

Prevalence of Asthma Among Youth on Hispanic-Operated Farms in the United States—2000

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ABSTRACT. The objective of this study was to estimate prevalence of asthma and asthma attacks among youth (0–19 years old) working and/or living on Hispanic-operated farms. The 2000 U.S. Minority Farm Operator Childhood Agricultural Injury Survey (M-CAIS) data were used to calculate prevalence of asthma, asthma attacks and serious asthma attacks among youth (0 to 19 years) living on Hispanic-operated farms. Age-specific asthma prevalence rates with corresponding 95% confidence intervals (CIs) were calculated for working and nonworking youth. In 2000, an estimated 17,573 youth lived on Hispanic-operated farms; 7.4% had asthma ever diagnosed, 8.1% had an asthma attack while at work in the last year, and 1.4% had a serious asthma attack. Asthma prevalence was highest among youth aged 16–19 (9.1%), males (8.6%), and those driving tractors (9.7%). Serious asthma attacks that required an emergency room visit or hospitalization in the last year were most prevalent among youth aged 0–9 years (1.8%), males (1.7%), and those riding horses (1.7%). Compared with nonworking youth, prevalence of asthma (8.9% versus 6.1%; $p < .05$) and serious asthma attacks (1.6% versus 1.3%; $p > .05$) was higher among working youth. Prevalence of asthma attacks in the last year while at work was also significantly higher among males than females (8.6% versus 6.0%; $p < .05$) and among youth living on livestock farms than among youth on crop farms (9.4% versus 7.4%; $p < .05$). These findings contribute to the limited information on asthma among youth working on Hispanic-operated farms, and indicate the need for asthma prevention programs on farms and intervention studies targeting farming youth populations.

KEYWORDS. Agricultural workers, asthma, Hispanics, youth

INTRODUCTION

Asthma is a major public health problem and is one of the leading chronic illnesses among children in the United States.^{1–3} Asthma

is characterized by recurrent wheezing, breathlessness, chest tightness, and coughing and can be caused or exacerbated by exposure to irritants (e.g., dust, smoke, chemicals, fertilizers, vapors, gases, and fumes) or to allergens (e.g., house

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dust mites, mold, animal dander, pollen, fungal spores, and others). In 2002, approximately 30.8 million people were diagnosed with asthma during their lifetime; of these, nearly 8.9 million were children aged 0–17 years.⁴ Asthma prevalence among children (0–17 years) increased from 3.6% in 1980 to 6.2% in 1996.¹ In addition, the asthma hospitalization rate for youth (0–17 years) increased from 2.2% in 1980–1981 to 2.7% in 1998–1999, and asthma death rates from 1.8 (per million) in 1980–1981 to 3.3 (per million) in 1998–1999.⁵

Studies have consistently reported that children on farms are often less atopic and have lower prevalence of asthma and allergy than children not living on farms.^{6–9} For example, a Canadian study of rural school children showed that asthma prevalence was lower among children who have been raised on a farm (5.1%) than among those without exposure to a farming environment (9.3%).⁸ Similarly, a German study reported lower prevalence of asthma among children of full-time farmers (3.0%) and part-time farmers (3.7%) than among children of nonfarming parents (6.4%).⁹ However, other studies reported a high prevalence of asthma and asthma-related symptoms among rural children (11.9%) that was comparable to the prevalence among urban/inner city children (13.8%).^{10,11} These conflicting results raise questions regarding the association of other, unmeasured risk factors potentially present on a farm, as well as the sample selection criteria used in these studies.

Risk factors leading to increased frequency of asthma and asthma symptoms may differ depending on the environment, geographic location, individual susceptibility, and other factors. Among children living in inner-city low-quality housing conditions, exposures such as indoor and outdoor allergens, environmental tobacco smoke, and psychosocial (e.g., poverty, stress, education, adherence, needs, access to care) surrounding are closely intertwined and may lead to increased asthma prevalence.^{10,12,13} In contrast, among farm children, factors such as family size, dietary habits, presence of dampness, exposure to mold, dust, livestock, pesticides, respiratory endotoxins and other factors play an important role in the development of asthma.^{6,9}

