
Journal of Agromedicine
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/wagr20

# Respirator Use Among US Farm Operators: Evidence from the 2006 Farm and Ranch Safety Survey

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Version of record first published: 10 Jan 2013.

To cite this article: Girija Syamlal MBBS , Patricia L. Schleiff MS , Jacek M. Mazurek MD , Brent Doney MS & Mark Greskevitch BS (2013): Respirator Use Among US Farm Operators: Evidence from the 2006 Farm and Ranch Safety Survey, Journal of Agromedicine, 18:1, 27-38

To link to this article: http://dx.doi.org/10.1080/1059924X.2012.743379

*Journal of Agromedicine*, 18:27–38, 2013

ISSN: 1059-924X print/1545-0813 online
DOI: 10.1080/1059924X.2012.743379

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# Respirator Use Among US Farm Operators: Evidence from the 2006 Farm and Ranch Safety Survey

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**ABSTRACT.** The objective of this study was to estimate the national prevalence of respirator use among primary farm operators in the United States. The authors analyzed the 2006 Farm and Ranch Safety Survey data collected for 12,278 actively farming primary farm operators. Weighted prevalence and adjusted prevalence ratios (PRs) of respirator use were calculated by farm operator characteristics, farm characteristics, and selected exposures/hazards. Of the estimated 2.1 million farm operators, 37.2% used a respirator on their farm. Respirator use prevalence was significantly higher among operators aged 16–34 years than those aged ≥65 years (46.9% vs. 30.0%; PR = 1.6); male than female operators (39.0% vs. 24.4%; PR = 1.6); operators managing crop farms than operators managing livestock farms (40.9% vs. 33.7%; PR = 1.2); and operators managing farms with value of sales ≥$100,000 than operators managing farms with value of sales ≤$9999 (57.4% vs. 31.4%; PR = 1.8). Of the operators who used a respirator, 69.9% used while working in a dusty environment, 22.6% used while applying/handling pesticides, and 30.4% used while doing other farm-related activities. These results show that an estimated one third of operators used respirators in 2006, and respirator use is most frequent among operators working in a dusty environment. Additional research identifying specific exposures for which respirators or dust masks are used, barriers to respirator or dust mask use, motivators for wearing respirators, and opportunities to increase the use of respiratory protection among farm operators, particularly on smaller farms, is needed.

**KEYWORDS.** Agriculture worker, farm operator, occupational exposure, respirator

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This study was supported by the Centers for Disease Control and Prevention. The authors thank Mr. Larry A Layne and Dr. Kimberly Faulkner from the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, for their thoughtful comments.

*Disclaimer:* The findings and conclusions in this report are those of authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

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## INTRODUCTION

Farming is considered a high-risk occupation and is associated with multiple exposures, including inorganic and organic dusts, pesticides, and toxic gases.[1–3] These exposures can lead to acute and chronic respiratory diseases, such as chronic bronchitis, pneumoconiosis, pulmonary fibrosis, asthma, hypersensitivity pneumonitis (Farmer's lung), and organic dust toxic syndrome (ODTS).[1–11] In previous studies, increased respiratory symptoms and lung function decline were seen among workers on swine confinement operations,[8–10] dairy farms, animal and grain production farms,[4,5,9] and poultry enclosures.[4] In a lung autopsy study among California workers, farm workers exposed to inorganic dust were five times more likely to have pneumoconiosis than non-farm workers.[6]

Airborne exposures on the farm can be prevented or reduced by implementing measures to protect the worker, for example, applying engineering controls such as enclosing tractor cabs[12] or adequately ventilating confinement areas,[13] or by using personal protective equipment (PPE), including respirators.[3,14] The application of engineering controls can be limited due to cost of equipment, lack of knowledge/training of how to use new technologies, and the diverse nature of exposures on the farm.[15,16] Therefore, in such circumstances when engineering controls are not feasible, respirators may be used to protect workers' health.[14] Because respirators come in a variety of styles and sizes, their selection and fit testing is critical to assure maximum protection and should be done by qualified personnel.[14]

The Occupational Safety and Health Administration (OSHA) requires employers to have a written respiratory protection program with worksite-specific procedures and elements, and to provide respirators to employees to prevent exposures when engineering and administrative controls are not feasible.[14] The Occupational Safety and Health Standard, Respiratory Protection, 29 CFR 1910.134,[14] applies to most industries, except for agriculture (with the exception of parts of the storage and handling of anhydrous ammonia and cadmium standard requirements that are applicable to agriculture[17]). Furthermore, the Occupational Safety and Health (OSH) Act of 1970 does not cover self-employed and immediate members of farm families.[18] In addition, employers with 10 or fewer employees do not have to report workplace incidents (fatalities, injuries, and illnesses) and are exempt from OSHA inspections.[19] In the agriculture, forestry, and fishing sector, nearly 80% of workers are self-employed or unpaid, immediate members of farm families and nearly 78% of establishments in this sector employ 10 or fewer employees.[20] Therefore, the regulations or standards under the OSH Act apply only to approximately 20% of the agriculture, forestry, and fishing sector.

