THE PREVALENCE OF ASTHMA IN CHILDREN OF ELEMENTARY SCHOOL AGE IN WESTERN NEW YORK

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ABSTRACT To determine the prevalence of caregiver-reported asthma in children 4 to 13 years old in metropolitan western New York State, surveys were conducted during 1997–1999 in the Buffalo, Niagara Falls, Iroquois, and Gowanda school systems. Questionnaires (3,889) were sent to the homes of elementary school children in nine schools in western New York. The caregivers were asked to complete a 13-item questionnaire for the child. Of the questionnaires, 60.5% (2,353/3,889) were completed.

Of all children, 18% had physician-diagnosed asthma. Of children diagnosed with asthma, 86% were taking medication. Symptoms were consistent with suspected undiagnosed asthma for 13% of the children. Buffalo had the highest rate of diagnosed asthma (20%) for the age group. Gowanda had a prevalence of 18%, Iroquois 16%, and Niagara Falls 15%. Variations were observed in asthma prevalence rates among different racial/ethnic groups. In general, boys had a significantly ($P = .001$) increased odds of being asthmatic compared with girls. Overall, African-Americans and Hispanic/Latino children had significantly ($P = .012$ and $P = .005$, respectively) higher asthma prevalence rates, two to five times those of their Caucasian peers. In Gowanda, the prevalence of diagnosed asthma among Native American children was 23%, compared to 15% among Caucasian children. Of diagnosed Native American children, 71% were female. In Gowanda, a significant association ($P = .007$) of asthma among children in split-grade classes was observed compared to nonsplit grades. Of Native American children in split grades, 60% were diagnosed asthmatics. These observations reveal a high prevalence of asthma in the age group of 4 to 13 year olds in western New York. Local variations in potential triggers of asthma need to be considered when advising asthmatics. The results suggest that some grades have a disproportionate amount of children with asthma. The implications of asthma for children's early education need to be examined further.

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INTRODUCTION

Asthma is the most common chronic disease in childhood and is estimated to have an overall prevalence of 4.3% to 6.9% in children in the US.¹⁻⁴ Prevalence over the past two decades, especially in urban areas, has increased worldwide and in the US.⁵ Asthma is notably high among minority populations living in poor urban communities and is often underdiagnosed.⁶ An estimated 14.3% of the disease is undiagnosed in African-American schoolchildren, 9 to 11 years of age, living in urban Detroit, Michigan.⁶ In the US, asthma prevalence and hospitalization rates parallel socioeconomic status.⁷ Asthma deaths, though comparatively rare, are also highest in minorities and women living below the poverty level in inner cities.⁸ In 1993, asthma was estimated to account for 198,000 hospital admissions and 342 deaths among persons aged less than 25 years. Among children 5 to 14 years of age, the asthma death rate was 1.7 to 3.2 per 1 million population. Also, in 1993, African-American children were four times more likely than whites to die from asthma, and African-American boys were 1.3 times more likely than girls.³

Asthma hospitalizations and mortality have been well evaluated in large urban areas, but less information is available on medium-size urban centers and their surrounding areas. Hospitalization and mortality data have shown comparable rates of hospitalization for children 0 to 19 years of age in the New York State cities of Buffalo and Niagara Falls and lower rates for surrounding nonurban areas.⁹ The prevalence of asthma among school-aged children in western New York has not been reported previously. Based on hospitalization and emergency department discharges, asthma is a major health problem in western New York.¹⁰

Little information is available about the respiratory health of Native American children. Western New York is home to several Native American nations. The Gowanda School district serves children from the nearby Cattaraugus Indian Reservation. A smaller percentage of Native American children also attend Niagara Falls school district.

It has been shown that hospitalizations and morbidity due to asthma can be prevented by targeting high-risk populations for surveillance, proper diagnosis, and education.¹¹⁻¹⁴ Elimination of home environmental triggers has also been shown to lower asthma morbidity.¹⁴⁻¹⁶ Information about asthma in children of elementary school age is important for educators and policymakers to consider in planning for the health needs of children.

The purpose of the current study was to determine the prevalence of diagnosed asthma and suspected undiagnosed asthma in children 4 to 13 years old in

western New York to aid in establishing a regional school-based program for secondary prevention of asthma.

