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Farm Work-Related Asthma Among US Primary Farm Operators

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Abstract

The objective of this study was to estimate the prevalence of current asthma and the proportion of current asthma that is related to work on the farm among primary farm operators. The 2011 Farm and Ranch Safety Survey data were used to produce estimates and prevalence odds ratios. An estimated 5.1% of farm operators had asthma. Of these, 15.4% had farm work-related asthma. Among operators with farm work-related asthma, 54.8% (95% confidence interval [CI]: 41.8%–68.2%) had an asthma attack in the prior 12 months and 33.3% (95% CI: 21.2%–45.4%) had an asthma attack that occurred while doing farm work. Of those who had an asthma attack that occurred while doing farm work, 65.0% associated their asthma attack with plant/tree materials. This study provides updated information on asthma and the proportion of current asthma that is related to work on the farm and identifies certain groups of farm operators that might benefit from workplace asthma prevention intervention.

Keywords

Agriculture; asthma; epidemiology; health surveys; occupational health

INTRODUCTION

Asthma is one of the most common diseases in the United States. In 2010, 8.2% (18.7 million) of adults aged 18 years and older had current asthma.[1] Asthma is associated with considerable morbidity, mortality, and cost.[1–3] In 2007, there were 7.2 million physician office visits, 1.1 million emergency department visits, 299,000 hospitalizations, and 3,262 deaths related to asthma in adults.[4] Among currently employed adults who had at least one asthma attack in the past 12 months, asthma was associated with an average annual 14.2 million lost work days in 2008.[4] In 2007, the total cost of asthma to society was estimated at $56 billion.[3]

Work-related asthma includes occupational asthma (new-onset asthma or the recurrence of previously quiescent asthma induced by exposures at work) and work-exacerbated asthma

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(preexisting or concurrent asthma worsened by factors in the workplace).[5] Work-related asthma is associated with serious adverse economic and health consequences.[6–8] Adults with work-related asthma have higher unemployment rates than adults without asthma, higher mean number of days with asthma symptoms, trouble sleeping because of asthma, and activity limitation due to asthma.[7,9] Persons with work-related asthma may need to change or leave employment and thus lose income and benefits. In addition to socioeconomic consequences, work-related asthma has been associated with disability, poor health-related quality of life, and mortality.[8,10,11] A review of population-based studies estimates that 7% to 51% (median 17.6%) of adult-onset asthma is attributable to occupational exposures such as vapors, gas, dust, and fumes.[12] Work-related asthma is associated with over 400 causative agents.[13]

Work on a farm is associated with exposure to a variety of irritants and allergens that can cause or aggravate respiratory symptoms and diseases, including asthma. Organic and inorganic dusts, particulate matter, microbial agents, gasses, volatile organic compounds (VOCs), cleaning agents, fertilizers, and feed additives are frequently present in agricultural settings.[14]

In 2007, there were 2.2 million farms and 3.3 million farm operators in the United States.[15] Historical data from the US Third National Health and Nutrition Examination Survey (NHANES III) 1988–1994 indicated that asthma prevalence for the farm-related occupations (i.e., farm operators, managers, and supervisors; and farm and nursery workers) was 3.6%.[16] Based on data collected in 1993 from California farm operators, Schenker et al. documented that 7.8% of operators had current doctor-diagnosed asthma.[17] Using data from the 2006 Farm and Ranch Safety Survey, we previously reported that 4.9% of primary farm operators have current asthma and that 24.8% of primary farm operators with current asthma had asthma that may be related to work on the farm.[18]

In 2006, the National Institute for Occupational Safety and Health (NIOSH) sponsored the Farm and Ranch Safety Survey to better understand the magnitude and scope of adult agricultural injuries. The survey was conducted as part of the NIOSH Agricultural Injury and Health Initiative and the NIOSH Childhood Agricultural Injury Prevention Initiative. It collected information on asthma, asthma attacks and attacks that occurred while doing farm work, and asthma-related unscheduled health care visits, including hospitalizations and emergency room visits. In 2011, the Farm and Ranch Safety Survey was repeated and included additional questions on asthma attacks on the farm and associated tasks and exposures.