Workers who apply pesticides are required by the US Environmental Protection Agency (EPA) to use PPE, including respiratory protection devices, according to the pesticide label specification, and agricultural operations are required to provide decontamination stations and training to help reduce the risk of pesticide exposure.[21]

Respirator use can help prevent acute and chronic respiratory diseases.[3,4] Von Essen et al. reported that farm workers who used respirators all the time while working in swine confinement buildings and handling grain crops had better respiratory health than those who used respirators part of the time.[22] However, respirators are not routinely worn in agricultural operations.[23] For example, results of the Survey of Respirator Use and Practices conducted in 2001 by the National Institute for Occupational Safety and Health (NIOSH) and the US Bureau of Labor Statistics among 40,000 randomly selected private sector establishments in the United States showed that 9.4% of establishments and 5.8% of employees in the agriculture, forestry, and fishing sector used respirators.[24] In agricultural production (86% of the agriculture, forestry, and fishing sector[24]), respirators were used by 8.2% of employees in crop and 2.2% of employees in livestock. In agriculture services (7% of the agriculture, forestry, and fishing sector[24]), respirators were used by 5.4% of employees. Other studies also show that respirator use among workers on agricultural operations is low,[22,23,25] given the extent of exposures and respiratory illnesses.

Limited information is available on the prevalence of respirator use among US farm operators.[16,25] To address this gap, we identified operator and farm characteristics and type of farm activities associated with respirator use by analyzing national level farm data from the 2006 Farm and Ranch Safety Survey.

## METHODS

In 2006, the US Department of Agriculture's National Agricultural Statistics Service (NASS) conducted the Farm and Ranch Safety Survey for NIOSH. This survey was designed to collect demographic data on primary farm operators, farm-related data, and information on respirator use. Data were self-reported either by the operator or the operator's spouse. NASS identifies a primary farm operator as one who runs the farm making day-to-day management decisions.[25] The Farm and Ranch Safety Survey was determined by the NIOSH Human Subjects Review Board (HSRB) to be routine and ongoing public health surveillance and was exempt from human subjects review (protocol no. HSRB 94-DSR-01). However, participation in the survey required an informed consent.

A telephone survey of 25,000 farm operators was conducted during the month of September 2006. The sample was obtained from the NASS sampling frame of active farms and ranches, and was stratified by region of the country. There were a total of 12,278 completed telephone interviews with operators of active farms, and an additional 1881 operators who were contacted but were no longer actively farming. There were 4704 farm operators who were contacted but refused to participate in the survey. Finally, there were 6137 operators who could not be reached by phone during the survey period. The adjusted survey response rate, excluding noncontacts, was 75%.

Information on respirator use was collected from the operator or the operator's spouse (if the operator was not available) using the following questions: "In the last 12 months, have (you/the farm operator) used a respirator or dust mask on your farm or ranch?" If "yes," three additional questions were asked: "When using pesticides?" "When working in dusty environments?" and "For other work activities on the farm besides using pesticides or in dusty environments?"

The terms respirator and dust mask were both used during the telephone interview because cognitive testing of the questionnaire showed that a respondent often defined a respirator as a rubber face mask with screw-in cartridge(s) or supplied oxygen. Respondents who used N-95 respirators were responding "No" to the respirator question because they considered the N-95 respirators to be dust masks. To avoid undercounting of respirator use, the questionnaire was modified and included both terms. In this paper, further use of the term "respirator" refers to both respirators and dust masks.

Exposures/hazards were determined to be present if the operator responded "yes" to questions indicating involvement with the following activities: baling hay; breathing moldy dust from things such as hay, straw, grain, wood chips, or any other agricultural products; and handling or applying anhydrous ammonia. If the operator responded "yes" to having diesel tractor(s), welder or oxyacetylene system, or a manure pit(s) on the farm and if the operator personally operated a tractor, used a welder, or entered the pit one or more times in the past 12 month prior to the survey, it was also considered to be an exposure/hazard. We cross-tabulated the information on specific exposures/hazards with respirator use to assess whether operators with a specific exposure/hazard were more likely to have used respirators than those without the specific exposure/hazard.