Youth on farms are identified as a special population at high risk for injuries and illnesses.¹⁴ Youth can be exposed to farm hazards while working on a farm, living on a farm, visiting a farm or while accompanying their parents or adults on the farm. In this regard the farm work environment is unique. Most children who live on the farm start working at a very early age.¹⁵ About one third of youth perform hazardous work on farms which is prohibited for children less than 16 years of age in nonagricultural occupations.¹⁶ Moreover, youth on farms have limited protection. The Fair Labor Standards Act of 1938 covers employees who work only on the production of agricultural goods and does not apply to youth working on farms owned by family members.¹⁷ In addition, youth who work on small (i.e., fewer than 11 employees) farms are not protected by Occupational Health and Safety Administration (OSHA) standards. These small farms are not inspected by OSHA.^{18,19}

Farmers of Hispanic origin are a growing part of the U.S. agricultural industry. During 1982–2002, the number of Hispanic-operated farms more than tripled from 16,183 to 50,592 farms.^{20,21} Moreover, the proportion of farm workers who were younger than 17 years doubled from 4% in 1989 to 8% in 1995.²⁰ However, there is limited information on asthma and other health conditions among youth living and working on Hispanic-operated farms. To address this gap and to gain a better understanding of the demographic and health characteristics of youth population on minority-operated farms, the National Institute for Occupational Safety and Health (NIOSH) through an Interagency Agreement with the U.S. Department of Agriculture, National Agricultural Statistics Service initiated the Minority Farm Operator Childhood Agricultural Injury Survey (M-CAIS).²² In this paper we present information on asthma collected for youth who were living on Hispanic-operated farms in 2000.

METHODS

M-CAIS is a telephone survey of minority-operated farm households in the United States.²²

Hispanic operators and racial minority operators were handled separately in M-CAIS for confidentiality reasons. For this study, we used the 2000 M-CAIS data for all youth (0–19 years) living on Hispanic-operated farms. Hispanic farm operators were those who identified themselves as of Spanish, Hispanic, or Latino origin or background such as Mexican, Cuban, or Puerto Rican, regardless of race.²² In 2000, a total of 20,789 Hispanic-operated farms were identified and contacted. Of these, 10,862 (52%) farms participated in the survey. Demographic data, selected clinical data, farm data, and work history were self-reported by either the male or female head of household. If the injury or condition occurred to a youth 16 years of age or older, and if the youth was available, then he or she was asked to answer the questions regarding the injury or condition. Demographic data were collected for members of the farm household and for any youth directly hired by the farm operator to work on the farm. All youth living on Hispanic-operated farms were considered to be Hispanics. Asthma was ascertained on the basis of the question: *Has (he/she) been diagnosed as having asthma by a health professional?* (i.e., asthma). If the answer was positive, two additional questions were asked: *Has (he/she) had an asthma attack requiring the use of an inhaler, or other medical treatment in the last year while at work?* (i.e., asthma attack at work) and *Has (he/she) had a serious asthma attack that required an emergency room visit, hospitalization, or other professional medical attention in the last year?* (i.e., serious asthma attack). Farm data included information on farm type and potential exposures related to the farming operation. Any farm operations with \$1000 or more of gross agricultural production within a calendar year (including crop and livestock operations) were included in the analysis. Excluded from the analysis were contract laborers defined as workers who were hired by and worked for a contractor.

Detailed methodology of the estimation procedure and calculation of numbers has been described elsewhere.²³ Variance estimates were derived by applying the unbiased estimators for a stratified simple random sample to the

post-stratified data. The poststratified survey results were benchmarked to the published counts for minority-operated farms released in the 1997 Census of Agriculture.

We calculated group specific prevalence (expressed as a percentage of survey respondents) using the estimated number of asthma cases at the regional and national level. For both working and nonworking youth, we calculated asthma prevalence with corresponding 95% confidence intervals (CIs) by age group (0–9, 10–15, and 16–19 years); gender; exposure to a horse, an all terrain vehicle (ATV), or a tractor; type of farm (livestock or crop); and region (Northeast [Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, New Jersey, New York, Pennsylvania], Midwest [Illinois, Indiana, Michigan, Ohio, Wisconsin, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota], South [Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia, Alabama, Kentucky, Mississippi, Tennessee, Arkansas, Louisiana, Oklahoma, Texas], and West [Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming, Alaska, California, Hawaii, Oregon, Washington]). Age-specific asthma prevalence rates were calculated using the total number of survey respondents in the denominator. Pooled relative standard errors were calculated and multiplied by 1.96 to obtain the 95% CI for estimates. To compare groups we performed χ^2 test statistics. All calculations were made using SAS version 9.1 (SAS Institute, Cary, NC) and Microsoft Office Excel 2003 (Microsoft, Redmond, WA).