The National Occupational Research Agenda (NORA) is a partnership program conducted by NIOSH to stimulate innovative research and improved workplace practices. The NORA plan for the US agriculture, forestry, and fishing industries focuses on surveillance; vulnerable populations; and outreach, communication, and partnerships.[19] Of the nine strategic goals, the surveillance-related goal seeks to “describe: the nature, extent, and economic burden of occupational illnesses, injuries, and fatalities; occupational hazards; and worker populations at risk for adverse health outcomes.” To address this NORA goal, we estimate the prevalence of current asthma and the proportion of current asthma that is related

to work on the farm among US primary farm operators using data from the 2011 Farm and Ranch Safety Survey.

METHODS

The US Department of Agriculture National Agricultural Statistics Service (NASS) conducted a random telephone survey of active farm operations for NIOSH in 2011. Of the 25,000 farm operations selected for the survey, 7,497 (30.0%) could not be reached by telephone during the survey period and 5,103 (20.4%) refused to participate in the survey. After excluding 1,190 (4.8%) nonactive farms, the remaining 11,210 (44.8%) active farm operations were surveyed. Data were self-reported either by the primary farm operator or the operator's spouse; no children were interviewed. Primary farm operator was defined as the individual who runs the farm, making day-to-day management decisions.[20] The adjusted survey response rate, excluding noncontacts, was 70.8%. The data are owned and retained by the US Department of Agriculture.

Definitions

Survey participants were determined to have lifetime asthma if they have ever been told by a doctor, nurse, or other health professional that they had asthma. Operators with lifetime asthma were further asked about age at asthma diagnosis and if they currently have asthma. Those with current asthma were asked whether a doctor, nurse, or other health professional ever told them that their asthma was related to their work on the farm. If the answer was "yes," operators were considered to have farm work-related asthma. They were also asked whether they have had one or more asthma attacks requiring the use of an inhaler or other medical treatment in the last 12 months and, if so, whether the asthma attack occurred while doing farm work. Those who reported an asthma attack were asked to describe what they were doing when the asthma attack occurred. We used this information to categorize exposures associated with asthma attacks according to the Association of Occupational and Environmental Clinics (AOEC) Exposure Code System (available at http://www.aoecdata.org/Default.aspx).

Current smokers were defined as those who smoked at least 100 cigarettes in their lifetime and smoked cigarettes either every day or some days at the time of the survey. Former smokers were those who smoked at least 100 cigarettes in their lifetime but are no longer smokers. Nonsmokers included those who smoked less than 100 cigarettes in their lifetime.

Survey participants were asked about their farm acreage and value of sales and responses were categorized by the NASS coders. Farms were classified based on the largest source of revenue for the farm. Farm operators reporting their largest source of revenue from swine, dairy, beef cattle, sheep or goats, equine, poultry, aquaculture, and other animals were classified as operating livestock farms. Farm operators reporting their largest source of revenue from grains, tobacco, cotton, vegetables, fruits or nuts, nursery or greenhouse, cutting Christmas trees, and other crops or hay were classified as operating crop farms.

Statistical Analysis

Population-based estimates were calculated using survey weights to account for unequal selection probabilities, unit nonresponse, and poststratification. Farms were stratified within census regions of the United States, and post-stratified by value of sales according to the NASS sampling methodology. Prevalence and proportions with corresponding 95% confidence intervals (CIs) were estimated. Weighted bivariate analyses were performed using the Rao-Scott chi-square test of independence to test the differences in the distribution of proportions. Using multivariate logistic regression, we estimated prevalence odds ratios (PORs) for the associations between current asthma that may be farm work-related and age, sex, second job, census region, farm acreage, value of sales, and farm type. In the model we included second job because of its potential as a second source of agents that could cause or exacerbate asthma and farm type because of the differences in farm location by census region.[21–23] Marital status and smoking status were not included in the logistic regression model because the estimated numbers of operators with farm work-related asthma in these two groups were not reliable (the relative standard error for the estimates >50%). All tests were two-sided, with $P < .05$ considered significant. Analyses were conducted using SAS software version 9.3 (SAS Institute, Cary, NC).

