Decreased prevalence of asthma among farm-reared children compared with those who are rural but not farm-reared

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Background: Farm exposure has been associated with decreased asthma prevalence.

Objectives: We compared asthma prevalence among rural farm-reared and non–farm-reared children and examined farm demographic and environmental factors.

Methods: We performed a cross-sectional, population-based survey among 36,500 rural kindergarten through 12th grade school children. Surveys were distributed through schools and returned by mail.

Results: Of the 4152 participants, 18% had lived or were currently living on a farm. Compared to other rural children, farm children had more siblings (3.0 vs 2.5; $P < .015$), were more likely to be breast-fed (64% vs 58%; $P < .002$), to have pets (88% vs 79%; $P < .001$), and were less likely to have attended daycare (39% vs 50%; $P < .001$). Farm-reared children were less likely to have had a history of wheezing (28% vs 34%; $P < .003$) or a diagnosis of asthma (22% vs 26%; $P < .002$). This effect was greater among children younger than 10 years of age than among older children. There was no difference in the frequency of either asthma or non-asthma allergy symptoms during the previous 12 months. When analyzed by age and sex, decreased asthma prevalence was associated with farm rearing among younger children more than among adolescents. Farm residence beginning during the first 5 years, but not later, was associated with decreased rates of ever asthma (23.7% vs 33.7%; $P < .005$).

Conclusions: Asthma, but not other manifestations of allergy, is less commonly reported among farm-reared children. Early exposures may be more important than those occurring later. Without ongoing exposures, their effects on disease expression may diminish over time. (J Allergy Clin Immunol 2005;115: 67-73.)

Key words: *Asthma, allergy, farm, epidemiology, childhood*

Abbreviations used

ECRHS: European Community Respiratory Health Survey
ISAAC: International Study of Asthma and Allergies in Children
K-12: Kindergarten through 12th grade
LRI: Lower respiratory illness
MSA: Metropolitan statistical area
OR: Odds ratio

Investigators in Europe, Australia, and Canada have reported that farm-reared, as opposed to either urban or rural non–farm-reared, children have a decreased prevalence of wheezing, asthma, and, in some cases, allergic rhinitis.[1-7] The International Study of Asthma and Allergies Among Children[8] (ISAAC) and the European Community Respiratory Health Survey[9] (ECRHS), among others,[10] have demonstrated dramatic differences in the prevalence of asthma between and even within countries.[10,11] Higher rates of asthma and atopy have been consistently associated with both westernization and urbanization.[12,13]

Factors that contribute to the clinical expression of asthma have been identified, in part, from comparisons of asthma prevalence across populations.[14,15] There is reason to believe that differences in asthma prevalence are due to environmental differences.[16,17] Most studies of asthma among children on farms have found that the frequency of wheezing, asthma, and other indices of atopy are decreased compared to other groups of children. Neither a ''healthy farmer'' effect nor genetic differences appear to explain these findings. These studies have suggested that specific environmental and demographic factors unique to a farm setting may be important in the induction or the expression of the asthma phenotype and further suggest that the timing of these exposures may be critical in determining their effect on the subsequent expression of asthma.

Studies that have compared children reared on farms to those reared in both urban and rural non-farm areas have shown significant differences in both the immediate environment and lifestyle in terms of family size, exposure to livestock and pets, dampness, molds and dust, methods of heating and cooking, environmental tobacco smoke exposure, and dietary habits.[2,18,19] The prevalence of asthma among non-urban children in the United States has not been studied extensively.[7,20] Furthermore, studies done in Europe and elsewhere may not be applicable to

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Supported by Children's Hospital Foundation, Medical College of Wisconsin.

Received for publication May 31, 2004; revised October 1, 2004; accepted for publication October 4, 2004.

Available online November 19, 2004.

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0091-6749/$30.00

doi:10.1016/j.jaci.2004.10.008

TABLE I. Characteristics of rural school children by participation status

	Participants* 4152 (97.8%)	Refusals 95 (2.2%)	95% CI for differences (%)
Age (mo)	120.9 ± 38.3	124.7 ± 35.4	9.1-17.1
Current residence			
In town	25.9% (1051)	18.3% (17)	−0.4 to 15.6
Out of town	61.5% (2497)	74.2% (70)	−21.8 to −3.4
On a farm	12.7% (515)	7.5% (7)	−0.3 to 10.6
Ever lived on a farm	18.4% (3392)	12.8% (12)	−1.2 to 12.5
History of wheeze/whistle in the chest	33.0% (1352)	25.5% (24)	1.2-16.7
Been told by doctor wheeze or asthma	25.8% (1063)	16.8% (16)	−1.5 to 16.4
Taken medications for asthma	28.1% (1156)	20.0% (19)	0.0-16.3
Has allergies†	35.7% (1439)	27.4% (26)	−0.7 to 17.4

*Not all participants responded to all questions.
†See text for definition of variable.

the farming population of the US, where farming and the attendant lifestyle may be significantly different from those typical in Europe. This study examines the prevalence of asthma and allergies in a large sample of rural school children in Wisconsin.

