A Survey of the Prevalence of Asthma Among School Age Children In Connecticut

ENVIRONMENT & HUMAN HEALTH, INC.

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Environment and Human Health, Inc.

Mission Statement

Environment and Human Health, Inc., founded in 1997, is a nonprofit organization made up of doctors, public health professionals and policy experts dedicated to the purpose of protecting public health from environmental harms through research, education and the promotion of sound public policy. We are committed to improving public health and to the reduction of environmental health risks to individuals.

Our mission is:

1. To conduct research to identify environmental harms affecting human populations.

2. To promote public education concerning the relationships between the environment and human health.

3. To promote effective communication of environmental health risks to those exposed and to responsible public and private officials, thereby empowering individuals and groups to take control over the quality of their environment and be more protective of themselves and their families.

4. To promote policies in all sectors that ensure the protection of human and environmental health with fairness and timeliness.

Environment and Human Health, Inc. has put human health at the center of its environmental agenda.

A Survey of The Prevalence of Asthma Among School Age Children in Connecticut

by

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A Survey of The Prevalence of Asthma Among School Age Children in Connecticut

Asthma, a chronic inflammatory disease of the airways, currently afflicts an estimated 15 million people in the United States, 5 million of whom are under the age of 18 years.[1] *Indeed, asthma is the most common chronic disorder of school-age children and youth. It is also one of the leading causes of school absences among students in our nation: on average, children with asthma have more than three times the school absences of children without asthma.*[2]

The prevalence of asthma in the United States continues to rise. While the percentage of individuals of all ages with asthma increased 75% between 1980 and 1994, in the same period the percentage of children under 5 years with asthma increased an estimated 160%.[3] *Each year, the disease is estimated to cost the U.S. economy $11 billion in health care costs and lost productivity.*[4] *Despite the increasing impact of asthma, we do not fully understand what causes it. Furthermore, the majority of states, including Connecticut, do not have valid data to determine the prevalence of asthma by age, location or other critical variables related to causes, triggers, and prevention strategies. Without sufficient data, it is not possible to determine the real burden of this disease on the state, its health care system and its citizens.*

This study targets the prevalence of asthma among Connecticut school-age children. It was undertaken by Environment and Human Health, Inc. (EHHI) in recognition that the first step to preventing and controlling asthma requires accurate, statewide prevalence data. Findings of the study illuminate directions for further investigation and support the need for an ongoing state surveillance system.

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[1] *Vital and Health Statistics*. (1995, December). 10 (193): table 62.

[2] American Academy of Allergy, Asthma & Immunology. (1999). *Pediatric asthma: Promoting best practice*. Milwaukee: Author.

[3] Surveillance for asthma – United States 1960-1995. (1998, April 24). *Morbidity and Mortality Weekly Report*, 47(SS-1).

[4] Shalala, D.E. (2000). Statement by the Secretary of Health and Human Services on World Asthma Day, May 3, 2000. *HHS NEWS*. Washington, DC: HHS Press Office.

Asthma data in this survey were collected from Connecticut's school nurses. The survey asked for asthma prevalence data from school nurses in elementary, middle and high schools across Connecticut. Of 169 school districts, 138 responded, including 132 that have elementary school children.

SUMMARY OF FINDINGS

- **The findings of this survey are based on data collected from 83% of all Connecticut school children in grades K-12.**

- **The number of children attending schools in school districts surveyed was 513,688.** These children attended 1027 public and nonprofit schools during the 1999-2000 school year.

- **8.7% is the overall mean prevalence rate of asthma for school children in Connecticut, grades K-12. The mean rates of asthma prevalence by school level are:**

  7.8% for elementary school children

  10.2% for middle school children

  9.4% for high school students

- **Rates of asthma among elementary school children in school districts surveyed range from a low of over 3% to a high of just under 14%.**

- **All but 7 of 132 school districts surveyed have asthma prevalence rates among elementary school children that range between 4% and 12%.** Of those 7, none had an asthma prevalence rate among its elementary school children as high as 14%.

- **Asthma prevalence rates for elementary school children are consistent among urban, suburban, and rural districts.** Whether a district is urban, suburban or rural makes no appreciable difference.

- **Asthma prevalence rates among Connecticut elementary school children in districts grouped by socioeconomic status (SES) are significantly different.** Based on a classification used by the Connecticut Department of Education to place school districts into socioeconomic groupings, called Education Reference Groups (ERGs), asthma prevalence rates rise from the highest SES grouping with the lowest prevalence rate of 5.5%, to the lowest SES grouping with the highest prevalence rate of 9%.

- **Asthma prevalence rates among Connecticut elementary school children in districts grouped by county are also significantly different.** Windham County has the highest prevalence rate of asthma and Fairfield County has the lowest rate.[5]

INTRODUCTION AND BACKGROUND

Asthma is a chronic, inflammatory and life-threatening disease of the airways that afflicts Americans of all ages, races, and ethnic groups. It is one of the few chronic diseases where the prevalence rates are increasing despite a better understanding of the disease and improved medical treatments.[6] For example, the Pew Environmental Health Commission estimates that the 1993-95 prevalence rate of asthma among children, age 5-14 years, in the United States was approximately 7.6%, up from just over 4% in 1980.[7] Despite more effective medical management, death rates for asthma continue to rise at a rate parallel to the rising rates of asthma prevalence.[8] Of additional concern, the

[5] According to 1990 U.S. Census Bureau data for the eight Connecticut counties, Fairfield County had the highest per capita income, while Windham County had the lowest per capita income.

[6] Davies, R., Wang, J., Adelaziz, M., Calderon, M., Khair, O., Devalia, J. & Rusznak, C. (1997, Feb). New insights into the understanding of asthma. *CHEST: The Cardiopulmonary and Critical Care Journa1*, 111, 2S-10S.

[7] The Pew Environmental Health Commission. (2000). *Attack asthma*. Baltimore: Johns Hopkins School of Public Health, p. 10.

[8] Ibid, p. 8.

incidence of asthma in children is increasing at a considerably faster rate than the incidence of asthma in the U.S. population as a whole, and studies indicate that low income and minority populations experience significantly higher rates of related fatalities, hospital admissions and emergency room visits than do other segments of the population.[9] As a result, asthma has become a major public health concern both in Connecticut and across the nation. Although a better understanding of the mechanisms of asthma has helped to improve medical treatment of the condition, additional information regarding the causes of asthma is needed to reduce its incidence.[10]

The underlying causes of asthma and its increasing incidence are not yet fully understood. While it appears clear that there are genetic and environmental components to the disease, the rapidity of the increase in the prevalence of asthma during the past decade suggests that changes at the genetic level are unlikely to be the cause.[11] While some of the increase in asthma prevalence may be due to improved recognition and diagnosis of the disease, experts believe that these factors are unlikely to account for all of the increase in asthma prevalence.[12] In addition, while many of the environmental triggers that precipitate asthmatic episodes and make the condition worse have been identified, the comparative influence and interactions of indoor and outdoor pollutants, irritants, and infectious agents on the prevalence of the disease have not yet been fully determined.

The U.S. Department of Health and Human Services (HHS) reports that information regarding how asthma varies from one location to another at the state and local levels is "greatly needed for an effective public health response to

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[9] Shalala, D.E. Statement by the Secretary of Health and Human Services on World Asthma Day, May 3, 2000. *HHS NEWS*. Washington, DC: HHS Press Office.

[10] Newman-Taylor, A. (1995). Environmental determinants of asthma. *The Lancet, Ltd.* 345 (8945), 296-299.

[11] U.S. Department of Health and Human Services. (1997). Asthma: The states' challenge. *Public Health Report, 112*, Section: No. 3, 198.