METHODS

A total of 3,889 questionnaires was distributed between 1997 and 1999 to nine schools in Buffalo and surrounding areas. Initially, three elementary schools, comprised mainly of African-American students, were selected from Buffalo's east side. A feasibility study was performed during the spring term of 1997 on a random sample of 200 children at each of the schools. A subsequent survey including all children (1,300 total) at the three schools was conducted during September 1997. In the fall of 1998, questionnaires (291) were distributed to a fourth school on Buffalo's west side, comprising a mainly Hispanic/Latino population. In spring 1999, questionnaires were distributed to one elementary school in Niagara Falls (922), two schools in Iroquois (625), and two elementary schools in Gowanda (751).

The surveys were adapted from questions published in the *Global Initiative on Asthma*.¹⁷ Information on demographics, common asthma symptoms, and asthma environmental triggers was surveyed. The questionnaires, in English and Spanish, were distributed by the homeroom teachers at each grade level with instructions for children's caregivers to complete and return them by the following day. Children whose questionnaires were not returned were given reminders for their caregivers. New questionnaires were issued to the children who had lost or misplaced the originals.

To evaluate the validity of the screening instrument, we used a sample of 70 children (4 to 13 years old) in the city of Buffalo identified from parent/guardian response to the screening questionnaire as having diagnosed asthma. Letters were mailed to these children's health care providers requesting confirmation of asthma diagnosis and medication usage. Health care providers were asked to confirm diagnosis and medication use by filling out written asthma care plans for children to be returned to schools. Of 70 letters mailed to health care providers requesting asthma care plans, 63 (90%) asthma care plans were returned. Among those returned, 86% ($n = 54$) of children whose parents/guardians classified them as diagnosed with asthma had a confirmed diagnosis from their health care provider. Of the 63 children stated to be taking asthma medications currently, 84% ($n = 53$) had a confirmed diagnosis from their health care provider.

STUDY POPULATION

Western New York contains the two mid-size urban centers of Buffalo and Niagara Falls and several surrounding suburban, semiurban, and rural town-

ships. The majority of people in these areas are employed in either Buffalo or Niagara Falls.

The study population consisted of children enrolled in elementary schools located in Buffalo's east and lower west sides, an inner-city area of Niagara Falls, and the semiurban areas of the Gowanda and Iroquois school districts. The study covered census tracts 3901, 3902, and 4001 located on Buffalo's east side and included an early childhood center on Buffalo's lower west side, which is a predominantly Hispanic/Latino community of Puerto Rican descent. Buffalo's east and lower west sides were selected because preliminary data had shown them to have high hospital and emergency department admission rates for asthma. These areas have a high prevalence of (1) poverty (<\$14,000 annual household income), (2) adults with less than 12 years of education, (3) a population that is greater than 35% minority, (4) an infant mortality greater than 15 per 100,000 live births, (5) births with low birth weight (<2500 g), (6) births with no or late prenatal care, and (7) a majority of homes built before 1950. According to the 1990 census, Buffalo's population is 328,123, and its people have a median household income of \$18,482.

The city of Niagara Falls is the largest city in Niagara County with a population of 65,000 people. Median household income for Niagara Falls is \$20,644 (1990 census). The minority population of 19% is concentrated within the city and lives mainly in public housing projects. The median income of families living in the public housing projects is unavailable, but is most likely considerably lower than the mean income for the city. The survey was conducted in the local elementary school that serves this population.

The Iroquois Central School District serves a suburban community 20 miles southeast of Buffalo in Elma, New York. It is a semirural area comprised mostly of professionals who commute to work in Buffalo. The school district serves a community that is over 95% Caucasian. Two elementary schools in this district were surveyed. The median household income of the area served by this school district is \$40,000 (1990 census).

Gowanda Township is located 40 miles south of Buffalo, just across the Erie County line into Cattaraugus County. The Gowanda Central School District serves a predominantly rural population of about 3,000, including children from a nearby Native American reservation. According to the 1990 census, median household income for this area is \$20,000 (Table I). Questionnaires were distributed to two elementary schools in this district.