RESULTS

In 2011, of the 2.2 million primary farm operators, 94.7% were over 40 years old (mean age: 59.9 years), 83.7% were males, 83.5% were married or living with a partner, 60.3% were nonsmokers, and 51.7% did not have a second job. Operators were approximately equally divided between managing livestock (51.1%) and crop (48.9%) farms and were more likely to manage smaller farms with less than 101 acres (63.7%) and less than $10,000 in value of sales (55.0%) (Table 1).

An estimated 2.5% of primary farm operators had unknown or missing information on asthma. Compared with those who provided information, operators with missing data on asthma were slightly older (mean age: 66.0 years versus 59.8 years; $P < .0001$) and more likely to have a second job (72.2% versus 48.6%; $P < .0001$).

An estimated 5.1% of primary farm operators had current asthma. The mean age at current asthma diagnosis was 33.9 (range: 1–84) years. Current asthma prevalence was significantly higher among female than male operators (7.3% versus 4.6%; $P = .0009$) and among operators managing farms in the West than in the Midwest (6.6% versus 4.3%; $P = .001$) (Table 1).

Among primary farm operators with current asthma, an estimated 51.0% (95% confidence interval [CI]: 45.3%–56.7%) had an asthma attack in the prior 12 months. The proportion of operators having an asthma attack was higher among operators who were former smokers than current or nonsmokers, those who had a second job than those who did not have a second job, those who managed farms in the North than in other regions, those who managed farms with <101 acres than >101 acres, and those who managed farms with < $10,000 value of sales than farms with ≥$10,000 value of sales, but these differences were not statistically significant (Table 2).

Of operators with current asthma, 15.4% were ever told by a doctor, nurse, or other health professional that their asthma was related to their work on the farm (Table 2). The proportion of current asthma that may be farm work related was significantly higher among nonsmokers than former smokers, operators managing farms with ≥1,000 acres than farms <101 acres or 101–999 acres, and managing farms with an annual value of sales ≥$100,000 than farms with <$10,000 or $10,000–$99,999 value of sales (Table 2).

Multivariate associations between farm work-related asthma and second job, census region, farm acreage, value of sales, and farm type among primary farm operators with current asthma are shown in Table 2. After controlling for other variables, proportion of current asthma that may be farm work related remained associated with region, farm acreage, and value of sales.

The mean age of farm operators with farm work-related asthma was 59.7 (range: 34–84) years and their mean age at asthma diagnosis was 31.6 years. Most operators with farm work-related asthma were males (83.9%), married or living with a partner (87.2%), nonsmokers (77.5%), had a second job (51.2%), and operated livestock farms (52.5%). Significantly more operators with farm work-related asthma managed farms located in the South or West than in the North, farms with <101 or 101–999 acres than with ≥1,000 acres, and farms with <$10,000 or with $10,000–$99,999 in value of sales than with ≥$100,000 value of sales (Table 3).

Among operators with farm work-related asthma, 54.8% (95% CI: 41.4%–68.2%) had an asthma attack in the prior 12 months and 33.3% (95% CI: 21.2%–45.4%) had an asthma attack that occurred while doing farm work. Of operators who had an asthma attack that occurred while doing farm work, 65.0% reported that plant/tree materials triggered their asthma attacks. Farm work reported during these asthma attacks included baling hay or straw, handling grain or animal feed, bush/brush hogging, corn planting, or cutting grass/weeds. Other exposures were reported by a small number of operators (estimated proportions of attacks associated with these exposures were not reliable) and include miscellaneous chemicals, physical factors, animal material, and mold.