[12] Ibid.

the disease." [13] Because such information is essential to better understanding the increased incidence of asthma, both nationally and worldwide, HHS recently made tracking of the disease a priority of its nationwide asthma initiative. To date, however, few states have developed a statewide surveillance system to provide this essential information, which is the first step necessary to determining how to prevent and better manage this debilitating disease.

Like many other states without a surveillance system, Connecticut has had to rely on estimates of disease prevalence that are based on limited and biased data, such as asthma-related deaths, hospitalizations, and emergency room visits. These types of data may yield information regarding certain high risk groups, particularly those in urban areas where emergency rooms are frequently used as a source of primary health care, or where health care is poorly accessed in general, but they are insufficient for estimating the actual prevalence of asthma in the state and for developing hypotheses about the underlying causes.

This study provides the first statewide child-based data regarding the prevalence of asthma in Connecticut, including comparisons by geographic location, socioeconomic indicators, and demographic characteristics. It is both timely and compelling in light of the national priority to establish and improve asthma surveillance systems, as well as the increasing burden of asthma on our children, health care system and state.

Understanding the serious need for reliable asthma prevalence data in Connecticut, Environment and Human Health, Inc. (EHHI) obtained funding for a study designed to obtain basic information about the current prevalence of asthma in school-age children in the state. The proposal included a plan to collaborate with school nurses, school districts and local departments of health to obtain information at the local level about school-age children known to have asthma.

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[13] US Department of Health and Human Services. HHS targets efforts on asthma. *HHS Fact Sheet*, May 3, 2000, p. 5. Available on-line: http://www.hhs.gov/news/press/2000pres/20000503a.html

METHODS

1. DATA COLLECTION

In the summer of 1999, EHHI drafted a survey to collect basic information from school nurses about the numbers of students in Connecticut schools known to have a diagnosis of asthma and, of those, the number of students receiving asthma medication in school.[14] To ensure a high response rate, the survey designers understood that the information requested had to be limited to data that:

- was readily available in school health services offices;
- would not require school nurses to conduct record reviews;
- would fit on one side of a page;
- was in aggregate form and not personally identifiable; and
- would not be used to identify individual schools or school districts.

In addition to setting these criteria, the survey designers relied on certain characteristics of school nurse staffing in Connecticut. Each school district is required to have at least one qualified school nurse or school nurse practitioner. While there is no mandate regarding additional staffing, Connecticut is estimated to have an approximate ratio of one school nurse to 550 students, ensuring the availability of professional nurse responders, rather than unlicensed assistants or other non-healthcare personnel. Another important characteristic is that the majority of large and urban school districts have school nurse supervisors who could be expected to understand the importance of and support the survey initiative. While the majority of smaller school districts do not have school nurse managers, alternate contact persons (usually a school nurse in the district or the administrator responsible for overseeing the school health services program) are identified on an annual basis by the State Department of Education. These contact persons are accustomed to receiving communications about school health and nursing services from both the State Departments of Education and

[14] The intent was to obtain data regarding students currently under care for asthma.

Public Health, and were generally expected to support the survey by passing it on to their school nursing staff. For the remainder of this report, the term "school nurse supervisors" will include both supervisors and contact persons.

Another important characteristic of school health services in Connecticut is that public school districts are required by Connecticut General Statutes, Section 10-217a, to provide "like" health services to private, nonprofit schools in their districts. Although certain restrictions apply to this mandate, school nurses and their supervisors in public school districts are generally responsible for providing services in the parochial and other nonprofit schools located within their communities. Through this mechanism, all or nearly all parochial schools, and some other nonprofit private schools in Connecticut, receive nursing services provided by public school districts. Therefore, these schools could be accessed through the same school nurse supervisors, simplifying the data collection process and providing a potential database of nearly all Connecticut kindergarten through 12th grade students.

The draft survey consisted of two one-page forms: The first form was the *Individual School Survey* form (see appendix A), and the second form was the *District Totals* form (see appendix B). The draft forms, along with a cover letter to explain the purpose of the survey and directions for completing the forms (see Appendix C), were shared with representatives of the Association of School Nurses of Connecticut and with three school nurse supervisors. Based on their feedback, the forms and cover letter were revised for clarity.

The primary purpose of the survey was to obtain individual school district data on the number of students known to have asthma at the elementary, middle, and high school levels. It was decided to collect K-8 student data separately in order to minimize the work required of school nurses. For data analysis purposes, however, the K-8 school data were added to the elementary data. It was also recognized from the outset that the designation "middle school" might mean grades 5 to 8, grades 7 to 9, or another configuration of "middle" grades, depending on the district. Data from some schools that were considered "middle schools" by the district, but had no students beyond the sixth grade level, were grouped with the elementary data, rather than with the middle school data.

In addition to requesting information about the number of students known to have asthma, school nurses were asked to provide information about the number of students receiving medication in school, by category of medication. It was hoped that these data might provide a way to estimate the severity of the disease among asthmatic students known to their schools. Finally, it was recognized that not all students with asthma are known to their schools or school nurses, particularly those at the high and middle school grade levels, and those students at all levels who do not need medication in school.

At the outset, study investigators determined that it was necessary to obtain data from at least 70 percent of school districts in each of the 9 Education Reference Groups (ERGs) in order to assure that the sample would be representative of each ERG's entire K-12 student population. (See "Data Analysis, Background" below for further information regarding ERGs.) To obtain that level of participation, all 169 school districts were asked to participate in the study. The study questionnaires and a cover letter explaining the study were sent out at the end of September, 1999. It was expected that, by this time in the school year, school nurses would generally know the number of students in their schools requiring monitoring, medication administration or other accommodation due to asthma.

The school nurse supervisors were asked to return the survey questionnaires (either the district totals form or all of the individual building forms) by the end of October. Although the initial response was excellent, the goal of 70 percent participation across ERGs was not met. Follow-up letters were sent on Nov. 30th to supervisors in all school districts that had not yet responded. They were asked to complete and return the forms by January 15th, 2000. By mid-January, over 66% of all districts had returned completed survey forms: 90% or better in 3 ERGs, 70% in 2 ERGs, and 50-60% in 4 ERGs. In February, the principal investigator began to contact by phone, and provide additional copies of the survey forms to, school nurse supervisors and, when necessary, individual school nurses in districts that had not yet responded.[15] While the follow-up activity was

[15] Fundamental to the sampling strategy was an investigator who was both knowledgeable about the operations of school health services programs and well known to school nurse supervisors and school nurses across the state.

targeted to districts essential for a 70 percent response rate in the 4 lowest-responding ERGs, phone calls were also made to non-responders in the other 5 ERGs. Efforts were made to obtain 100 percent participation across the 9 ERGs; these efforts continued until the end of April, 2000.

Follow-up calls were also made between February and April to all districts with missing or unusual data, districts with K-8 schools (due to confusion regarding this category of schools), and all districts that did not account for the total number of public and parochial schools in their communities. The latter information was obtained from the Connecticut Education Directory, a publication of the Connecticut State Department of Education. Finally, telephone calls were made in August, 2000 to school nurse supervisors in the few districts identified by statistical analysis of the data to have a high likelihood of error in the data they submitted. Errors in the data that were identified by this method were corrected and the data were re-analyzed.