We used SAS software version 9.2 (SAS Institute, Cary, NC) survey procedures and SUDAAN release 10.0.1 software (Research Triangle Institute, Research Triangle Park, NC) for analysis. Because of the sampling design of the Farm and Ranch Survey, sample weights were used to produce representative estimates. Survey weights were derived using farm counts published by NASS, for calendar year 2006. To calculate the survey weights, farms were poststratified within regions of the United States by three broad categories of the farm operation's gross value of sales ($<$\$10,000, $\geq$\$10,000–\$99,999, $\geq$\$100,000). We estimated prevalence of respirator use by farm operator and

farm characteristics (e.g., farm size). Previous research has shown that variation in farm size can be measured by acres, labor use, and value of sales.[26,27] For this study, we defined small farms as those with annual value of sales of <$100,000 and large farms as those with annual value of sales ≥$100,000.[28]

We used multivariate logistic regression models to estimate prevalence ratios (PRs) adjusted for age and gender, because age and gender have previously been associated with respirator use.[16,25] If the relative standard error for the prevalence estimate was >30%, the estimate was considered unreliable and was not reported.

## RESULTS

Of the estimated 2.1 million primary farm operators who were actively farming in 2006, 66.1% were aged 35–64 years (median 57.0 years), 88.1% were males, 79.7% managed farms located in the Midwest and the South, 49.1% managed crop farms, 50.9% managed livestock farms, 83.8% managed farms with <$100,000 in value of sales, and 80.7% managed farms with less than 300 acres (Tables 1 and 2).

An estimated 37.2% of primary farm operators used a respirator during the 12-month period prior to the interview. The prevalence of respirator use was significantly higher among farm operators aged 16–34 years than operators 65 years or older (46.9% vs. 30.0%; PR = 1.6); among male than female farm operators (39.0% vs. 24.4%; PR = 1.6); among operators in the West than in the Northeast region (41.1% vs. 35.3%; PR = 1.1); among operators on crop farms than on livestock farms (40.9% vs. 33.7%; PR = 1.2); among operators managing farms with ≥700 acres than operators managing farms with ≤300 acres (53.4% vs. 34.2%; PR = 1.5) and operators managing farms with ≥$100,000 in sales than operators managing farms with ≤$9000 in sales (57.4% vs. 31.4%; PR = 1.8). For the agricultural subsector

TABLE 1. Demographic Characteristics of the Primary Farm Operator, Farm and Ranch Safety Survey, 2006

| Characteristics | Unweighted sample *n* | Weighted estimates % | Respirator use | |
|---|---|---|---|---|
| | | | % (95% CI) | PR* (95% CI) |
| Age group (years) | | | | |
| 16–34 | 286 | 2.3 | 46.9 (39.3–54.4) | 1.6 (1.3–1.9) |
| 35–64 | 8081 | 66.1 | 40.7 (39.3–42.1) | 1.4 (1.3–1.5) |
| ≥65 | 3609 | 29.3 | 30.0 (28.1–31.9) | Ref. (1.0) |
| Unknown/missing | 302 | 2.3 | —† | — |
| Gender | | | | |
| Male | 10,885 | 88.1 | 39.0 (37.8–40.1) | 1.6 (1.4–1.8) |
| Female | 1381 | 11.8 | 24.4 (21.4–27.4) | 1.0 (Ref.) |
| Unknown/missing | 12 | — | — | — |
| Region‡ | | | | |
| Northeast | 2869 | 6.3 | 35.3 (33.4–37.3) | 1.0 (Ref.) |
| Midwest | 2998 | 37.5 | 40.0 (38.2–41.8) | 1.1 (1.0–1.2) |
| South | 3340 | 42.2 | 33.7 (31.8–35.6) | 0.9 (0.9–1.0) |
| West | 3071 | 14.1 | 41.1 (39.2–42.9) | 1.1 (1.1–1.2) |

*Note.* CI = confidence interval; PR = prevalence ratio. Prevalence estimates and PRs were calculated using weighted data.
*PR adjusted for age and gender; PR is the likelihood of using a respirator among operators within a specific group compared with the likelihood of using a respirator among operators in the reference group (PR = 1.0).
†Estimates not calculated.
‡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; West: Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming, Alaska, California, Hawaii, Oregon, Washington.