DISCUSSION

This cross-sectional study indicates that 5.1% of primary farm operators had current asthma. Similar asthma prevalence among farmers and rural populations has been reported from other studies.[24–27] Within these studies, prevalence of current asthma among farmers ranged from 2.7% to 7.7%. This finding is similar to that previously reported using the 2006 Farm Safety Survey data (4.9%; 95% CI: 4.4%–5.4%) and is lower than the estimated national prevalence of current asthma among adults employed at any time in the prior 12 months (7.2%).[18,28] Several factors have been proposed that may explain the lower prevalence of asthma in farmers and include the healthy worker effect among farmers (i.e., susceptible persons may leave dusty work areas early in the course of the job, leaving behind a relatively less susceptible group of workers who are potentially more able to tolerate the work environment)[17,29] and the “hygiene” hypothesis (i.e., early in life exposure to bacterial

and viral agents through contact with other children or farm animals result in a reduced incidence of atopy and asthma).[30–36]

In this study, over half of the primary farm operators with current asthma had an asthma attack requiring the use of an inhaler or other medical treatment in the last 12 months. These results are consistent with other studies reporting that 49.1% of adults with current asthma had an asthma attack in 2010.[2]

Of primary farm operators with current asthma, 15.4% had asthma that may be related to work on the farm. This proportion is greater than the proportion of current asthma that is work-related asthma among all ever-employed adults that was estimated using data from the Behavioral Risk Factor Surveillance System (BRFSS) Asthma Call-back Survey conducted in 38 states and the District of Columbia (9.7%) and lower than that previously reported using the 2006 Farm and Ranch Safety Survey data (24.8%).[7,18] Although some of the differences between the populations may be due to differences in survey methodologies, both BRFSS and Farm and Ranch Safety Survey used similar question on health care professional diagnosis of work-related asthma (BRFSS Asthma Call-back Survey questionnaires are available at http://www.cdc.gov/brfss/acbs/index.htm). Thus, it is unlikely that differences in methodologies can explain the substantially greater proportion of asthma that may be work related in farm operators. The differences can be explained, in part, by the presence of exposures (e.g., dusts, agricultural chemicals, bacteria, fungi, toxic gases) at substantially higher concentrations in agriculture than in other industries.[14,30] The reason for the lower proportion of current asthma that may be farm work related found in this study is unclear. Longitudinal follow-up studies of children of farmers or new farmers could confirm this change.

We found that female primary farm operators have a significant higher prevalence of current asthma than male farm operators. These findings are consistent with our previous report that an estimated 62.8% of ever-employed adults with asthma in 38 states and District of Columbia are females.[11] In addition, although we found a higher proportion of asthma that is farm related for male operators than for female operators (16.9% versus 10.4%), this difference was not statistically significant. This was consistent with a report by Torén and Blanc where proportion of asthma that could be attributed to occupational exposures was 9.1% for males and 11.5% for females.[12] Moreover, we found that among operators with farm work-related asthma 83.9% were males. This finding is slightly higher than previously reported results from California, Massachusetts, Michigan, and New Jersey work-related surveillance systems where 68.6% of individuals with work-related asthma in the agriculture, forestry, and fishing industry were males.[37] Other studies from work-related asthma surveillance systems reported that more of the work-related asthma patients are females.[38,39] However, in these reports no separate results for men and women by industry and occupation were presented.

The prevalence of current asthma among primary farm operators was not associated with the farm size or annual value of sales. However, the proportion of farm operators with current asthma that may be farm work related increased with increasing farm size and value of sales. In addition, more operators with asthma that may be farm work related operated farms

located in the North. No information on possible factors (e.g., farm operator's recognition of the asthma work-relatedness, opportunities to discuss asthma work-relatedness with health care providers, access and barriers to medical care, health insurance, income, presence of occupational health medical surveillance on the farm, number of hours spent doing farm activities) that might explain these differences was available. More research is needed to better understand the current findings that the proportion of current asthma that may be farm work related is greater among operators managing larger farms, farms with greater value of sales, and farms located in the North.