2. Data Analysis

Background

Data collected from participating Connecticut school districts' elementary schools were analyzed according to five sets of variables. The first two were number of students and number of schools. The third set of variables used for analysis was the Education Reference Groups (ERGs), a classification system used by the Connecticut State Department of Education. This classification system groups together the school districts that have public school students with similar socioeconomic status (SES) and need. Grouping like districts together is useful to the Department of Education and the state's 169 local and regional public school districts in order to make legitimate comparisons among districts, including attention to district resources, student participation and student achievement.[16] This classification system was last updated in 1996, based in part on 1990 census data and 1994 state data for poverty and enrollment. There were seven variables used to categorize districts in 1996, all based on families with children attending

[16] Bureau of Research and Teacher Assessment, *Research Bulletin*, Hartford: Connecticut State Department of Education, November, 1996

public school. These variables were: family income, education of parent(s), occupation of parent(s), children 5-17 years receiving Aid to Families with Dependent Children, family structure, home language, and district enrollment. In the 1996 ERG system of classification, there are 9 education reference groups. As described by the Connecticut Department of Education, the groups run from "the very affluent, low need suburban districts of group A to the seven high need, low SES urban areas of group I".[17] See Figure 1 for a list of Connecticut public school districts in each ERG.

The fourth set of variables used for analysis was geographic location of districts by county. School districts were sorted according to the county in the state to which they belong. Connecticut has eight counties: Fairfield, Hartford, Litchfield, Middlesex, New Haven, New London, Tolland, and Windham. See Figure 2 for a map of Connecticut showing the geographic location of, and towns within, these counties. See Figure 3 for a map of the counties showing location and the number of elementary students included in the study analysis of variation by county.

The fifth set of variables included school districts categorized as urban, suburban and rural. The 1990 U.S. Census Bureau figures for Connecticut were used to group the 132 school districts with elementary schools. They were grouped by rural, suburban or urban according to the overall population of their town or city. While efforts were made to identify official state and federal definitions for each of these categories, none were found. As a result, the study investigators arbitrarily defined "urban" for Connecticut as those communities having an estimated population of 50,000 or more, "suburban" as having an estimated population of between 5,000 and 49,999, and "rural" as having a population of 4,999 or less. According to these criteria, 30 school district communities were classified as rural, 85 as suburban and 17 as urban. It is useful to note that, although there are a total of 169 towns and 169 public school districts in Connecticut, they are not exactly the same. The 169 school districts include 19 regional school districts and three endowed and incorporated high schools that serve public school students.

[17] Ibid.

FIGURE 1
SCHOOL DISTRICTS BY EDUCATION REFERENCE GROUPS (ERGS)

ERG A

Avon
Darien
Easton
New Canaan
Redding
Regional #9
Ridgefield
Simsbury
Weston
Westport
Wilton
Woodbridge

ERG B

Bethel
Brookfield
Cheshire
Fairfield
Farmington
Glastonbury
Granby
Greenwich
Guilford
Madison
Marlborough
Monroe
New Fairfield
Newtown
Orange
Regional #5
South Windsor
Trumbull
West Hartford

ERG C

Andover
Barkhamsted
Bethany
Bolton
Bozrah
Canton
Cornwall
Deep River
East Granby
Ellington
Essex
Hebron

ERG C (Cont'd)

Ledyard
Litchfield
Mansfield
New Hartford
Oxford
Pomtret
Preston
Regional #10
Regional #13
Regional #14
Regional #15
Regional #17
Regional #18
Regional #19
Regional #4
Regional #6
Regional #7
Regional #8
Salem
Salisbury
Sherman
Somers
Suffeld
Westbrook
Willington
Woodstock

ERG D

Berlin
Branford
Clinton
Colchester
Columbia
East Hampton
East Lyme
Hamden
New Milford
Newington
North Branford
North Haven
Old Saybrook
Regional #12
Rocky Hill
Shelton
Southington
Tolland
Watertown
Wethersfield
Windsor

ERG E

Ashford
Brooklyn
Canaan
Canterbury
Chester
Colebrook
Coventry
Cromwell
East Haddam
Eastford
Franklin
Hampton
Hartland
Kent
Lebanon
Lisbon
Norfolk
North Stonington
Portland
Regional #1
Regional #11
Regional #16
Scotland
Sharon
Union
Woodstock Acad.

ERG F

Bloomfield
Enfield
Groton
Manchester
Milford
Montville
Naugatuck
Seymour
Stonington
Stratford
Torrington
Vernon
Wallingford
Waterford
Windsor Locks
Wolcott

ERG G

Chaplin
East Haven
East Windsor
Griswold
North Canaan
Plainfield
Plainville
Plymouth
Sprague
Stafford
Sterling
Thomaston
Thompson
Voluntown
Winchester
Gilbert Academy

ERG H

Ansonia
Bristol
Danbury
Derby
East Hartford
Killingly
Meriden
Middletown
Norwalk
Norwich
Putnam
Stamford
West Haven
Norwich Free Acad.