TABLE 2. Farm Characteristics and the Prevalence of Respirator Use, Farm and Ranch Safety Survey, 2006

| Characteristics | Unweighted sample *n* | Weighted estimates % | Respirator use | |
|---|---|---|---|---|
| | | | % (95% CI) | PR* (95% CI) |
| Farm type | | | | |
| Crops | 6340 | 49.1 | 40.9 (39.3–42.4) | —† |
| Grains | 1708 | 13.7 | 53.7 (51.0–56.5) | 1.6 (1.4–1.7) |
| Tobacco | 115 | 1.4 | 26.2 (16.7–35.7) | 0.8 (0.5–1.1) |
| Cotton and cotton seed | 59 | 0.4 | 45.0 (31.3–58.7) | 1.3 (0.9–1.8) |
| Vegetables, melon, potatoes, and sweet potatoes | 378 | 1.8 | 42.4 (31.3–58.7) | 1.3 (1.0–1.5) |
| Fruit, tree nuts, and berries | 853 | 4.4 | 50.3 (45.9–54.6) | 1.5 (1.3–1.7) |
| Nursery, greenhouse, floriculture, and sod | 452 | 1.8 | 49.1 (42.8–55.3) | 1.5 (1.3–1.8) |
| Cut Christmas trees and short-rotation woody crops | 153 | 0.9 | 45.2 (34.1–56.3) | 1.4 (1.1–1.7) |
| Other crops‡ | 2622 | 24.5 | 33.0 (30.6–35.4) | 1.0 (Ref.) |
| Livestock | 5938 | 50.9 | 33.7 (32.2–35.3) | —† |
| Hogs and pigs | 145 | 1.1 | 54.1 (44.3–64.0) | 1.7 (1.4–2.1) |
| Milk and other dairy products | 825 | 3.3 | 47.3 (42.5–52.0) | 1.5 (1.3–1.7) |
| Cattle and calves | 3635 | 33.0 | 31.6 (29.7–33.5) | 1.0 (Ref.) |
| Sheep, goats, and their products | 242 | 2.6 | 38.9 (31.0–46.9) | 1.2 (1.0–1.6) |
| Horses, ponies, and mules | 743 | 8.3 | 30.3 (26.1–34.5) | 1.0 (0.9–1.2) |
| Poultry and eggs | 217 | 1.7 | 58.2 (50.1–66.3) | 1.9 (1.6–2.2) |
| Aquaculture | 33 | —§ | — | — |
| Other animals and animal products | 98 | 0.7 | 31.5 (20.1–42.9) | 1.0 (0.7–1.5) |
| Farm size (value of sales) | | | | |
| ≤$9999 | 3940 | 55.2 | 31.4 (29.7–33.1) | 1.0 (Ref.) |
| $10,000–$99,999 | 5224 | 28.6 | 37.0 (35.5–38.5) | 1.2 (1.1–1.2) |
| ≥$100,000 | 3114 | 16.2 | 57.4 (55.4–59.4) | 1.8 (1.7–1.9) |
| Farm size (acres) | | | | |
| ≤300 | 8987 | 80.7 | 34.2 (32.9–35.5) | 1.0 (Ref.) |
| 301–699 | 1620 | 9.9 | 46.2 (43.3–49.1) | 1.3 (1.2–1.4) |
| ≥700 | 1671 | 9.4 | 53.4 (50.8–56.1) | 1.5 (1.4–1.6) |
| Exposures/Hazards¶ | | | | |
| Welding | | | | |
| Yes | 6544 | 49.6 | 46.0 (44.4–47.5) | 1.5 (1.4–1.6) |
| No | 5556 | 48.9 | 29.2 (27.7–30.8) | 1.0 (Ref.) |
| Manure pit | | | | |
| Yes | 136 | 0.6 | 54.1 (41.6–66.7) | 1.4 (1.1–1.8) |
| No | 12,000 | 98.2 | 37.5 (36.4–38.6) | 1.0 (Ref.) |
| Ammonia | | | | |
| Yes | 1031 | 9.0 | 53.6 (49.9–57.3) | 1.5 (1.3–1.6) |
| No | 11,027 | 89.8 | 36.2 (35.0–37.4) | 1.0 (Ref.) |
| Mold | | | | |
| Yes | 5781 | 45.6 | 46.5 (44.8–48.2) | 1.5 (1.4–1.6) |
| No | 6246 | 52.3 | 30.2 (28.8–31.7) | 1.0 (Ref.) |
| Diesel | | | | |
| Yes | 9031 | 69.2 | 41.9 (40.6–43.2) | 1.4 (1.3–1.6) |
| No | 2954 | 28.5 | 27.4 (25.4–29.5) | 1.0 (Ref.) |

(*Continued*)

TABLE 2. (Continued)

| Characteristics | Unweighted sample *n* | Weighted estimates % | Respirator use | |
|---|---|---|---|---|
| | | | % (95% CI) | PR* (95% CI) |
| Bale hay | | | | |
| Yes | 5558 | 40.3 | 41.4 (39.7–43.1) | 1.2 (1.1–1.2) |
| No | 6626 | 58.9 | 34.8 (33.3–36.2) | 1.0 (Ref.) |
| Total | 12,278 | 100.0 | 37.2 (36.1–38.3) | |

*Note.* CI = confidence interval; PR = prevalence ratio. Totals do not add up to a 100% due to missing data. Prevalence estimates and PRs were calculated using weighted data.