TABLE 1 Demographic Characteristics

	Buffalo		Niagara Falls		Iroquois		Gowanda		Total, N
	n	%	n	%	n	%	n	%	
Grade*									
Pre-K (3–4.9)	100	84	19	16	0	0	0	0	119
Kindergarten (5–5.9)	173	48	100	27	54	15	37	10	364
1st–4th (6–9.9)	555	38	337	23	294	20	277	19	1,463
5th–8th (10–13.9)	54	16	159	47	0	0	125	37	338
Not given	91	54	69	41	0	0	9	5	169
Total	973	41	584	25	348	15	448	19	2,353
Race/ethnicity									
African-American	449	63	258	44	1	<1	1	<1	709
Caucasian	158	16	206	35	320	93	314	72	998
Hispanic/Latino	145	15	23	4	3	<1	3	<1	174
Native American	15	2	27	5	0	0	106	24	148
Other	125	13	70	12	20	6	15	3	230
Not given	81	86	0	0	4	4	9	10	94
Total	892	41	584	25	348	15	448	19	2,353
Gender									
Female	499	41	301	24	179	16	232	19	1,211
Male	447	43	237	23	163	16	197	19	1,044
Not given	27	28	46	47	6	6	19	19	98
Total	973	41	584	25	348	15	448	19	2,353

*Corresponding ages are given in years in parenthesis next to each grade level.

DATA ANALYSIS

Descriptive statistics were tabulated using Corel Quattro Pro spreadsheet software (www.WordPerfect.com). Tests for significance among variables were calculated using the Statistical Package for Social Sciences (SPSS) for Windows 9.0 (SPSS, Inc., Chicago, IL). A *P* value of less than .05 was considered significant. All odds ratios (ORs) and confidence intervals (CIs) were calculated at 95%.

ETHICS

The study was approved by the Institutional Human Investigation Review Committee of the University at Buffalo School of Medicine, Buffalo, New York.

DEFINITIONS

In this study, diagnosed asthma was defined by a positive response to one or both of the following survey questions: "In the past 12 months, has the child

used medicines to treat asthma?" or "Has a health professional or doctor told you that the child has asthma?"

Suspected undiagnosed asthma was defined by a positive response to any of five survey questions that addressed the occurrence of the common symptoms of asthma, such as repeated attacks of wheezing, bothersome coughing at night that wakes the child, colds lasting more than 10 days or chest tightness, cough, or wheezing after exercise; or coughing, wheezing, or chest tightness when exposed to molds, pollens, or hairy pets in the past 12 months.

RESULTS

OVERALL DEMOGRAPHICS

The questionnaire response rate was 60.5% (2,353/3,889). Demographic characteristics of the study group are shown in Table I. Overall, the mean age of the children was 6.54 ± 1.72 SD years. The mean age of the children with asthma was 6.52 ± 1.72 SD years, which was comparable with 6.56 ± 1.72 SD years of the nonasthmatics. No significant difference in ages of the two groups was observed.

Of the children, 46% were male, and 54% were female. Of those with asthma, boys were 53.2%, and the girls were 46.8%. Of the suspected asthmatics, 43% were male, and 57% were female. Among nonasthmatics, boys made up 51%, and girls comprised 49%.

Overall, the race/ethnicity of the population was 30% African-American, 44% Caucasian, 8% Hispanic/Latino (primarily Puerto Rican), 6% Native American, and 10% from other race/ethnic groups. Children of other races included Asians and Pacific Islanders and children of biracial origin. Due to the small number of Native Americans in the Iroquois and Buffalo school districts, these children were included in the other race/ethnic group for those areas. Essentially all African-American (99%) and Hispanic/Latino (96%) children were in either Buffalo or Niagara Falls school districts. Iroquois and Gowanda had less than a 1% population of African-American and Hispanic/Latino students. Caucasians made up 93% of Iroquois schools and 72% of Gowanda schools. Of the Gowanda school population, 24% was Native American. The school population of Niagara Falls had 44% African-American, 35% Caucasian, 5% Native American, and 4% Hispanic/Latino children. Other racial/ethnic backgrounds were indicated by 13% of Buffalo schoolchildren and 12% of the Niagara Falls children.