ERG I

Bridgeport
Hartford
New Britain
New Haven
New London
Waterbury
Windham

FIGURE 2. CONNECTICUT MAP SHOWING ALL TOWNS AND COUNTIES

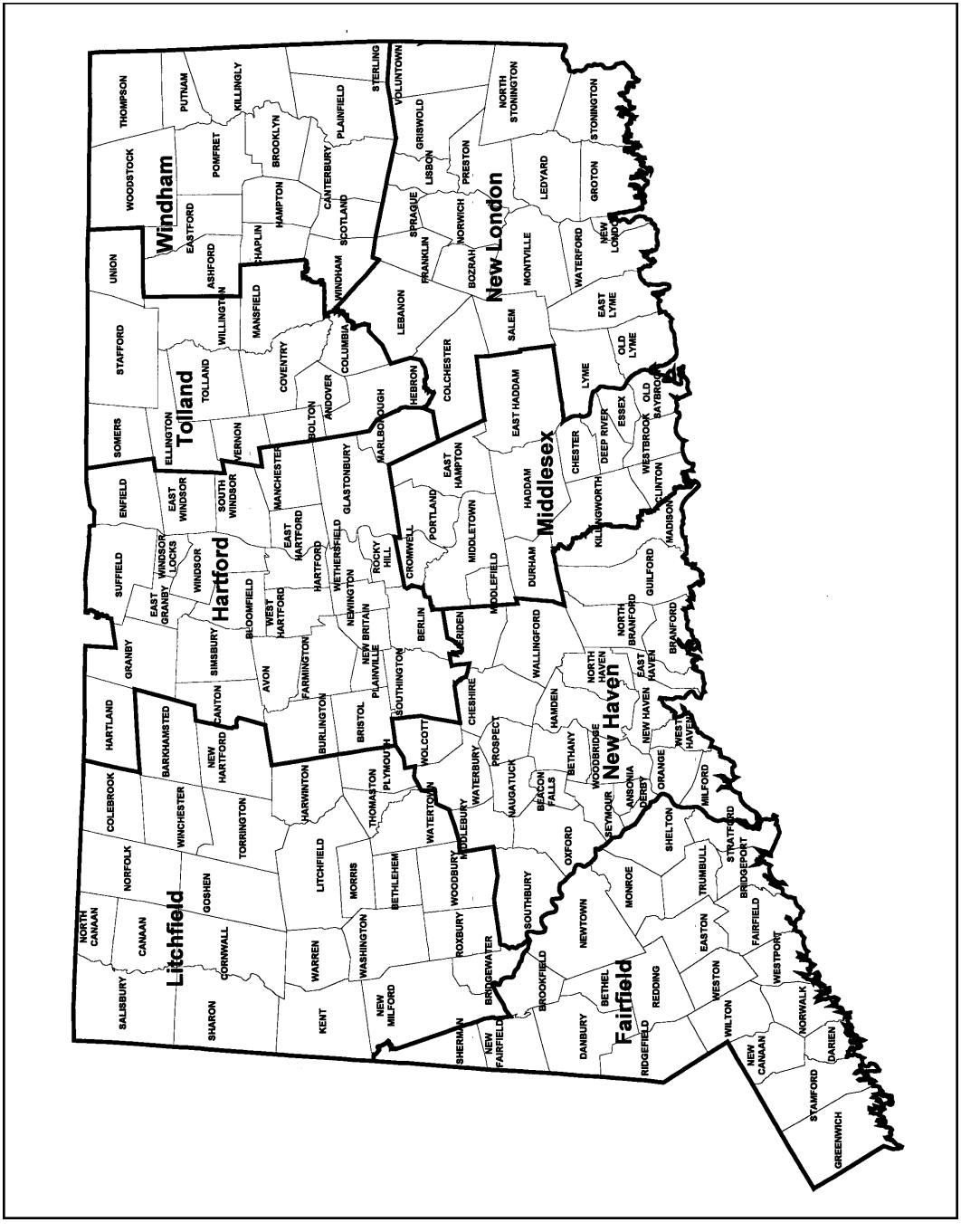
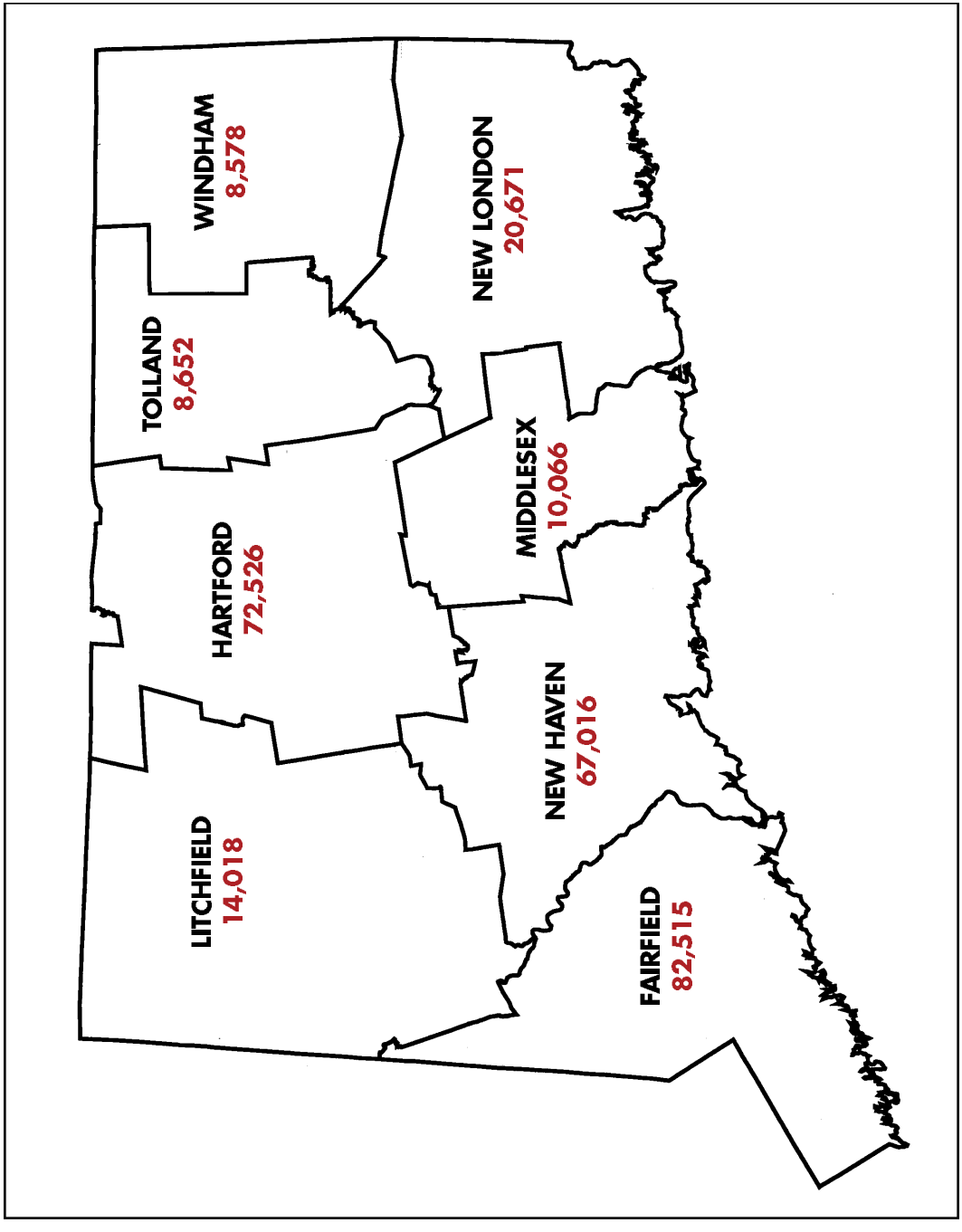


FIGURE 3. COUNTIES WITH NUMBER OF ELEMENTARY STUDENTS SURVEYED



STATISTICAL ANALYSIS

The objective of the analysis is to determine the prevalence of asthma in each category in order to evaluate the overall relationship between asthma rates and different variables. The unit of analysis in this dataset is a school district. This report presents our analysis of the asthma rates among students enrolled in elementary schools. Of the 138 school districts, 132 had elementary schools. Conceptually, we assume that each school district has its own "underlying" prevalence rate of asthma among its elementary school students, π_j, and that the observed number of elementary school students with asthma in that district represents a random observation from the binomial distribution with probability of a "success" equal to π_j and number of trials equal to the total number of elementary school students in the district. While we do not expect the observed prevalence rate of asthma, p_j, to exactly equal π_j, we assume that the difference is attributable to random sampling variability, which diminishes as the total number of elementary level students in the district increases. To estimate how the prevalence rates vary by county urban-rural status, and socioeconomic status (SES) of the school district, we fit a logistic regression function to the observed prevalence rates, under the assumption that

$$\ln\{\pi_j / (1-\pi_j)\} = f(\text{predictor variables}).$$

County (n=8), urban/rural status (urban, suburban, rural), and SES (9 categories) are treated as categorical variables, as in an analysis of variance. Additional analyses treat SES as a continuous variable, along with the number of elementary schools and the number of elementary school students in the school district.

To summarize, we fit a logistic regression model to the prevalence rates under the assumption that the residuals have a binomial distribution. Maximum likelihood estimates of this generalized linear model[18] are obtained using PROC GENMOD in version 7 of the SAS statistical software.

[18] McCullagh, P. and Nelder, J.A. (1989), Generalized Linear Models, 2nd Edition, New York: Chapman and Hall.

FINDINGS

GENERAL FINDINGS: ALL STUDENTS

The final response rate across all school districts and ERGs was 81.6%, with a range among ERGs from 74% to 100%. See Table 1 below.

TABLE 1
PERCENT OF DISTRICT RESPONDERS BY EDUCATION REFERENCE GROUP

ERG	NO. DISTRICTS PARTICIPATING	TOTAL DISTRICTS IN ERG	FINAL PERCENTAGE
A	11	12	91.6
B	14	19	73.6
C	28	38	73.6
D	19	21	90.4
E	20	26	76.9
F	13	16	81.3
G	12	16	75.0
H	14	14	100.0
I	7	7	100.0
ERGS A-I	**138**	**169**	**81.6**

According to the Connecticut State Department of Education, in the fall of 1999 Connecticut public schools had a total of 543,475 students in grades kindergarten through 12 (K-12).[19] In addition, private, nonpublic schools had 76,898 students enrolled in the K-12 grades. Of the total population of 620,373

[19] Personal communication with Allison Zhou, CT State Department of Education, April, 2000

K-12 Connecticut public and nonpublic school students at that time, data regarding asthma were collected on 513,688 students, or 83% of all Connecticut students in grades K-12. These students were located in 1027 different schools, representing close to 85% of combined public schools (1073) and parochial schools (128) in the state. Of the 513,688 K-12 students for whom data was collected, 44,571 (or 8.7% overall) were known by their school nurses to have asthma. See Table 2 for the percent of these students known to their school nurse to have asthma by grade level.