*PR adjusted for age and gender; PR is the likelihood of using a respirator among operators within a specific group compared with the likelihood of using a respirator among operators in the reference group (PR = 1.0).

†Operators on crop farms (PR = 1.2; 95% CI: 1.1–1.3) were more likely to use respirators than operators on livestock farms.

‡Other crops include hay, Conservation Reserve Program (CRP), and pasture. CRP is a cost-share and rental payment program administered by the USDA Farm Service Agency.

§The relative standard error for the estimate >30%; estimate not shown.

¶Operators who handled or worked with exposures/hazards in the past 12 months of the interview and used a respirator during the same 12-month period.



categories, the proportion of farm operators using a respirator was the highest among those in poultry and eggs (58.2%) and grains (53.7%) (Table 2).

Of the estimated 2.1 million primary farm operators, 69.2% had operated diesel tractors, 49.6% used a welder, 45.6% were exposed to moldy dust, 40.3% baled hay, 9.0% applied/handled anhydrous ammonia, and 0.6% entered manure pit(s). Operators exposed to diesel, welding hazards, mold, and hay used respirators greater than 40% of the time and operators exposed to manure pit hazards and anhydrous ammonia used respirators greater than 50% of the time (Table 2).

Of the farm operators (37.2%) who used a respirator, 69.9% used one when working in dusty environments, 22.6% used one when using pesticides, and 30.4% used one when doing other farm activities other than pesticides or dusty environment. Dusty environments were the predominant reason for respirator use regardless of operator or farm characteristics. Pesticide use was associated with higher respirator use among operators on crop (26.0%) farms and specifically on nursery, greenhouse, floriculture, and sod farms (51.7%) and fruit, tree nuts, and berries farms (49.9%) (Table 3).

Of the 83.8% of farm operators managing farms with value of sales <$100,000, 33.3% used a respirator. Of the farm operators managing these farms, the prevalence of respirator use was highest among operators: 16 to 34 years old (42.3%); males (34.9%); on crop farms (35.9%); and on farms in the West region (39.1%) (Table 4).

For farm operators managing farms with value of sales ≥$100,000, 57.4% used a respirator and they were 1.7 times more likely to use a respirator than operators managing farms with value of sales <$100,000. Furthermore, the prevalence of respirator use was highest among operators: 16 to 34 years old (64.6%); males (58.4%); on crop farms (61.9%); and on farms in the Midwest region (63.4%) (Table 4).

Among operators who entered manure pit(s) or handled/applied anhydrous ammonia, if they managed farms with value of sales ≥$100,000 they were 1.9 and 1.8 times more likely to have used a respirator compared with operators managing farms with value of sales <$100,000, respectively (Table 4).

## *DISCUSSION*

This study found that 37% of US primary farm operators used a respirator while working on the farm. These findings are consistent with two previous studies examining respirator use among California farm operators.[16,25] Based on 1992 data, Schenker et al. reported that

TABLE 3. Proportion of Primary Farm Operators Using a Respirator, by Work Activity,* Farm and Ranch Safety Survey, 2006