In this study, smoking prevalence among farm operators was 9.2% and was lower than the 2011 estimate for all US working adults (19%) and for all working adults in the agriculture, forestry, fishing, and hunting industry (18.5%).[40] Lower smoking prevalence among farmers and other agricultural industry workers has been previously reported.[26] It is likely that some operators use smokeless tobacco. In 2005, an estimated 8.8% of working adults in the agriculture, forestry, fishing, and hunting industry used smokeless tobacco.[41] No data were available to assess smokeless tobacco use among farm operators in this study.

Early identification of persons with work-related asthma is essential for preventing worsening of symptoms and outcomes. Patients with sensitizer-induced work-related asthma may need to be removed from exposure in addition to other asthma management. For those with irritant-induced asthma management should aim at optimizing treatment and reducing the exposure to workplace triggers. Moreover, the diagnosis of work-related asthma should be considered an occupational sentinel health event and serve as a warning signal that other workers in the same workplace may also be exposed and that implementation of primary preventive measures may be warranted (eg, elimination, substitution, process modification, respirator use, and engineering control).[5] If elimination of exposures is not feasible, other preventive measures play an important role in reducing exposures. Studies showed that providing education on occupational health and safety (e.g., safety training, familiarity with material safety data sheets, knowledge of legislation) and asthma causes and prevention (e.g., recognition of respiratory hazards, work/environmental hygiene practices, use of respirators) is feasible and effective, and has a positive effect on farmer health and farm practices.[42–46] In addition, in workplaces with high prevalence and incidence of work-related asthma, implementation of medical surveillance (i.e., secondary prevention) may assist in measuring the impact of primary prevention and, in work environments with potential exposure to sensitizers, in early detection of sensitized workers.[5,47]

This cross-sectional study has some limitations. The Farm and Ranch Safety Survey was designed to collect data only on primary farm operators and no information on other farm workers was available. Diagnosis of asthma or asthma in relation to farm work was not validated; thus, estimates may be subject to misclassification. Also, information on race/ethnicity or family income was not available to assess their associations with asthma and asthma attacks. Moreover, the survey was designed to allow for both self- and proxy report. No information was available to assess the number of proxy responses and their potential bias. In addition, although the survey asked for information on asthma attack in the prior 12 months, some respondents may report events outside this time frame, thus overestimating our results.[48] Finally, because of small sample sizes resulting in unreliable estimates, we

could not include marital status and smoking status in the logistic regression models, estimate the prevalence of current asthma by specific farm type, and examine associations between asthma attack and specific exposures on the farm.

This study documents the prevalence of current asthma and farm work-related asthma among US primary farm operators in 2011. The results suggest that the proportion of farm operators with current asthma that may have farm work-related asthma is higher than the proportion of US ever-employed adults with current asthma who have work-related asthma. In addition, the proportion of farm work-related asthma varies by farm size, value of sales, and region, indicating that certain groups of farm operators might experience greater benefits than others from work-related asthma prevention interventions. Future studies should examine operators' asthma history and work-related factors to fully characterize the burden of work-related asthma among primary farm operators.

