from lower income families, ranging from 33% to 88%, depending on the school. Given concerns about racial disparities in health status and health care, and acknowledged barriers to caring for the poor and uninsured, SBHCs are particularly important and beneficial for these children and children with chronic diseases like asthma.

This study was limited to school-age children with asthma enrolled in their schools and the Ohio Medicaid program. It is difficult to verify accuracy of the ICD-9 codes provided in encounter data, hence it is possible that there are some misclassifications of disease diagnoses. Although the SBHCs provided the health services for students in those intervention schools, we were unable to measure what proportion of children with asthma did receive their primary care from the SBHCs during the study period. Because the primary data source used was a retrospective Medicaid medical claims database, we were unable to assess children

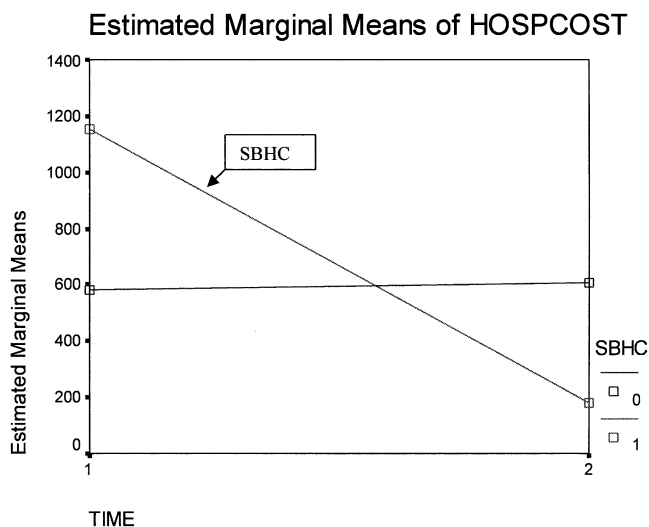


Fig. 2. Costs of hospitalization before and after SBHC for students with asthma (n = 273). SBHC = 1 for children in SBHC schools and SBHC = 0 for children in non-SBHC schools. HospCost is cost for hospitalization per child. Marginal means are the average costs of hospitalization per child. Time 1 refers to before the SBHC program; Time 2 refers to after the SBHC program. HospCost per student (SBHC): Time 1 \$1152 (95% CI 621, 1682); Time 2 \$180 (95% CI -107, 466). HospCost per student (non-SBHC): Time 1 \$583 (95% CI -229, 1396); Time 2 \$606 (95% CI 168, 1045).

with other insurance plans or no insurance. Also, we did not differentiate between students who were treated by the SBHCs and students in the SBHC schools who were not

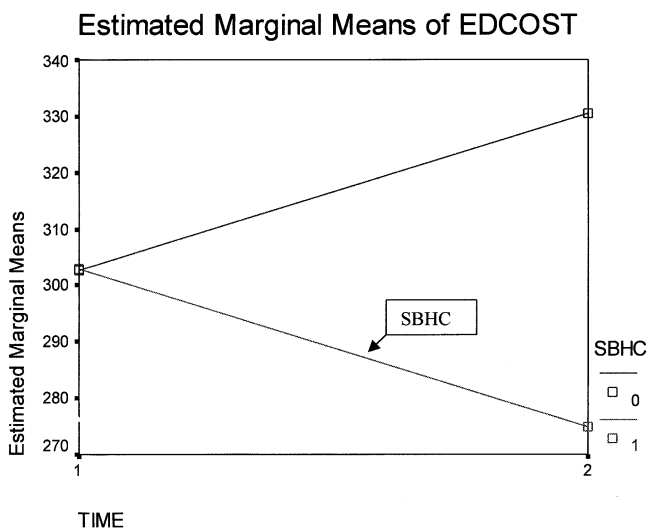


Fig. 3. Costs of emergency department visits before and after SBHC for students with asthma (n = 273). SBHC = 1 for children in SBHC schools and SBHC = 0 for children in non-SBHC schools. EDCost is cost for emergency department visits per child. Marginal means are the average costs of ED visits per child. Time 1 refers to before the SBHC program; Time 2 refers to after the SBHC program. EDCost per student (SBHC): Time 1 \$303 (95% CI 246, 415); Time 2 \$275 (95% CI 220, 330). EDCost per student (non-SBHC): Time 1 \$303 (95% CI 187, 419); Time 2 \$331 (95% CI 246, 415).

treated. There might be more positive changes for children who were treated by SBHCs compared with those who weren't treated by SBHCs. Owing to limitations of the Medicaid claims data, we cannot measure clinical parameters of asthma treatment, such as effect on forced expiratory volume (FEV<sub>1</sub>) or changes in nocturnal awakenings.

Despite the growing number of SBHCs, data concerning their benefits are scarce. Because of the limited literature about the impact of SBHCs on children with asthma, this study provides useful information for future SBHC management and operation. Because state Medicaid programs cover a large proportion of children who are disabled or from low-income families, the present study findings would be important information for health care decision-makers to support future extension and improvement of SBHCs. A greater understanding of SBHCs requires more health outcome assessments and economic evaluations. A particular area of focus should be on children with specific chronic diseases other than asthma. Further investigation is also warranted to assess children's quality of life, total health costs, student school attendance, academic performance, and other issues that are associated with the SBHC intervention.

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