Socioeconomic status has been shown to correlate with asthma prevalence, morbidity, and mortality in the US. Iroquois School District, which serves the Elma and Wales communities, had a median household income twice that of the other communities in the study.

ASTHMA PREVALENCE

The overall percentage of children with physician-diagnosed asthma was 18%. The highest prevalence of asthma, 20%, was seen in Buffalo. Niagara Falls had an overall prevalence of 15%, Iroquois 18%, and Gowanda 18%.

ASTHMA PREVALENCE BY GENDER

It is well recognized that asthma hospitalizations are higher among males during early childhood and then switch to be higher among females during early and late adulthood. The diagnosed asthma rates for this study population followed the predicted pattern. Overall, boys had a significantly ($P = .001$) higher risk ($OR = 1.29$, $CI = 1.13, 1.45$) of being asthmatic than did girls. Being male was associated significantly ($P = .01$ and $P = .002$, respectively) with asthma in Buffalo and Iroquois schools. No significant association was seen in Niagara Falls or Gowanda.

ASTHMA PREVALENCE BY RACE/ETHNICITY

The prevalence of asthma by race and school is shown in Table II. Comparable percentages of Caucasians were represented in the asthmatic and nonasthmatic groups. Caucasian children reported the lowest rate of diagnosed asthma in Niagara Falls (7%). There were 13% of children in Buffalo, 15% in Gowanda, and 18% in Iroquois who were reported as diagnosed asthmatics. However, African-Americans and Hispanics/Latinos were over-represented among asthmatic children and had significantly increased risk ($P = .012$ and $P = .005$, respectively) of being asthmatic compared with Caucasian children. Although not significantly associated with race, diagnosed asthma was prevalent at 22% among African-American children in Buffalo and Niagara Falls. African-American children had twice the prevalence rate of asthma compared to their Caucasian peers in Buffalo. Similarly, Hispanics/Latinos in Buffalo had an asthma prevalence rate twice that of Caucasian children. In Niagara Falls, African-American children had a significantly ($P = .008$) increased risk ($OR = 1.3$, $CI = 1.09, 1.55$) of being asthmatic compared with their Caucasian peers. Similarly, Hispanics/Latinos in Niagara Falls had an asthma prevalence rate twice that of Caucasian children and were significantly ($P = .005$) more at risk for being asthmatic ($OR = 3.06$, $CI = 1.4, 6.65$).

The prevalence of asthma among Native Americans in Gowanda is described in Table III. Native Americans constituted 24% of the children in the Gowanda schools. The prevalence of physician-diagnosed asthma was 23% among Native Americans in Gowanda. Native American girls in the Gowanda area constituted 70% of the diagnosed asthmatics. No significant association between race and asthma status was found in the Gowanda or Iroquois populations.

TABLE II Asthma Status by Race and School

	Diagnosed Asthma		Suspected Asthma*		Nonasthmatic		Total, N
	n	%	n	%	n	%	
Buffalo schools							
African-American	101	22	97	22	251	56	449
Caucasian	20	13	34	22	104	66	158
Hispanic	34	23	21	14	90	62	145
Other	20	32	7	11	36	57	63
Not given	18	11	19	12	121	77	158
Total	193	20	178	18	602	62	973
Niagara Falls							
African-American	54	21	48	18	155	61	255
Caucasian	16	7	48	18	141	69	203
Hispanic	8	36	4	18	10	45	22
Native American	5	19	6	23	15	58	26
Other	2	4	13	27	33	69	48
Not given	2	11	5	18	19	70	27
Total	87	15	124	21	373	64	584
Iroquois							
African-American	1	100	0	0	0	0	1
Caucasian	47	18	103	32	163	50	323
Hispanic	0	0	2	100	0	0	2
Other	3	33	3	33	3	33	9
Not given	2	21	6	32	13	47	19
Total	55	16	114	32	179	49	348
Gowanda							
African-American	1	100	0	0	0	0	1
Caucasian	46	15	80	26	181	59	307
Hispanic	0	0	0	0	2	100	2
Native American	23	23	17	17	63	61	103
Other	2	22	1	11	6	66	9
Not given	10	38	3	12	13	50	26
Total	82	18	101	23	265	59	448

*Suspected undiagnosed asthma is defined as children presenting symptoms of asthma, but never having been diagnosed with or medicated for asthma by a physician.