TABLE 2 BY GRADE LEVEL, PERCENT OF SURVEYED STUDENTS KNOWN TO THEIR SCHOOL NURSE TO HAVE ASTHMA

7.8% at the elementary level
10.2 % at the middle school level
9.4 % at the high school level

Of the 44,571 Connecticut students at all grade levels who were known by their school nurses to have asthma, approximately half (47% overall) had a medical order for asthma medication in school, either on an "as needed" basis or daily. In keeping with the expectation that high school students may report less information about their diagnoses and medications, the data divided by grade level revealed that, of students known to their school nurses to have asthma, the percent of those who had orders for medication in school was:

TABLE 3 BY GRADE LEVEL, PERCENT OF SURVEYED STUDENTS WHO HAVE MEDICATION ORDERS

54% at the elementary level
52% at the middle school level
29% at the high school level

Data regarding the types of medication prescribed were not further analyzed.

Detailed Findings: Elementary Students

Due to greater variability in the data at the middle and high school levels, it was decided to further analyze only data from the elementary schools. This data represents 284,042 elementary school students included in the survey. They attended school in 132 of the 138 districts that participated in the survey.[20] Although the 50,371 K-8 school students in this group include a relatively small number of middle school students, omitting these schools would have left out a sizable number of elementary students attending K-8 public schools in urban districts, and those attending K-8 parochial schools in urban and suburban districts. Therefore, data from the K-8 schools were included in the elementary data.

Rates of asthma among elementary school students range from a low of over 3% to a high of just under 14%, with all but seven districts between 4 and 12%. The mean for elementary students in the state is approximately 7.8%.

In order to test which variables are most closely related to asthma prevalence rates among school-age children in this state, a statistical analysis of variance was carried out. Those variables most closely associated with observed prevalence rates have a higher percent of R^2. Analysis of the variation in rates based on the five variables for which data are available (urban/rural; county; ERG; number of schools and number of students) demonstrates that much of the variation between districts can be explained by these five variables (Overall R^2 = 45.6%). The effect of each variable, however, is different, as shown in Figures 4–8. Somewhat surprisingly, there is very little difference when comparing urban versus suburban and rural schools (R^2 = 4.4%) (Figure 4). Neither the number of schools nor the total number of students in the district was a strong predictor of asthma rate (R^2=6.5% and R^2=6.0%, respectively) (Figures 5–6). There is a larger variation by ERG and county (R^2=19.3% and R^2=27.7%, respectively) (Figure 7 and Figure 8).

[20] There were 133 districts with elementary schools, but one was eliminated from the analysis due to a very low number of students and very high number of asthma cases that could not be confirmed.)

FIGURE 4

Prevalence of Asthma Among Elementary School Students by Rural/Suburban/Urban Status

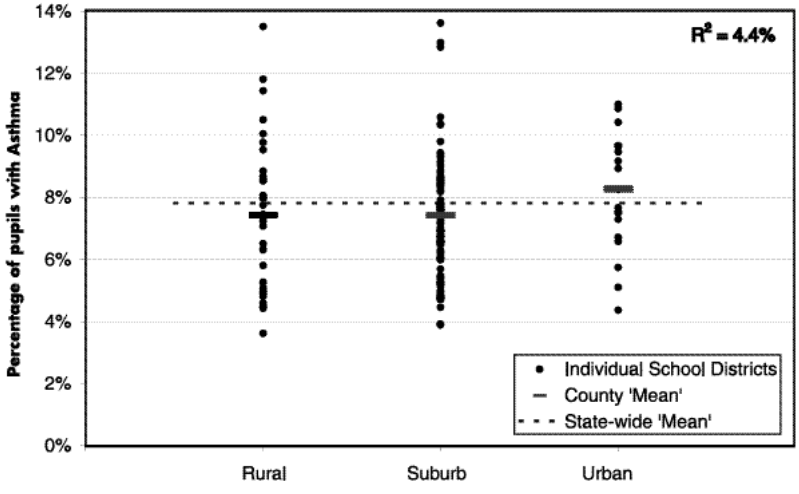


FIGURE 5

Prevalence of Asthma Among Elementary School Students by Number of Elementary Schools in District