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TABLE 1

Select Characteristics of Primary Farm Operators and Prevalence of Current Asthma

Characteristic	No. in sample[a]	Estimated primary farm operators		Current asthma prevalence
		No. (in 1,000s)	%[b] (95% CI)	%[b] (95% CI)
Total	11,210	2,181	100.0	5.1 (4.5–5.6)
Age group (years)				
16–39	626	113	5.3 (4.7–5.9)	3.8(1.9–5.6)
40–64	6,427	1,270	59.6 (58.3–60.8)	5.0 (4.2–5.8)
65–99	3,909	749	35.1 (33.9–36.3)	5.5 (4.6–6.5)
Sex				
Male	9,538	1.823	83.7 (82.8–84.7)	4.6 (4.1–5.2)[c]
Female	1,653	354	16.3(15.3–17.2)	7.3(5.6–9.1)
Marital status				
Married or living with a partner	9,264	1,802	83.5 (82.6–84.5)	5.0 (4.4–5.7)
Widowed, divorced, separated	1,304	266	12.4(11.5–13.2)	5.3 (3.7–6.9)
Single, never married	533	89	4.1 (3.6–4.6)	5.3 (2.7–8.0)
Smoking status				
Current smoker	872	200	9.4(8.6–10.2)	6.1 (3.8–8.4)
Former smoker	3,069	645	30.3(29.1–31.5)	5.5 (4.5–6.5)
Nonsmoker	6,985	1,281	60.3(59.0–61.5)	4.7 (4.1–5.4)
Second job				
Yes	4,879	1,041	48.3 (47.0–49.6)	4.8 (4.0–5.7)
No	6,216	1,114	51.7(50.4–53.0)	5.3(4.6–6.1)
Region[d]				
North	2,866	142	6.5 (—[e])	5.4 (4.4–6.4)
Midwest	2,520	796	36.5 (—)	4.3 (3.4–5.2)[f]
South	2,851	916	42.0 (—)	5.2 (4.2–6.2)
West	2,973	327	15.0 (—)	6.6 (5.6–7.5)
Farm acreage				
<101	5,907	1,389	63.7 (62.8–64.6)	5.3(4.5–6.1)
101–999	4,368	666	30.5 (29.6–31.4)	4.6 (3.8–5.4)
≥ 1,000	935	126	5.8(5.4–6.1)	5.1 (3.4–6.7)
Farm value of sales				
<$10,000	3,451	1,201	55.0 (53.1–57.0)	5.3 (4.4–6.2)
$10,000–$99,999	4,827	600	27.5 (26.9–28.2)	5.3 (4.5–6.0)
≥$100,000	2,932	380	17.4(16.8–18.1)	4.2 (3.3–5.0)
Farm type[g]				
Livestock	5,450	1,113	51.1 (49.8–52.3)	5.3(4.5–6.1)
Crop	5,760	1,068	48.9 (47.7–50.2)	4.9 (4.1–5.7)

Note. 95% CI = 95% confidence interval.

[a]Unweighted sample size. Differences between the total number of subjects and the 11,210 participants in the survey resulted from missing data (248 for age, 19 for sex, 109 for marital status, 284 for smoking status, 115 for second job, 280 for current asthma).

[b]Weighted to the national population of primary farm operators using the survey sample weights for each participant.

[c]Males versus females, $P = .0009$.

[d]North: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont; Midwest: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin; South: Alabama, Texas, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Virginia, and West Virginia; West: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

[e]Farm counts considered a population measure, no confidence interval calculated.

[f]Midwest versus West, $P = .001$.

[g]Livestock farm type includes swine, dairy, beef cattle, sheep/goats, equine, poultry, aquaculture, and other animal; crop farm type includes grains, tobacco, cotton, vegetables, fruits/nuts, nursery/greenhouse, cut Christmas trees, and other crops/hay.