DIAGNOSED CHILDREN WITH ASTHMA TAKING MEDICATION

Overall, 86% of children with diagnosed asthma were reported to be taking medications for asthma. In Niagara Falls, 100% of children with diagnosed asthma had taken medication for asthma within the past 12 months. Buffalo had a rate of 85%, Iroquois 82%, and Gowanda 78% of children reported taking asthma medication within the past 12 months.

TABLE III Asthma Prevalence Among Native Americans in Gowanda

Grade	Diagnosed Asthma (n = 24)	Suspected Asthma (n = 17)	Nonasthmatic (n = 63)	Total (n = 106)
K-2 (aged 4-7.9 years)				
Male	2 (20%)	3 (43%)	12 (63%)	17 (45%)
Female	8 (80%)	4 (57%)	7 (37%)	19 (55%)
Total	10 (26%)	7 (18%)	19 (50%)	38 (36%)
3-6 (aged 8-11.9 years)				
Male	6 (43%)	4 (40%)	18 (41%)	28 (41%)
Female	8 (57%)	6 (60%)	26 (59%)	40 (59%)
Total	14 (21%)	10 (15%)	44 (65%)	68 (64%)
Overall total	24 (22.6%)	17 (16.0%)	63 (59.4%)	106 (100%)

ASTHMA PREVALENCE BY SCHOOL GRADE

Analysis of asthma prevalence by grade for each region of schools revealed variations in rates of diagnosed asthmatics and suspected undiagnosed asthmatics. In Buffalo and Iroquois schools, rates of diagnosed asthmatics were higher in 1st-4th grades than in other grades, 23% versus 16% and 18% versus 9%, respectively. In addition, suspected undiagnosed asthma (see above definition) was high in all schools. Overall, 22% of the children had suspected undiagnosed asthma. Iroquois had the highest rate of suspected undiagnosed asthma, 33%. Gowanda had 23%, Niagara Falls 21%, and Buffalo 19%. No significant association between asthma status and school location or grade level was observed.

ASTHMA PREVALENCE AND CLASSROOM PLACEMENT

Gowanda schools provided an opportunity for assessing the impact of asthma on classroom placement. These schools have split-grade classrooms. Placement of the children in split-grade classrooms has been made without regard to children's asthma status. Children in one/two and three/four split-grade classes had asthma prevalence rates (38% and 24%, respectively) that were much higher than their peers in non-split-grade classes (9-22%). When compared with peers in non-split-grade classes, children in split-grade classrooms had a significantly ($P = .007$) higher risk of being asthmatic ($OR = 1.97$, $CI = 1.2, 3.22$). Data comparison of classroom placement of diagnosed asthmatics was available only for Gowanda schools.

The prevalence of physician-diagnosed asthma among split-grade Native American children was 73% in grade one/two compared to Native American children in first grade at 13% or second grade at 7%. Similarly, the prevalence of asthma among three/four split-grade Native American children was 67%

TABLE IV Prevalence of Potential Home Triggers by School Location

Trigger	Buffalo (n = 975)	Niagara Falls (n = 584)	Iroquois (n = 348)	Gowanda (n = 448)	Total (n = 2,355)
Tobacco	511 (52%)	292 (50%)	78 (22%)	260 (58%)	1,141 (48.5%)
Pets	315 (32%)	139 (24%)	248 (71%)	379 (85%)	1,081 (45.9%)
Roaches	144 (15%)	31 (5.3%)	1 (<1%)	4 (<1%)	178 (7.5%)
Rats/mice	99 (10%)	66 (11%)	69 (20%)	133 (30%)	367 (15.6%)
Humidifier	58 (33%)	179 (31%)	122 (35%)	162 (36%)	521 (33.5%)

compared to 17% and 12% in non-split third and fourth grades, respectively. No significant association was observed between asthma and race in regard to classroom placement.