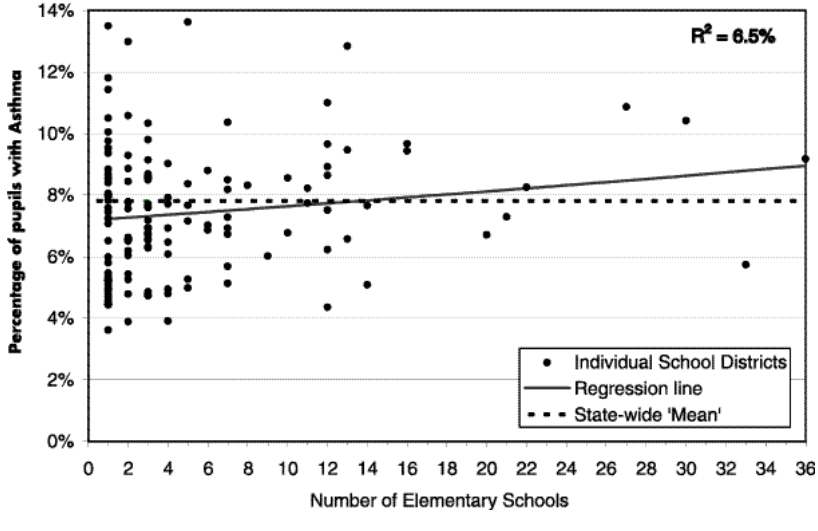


FIGURE 6

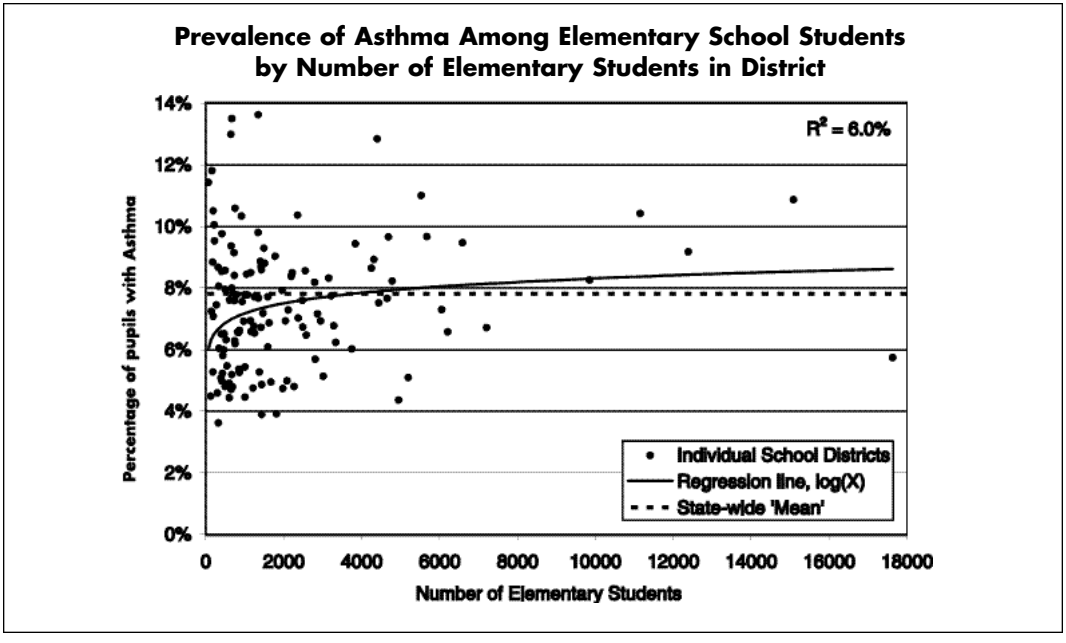


FIGURE 7

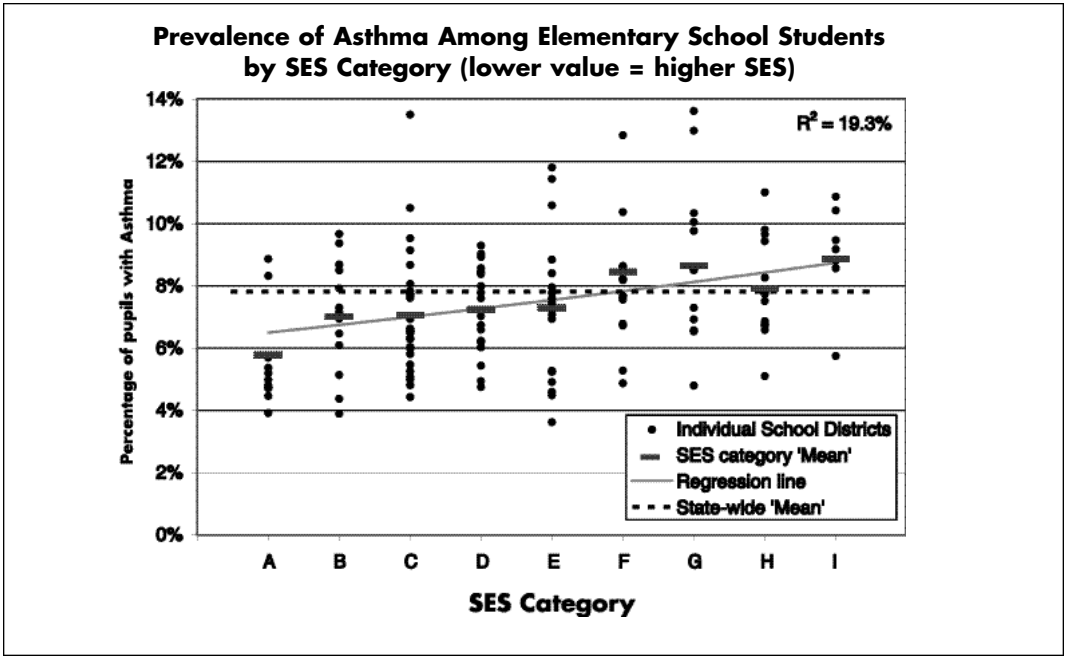
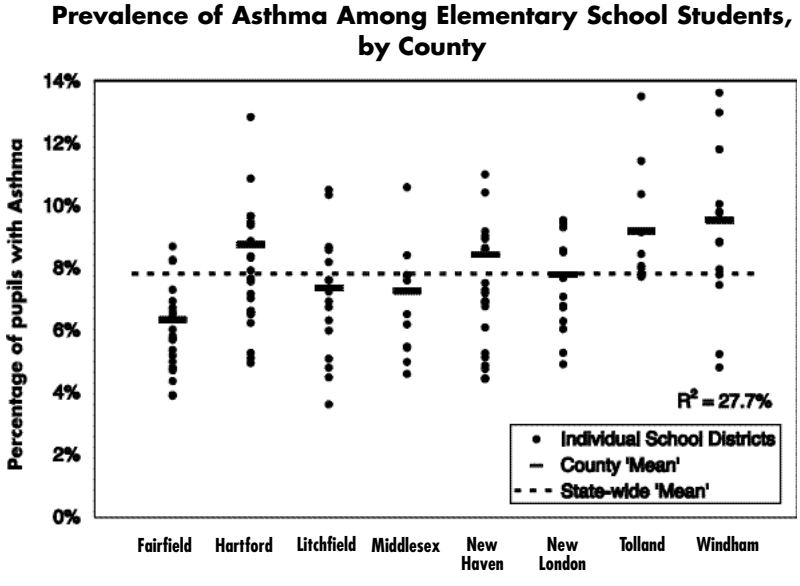
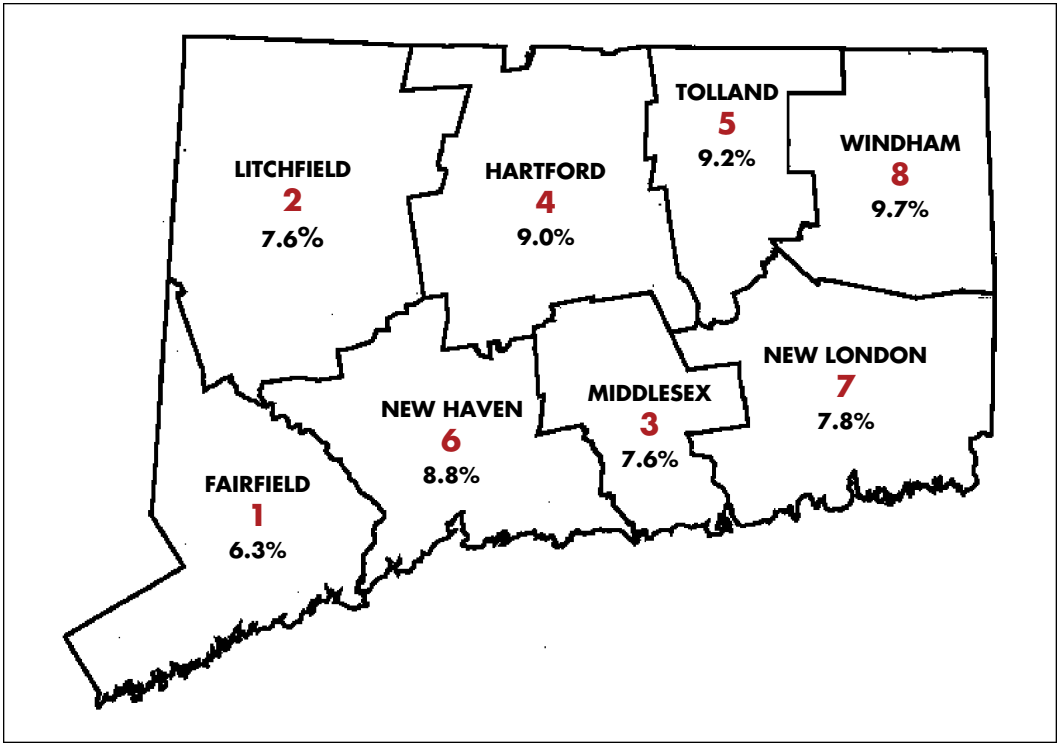


FIGURE 8



As can be seen in Figure 7, there is an apparent stepwise increase in the mean rates of asthma as one descends the ERG scale, with the best ERG group having a mean rate of about 5.5%, and the worst, almost 9%. Similarly, variation is seen in the comparison by county (Figure 8). This shows that the counties with the lowest asthma prevalence rates – Fairfield, followed by Middlesex and Litchfield — have rates of 6.3% and 7.6% respectively, whereas the counties with the highest asthma prevalence rates — Windham and Tolland— have rates of 9.7% and 9.2%, with the remaining 3 counties ranging from the State mean of 7.8% to 9%. See Figure 9 for a map of the counties showing asthma prevalence rates of elementary students by county, and county ranking by per capita income. As with the ERG results, these findings appear to follow the pattern of socioeconomic level to a far greater degree than other possible geographic relationships, such as proximity to industry, agriculture or the major highway systems that traverse the state. Understanding such relationships will require further analysis.

