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POPULATIONS AT RISK ACROSS THE LIFESPAN: PROGRAM EVALUATIONS

Knowledge, Attitudes, and Practices for Respiratory and Hearing Health among Midwestern Farmers

Mary E. Cramer, PhD, APHN-BC, FAAN,[1] Mary J. Wendl, MSA,[2] Harlan Sayles, MS,[3] Ellen Duysen, MPH,[4] and Chandran Achutan, PhD[3]

[1]University of Nebraska Medical Center (UNMC) College of Nursing, Omaha, Nebraska; [2]Central States Center for Agricultural Safety and Health (CS-CASH) UNMC College of Nursing, Omaha, Nebraska; [3]UNMC College of Public Health, Omaha, Nebraska; and [4]CS-CASH, UNMC College of Public Health, Omaha, Nebraska

Correspondence to:
Mary E. Cramer, UNMC College of Nursing, 4101 Dewey Avenue, Omaha, NE 68198-5330. E-mail: mecramer@unmc.edu

ABSTRACT ***Objective:*** The purpose of this study was to assess knowledge, attitudes, and practices for hearing and respiratory health/safety among farmers in seven Midwestern states served by a federally funded Agricultural Center. Findings provided a baseline to longitudinally track the Agricultural Center's program outcomes and to design community education to improve safety and health among farmers. ***Design and Sample:*** This was a cross-sectional study using a 30 item mailed survey to describe farmers' operations, demographics, health conditions, related information sources, and knowledge/attitude/practices for personal protective equipment (PPE) (i.e., ear plugs/muffs and dust masks/respirators). ***Measures:*** Frequencies and percentages were calculated for each item and according to responses from younger versus older farmers. The unit of study was farm operators (N = 280) randomly selected from a publicly available database of corn/soybean and hog farmers in seven Midwestern states. ***Results:*** Findings revealed important knowledge gaps among respondents regarding (1) hazardous exposure sources; (2) long-term health consequences of noise/dust exposure; (3) proper selection/fitting of PPE. ***Conclusions:*** Public health nurses and primary care providers in rural communities should address specific knowledge gaps in order to enhance farmers' perceived understanding of their susceptibility to hazardous exposures. Increasing farmers' knowledge through preferred venues may help to improve PPE effectiveness.

Key words: Agriculture, hearing loss, occupational exposure, personal protective equipment, program evaluation.

Agriculture is big business in the United States (U.S.). Agriculture and agriculture-related industries contributed $789 billion to the U.S. gross domestic product in 2013, representing a 4.7% share (U.S. Department of Agriculture, Economic Research Service, 2013). In 2013, over 16.9 million full-time and part-time jobs were related to agriculture—about 9.2% of total U.S. employment. Despite the importance of agriculture to the U.S. economy, the health and safety of the population that works in this industry remains a concern.

Agriculture ranks among the most hazardous occupations in the U.S. Workers in agriculture, forestry, fishing and hunting experience the highest fatal injury rate of any industry at 24.9 work injuries per 100,000 full-time workers (U.S. Department of Labor, Bureau of Labor Statistics, Census of Fatal Occupational Injuries, 2014). Other agriculture-related hazards include hearing loss and respiratory diseases. Farming is among the top three occupations and industries having the highest risk for hearing loss (Ehlers & Graydon, 2011). Hearing

damage can occur with constant exposure to hazardous noise, which is defined as exceeding 85 decibels (U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, 1998). Noise sources include farm machinery and livestock, and these sources can be well above the recommended exposure level of 85 decibels (Achutan & Tubbs, 2007a, b). Hearing loss in agricultural workers has been associated with decreased function, reduced quality of life, increased injuries, and even the increased incidence of cardiovascular disease (Choi et al., 2005; Dalton et al., 2003; Tomei et al., 2013).

Another agricultural health hazard is dust from grain and animal confinement operations. Research shows prolonged exposures are associated with the increased incidence of nonspecific respiratory ailments [wheezing, coughing, dyspnea], as well as, specific chronic obstructive pulmonary diseases (COPD) (Bailey, Meza, Smith, Von Essen, & Romberger, 2007; Lamprecht, Schirnhofer, Kaiser, Studnicka, & Buist, 2007; Linaker & Smedley, 2002). The total age-adjusted rates for COPD, which include emphysema and bronchitis, tend to be higher in the Midwest and Southeast states, however, there are also higher smoking rates in both areas (American Lung Association, Epidemiology and Statistics Unit Research and Health Education Division, 2013; U.S. Centers for Disease Control and Prevention, 2010).