HOUSEHOLD TRIGGERS

As shown in Table IV, examination of data by school location revealed differences in the prevalence of some environmental triggers in the homes of children. There were 50% to 52% who reported a smoker at home in Buffalo, Niagara Falls, and Gowanda (58%). However, only 22% percent of the children from Iroquois reported a smoker at home. Pets were reported in 24% to 32% of homes in Buffalo and Niagara Falls. In contrast, Iroquois had a 71% and Gowanda an 85% rate of reporting pets in homes. Cockroaches were reported in 15% of the homes from Buffalo, but were reported rarely in the other communities. In contrast, rats/mice in the home were reported in 10% of homes in Buffalo, but reported in 30% of homes in Gowanda. These observations are consistent with the observations made by direct visits to homes in Buffalo.¹⁰

Table V describes household triggers in relation to asthma status. We investigated the possible contributions of home environmental triggers to asthma prevalence. When data from all schools were analyzed together, rates for the presence of smokers, pets, cockroaches, and mice in the homes of diagnosed, suspected,

TABLE V Overall Prevalence of Potential Home Triggers by Asthma Status

Trigger	Diagnosed Asthmatics (n = 422)	Suspected Asthmatics (n = 522)	Nonasthmatics (n = 1,411)	Total (n = 2,355)
Tobacco	230 (50%)	248 (48%)	636 (45%)	1,114 (47.3%)
Pets	185 (44%)	266 (51%)	630 (45%)	1,081 (45.9%)
Roaches	37 (9%)	40 (8%)	101 (7%)	178 (7.5%)
Rats/mice	58 (14%)	103 (20%)	206 (14%)	367 (15.6%)
Humidifier	108 (38%)	138 (39%)	275 (20%)	521 (33.5%)

and nonasthmatic children were comparable. Overall, 47% reported the presence of a smoker in the home. No significant associations were observed among the 46% of homes that had pets, reported cockroaches (7.5%), or had rats/mice (15.6%). The frequency of smokers in the home of asthmatic and nonasthmatic children was comparable, 50% versus 45%, and was not significant. The presence of a humidifier (33.5%) in the home was associated significantly ($P < .001$) with increased risk ($OR = 1.84$, $CI = 1.63, 2.09$) of asthma. The presence of a humidifier was also associated significantly ($P < .001$) with increased risk ($OR = 1.65$, $CI = 1.45, 1.87$) of suspected undiagnosed asthma when compared with nonasthmatics. The presence of rats/mice in the home was also related significantly ($P < .001$) to increased odds ($OR = 1.58$, $CI = 1.27, 1.97$) of suspected undiagnosed asthma. Pets, roaches, and smoking were not associated significantly with suspected undiagnosed asthma.

POTENTIAL ASTHMA TRIGGERS AMONG NATIVE AMERICAN ELEMENTARY SCHOOL CHILDREN

Since Native Americans were over-represented among children in Gowanda with diagnosed asthma, we evaluated patterns of potential home triggers of asthma among Native American children and their Caucasian peers. Reported presence of a smoker in the home was comparable between Native American and Caucasian children and was not significant. Regardless of asthmatic status, pets were significantly ($P = .001$) more prevalent among Caucasian homes compared to Native American homes in Gowanda. The reported presence of mice/rats in the home was significantly ($P < .05$) higher in Native American homes (37.5%) compared to Caucasian homes (15%) among asthmatics. Nonasthmatic Caucasians were more likely ($P = .034$) to have a humidifier than nonasthmatic Native Americans. No significant association between the presence of a humidifier and asthma among Caucasians was observed. Cockroaches were reported rarely in either Native American or Caucasian homes in the Gowanda School District, and no significant association was seen.