TABLE 2

Prevalence of Asthma Attacks and Proportion of Current Asthma That Is Farm Work Related Among Primary Farm Operators With Current Asthma

Characteristic	Asthma attack prevalence		Proportion of current asthma that is farm work related		Current asthma that is farm work related versus asthma that is non-farm related	
	%[a]	(95% CI)	%[a]	(95% CI)	POR[b] (95% CI)	*P*
Total	51.0	(45.3–56.7)	15.4	(11.5–19.2)	—	
Age group (years)						
16–39	47.9	(23.1–72.7)	16.8	(2.5–31.1)	1.00 (Ref)	
40–64	55.1	(47.5–62.8)	17.1	(11.7–22.5)	0.97 (0.31–3.07)	1.00
65–99	44.9	(36.1–53.6)	12.4	(6.7–18.2)	0.67 (0.19–2.42)	.55
Sex						
Male	51.1	(44.7–57.5)	16.9	(12.3–21.6)	1.55 (0.68–3.56)	.30
Female	50.7	(38.4–63.0)	10.4	(4.3–16.4)	1.00 (Ref)	
Marital status						
Married or living with a partner	51.3	(45.0–57.5)	16.3	(11.9–20.7)	__[b]	
Widowed, divorced, separated	50.5	(35.2–65.9)	11.4	(2.1–20.7)[c]	—	
Single, never married	48.3	(22.6–74.0)	__[d]		—	
Smoking status						
Current smoker	41.3	(22.0–60.7)	2.9	(0.0–5.8)[c,e]	__[b]	
Former smoker	54.5	(44.9–64.2)	9.5	(4.5–14.5)	—	
Nonsmoker	50.8	(43.5–58.2)	21.1	(15.2–27.1)	—	
Second job						
Yes	54.4	(45.9–62.9)	17.3	(10.9–23.6)	1.00 (Ref)	
No	48.1	(40.6–55.5)	13.7	(9.1–18.4)	0.73 (0.34–1.58)	.43
Region[f]						
North	56.5	(46.2–66.8)	26.2	(18.2–34.2)	1.00 (Ref)	
Midwest	53.0	(43.8–62.3)	15.7	(8.6–22.7)	0.32 (0.15–0.72)	.01
South	47.3	(37.2–57.5)	13.4	(6.4–20.3)	0.46 (0.22–0.95)	.04
West	49.6	(41.8–57.5)	15.2	(9.8–20.6)	0.41 (0.21–0.80)	.01
Farm acreage						

Characteristic	Asthma attack prevalence		Proportion of current asthma that is farm work related		Current asthma that is farm work related versus asthma that is non-farm related	
	%[a]	(95% CI)	%[a]	(95% CI)	POR[b] (95% CI)	*P*
<101	53.9	(46.4–61.5)	11.3	(6.8–15.9)[g]	0.21 (0.06–0.72)	.01
101–999	46.1	(37.5–54.8)	19.5	(12.3–26.6)	0.40 (0.15–1.08)	.07
≥1,000	40.6	(24.1–57.0)	41.1	(24.1–58.0)	1.00 (Ref)	
Farm value of sales						
<$10,000	54.9	(46.1–63.7)	12.7	(6.9–18.4)[h]	0.60 (0.20–1.81)	.36
$10,000–$99,999	46.5	(39.3–53.6)	12.0	(7.5–16.4)	0.44 (0.21–0.90)	.03
≥ $100,000	44.4	(33.9–55.0)	32.5	(22.5–42.6)	1.00 (Ref)	
Farm type[i]						
Livestock	52.0	(44.2–59.7)	15.2	(9.7–20.7)	1.00 (Ref)	
Crop	49.9	(41.6–58.1)	15.5	(10.2–20.9)	0.94 (0.52–1.68)	.82

Note. 95% CI = 95% confidence interval; Ref = reference group.

[a]Weighted to the national population of primary farm operators using the survey sample weights for each participant.

[b]Prevalence odds ratio. In the model, the outcome variable was current asthma that may be farm work related, and the predictor variables were age, sex, second job, census region, farm acreage, value of sales, and farm type. Marital status and smoking status were not included in the logistic regression model because the numbers of operators with farm work–related asthma in these two groups were not reliable.

[c]Estimated proportion may be unreliable because the relative standard error for the estimated number of operators with farm work–related asthma is 30%–50%.