| Characteristics | Dusty environment % (95% CI) | Using pesticides % (95% CI) | Other % (95% CI) |
|---|---|---|---|
| Age group (years) | | | |
| 16–34 | 78.9 (70.1–87.8) | 22.2 (13.2–31.1) | 30.6 (20.7–40.6) |
| 35–64 | 71.1 (69.1–73.0) | 23.2 (21.4–24.9) | 29.7 (27.7–31.6) |
| ≥65 | 65.8 (62.3–69.4) | 20.9 (18.0–23.7) | 32.9 (29.4–36.5) |
| Gender | | | |
| Male | 69.9 (68.2–71.7) | 22.9 (21.3–24.4) | 30.0 (28.2–31.7) |
| Female | 69.8 (63.5–76.2) | 19.2 (14.2–24.2) | 36.1 (29.4–42.8) |
| Second job | | | |
| Yes | 77.4 (68.9–73.8) | 21.5 (19.3–23.7) | 29.6 (27.1–32.1) |
| No | 68.5 (66.3–70.8) | 23.6 (21.6–25.6) | 31.2 (28.9–33.5) |
| Region† | | | |
| Northeast | 60.9 (57.6–64.2) | 28.2 (25.3–31.2) | 28.4 (25.2–31.5) |
| Midwest | 73.4 (70.7–76.0) | 17.0 (14.9–19.1) | 29.5 (26.8–32.2) |
| South | 69.3 (66.2–72.4) | 24.5 (21.6–27.4) | 32.3 (29.1–35.5) |
| West | 65.9 (63.2–68.7) | 30.4 (27.8–33.0) | 28.9 (26.3–31.6) |
| Farm type | | | |
| Crops | 69.0 (66.8–71.2) | 26.0 (24.0–28.0) | 28.3 (26.1–30.5) |
| Grains | 75.5 (72.5–78.6) | 20.1 (17.3–23.0) | 27.8 (24.6–30.9) |
| Tobacco | 93.3 (86.0–100.0) | 40.0 (18.8–61.3) | —‡ |
| Cotton and cotton seed | 72.9 (55.2–90.5) | — | — |
| Vegetables, melon, potatoes, and sweet potatoes | 56.0 (46.1–65.8) | 39.0 (29.1–48.9) | 26.1 (18.0–34.3) |
| Fruit, tree nuts, and berries | 49.9 (43.8–56.0) | 49.4 (43.4–55.4) | 28.6 (23.4–33.9) |
| Nursery, greenhouse, floriculture, and sod | 46.1 (37.5–54.8) | 51.7 (43.0–60.4) | 29.9 (21.7–32.9) |
| Cut Christmas trees and short-rotation woody crops | 51.8 (35.7–68.0) | 39.9 (24.3–55.6) | 31.7 (21.7–38.1) |
| Other crops§ | 71.7 (67.7–75.7) | 19.5 (16.0–22.9) | 29.1 (25.6–33.2) |
| Livestock | 71.0 (68.5–73.6) | 18.6 (16.5–20.8) | 32.9 (30.3–35.5) |
| Hogs and pigs | 77.1 (67.4–86.8) | — | 33.2 (21.6–44.8) |
| Milk and other dairy products | 69.3 (62.8–75.8) | 18.4 (12.8–24.1) | 31.1 (24.6–37.6) |
| Cattle and calves | 70.0 (66.6–73.4) | 19.8 (16.9–22.7) | 32.7 (29.3–36.2) |
| Sheep, goats, and their products | 81.3 (71.8–90.7) | 18.1 (7.9–28.3) | 32.7 (20.4–45.1) |
| Horses, ponies, and mules | 69.0 (61.3–76.7) | 14.0 (8.3–19.8) | 35.1(27.2–45.0) |
| Poultry and eggs | 71.6 (62.7–80.4) | 17.5 (10.9–24.2) | 34.0 (24.6–43.4) |
| Aquaculture | 91.7 (79.2–100.0) | — | — |
| Other animals and animal products | 84.5 (73.5–95.5) | — | — |
| Farm size (value of sales) | | | |
| ≤$9999 | 69.3 (66.3–72.3) | 21.0 (18.4–23.7) | 31.9 (28.8–35.0) |
| $10,000–$99,999 | 69.5 (67.1–71.8) | 22.7 (20.6–24.7) | 30.2 (27.8–32.6) |
| ≥$100,000 | 71.6 (69.1–74.0) | 25.5 (23.1–27.8) | 27.9 (25.5–30.4) |
| Farm size (acres) | | | |
| ≤300 | 68.4 (66.3–70.4) | 23.1 (21.3–24.9) | 31.2 (29.1–33.3) |
| 301–699 | 71.9 (68.0–75.8) | 19.8 (16.4–23.1) | 28.6 (24.8–32.5) |
| ≥700 | 76.6 (73.5–79.7) | 22.5 (19.4–25.6) | 27.9 (24.6–31.2) |
| Total | 69.9 (68.3–71.6) | 22.6 (21.1–24.1) | 30.4 (28.7–32.1) |

*Note.* CI = confidence interval. Prevalence estimates and PRs were calculated using weighted data.

*The respirator use for work activity is based on responses to the questions: "In the last 12 months, have (you/the farm operator) used a respirator or dust mask on your farm or ranch?" If the response was "yes," then three additional questions were asked: "When working in dusty environments?" "When using pesticides?" and "For other work activities on the farm besides using pesticides or in dusty environments?"

†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; West: Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming, Alaska, California, Hawaii, Oregon, Washington.

‡The relative standard error for the estimate >30%; estimate not shown.

§Other crops include hay, Conservation Reserve Program (CRP), and pasture. CRP is a cost-share and rental payment program administered by the USDA Farm Service Agency.