DISCUSSION

This paper reports a high prevalence of caregiver-reported asthma in a cross-sectional survey of 2,353 children 4 to 13 years old in western New York State. We found a high prevalence (18%) of asthma diagnosed by health care providers in children 4 to 13 years old. Asthma prevalence was particularly high among Native American children and was significant in the children placed in split-grade classrooms. African-Americans and Hispanic/Latino children were over-represented among children with asthma. Native American children had the

highest prevalence of diagnosed asthma (23%) among any of the analyzed racial/ethnic groups. Within the western New York region, there was observable variation in the percentages of asthmatics receiving medications and in the presence of potential asthma triggers reported in the homes. This report demonstrates the usefulness of the 13-item questionnaire in a large-scale survey of asthma and its use in cross-sectional comparative studies of prevalence rates in different communities. Our findings are consistent with other published studies, which also found the prevalence of asthma to be higher in boys than girls among children 15 years and under.^{3,18}

The city of Buffalo had the highest prevalence rate of diagnosed asthma (20%) for the age group. This population is composed mainly of African-Americans and Hispanics/Latinos living in the inner city. Previous studies have shown asthma to be a growing problem in this community due to low socioeconomic status, poor medical care, and the stress of inner-city life.¹⁹⁻²¹ Our study also found a large percentage (16-18%) of children living in a predominantly Caucasian, nonurban area to have been diagnosed with asthma. Thus, there is a high prevalence of elementary school children with asthma in both urban and nonurban communities in western New York. Further study about the prevalence and pathways of asthma in nonurban populations is needed.

In Gowanda, we examined asthma among a Native American population. Very little research has been published on the rates of asthma within Native American populations. It is believed generally that the asthma rates are low among Native Americans, and prevalence has been estimated at 7-12%.²² Our study found a high prevalence rate of 23%, but no significant association among Native Americans. The high prevalence may be due to the small number of Native American respondents, and further study with a larger sample size would be needed to evaluate the suggestions of our results. Furthermore, contrary to national figures, which show asthma prevalence is higher in boys than girls before the age of 15, our results show that among Native Americans in this population, the rate is much higher in girls (71%). This high rate among girls may be due to previously unexamined lifestyle or cultural differences among Native American populations. One study reported a high rate of respiratory problems in Native American homes that used wood-burning stoves for cooking.²³ Our survey did not inquire about the use of nongas or nonelectric cooking mechanisms. We examined differences in potential triggers within Native American homes versus other homes within the Gowanda region, but found no significant association with asthma status. Caucasians in Gowanda, compared to Native Americans, generally had a higher percentage of pets (72% versus 43%) and

humidifiers (33–43% versus <1–29%) in the homes regardless of asthma status. The presence of rats or mice in the home was reported much more highly by Native Americans than by Caucasians (30–50% versus 18–30%). This difference may be attributed to a greater number of Native Americans living in the less-urban areas. Further examination is needed of census and ZIP code data, as well as the high usage of trailer housing among Native Americans. Smoking was high and uniform in both ethnic groups, remaining around 45–50% in all cases. Cigarettes are available readily and cheaply on Native American reservations, which may somewhat explain the high smoking rate within this region. One study reported that, although Native Americans identify themselves as smokers, they often smoke less than other ethnic groups.²⁴ Further examination of the use of cigarettes and tobacco primarily for cultural or religious reasons is needed. The observations in Gowanda suggest that other factors, in addition to the triggers investigated, may play a role in asthma prevalence among Native Americans.

The importance of various environmental factors in the etiology of asthma has been recognized.^{18,25–27} These factors include passive smoking, home dampness, visible mold in the home, cockroaches, and household pets and dust mites.^{18,25–28} We observed notable percentages of triggers, particularly smoking and pets, in suspected undiagnosed and diagnosed asthmatics. Cigarette smoking was high in both asthmatic and nonasthmatic populations, but was highest in the predominantly minority populations of Buffalo and Niagara Falls. These observations are consistent with other reports, which have shown a high prevalence of smoking in minority populations.²⁹ The results further show geographic variations in potential triggers of asthma that need to be considered when advising asthmatics. Cigarette smoking in urban areas and in Native American populations and the presence of pets in nonurban areas stand out as environmental triggers that should be considered when educating asthmatic patients about the prevention and control of symptoms.