RESULTS

In 2000, an estimated 17,998 youth lived on Hispanic-operated farms in the United States. Of these, 425 (2.4%) were excluded from the study due to having incomplete or no information on their working status. Of the remaining 17,573 youth, 52% were males, 34% were aged 0–9 years, 37% were 10–15 years, and 28% were 16–19 years. More youth lived or worked on crop than livestock farms (Table 1).

TABLE 1. Estimated Number and Percent of Youth (0–19 Years) Living or Working on Hispanic-Operated Farms, by Selected Characteristics, 2000

Characteristics	Working Youth		Nonworking Youth		Total***
	Number	% ± CI	Number	% ± CI	Number
0–19 years					
Gender					
All	7,887	44.9 ± 1.3	9,663	55.0 ± 1.6	17,573
Males	4,817	61.0 ± 3.4	4,347	45.0 ± 2.3	9,177
Females	3,070	38.9 ± 2.5	5,301	54.9 ± 2.6	8,381
Farm type*					
Crops	4,763	60.4 ± 3.7	4,769	49.4 ± 2.7	9,544
Live stock	3,299	41.8 ± 2.8	5,271	59.2 ± 2.1	8,585
Exposure**					
Horse	3,535	44.8 ± 3.0	1,777	18.4 ± 1.4	5,314
ATV	3,594	45.6 ± 2.9	1,275	13.2 ± 1.2	4,871
Tractor	3,864	49.0 ± 3.0	544	5.6 ± 0.6	4,412
0–9 years					
Gender					
Males	661	60.1 ± 22.4	2,461	50.1 ± 4.6	3,124
Females	438	39.9 ± 16.6	2,444	49.8 ± 4.6	2,886
Farm type*					
Crops	727	66.2 ± 4.4	2,481	50.5 ± 5.1	3,210
Livestock	388	35.3 ± 5.0	2,587	52.7 ± 5.1	2,978
Exposure**					
Horse	610	55.5 ± 21.7	840	17.1 ± 2.5	1,450
ATV	297	27.0 ± 12.6	298	6.1 ± 1.3	595
Tractor	140	12.8 ± 8.6	64	1.3 ± 0.4	205
10–15 years					
Gender					
Male	2,177	57.6 ± 6.2	1,169	41.6 ± 6.6	3,349
Female	1,601	42.4 ± 5.1	1,634	58.2 ± 8.3	3,235
Farm type*					
Crops	1,285	34.0 ± 4.6	2,243	63.4 ± 7.6	3,528
Livestock	1,645	43.6 ± 5.3	1,633	49.8 ± 6.8	3,281
Exposure**					
Horse	594	15.7 ± 2.9	738	63.4 ± 9.2	2,331
ATV	567	15.0 ± 2.7	1,780	63.6 ± 7.6	2,346
Tractor	218	5.8 ± 1.5	1,697	49.8 ± 6.8	1,915
16–19 years					
Gender					
Male	1,979	65.8 ± 8.1	717	36.9 ± 8.5	2,704
Female	1,031	34.3 ± 5.3	1,221	62.9 ± 12.0	2,260
Farm type*					
Crops	1,793	59.6 ± 7.9	1,003	51.6 ± 10.9	2,806
Livestock	1,278	42.5 ± 6.2	1,039	53.4 ± 10.9	2,326
Exposure†					
Horse	1,187	39.5 ± 6.0	343	17.7 ± 5.5	1,533
ATV	1,517	50.4 ± 6.9	410	21.1 ± 6.0	1,930
Tractor	2,026	67.3 ± 8.5	262	13.5 ± 4.6	2,291

*Youth might have been on more than one type of farm type.

**May have responded for more than one mode of transportation.

***Estimates may not add to the total due to rounding and missing data.

†For exposure questions respondents were asked if they driven an ATV, tractor, or rode a horse for work or for recreation in the last year.

Of all youth living on farms, 7,887 (44.9%) worked and 9,663 (55.0%) did not work; most of the working youth were aged 10–19 years (81.7%). Overall and within each age group the working youth were predominantly males. Youth at work most frequently reported operating a tractor (48.9%), followed by driving an ATV (45.6%), and riding a horse (44.8%) in the last year (Table 1).

Prevalence of asthma and serious asthma attacks among youth on Hispanic-operated farms is shown in Table 2. The overall health professional-diagnosed asthma prevalence was 7.4%; prevalence of a serious asthma attack that required an emergency room visit, hospitalization, or other professional attention in the year prior to the survey was 1.4% and prevalence of an asthma attack requiring the use of an inhaler or other medical treatment while doing farm work in the year prior to the survey was 8.1% (Table 2).