FIGURE 9 CONNECTICUT COUNTY MAP SHOWING ASTHMA PREVALENCE RATES OF ELEMENTARY STUDENTS BY COUNTY AND COUNTY RANKING BY PER CAPITA INCOME (U.S. CENSUS BUREAU, 1990).



DISCUSSION

Study investigators believe that three key factors strongly influenced the high level of school district participation in the study. The first factor was that the Principal Investigator, hired by EHHI to design and conduct the survey, had been the school nurse consultant at the State Department of Education for the 10 preceding years. Her knowledge of school districts and school health services programs, and her working relationships with school nurses and their supervisors statewide were essential. They helped in developing a questionnaire that would target data which school nurses have readily available in their offices, and in

obtaining the positive responses of school nurses and supervisors both to the survey and follow-up phone calls. The second key factor in obtaining widespread participation was the promise that data would only be reported in aggregate form. Specifically, it was promised that no data from individual school buildings and individual school districts would be identified in the survey report. A third critical factor appeared to be high motivation among school nurse supervisors and school nurses to contribute to health promotion and disease prevention efforts related to the most common chronic health problem of Connecticut school children. It was also remarkable – and important – that school nurse supervisors had maintained documentation of the original school-by-school data up to ten months after first completing the survey forms and, when contacted, were willing to review them for potential errors.

Some variation in the data may result from the factors highlighted below.

- Students who do not require medication or other nursing services or classroom accommodations during the school day are less likely to be known to school nurses than those who do require in-school services. Students with asthma at the mildest end of the spectrum, therefore, are less likely to be known to school nurses than those with moderate to severe asthma who require accommodations and services in school, especially at the elementary level.

- Some variation among school districts is likely due to the time of year when the data were collected in the first place and when missing and corrected data were obtained. By reports of school nurses, the number of asthma cases known to school nurses increases between the fall and winter months related to the onset of cold weather, increased numbers of upper respiratory infections among students, increased need for medication in school, and increased number of students actually diagnosed. These reports appeared valid when investigators were checking on data that had been collected in the fall and, in telephone follow-up, found that the number of asthmatic students known to school nurses had increased by the winter and spring months. For example, the number of known asthmatic elementary school students in an ERG H school district rose from 318 in the fall to 360 by the end of February, increasing the prevalence rate among those students from 10% to 11%. Thus, it is important to plan data

collection for this type of study in the spring, when possible, and to identify when data are collected.

- It was anticipated and substantiated by study data that high school, and to a lesser degree middle school data might be more variable. First, students at these levels and their families are less likely than elementary school students and families to report to school nurses the diagnosis of asthma and medications they may be taking. This pattern follows a general trend in schools for parental reporting of chronic health conditions that is generally highest at the elementary level and lowest at the high school level. This may be due to a combination of students' increasing independence, competence in self-care, and desire for personal privacy, along with concerns (founded or unfounded) regarding the impact of their diagnosis on eligibility to play sports or participate in other school and extracurricular activities. On the other hand, while there may be less reporting in that respect, school nurses are more likely with higher grade-level students to incorporate past history information (e.g., from school health records) in their determination of students' current asthma status.

- Some student populations may have more asthmatic students who have never been properly diagnosed than others, particularly those that do not have adequate access to primary and specialty health care services. School nurses, particularly in the urban districts, reported that identification and referral of undiagnosed students for medical evaluation and treatment was not uncommon.

- While data regarding the prevalence of asthma among students in four of six Regional Education Service Centers (RESCs) were collected, they were not included in the study analysis, including the totals, because students in the RESCs actually reside in multiple communities within the RESC region. These six regions are not the same as the state's eight counties. Also, private-approved special education schools were not included in the survey unless they were receiving school nursing services through the public school program in the community in which they are located.

- Some variability may be due to differences in the perceptions and practices of school nurses regarding asthma and the survey. For example, some school

nurses reported conducting a more in-depth record review than others, even though it was stated in the cover letter that such a review should not be necessary. Since no definition of asthma was provided, school nurses or their supervisors were each left to interpret the meaning of "students diagnosed with asthma." Finally, some school nurses may have been more likely than others to aggressively pursue parents and students for information regarding current health status and medication orders based on past medical histories or other data, while others may have provided more educational programs related to asthma.

Despite these potential limitations intrinsic to such ecologic data, there are compelling reasons to believe the major findings. At the most basic level, there is strong a priori reason to believe that among grade school students who have more than the very mildest form of asthma, the reporting is likely to be uniform, accurate and complete (content validity) because parents of younger students generally inform the school nurse when their child has a chronic health condition that may need health monitoring, classroom accommodation, medication, or other treatment or emergency intervention in school. At the empirical level, the internal consistency in the data, with remarkably few outlying or impossible values obtained, as well as the fact that such a high proportion of all variation is explicable by five ecologic variables, points to the validity of the results (internal validity).

The finding of only small differences between urban and non-urban school districts was surprising in view of literature that has highlighted the problem of asthma in the cities. Unlike some of these reports, our data suggest that relative deprivation, rather than some factor intrinsic to the urban environment or population, is far more strongly correlated with the rate of disease, although there might be unmeasured differences in severity of the asthma between urban and non-urban districts, or other characteristics that cannot be evaluated by the available information. Another surprise in the data is the lack of any obvious association between geographic proximity to sources of air pollution, either industrial, agriculture, or related to automobile use. Again, the pattern by county appears more closely linked to the affluence of the county, than to local sources of pollution. Of course, it must be emphasized than many of the more

important aspects of outdoor air quality are regional— i.e., affecting the whole state—and cannot be evaluated by any internal comparisons here. Moreover, as with the urban question, unmeasured differences in severity of other effects of local pollution would escape analysis in our data set.

The overwhelmingly most striking finding in our study is the continuous effect of the socioeconomic factors in relationship to asthma prevalence, rather than an effect of poverty per se. In other words, although there is an almost doubling of prevalence between the poorest and richest districts, those in between have rates that rise continuously, similar to patterns of many other chronic diseases. From our data, it would seem correct to conclude that the asthma epidemic is widespread, with prevalence falling as a function of relative prosperity.

Although the qualities of indoor environments at home and school, as well as local outdoor environments, raise themselves as obvious contenders to explain observed differences, one can only speculate on the causes. Ethnic or other factors intrinsic to the different populations who live in different towns could be important, but do not explain the variance based on our data. Whatever the cause for the differences, it is important to point out that, if the factors which actually are causing more asthma in the poorer districts could be identified and eliminated, bringing the rate of asthma down to 6%, as in the best strata in our data, as much as 1/4 to 1/3 of all asthma in Connecticut's primary school children could be prevented.

In order to achieve a fuller understanding of the underlying causes of asthma and their interrelationships, collaborative action among researchers, legislators, health care providers and consumers, and public and private agency leaders at the state and local level, in concert with the U.S. Centers for Disease Control, is critical. Once the real prevalence of asthma can be identified and tracked, and its causes are better understood, Connecticut will be in a better position to target available resources to (1) the identification of prevention and intervention strategies that are most effective, and (2) their delivery to high-risk groups.

RECOMMENDATIONS FOR THE STATE OF CONNECTICUT

Environment and Human Health, Inc. has four recommendations for the State of Connecticut as a result of this asthma study. They are:

1. The state should establish a system for tracking the prevalence of asthma in Connecticut.

2. The legislature should provide funding for this tracking system so that it may be put in place and not become an unfunded mandate.

3. The state should investigate what factors are contributing to the differences in the prevalence rates of asthma among the different socioeconomic groups in Connecticut.