Evaluation of asthma prevalence by class in one of the school districts permitted recognition of the potential impact of asthma on school classroom placement. The Gowanda schools include split-grade classrooms. We found a significantly increased risk of asthma among children in split-grade classrooms. Placement into split grades can be done either at the school or the parent's request and is made independent of a child's asthma status. Although our data do not allow for direct examination of the link between asthma and these children's classroom placement, previous studies have examined the psychosocial impact of asthma, as well as the possible connection between attention deficit disorder and asthma in children.^{30–32} These studies have speculated that the effects of lack of sleep due

to chronic illness, improper use of medication, and continued absence or lost learning time may have a serious impact on a child's ability to perform well in school.³⁰⁻³² This observation needs further confirmation through an examination of these children's school history and a comparison of grades attained by asthmatics and nonasthmatic peers.

We have used the preliminary information gathered from this study to develop and implement an asthma control and prevention program with the western New York regional schools. Budgetary limitations and school restructuring have altered the ways in which schools deal with ill children. In Buffalo, for example, only 10 of the 77 schools are staffed with school nurses. Asthma exacerbations at schools without nurses are handled by the administrative staff and teachers, who are often untrained and unfamiliar with asthma medications and treatments. Our program has required, as school policy, physicians to provide written asthma action plans for each identified asthmatic student needing regular medication. Teachers and staff are trained in using these plans and in the basics of asthma control and prevention. In a pilot study, this program has resulted in a reduction of asthma exacerbations occurring in school for asthmatic children.

The current study is taken from a convenient sample of schools in the western New York area that identified asthma as a problem among their students. Response rate for a return of questionnaires overall was 60.5%. The low response rate and the high prevalence of asthma in the study sample may be due to self-selection bias of the participants. However, in a telephone follow-up of (129/625) parents/guardians from the Buffalo public schools who had not returned the questionnaire, we found a 17% (22/129) prevalence of diagnosed asthma. This number is similar to the 19% prevalence rate found among those returning the questionnaires.

This study is limited by the lack of information on nonrespondents, and no demographic information was collected on those who did not return the questionnaire or could not be reached by telephone for the attempt at follow-up. This study did not evaluate the severity of asthma by direct interview or evaluate the clinical significance of potential triggers of asthma by allergy skin testing. Due to differences in socioeconomic status and comparability of the four populations surveyed, analysis was limited for some inquiries.

Despite these limitations, however, the study provides a useful tool for comparisons of asthma prevalence rates and triggers among different communities. The study further has provided some insights into factors that form a basis for testable hypotheses for future studies.

We conclude that asthma is a major health problem in this group of 4 to 13

year olds. Furthermore, since over 40% of children in this group are either diagnosed or suspected as having asthma, it is essential that school staff become knowledgeable about asthma so that they may help educate children to comply with preventive measures. Further research is needed to examine factors that contribute to variations in diagnosis and treatment of asthma.

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CHILD LUNG HEALTH QUESTIONNAIRE

Parent/guardian: Please answer each question and return this form to school.

Child's Name _____

 Last First Middle Initial

Address _____ Zip _____

Age of child ____ Is the child Male or Female? [check one] ☐ Male ☐ Female

Race/Ethnic Background ☐ African-American ☐ Latino/Hispanic

☐ Native American ☐ Caucasian

☐ Asian/Pacific Islander ☐ Other _____

(For each question below circle one)

1. Has the child had an attack or repeated attacks of wheezing or whistling in his or her chest in the past 12 months?	Yes	No
2. Does the child cough at night?	Yes	No
3. Does the child cough, wheeze, or have whistling in the chest after exercise?	Yes	No
4. Does the child cough, wheeze, or have chest tightness when he or she is exposed to molds, pollens, or hairy pets such as cats and dogs?	Yes	No
5. Does the child have colds that "go to the chest" or take more than 10 days to clear up?	Yes	No
6. Does the child use medicines to treat asthma?	Yes	No
7. Has a health professional or doctor told you that the child has asthma?	Yes	No
8. Does the child keep up his or her physical activities with children of her age?	Yes	No
9. Does anyone at the child's home smoke?	Yes	No
10. Are there pets (such as dogs or cats) in the child's home?	Yes	No
11. Have mice or rats been seen in the child's home?	Yes	No
12. Have cockroaches been seen in the child's home?	Yes	No
13. Do you wish to receive more information about asthma?	Yes	No
- (Please make sure that you give us your name and address)

Thank you for taking the time to fill in the questionnaire.

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