METHODS

A population of non-urban school children was identified by using Wisconsin state educational data. Rural school districts were identified through the Wisconsin Department of Education School Database and the National Center for Educational Statistics.[21] The eligible rural population was defined on the basis of metropolitan statistical area (MSA) codes (US Department of the Census). MSA codes designate a school's location relative to census population areas. MSA codes are numbered 1 to 8, with 1 denoting a district within a central city with a population of greater than 250,000. The following codes were used to define the eligible population: (1) MSA 6, "small town," defined as "a town not within an MSA and with a population of less than 25,000 and greater or equal to 2,500 people"; (2) MSA 7, "rural outside an MSA," defined as "a place with less than 2,500 people and coded rural and outside an MSA" by the census bureau; and (3) MSA 8, "rural inside an MSA," defined as "a place with less than 2,500 people and coded rural and inside an MSA" by the census bureau.

School district administrators were contacted by mail and then phone to solicit participation. If the administrator agreed, a short phone questionnaire was administered to ensure the rural character of the district. Questions included (1) Is agriculture a major industry in the district?, (2) Over the last 5 years, has the district become more urban or suburban?, and (3) Do most parents of students work outside of the district? If the administrator responded affirmatively to question 1 and negatively to questions 2 and 3, we determined that the district represented a rural population, and the administrators were solicited to have their districts participate in the survey.

Survey packets contained an introductory letter, a parental consent form, and a postage-paid reply envelope. Survey instruments were based on the written ISAAC questionnaires,[22,23] to which were added questions about the family's residence at the time of the child's birth, during the first 5 years, after age of 5, and the area of current residence, whether urban, rural non-farm, or farm.

Study materials included a core questionnaire that asked for the following information: subject age, sex, whether the child attended daycare for at least ½ day for at least 3 months, whether the child was breast-fed at least ½ of all daily feeding: for a period of at least 1 month, whether there were current smokers in the child's home, whether the family lived "in town" in a rural area, "out of town but not on a farm," or "on a farm" when the child was born, between birth and 5 years of age, and after 5 years of age, and the number of years in each environment. We asked in which environment the family lived at the time they filled out the questionnaire. Of those families on farms, we sought to determine whether there were livestock and silage present. We used questions taken from the ISAAC questionnaire to determine the presence of wheezing, asthma, nasal or ocular allergies, or eczema.[24] In addition, we asked whether the subject child had had a recurrent cough or wheeze or a lower respiratory tract illness ("infection in the chest; pneumonia, bronchitis, RSV [respiratory syncytial virus], or bronchiolitis") during the first 2 years of life.

We also included age-specific ISAAC questionnaires. Those younger than 10 years of age were asked to fill out the questionnaire designed for younger children and those equal to or older than 10 years were asked to fill out the questionnaire designed for older children. Parents were asked to fill out both the core and the age-appropriate questionnaires. If they declined to participate, we asked them to fill out the core questionnaire and return it. Packets were sent to the schools and distributed by teachers to all of the students in the eligible districts during May and June 2003. The study was approved by the Institutional Review Boards of the Children's Health System and Medical College of Wisconsin.

Data analysis

Categorical data were analyzed with the "crosstabs" procedure, SPSS 11.0 (SPSS Inc, Chicago, Ill). Differences between continuous variables were evaluated with the Student independent t test. Variables that were associated ($P < .10$) with outcomes of interest were included in a multiple logistic regression model. Variables were entered in a conditional, forward, stepwise manner (criteria for inclusion, $P < .10$ and for exclusion, $P < .15$). Variables were checked for colinearity. Variables with an r^2 of less than 0.50 were considered independent. A list of the variables that were evaluated is summarized in Table I. Farm residence was based on a non-0 response to any one of the 3 questions regarding how long the family lived on a farm when the child was born, during the child's first 5 years of life, or when the child was older than 5 years, or a response stating that at the time of the study, the family lived on a farm.

RESULTS

Of 114 eligible school districts identified as rural, 72 participated (63.2%). Of those that did not participate, 20 schools (47.6%) were considered not to be rural by the administrators. Three (7.1%) declined because of concerns about privacy. Four (9.5%) declined because of lack of time, lack of administrator or school board interest, or