Compared with nonworking youth, working youth had significantly higher prevalence of asthma. In particular, asthma prevalence was significantly higher among working youth than among nonworking youth who rode a horse (8.9% versus 6.4%, $p < .05$). The prevalence was also higher among working youth who drove a tractor (9.9% versus 8.4%, $p < .05$), or an ATV (9.7% versus 8.8%, $p < .05$). Among working youth, asthma prevalence increased with age, was higher among males than females, higher among those working on livestock than on crop farms, and higher among those who had operated tractors (Table 2). Furthermore, among males (16–19 years) exposure to horses had a highest prevalence of asthma attack prevalence at work (10.4%) followed by ATV use (7.7% and 6.1%) and tractor (6.1%) (data not shown).

Working youth reported significantly higher prevalence of serious asthma attack compared with non-working youth. Serious asthma attack prevalence was highest among working youth aged 0–9 years (2.7%), males (1.8%), and those who had ridden a horse (1.7%). Youth reported significantly higher prevalence of an asthma attack while at work. Working youth in all age groups (0–9, 10–15, and 16–19) had higher asthma attack prevalence (15.0%, 6.9%, and 6.9%, respectively) and prevalence was highest

among the 0–9-year age. Youth who reported working on livestock farm type had significantly higher asthma attack prevalence while at work as compared to youth on crop farm type (9.4 versus 7.4%, $p < .05$) (Table 2).

Youth living on farms in the western region had highest asthma prevalence (8.2%) followed by youth living in the southern region (7.1%). Prevalence of an asthma attack while at work was highest (8.9%) in the western region while prevalence of a serious asthma attack was highest (2.1%) in the northeast region (Table 3). These differences between regions were not significant ($p < .05$).

DISCUSSION

The 2000 M-CAIS is the first survey of youth living on Hispanic-operated farms and provided nationwide estimates of asthma and asthma attack prevalence in this population. Survey results indicated that among working and nonworking youth who lived on Hispanic-operated farms, the overall prevalence of health professional-diagnosed asthma was 7.4% and the prevalence of an asthma attack while at work was even higher at 8.1%. Overall, asthma prevalence was higher than the national average annual estimates in 2001–2003 for Hispanic children (7.0%) and slightly lower than asthma prevalence for all U.S. children 0–17 years old (8.5%).²⁴ However, among working youth on Hispanic-operated farms, asthma prevalence was slightly higher than the national average among all children 0–17 years (8.9% versus 8.5%). The higher prevalence of asthma in youth on Hispanic-operated farms might be due, in part, to the fact that Hispanic children are 2.5 times more likely than white children and 1.5 times more likely than African-American children to report asthma.²⁴ Moreover, from 1985–1986 to 1995–1996, asthma prevalence increased 2.4 times among Hispanic children, from 3.2% to 7.6%.⁵ The causes of this increase are unclear. Possible explanations include increased awareness of the diagnosis and treatment of asthma, improved access to preventive health care, and changes in environmental exposures such as increased air pollution, urbanization, second-hand smoking,

TABLE 2. Estimated Prevalence of Asthma, Serious Asthma Attack, and Asthma Attack While at Work Among Youth (0–19 Years) Living or Working on Hispanic-Operated Farms, by Selected Characteristics, 2000