TABLE 4. Prevalence of Respirator Use Among Primary Farm Operators by Farm Value of Sales, Farm and Ranch Safety Survey, 2006

| Characteristics | <$100,000 % (95% CI) | ≥$100,000 % (95% CI) | PR* (95% CI) |
|---|---|---|---|
| Age group | | | |
| 16–34 | 42.3 (33.4–51.2) | 64.6 (53.4–75.8) | 1.6 (1.2–2.0) |
| 35–64 | 36.1 (34.5–37.7) | 61.9 (59.6–64.2) | 1.7 (1.6–1.8) |
| ≥65 | 27.6 (25.4–29.7) | 44.0 (39.4–48.6) | 1.5 (1.3–1.7) |
| Gender | | | |
| Male | 34.9 (33.5–36.2) | 58.4 (56.3–60.5) | 1.7 (1.6–1.8) |
| Female | 23.1 (20.0–26.2) | 39.7 (31.5–47.9) | 1.7 (1.4–2.2) |
| Region | | | |
| Northeast | 32.6 (30.4–34.8) | 50.5 (46.9–54.1) | 1.5 (1.3–1.6) |
| Midwest | 33.1 (30.9–35.3) | 63.4 (60.4–66.4) | 1.9 (1.7–2.0) |
| South | 31.8 (29.8–33.8) | 51.1 (46.8–55.4) | 1.6 (1.4–1.8) |
| West | 39.1 (37.0–41.2) | 49.7 (46.2–53.3) | 1.2 (1.1–1.4) |
| Farm characteristics | | | |
| Crops | 35.9 (34.1–37.7) | 61.9 (59.3–61.6) | 1.6 (1.5–1.8) |
| Livestock | 31.0 (29.3–32.7) | 51.1 (48.0–54.3) | 1.5 (0.7–3.1) |
| Farm size (acres) | | | |
| ≤300 | 33.0 (31.7–34.3) | 54.1 (50.4–57.8) | 1.6 (1.5–1.8) |
| 301–699 | 37.6 (33.7–44.5) | 58.3 (54.1–62.4) | 1.5 (1.3–1.7) |
| ≥700 | 32.9 (33.7–41.5) | 58.8 (55.8–61.8) | 1.7 (1.4–2.0) |
| Work activity | | | |
| Dusty environment | 69.4 (67.3–71.4) | 71.5 (69.1–74.0) | 1.0 (1.0–1.1) |
| Pesticides | 21.7 (19.9–23.5) | 25.5 (23.1–27.8) | 1.2 (1.0–1.3) |
| Other | 31.3 (29.2–33.4) | 27.9 (25.5–30.4) | 0.9 (0.8–1.0) |
| Exposures/Hazards† | | | |
| Welding | 40.9 (39.0–42.8) | 62.0 (59.6–64.3) | 1.5 (1.4–1.6) |
| Manure pit | 36.8 (15.5–58.0) | 67.8 (55.8–79.7) | 1.9 (1.0–3.4) |
| Ammonia | 42.4 (37.5–47.2) | 75.9 (71.7–80.2) | 1.8 (1.6–2.0) |
| Mold | 42.5 (40.5–44.4) | 64.2 (61.5–66.9) | 1.5 (1.4–1.6) |
| Diesel | 37.0 (35.5–38.6) | 60.4 (58.3–62.5) | 1.6 (1.5–1.7) |
| Bale hay | 37.3 (35.3–39.3) | 57.7 (54.8–60.6) | 1.5 (1.4–1.7) |
| Total | 33.3 (32.1–34.5) | 57.4 (55.3–59.4) | 1.7 (1.6–1.8) |

*Note.* CI = confidence interval; PR = prevalence ratio. Prevalence estimates and PRs were calculated using weighted data.
*PR adjusted for age and gender; PR is the likelihood of using a respirator among operators on farms with value of sales <$100,000 compared with the likelihood of using a respirator among operators on farm with value of sales ≥$100,000.
†Operators who handled or worked with exposures/hazards in the last 12 months of the interview and used a respirator during the same 12-month time period.



24% operators working in dusty conditions used respirators more than 50% the time; use was higher among male operators (33%) and among those less than 40 years of age (39%).[25] Using data collected during 1993–2004, Mitchell et al. showed that respirator use among California farm operators decreased significantly from 53% in 1993 to 37% in 2004.[16] The authors reported that 20% of operators consistently used respirators during 1993–2004. These results suggest that some operators recognize the need for respiratory protection while working on the farm.

We found that respirators were used more frequently among farm operators aged 16–34 years. The results of other studies also suggest that younger operators are more likely to use respirators than those aged 70 years and older.[16,25] More frequent use of respirators among younger operators than among older operators could be explained, in part, by the fact that the younger operators spend longer hours and/or are more aware of the health hazards of farming.[16] Furthermore, older farm operators might be reluctant to change their work practices and might perceive that their

breathing troubles are a part of the aging process and not due to exposures on the farm.[16]