[d]Estimate suppressed because the relative standard error for the estimated number of operators with farm work–related asthma >50%.

[e]Former versus never smokers, $P = .007$; current versus former/never smokers not assesses because the estimated proportion may be unreliable.

[f]North: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont; Midwest: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin; South: Alabama, Texas, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Virginia, and West Virginia; West: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

[g]Farms with <101 acres versus farms with ≥1,000 acres, $P < .0001$; farms with 101–999 acres versus farms with ≥1,000 acres, $P = .01$.

[h]Farms with ≥$100,000 value of sales versus farms with <$10,000 value of sales, $P < .001$; farms with ≥$100,000 value of sales versus farms with $10,000–$99,999 value of sales, $P < .001$.

[i]Livestock farm includes swine, dairy, beef cattle, sheep/goats, equine, poultry, aquaculture, other animal; crop farm includes grains, tobacco, cotton, vegetables, fruits/nuts, nursery/greenhouse, cut Christmas trees, other crops/hay.

TABLE 3

Distribution of Primary Farm Operators With Farm Work-Related Asthma by Select Characteristics

Characteristic	%[a]	95% CI
Total	100.0	
Age group (years)		
16–39	4.4	(0.7–8.1)[b]
40–64	64.7	(64.7–77.5)
65–99	30.9	(30.9–43.5)
Sex		
Male	83.9	(74.9–92.8)
Female	16.1	(7.2–25.1)[b]
Marital status		
Married or living with a partner	87.2	(78.7–95.7)
Widowed, divorced, separated	9.8	(1.8–17.8)[b]
Single, never married	__[c]	—
Smoking status		
Current smoker	2.0	(0.1–3.9)[b]
Former smoker	20.5	(10.3–30.6)[d]
Nonsmoker	77.5	(67.2–87.8)
Second job		
Yes	51.2	(37.8–64.6)
No	48.8	(35.4–62.2)
Region[c]		
North	12.0	(7.1–16.8)[f]
Midwest	31.7	(19.2–44.2)
South	36.7	(22.3–51.1)
West	19.6	(11.7–27.5)
Farm acreage		
<101	49.0	(35.5–62.5)[g]
101–999	35.2	(22.8–47.6)
≥1,000	15.8	(7.5–24.1)
Farm value of sales		
<$10,000	47.0	(33.2–60.7)[h]
$10,000–$99,999	22.2	(13.4–31.0)
≥$100,000	30.8	(19.9–41.7)
Farm type[i]		
Livestock	52.5	(39.2–65.9)
Crop	47.5	(34.1–60.8)

Note. 95% CI = 95% confidence interval.

[a]Weighted to the national population of primary farm operators using the survey sample weights for each participant.

[b] Estimate may be unreliable because the relative standard error for the estimated number of operators with farm work–related asthma is 30%–50%.

[c] Estimate suppressed because the relative standard error for the estimated number of operators with farm work–related asthma >50%.

[d] Never smoker versus former smoker, $P = .007$; current versus former/never smokers not assesses because the estimate may be unreliable.

[e] North: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont; Midwest: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin; South: Alabama, Texas, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Virginia, and West Virginia; West: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

[f] Farms in South versus farms in North, $P = .03$; farms in West versus farms in North, $P = .02$.

[g] Farms with <101 acres versus farms with ≥1,000 acres, $P < .0001$; farms with 101–999 acres versus farms with ≥1,000 acres, $P = .01$.

[h] Farms with ≥$100,000 value of sales versus farms with <$10,000 value of sales, $P < .001$; farms with ≥$100,000 value of sales versus farms with $10,000–$99,999 value of sales, $P < .0001$.

[i] Livestock farm includes swine, dairy, beef cattle, sheep/goats, equine, poultry, aquaculture, other animal; crop farm includes grains, tobacco, cotton, vegetables, fruits/nuts, nursery/greenhouse, cut Christmas trees, other crops/hay.