Characteristics	Working*	Nonworking	Overall
Health Care Professional Diagnosis of Asthma (Prevalence [95% CI])			
All	8.9 (8.0–9.9)	6.1 (5.5–6.8)	7.4 (7.0–7.8)
Age group (years)			
0–9	7.7 (1.7–13.7)	4.8 (3.7–5.8)	5.3 (4.4–6.2)
10–15	8.4 (6.6–10.3)	7.3 (5.1–9.5)	7.9 (6.9–9.0)
16–19	10.0 (7.5–12.5)	7.9 (4.6–11.1)	9.1 (7.7–10.5)
Gender			
Males	9.8 (8.2–11.4)	7.3 (5.8–8.8)	8.6 (5.4–9.6)
Females	7.5 (5.4–9.6)	5.2 (4.2–6.2)	6.0 (5.4–6.7)
Farm type			
Livestock	9.4 (7.0–11.8)	5.6 (4.6–6.6)	7.4 (6.5–8.2)
Grain	8.8 (7.3–10.3)	6.2 (4.9–7.5)	7.5 (6.8–8.2)
Mode of transportation			
Horse	8.9 (7.1–10.8)	6.4 (3.1–9.9)	8.1 (6.7–9.4)
ATV	9.7 (7.6–11.7)	8.8 (3.2–14.3)	9.4 (7.8–11.3)
Tractor	9.9 (8.0–11.9)	8.4 (0.0–20.7)	9.7 (8.0–11.4)
Serious Asthma Attack in the Last Year (Prevalence [95% CI])			
All	1.6 (1.2–2.0)	1.3 (1.0–1.6)	1.4 (1.3–1.6)
Age group (years)			
0–9	2.7 (0.0–5.9)	1.6 (1.0–2.2)	1.8 (1.3–2.3)
10–15	1.5 (0.7–2.2)	1.0 (0.2–1.8)	1.3 (0.9–1.6)
16–19	1.4 (0.5–2.2)	0.9 (0.0–1.9)	1.2 (0.7–1.7)
Gender			
Males	1.8 (1.2–2.4)	1.5 (0.9–2.2)	1.7 (1.3–2.0)
Females	1.3 (0.5–2.1)	1.1 (0.7–1.5)	1.2 (0.9–1.4)
Farm type			
Livestock	1.8 (0.8–2.7)	1.1 (0.7–1.5)	1.4 (1.1–1.7)
Grain	1.5 (0.9–2.0)	1.5 (0.9–2.1)	1.5 (1.2–1.8)
Mode of transportation			
Horse	1.5 (0.9–2.5)	1.8 (0.0–4.3)	1.7 (1.1–2.2)
ATV	1.6 (0.8–2.4)	1.3 (0.0–2.7)	1.5 (1.0–2.1)
Tractor	1.6 (0.9–2.3)	0.8 (0.0–4.1)	1.5 (0.9–2.1)
Asthma Attack in Last Year While at Work (Prevalence [95% CI])			
All	8.1 (7.6–8.4)	—	—
Age group (years)			
0–9	15.0 (4.6–25.5)	—	—
10–15	6.9 (5.1–8.8)	—	—
16–19	6.9 (4.7–9.2)	—	—
Gender			
Males**	8.6 (7.8–9.4)	—	—
Females**	6.0 (5.4–6.7)	—	—
Farm type			
Livestock	9.4 (6.4–12.3)	—	—
Grain**	7.4 (6.4–8.4)	—	—
Mode of transportation			
Horse	7.3 (4.9–9.7)	—	—
ATV	7.1 (4.9–9.3)	—	—
Tractor**	4.9 (3.4–6.4)	—	—

*Chi-square test, *p* value for the difference in prevalence between working and nonworking youth <.05 except as noted.**Not significant values.

Denominators for the group specific asthma prevalence is available in Table 1.

TABLE 3. Estimated Prevalence** (95% CI) of Asthma, Asthma Attack, and Serious Asthma Attack Among Youth (0–19 Years) Living or Working on Hispanic-Operated Farms, by Region*, 2000

Characteristics	Region			
	Prevalence (95% CI)			
	Northeast	Midwest	South	West
Health professional diagnosis of asthma	6.4 (0.0–19.3)	6.0 (3.5–8.5)	7.1 (6.1–8.1)	8.2 (7.2–9.1)
Asthma attack while at work	5.3 (0.0–31.8)	5.6 (0–11.9)	8.6 (4.9–12.2)	8.9 (6.1–11.6)
Serious asthma attack	2.1 (0.0– 8.9)	1.4 (0.4–2.4)	1.1 (0.7–1.4)	1.7 (1.3–2.1)

*Northeast—Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, New Jersey, New York, Pennsylvania.

Midwest—Illinois, Indiana, Michigan, Ohio, Wisconsin, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota.

West—Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming, Alaska, California, Hawaii, Oregon, Washington.

South—Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia, Alabama, Kentucky, Mississippi, Tennessee, Arkansas, Louisiana, Oklahoma, Texas.

***p* value for differences between regions >.05.

cleaning agents, and others. However, because information on race of the youth on farms was not available, these factors may not fully explain the differences.

The overall age-specific prevalence of health professional diagnosed asthma among all youth on Hispanic-operated farms was significantly higher in males than females and was consistent with previously published data.^{11,25} Although, gender differences in asthma rates among farming population are not well understood, Faria et al. have shown that environmental working conditions in rural areas, notably exposure to organic and mineral dusts, have been associated with a 15% increase in risk of developing respiratory disease among females compared with a 10% increase in males.²⁵ In addition, a recent study has shown that there is an average of 50% increase in allergic asthma among women who apply pesticides on farms.²⁶ It is possible that type and duration of job, intensity of relevant occupational exposures, differences in individual susceptibility, as well as other risk factors (e.g., genetic or environmental) play an important role in developing asthma.