4. The state should target resources to those areas in the state that are shown to be the most heavily impacted.

Recommended Model for a Tracking System

1. Data should be collected using methods similar to those used in this study. The reasoning behind this is that, for most reportable diseases in Connecticut, it is laboratories that provide the data. Since asthma is not diagnosed by laboratory tests, a different system of tracking needs to be developed. Because school nurses can readily provide asthma prevalence data for school-age children, it makes sense to use them as the bases for the asthma tracking. Collectively, school nurses can provide statewide student asthma data.

2. Although a school-based system will not include data regarding the prevalence of asthma among the adult population, it will highlight changes in the prevalence of asthma among school age children. Data regarding trends in the prevalence of asthma among school age children will give the state an indication of the overall asthma trends and will also provide the state with sufficient information to make decisions regarding budget and resource allocation.

3. School-based asthma data collected by school nurses should be submitted to the: (a) local board of education, (b) local health department, (c) State Department of Education, and (d) State Department of Public Health. These reports should be submitted annually , preferably by the end of April.

APPENDIX A. INDIVIDUAL SCHOOL SURVEY

ASTHMA PREVALENCE IN CONNECTICUT SCHOOL AGE CHILDREN
INDIVIDUAL SCHOOL SURVEY - Fall, 1999
Environmental and Human Health, Inc.

Name of School _____ # Students * _____ District _____

Check One: (A) Elementary _____ (B) Middle/Jr. High _____ (C) High _____ (D) K-8 _____

Check One: Public ____ Non-Profit ____ Telephone # _____

School Nurse filling out form (give name): _____

*** Do not include preschoolers in count**

Please Note: Items F – J relate **only** to prescriptions for **in-school** medications.

E. Total # students diagnosed with asthma* *** Do not include preschoolers**	**E.** _____
F. Of students in **E,** total # with a prescription only for PRN bronchodilators (non-nebulizer)	**F.** _____
G. Of students in **E,** total # with a prescription only for daily bronchodilators (non-nebulizer)	**G.** _____
H. Of students in **E,** total # with a prescription only for daily anti-inflammatory medication	**H.** _____
I. Of students in **E,** total # with a prescription for daily anti-inflammatory medication AND a bronchodilator (non-nebulizer)	**I.** _____
J. Of students in **E,** total # with a prescription for PRN bronchodilator by nebulizer	**J.** _____
K. Of students in **E,** total # with a prescription for daily bronchodilator by nebulizer	**K.** _____

Please return this school survey to your school nurse supervisor by October 20, 1999.
Thank you for your assistance in conducting this important survey.

APPENDIX B. DISTRICT TOTALS

ASTHMA PREVALENCE IN CONNECTICUT SCHOOL AGE CHILDREN

DISTRICT TOTALS - Fall, 1999

Environmental and Human Health, Inc.

School District_____ School District Code #_____

 # Schools in District: Elementary _____ Middle/Jr. High _____ High _____ K-8 _____

A. Total # elementary students served in district * * **Do not include preschoolers in count**	Public schools: _____ Non-profit schools: _____ **Total (A):** _____
B. Total # of middle/jr. high students served in district* * **Do not include preschoolers in count**	Public schools: _____ Non-profit schools: _____ **Total (B):** _____
C. Total # of high school students served in district* * **Do not include preschoolers in count**	Public schools: _____ Non-profit schools: _____ **Total (C):** _____
D. Total # of K-8 school students served in district* * **Do not include preschoolers in count**	Public schools: _____ Non-profit schools: _____ **Total (D):** _____
E. Total # students diagnosed with asthma* * Based on students included in **totals** of A-D above	Elementary (K+) _____ Middle/Jr. _____ High _____ K-8 _____
F. Total # students in **E** with a prescription only for PRN bronchodilators (non-nebulizer)	Elementary (K+) _____ Middle/Jr. _____ High _____ K-8 _____
G. Total # students in **E** with a prescription only for daily bronchodilators (non-nebulizer)	Elementary (K+) _____ Middle/Jr. _____ High _____ K-8 _____
H. Total # students in **E** with a prescription only for daily anti-inflammatory medication	Elementary (K+) _____ Middle/Jr. _____ High _____ K-8 _____
I. Total # students in **E** with a prescription for daily anti-inflammatory AND bronchodilator medication (non-nebulizer)	Elementary (K+) _____ Middle/Jr. _____ High _____ K-8 _____
J. Total # students in **E** with a prescription for PRN bronchodilator by nebulizer	Elementary (K+) _____ Middle/Jr. _____ High _____ K-8 _____
K. Total # students in **E** with a prescription for daily bronchodilator by nebulizer	Elementary (K+) _____ Middle/Jr. _____ High _____ K-8 _____

APPENDIX C.

September 28, 1999

Dear School Nurse Supervisor:

Our non-profit organization is conducting a brief survey of Connecticut school age children to better understand the prevalence of asthma in kindergarten through 12th graders across the state. The data collected should (1) enhance our knowledge regarding the prevalence of asthma in different age groups and different areas of the state and (2) provide a basis for further inquiry by medical, public health and environmental scientists regarding causes, as well as prevention and intervention strategies.

We are asking schools to participate because they are the one setting in which all school age children can potentially be captured and because school nurses have the information readily available. The survey differentiates among children with different medication regimes in order to provide insight regarding the severity of asthma among those affected. The information may also be useful to school district administrators in communicating to others the potential impact of this health condition on student learning and student support services. Results of the survey will be shared with school districts.

Two forms have been designed to collect this data – one for each school building (the *Individual School Survey* form) and one for summing the district totals of individual school data (the *District Totals* form). Each form is contained on one side of a page. These forms ask only for data that your school nurses should already have at their fingertips; record reviews are not required, nor is personal identifying information. School nurses should be able to fill out the *Individual School Survey* form in approximately 5 minutes per building. Summing the totals for the "District Totals" form, should you choose to do this, will take longer, but is not difficult.

You can choose to return only the district totals, in which case you will need to sum the numbers from each of your schools on the *District Totals* form. Alternatively, you can fill in only the top portion of the *District Totals* form (identifying data), and send it with all of the *Individual School Survey* forms to us for tabulation. Instructions are included on the reverse side of the *District Totals* form. Please call me at (203) 795-0652 if you have any questions.

Thank you for your assistance in this important public health endeavor. We hope that all school districts will participate so that the information will be uniformly useful to school districts, public health officials, researchers, primary health care providers, state officials, parents, and other interested persons. Best wishes for a productive and healthy school year.

Sincerely,

Nadine C. Schwab, RN, MPH, FNASN
Asthma Project Consultant

APPENDIX C. (Cont'd) DIRECTIONS FOR RETURNING SURVEY FORMS

Please return the District Totals survey form no later than November 3, 1999, with either:

1. All of the totals tabulated and filled in on the front side, or

2. The district identifying information (above the table of survey questions) filled in, plus a completed form for each of the public and non-profit schools that receive health services in your district.

Please send to:

Nadine C. Schwab
Asthma Project Consultant
Environment and Human Health, Inc.
831 Oakwood Road
Orange, CT 06477

Thank you for your assistance with this important survey.

ENVIRONMENT AND HUMAN HEALTH, INC.

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Russell L. Brenneman, Esq. A Connecticut environmental lawyer, has served in many public policy capacities, including chairing the Connecticut Energy Advisory Board and the Connecticut Greenway Committee and serving as president of the Connecticut Resource Recovery Authority. Former chairman of the Connecticut Bar Association and serves as an elected member of the International Council on Environmental Law.

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John Wargo, Ph.D. Director of Doctoral Programs at Yale University's School of Forestry and Environmental Studies. Director of the Yale Center for Children's Environmental Health; Associate Professor of risk analysis and environmental policy. Author of *Our Children's Toxic Legacy*, which won the American Association Publisher's competition as best scholarly and professional book in the area of government and political science in 1997.

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