In the South region, an estimated 63% of the farms were livestock as compared with Northeast and Midwest regions where 62% were crop farms. Poultry, rice, and cotton farms are common in the South region, and fruits, vegetables, wheat, and cattle farms are common in the West region.[29] Farms in the Midwest and West regions are large or very large in size (both in production value and in cropland) and are predominantly crop farms and have the highest value of production as compared with other regions.[29] Our results show that respirator use was more frequent among operators managing farms in the Midwest and West regions than those managing farms in the South, and among operators on larger farms with ≥$100,000 value of sales as compared with operators on smaller farms with <$100,000 value of sales. The prevalence of respirator use while working in a dusty environment was significantly higher among operators managing farms in the Midwest region as compared with operators managing farms in the Northeast and West regions. Regional differences observed in this study may be related to various factors such as differences in farm size, agricultural practices, personal/cultural attitudes toward PPE, and availability of farm safety education.[30]

Exposures to pesticides have been associated with increased risk for respiratory symptoms and conditions among agricultural workers.[5,31] For example, exposure to organophosphate or carbamate compounds can cause bronchoconstriction,[31] paraquat can cause pulmonary fibrosis, and carbamate insecticides are associated with development of asthma and chronic bronchitis.[32] We found that 23% of farm operators used respirators while applying or handling pesticides. In addition, only 17% of farm operators managing farms in the Midwest used a respirator, a percentage that we would have expected to be higher given that 62% of farms in the Midwest are crop operations where pesticides are commonly used. The observed proportions of respirator use while applying or handling pesticides might be explained, in part, by the perceived notion that pesticide exposure is not presumed to be a respiratory health risk,[33] the type of pesticide used depends on the type of commodity grown,[34] and the perceived need for a specific type of protective equipment by the operator. EPA's protection criteria for the type of respirator required for applying pesticides depends on the toxicity and the physical state of the pesticide (i.e., solid, liquid, or gas) used. For instance, gas applied in an enclosed area will require the use of supplied air respirator or the use of a self-contained breathing apparatus.[35] Pesticides are toxic and respirators are useful in preventing pesticide exposure. Although proper selection may be complicated,[34] the most direct information regarding respirator use against pesticide exposure is the pesticide label.[21] Furthermore, the observed proportion of respirator use in our study may reflect the actual proportion of respirator use among operators because operators may have followed the pesticide label specifications when required to use a respirator for specific type of pesticides. Further information to examine whether label specification could have explained these proportions could not be done because this information was not available from the survey.

Respirator use was significantly higher among operators managing farms with value of sales ≥$100,000 as compared with those with value of sales <$100,000. This may in part be due to the fact that on smaller farms the decision to use a respirator may most often depend on availability of respirators, cost of respirators, and the operator's knowledge, attitudes, and beliefs about the need for respiratory protection. Furthermore, farms with value of sales ≥$100,000 may employ more than 10 workers and be more likely subject to OSHA regulations. In addition, safety measures are more likely to be enforced by farm managers and other regulatory agencies and, therefore, are more likely to follow recommended safety measures.[36]

### *Limitations*

The estimates reported in this study relied on self-reported survey data that required the respondents to recall information for up to 12 months. In addition, data were self-reported or reported by the operator's spouse. The information gathered from the operator's spouse may

or may not be accurate or complete; however, the assessment of this could not be determined because information on spouse participation was not available to the authors.

Respondents were asked questions about respirator or dust mask use on the farm. The ability to differentiate between the use of a respirator versus the use of a dusk mask could not be assessed with the information collected from the survey. In addition, the survey was not designed to allow assessment of whether a respirator was used at the time of exposure to a specific exposure/hazard except for when working in a dusty environment and/or when handling or applying pesticides.

Finally, the survey did not collect information on the application of engineering controls, airborne exposure levels, or the presence of a respiratory protection program[35] on the farm. Thus, it was not possible to assess if operators had a need to use respirators and if those who used a respirator were properly fit tested, medically evaluated, or trained to select and use respirators appropriate for the task.

### *Conclusions*

These results contribute to the limited information on respirator use among primary farm operators. Future studies are needed to identify opportunities to increase the use of respiratory protection among farm operators, particularly on smaller farms, to identify exposures for which respirators are used, to identify motivators for wearing respirators, and to identify barriers associated with respirator use on the farms.

### *Recommendations*

Health care providers may be instrumental in increasing respirator use by educating farm operators on the use of PPE.[30] Identifying motivators for and barriers to proper respirator use are needed so that interventions can be tailored to protect farm operators from respiratory hazards. Establishing a respiratory protection program would help ensure proper selection and use of respirators.[14,37,38] NIOSH offers information about the selection of appropriate respirators for the protection of workers in specific workplaces, and it is available at: http://www.cdc.gov/niosh/docs/2005-100/pdfs/2005-100.pdf.[39] In addition, the OSHA Small Entity Compliance Guide provides information and gives an example of a respiratory protection program that would meet the requirements of the Respiratory Protection Standard for small businesses. This information can be accessed at: http://www.osha.gov/Publications/SECG_RPS/secgrev-current.pdf.

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