Studies have shown that asthma prevalence varies by geographic location and depends on the individual's working and living environment.^{3,11} Although not significant, our results indicate that the western region had a higher asthma

prevalence followed by the southern region. These differences could be associated with multiple factors such as increased Hispanic-operated farming in the western and southern regions, population composition, the type of farming, climatic conditions, and other environmental factors.^{20,27} According to the U.S. Department of Agriculture, 41% of all hired farm workers in the western region are predominantly Hispanics (67%) and worked in crop production (typically on fruit, vegetable, and horticultural crop farm types).²⁷ Also, in regions associated with dry climatic conditions, farmers and farm workers are more commonly exposed to inorganic (mineral) dusts that have been associated with the development of asthma.²⁸

The results of this study indicate a high prevalence of asthma and asthma attacks among youth who have ridden horses and operated ATVs or tractors, in particular, among working youth. People living on farms frequently use these modes of transportation to get around or for farming purposes. Tractors are often used for soil preparation, crop harvesting or hay-making. These activities may generate tremendous dust and can lead to the development of various respiratory conditions including asthma.²⁹ In addition, the dusty environments, presence of allergens, and exposures to diesel and gasoline exhaust from tractors/ATVs or other farm

equipment may not only cause asthma but also trigger asthma attacks.³⁰

Overall, asthma prevalence among youth on farms was similar for both livestock (7.4%) and crop farm types (7.5%). However, prevalence differed by working status with working youth having significantly higher prevalence of asthma than non-working youth. Occupational asthma is one of the recognized effects of working with livestock such as cattle, hogs, sheep, and goats.³⁰ Animals or animal products such as dander, hair, scales, fur, saliva, and body wastes contain powerful allergens causing respiratory disorders. According to a Finnish registry of occupational diseases, animal epithelia, hair, dander, and secretions accounted for 60% of total occupational asthma cases.³¹ About 33% of animal handlers have allergic symptoms and approximately 10% have symptoms of animal-induced asthma.^{32,33} Workers working with animals on farms can develop wheeze and chronic cough, in particular, when required to work in large confinement areas with inadequate ventilation.^{34,35} Moreover, studies reported an increase in prevalence of childhood asthma on farms that was associated with an increasing number of swine, cattle, and poultry, and exposure to organic dusts.^{30,36,37} Finally, high prevalence of asthma attacks among youth working on a crop farm type can be associated with grain threshing and storing that can lead to high exposures to fungal spores, bacteria, and endotoxins, which, in turn can lead to respiratory problems and reduction in lung functions.³⁶

This study has some limitations. The survey sampling frame included farms from the 1997 census of agriculture list. Because the operators self-selected themselves into nonminority categories, some farms may have been excluded from the sample and the study. Also, the accuracy and completeness of the responses could not be verified. The possibility of a bias due to nonresponse to the survey exists. Nonresponders were not contacted because the survey was not designed to allow for a follow-back interview. However, for nonresponse due to inaccessibility, personal interviews were conducted which did improve the coverage but did not eliminate all the bias. The poststratification of the M-CAIS results greatly reduced the impact of the

nonresponse bias. Furthermore, asthma information was self-reported by the head of household. Asthma and asthma attacks could be underreported due to recall bias, resulting in underestimation of their prevalences. No information on the sensitivity and reliability of the data (i.e., diagnosis of asthma) is available.

RECOMMENDATIONS

Multiple resources for patients with asthma and their families exist. Youth at risk for developing asthma should be educated about precautions necessary to avoid or reduce exposures, and methods to prevent and control future attacks. Facts about asthma and its control are available both in Spanish and English on the Centers for Disease Control and Prevention Web site at <http://www.cdc.gov/health/asthma.htm>. The Lung Association offers educational programs for adults and children with asthma, and provides counseling and free education materials at <http://www.pei.lung.ca/programs.html>. NIOSH offers information on risks for injuries and illness and preventive measures related to the agricultural operations at <http://www.cdc.gov/niosh/topics/agriculture/> and specifically to occupational asthma at <http://www.cdc.gov/niosh/topics/asthma/>.

These findings contribute to the limited information on asthma among youth living on Hispanic-operated farms. Because youth on farms may have multiple exposures, assessment and identification of potential risk factors for asthma and their interactions with genetic and environmental determinants, family size, dietary habits, dampness, mold, and other exposures are vital for developing effective intervention strategies for preventing asthma among youth on farms.

REFERENCES

1. Akinbami LJ. The state of childhood asthma, United States, 1980–2005. *Advance Data from Vital and Health Statistics*, Number 381. Hyattsville, MD: National Center for Health Statistics (updated December 29, 2006). Available at <http://www.cdc.gov/nchs/data/ad/ad381.pdf> [cited May 20, 2008].

2. Cloutier MM, Wakefield DB, Hall CB, Bailit HL. Childhood asthma in an urban community: prevalence, care system, and treatment. *Chest*. 2002;122:1571–1579.
3. Hendricson WD, Wood PR, Hidalgo HA, Ramirez AG, Kromer ME, Selva M, Parcel G. Implementation of individualized patient education for Hispanic children with asthma. *Patient Educ Couns* 1996;29:155–165.
4. National Center for Health Statistics, Centers for Disease Control. Asthma prevalence, health care use and mortality, 2002. Available at <http://www.cdc.gov/nchs/products/pubs/pubd/hestats/asthma/asthma.htm> [cited May 19, 2008].
5. Akinbami LJ, Schoendorf KC. Trends in childhood asthma: prevalence, health care utilization, and mortality. *Pediatrics* 2002;110(2 Pt 1):315–322.
6. Adler A, Tager I, Quintero DR. Decreased prevalence of asthma among farm-reared children compared with those who are rural but not farm-reared. *J Allergy Clin Immunol* 2005;115:67–73.
7. Braun-Fahrländer C, Gassner M, Grize L, Neu U, Sennhauser FH, Varonier HS, Vuille JC, Wüthrich B. Prevalence of hay fever and allergic sensitization in farmer's children and their peers living in the same rural community. SCARPOL team. Swiss Study on Childhood Allergy and Respiratory Symptoms with Respect to Air Pollution. *Clin Exp Allergy* 1999;29:28–34.
8. Ernst P, Cormier Y. Relative scarcity of asthma and atopy among rural adolescents raised on a farm. *Am J Respir Crit Care Med* 2000;161:1563–1566.
9. Von Ehrenstein OS, Von Mutius E, Illi S, Baumann L, Böhm O, von Kries R. Reduced risk of hay fever and asthma among children of farmers. *Clin Exp Allergy* 2000;30:187–193.
10. Bauer EJ, Lurie N, Yeh C, Grant EN. Screening for asthma in an inner-city elementary school in Minneapolis, Minnesota. *J Sch Health* 1999;69:12–16.
11. Merchant JA, Naleway AL, Svendsen ER, Kelly KM, Burmeister LF, Stromquist AM, Taylor CD, Thorne PS, Reynolds SJ, Sanderson WT, Chrischilles EA. Asthma and farm exposures in a cohort of rural Iowa children. *Environ Health Perspect* 2005;113:350–356.
12. Eggleston PA, Buckley TJ, Breyse PN, Wills-Karp M, Kleeberger SR, Jaakkola JJ. The environment and asthma in U.S. inner cities. *Environ Health Perspect* 1999;107(Suppl 3):439–450.
13. Koinis-Mitchell D, McQuaid EL, Seifer R, Kopel SJ, Esteban C, Canino G, Garcia-Coll C, Klein R, Fritz GK. Multiple urban and asthma-related risks and their association with asthma morbidity in children. *J Pediatr Psychol* 2007;32:582–595.
14. Wright RJ, Subramanian SV. Advancing a multi-level framework for epidemiologic research on asthma disparities. *Chest* 2007;132(5 Suppl):757S–769S.
15. Hendricks KJ, Layne LA, Goldcamp EM, Myers JR. Injuries to youth living on U.S. farms in 2001 with comparison to 1998. *J Agromed*. 2005;10:19–26.
16. Marlenga B, Berg RL, Linneman JG, Brison RJ, Pickett W. Changing the child labor laws for agriculture: impact on injury. *Am J Public Health* 2007;97:276–282.
17. Fair Labor Standards Act of 1938, as amended (52 Stat. 1060, as amended; 29 U.S.C. 201–219). Available at http://www.dol.gov/dol/allcfr/ESA/Title_29/Part_570/29CFR570.1.htm [cited November 30, 2007].
18. U.S. Department of Labor. The National Agricultural Workers Survey (updated March 16, 2006). Available at <http://www.doleta.gov/agworker/report/ch1.cfm> [cited May 19, 2008].
19. U.S. Department of Labor. E-laws, FLSA, Child Labor Rules Advisor. Exemptions from child labor rules in non-agriculture. Available at <http://www.dol.gov/elaws/esa/flsa/cl/exemptions.asp> [cited May 20, 2008].
20. U.S. Department of Agriculture. Hispanic farm and ranch operators. Quick facts from the 2002 Census of Agriculture (November 2004). Available at http://www.agcensus.usda.gov/Publications/2002/Quick_Facts/hispanicquickfacts.pdf [cited May 19, 2008].
21. U.S. Department of Agriculture. Quick facts: Characteristics of Hispanic farm operators (updated September 26, 2000). Available at <http://www.nass.usda.gov/census/census97/quickfacts/hispanic/page3a.htm> [cited May 20, 2008].
22. Centers for Disease Control, National Institute for Occupational Safety and Health. Injury and asthma among youth less than 20 years of age on minority farm operations in the United States, 2000 Volume II: Hispanic national data. NIOSH Publication No. 2006–109. Available at <http://www.cdc.gov/niosh/docs/2006-109/> [cited May 19, 2008].
23. Cochran WG. *Sampling Techniques*, 3rd ed. New York: Wiley; 1977.
24. Homa DM, Mannino DM, Lara M. Asthma mortality in U.S. Hispanics of Mexican, Puerto Rican, and Cuban heritage, 1990–1995. *Am J Respir Crit Care Med* 2000;161(2 Pt 1):504–509.
25. Faria NM, Facchini LA, Fassa AG, Tomasi E. [Farm work, dust exposure and respiratory symptoms among farmers.] *Rev Saude Publica* 2006;40:827–836.
26. Hoppin JA, Umbach DM, London SJ, Lynch CF, Alavanja MC, Sandler DP. Pesticides associated with wheeze among commercial pesticide applicators in the Agricultural Health Study. *Am J Epidemiol* 2006;163:1129–1137.
27. Effland AB, Runyan JL. Hired farm labor in U.S. agriculture: Agricultural Outlook. Economic Research Service/USDA. (1998 October). Available at <http://www.ers.usda.gov/Publications/Agoutlook/oct1998/ao255f.pdf> [cited May 20, 2008].
28. Respiratory health hazards in agriculture. *Am J Respir Crit Care Med* 1998;158(5 Pt 2):S1–S76.
29. Chan-Yeung M, Malo JL. Aetiological agents in occupational asthma. *Eur Respir J* 1994;7:346–371.
30. Hoppin JA, Umbach DM, London SJ, Alavanja MC, Sandler DP. Diesel exhaust, solvents, and other occupational

exposures as risk factors for wheeze among farmers. *Am J Respir Crit Care Med* 2004;169:1308–1313.

31. Karjalainen A, Kurppa K, Virtanen S, Keskinen H, Nordman H. Incidence of occupational asthma by occupation and industry in Finland. *Am J Ind Med* 2000;37:451–458.

32. Heederik D, Sigsgaard T, Thorne PS, Kline JN, Avery R, Bønløkke JH, Chrischilles EA, Dosman JA, Duchaine C, Kirkhorn SR, Kulhankova K, Merchant JA. Health effects of airborne exposures from concentrated animal feeding operations. *Environ Health Perspect* 2007;115:298–302.

33. Zejda JE, Hurst TS, Rhodes CS, Barber EM, McDuffie HH, Dosman JA. Respiratory health of

swine producers. Focus on young workers. *Chest* 1993;103:702–709.

34. Douwes J, Pearce N, Heederik D. Does environmental endotoxin exposure prevent asthma? *Thorax* 2002;57:86–90.

35. Zuskin E, Zagar Z, Schachter EN, Mustajbegovic J, Kern J. Respiratory symptoms and ventilatory capacity in swine confinement workers. *Br J Ind Med* 1992;49:435–440.

36. Halstensen AS, Nordby KC, Wouters IM, Eduard W. Determinants of microbial exposure in grain farming. *Ann Occup Hyg* 2007;51:581–592.

37. Schenker MB, Farrar JA, Mitchell DC, Green RS, Samuels SJ, Lawson RJ, McCurdy SA. Agricultural dust exposure and respiratory symptoms among California farm operators. *J Occup Environ Med* 2005;47:1157–1166.