The Midwest has a relatively large concentration of farms (437,042) that are mostly corn and soybean operations as well as hog production facilities (U.S. Census of Agriculture, 2014; U.S. Department of Agriculture, National Agricultural Statistics Service Census of Agriculture, 2012). Each farm type presents increased exposure risks to hazardous noise and dust. Personal protective equipment (PPE) (i.e., facial masks or respirators, ear plugs, or ear muffs) has been available for many years. Used properly, PPE can protect a worker from developing respiratory diseases or worsening hearing (U.S. Department of Labor, Occupational Safety & Health Administration, 2006). However, there is little evidence to suggest that agricultural workers routinely wear PPE to reduce their exposures (Schenker, Orenstein, & Samuels, 2002).

This article presents evaluation findings that assessed Midwestern farmers' PPE use, as well as their knowledge and attitudes regarding hazardous exposures, long-term health consequences, and preferred venues for health information and safety education. The evaluation was conducted for the Central States Center for Agricultural Safety and Health (CS-CASH)—one of 10 federally funded Agricultural Centers in the U.S. (U.S. Centers for Disease Control and Prevention, National Institute of Occupational Safety and Health, 2014). The CS-CASH goal is to improve the health and safety of Midwestern agricultural populations through applied research, education, and community outreach. The data findings served as a baseline to longitudinally track CS-CASH program outcomes, and to tailor community outreach and education for hearing and respiratory health. The evaluation design and findings have implications for public health nurses and other public health practitioners who assess population health as one of their core public health responsibilities (American Public Health Association, 2004; U.S. Centers for Disease Control and Prevention, National Center for Environmental Health, 2004).

Methods

Design and sample

This was a descriptive, cross-sectional study administered by mailed survey. The study was approved by a university institutional review board. The unit of study was farmers in the seven states served by CS-CASH (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota). A power analysis was based on the anticipated effect of the intervention on the variables using the two-sided Fisher's Exact test. Based on the analysis of each variable and the expected 30% response rate, a sample size of $N = 1{,}000$ was needed. The sample list was secured from the Farm Market ID database because it was readily available and contained mailing addresses (Kaufmann, 2015). The list represented 24% of corn and soybean farmers (14,000/58,742) that had emails listed with the USDA and who resided in the seven states served by the Center. The data were stratified by types of farms (i.e., corn/soybeans only, hogs only, both) and by state; yielding 21 strata. The final sample ($N = 1{,}000$) was selected using simple random sampling within the 21 strata. The number of farmers selected

within each state was proportional to each state's percentage of total farmers in the region. Farms with both corn/soybeans and hogs were selected with certainty. The remaining sample represented a disproportionately large number of hog farms to allow for some possible analyses within farm type. After the "both" farmers were selected, approximately 1.40% (820/58,742) of the remaining corn/soybean farmers were selected and 38.06% (110/289) of the remaining hog farmers were selected to complete the 1,000 farmer sample. Using a sample size of 1,000 and assuming a 30% response rate would allow for estimating proportions with confidence intervals of ±12.0% or smaller within hog farmers and ±5.9% or smaller within corn/soybean farmers.

Measures

The survey had 30 items. Items describing farm operations and demographics were from the U.S. Census of Agriculture, National Agricultural Statistics Service (2007); smoking status items were from the Behavioral Risk Factor Surveillance Survey (U.S. Centers for Disease Control and Prevention, 2012) (see Table 1). Health status items were determined by asking respondents if they had any of the following conditions, that is, mild or severe hearing loss, COPD, asthma, sinus disease, and nasal symptoms) as well as Knowledge and Attitude items were developed in collaboration with faculty experts in audiology and pulmonary medicine and were tested for face validity with other faculty experts. Knowledge (see Table 2, Q2–Q8 and Table 3, Q2–Q6) and Attitude items (see Table 2, Q1 and Table 3, Q1) used a Likert scale (*strongly agree* to *strongly disagree*) to discern level of agreement regarding PPE selection and fitting; dust/noise exposure sources; long-term health consequences of exposures; exacerbating risk factors to hearing and respiratory health; and importance of PPE use. To measure PPE usage, participants estimated the percentage of time they wore PPE during dust or noise exposures. Another item asked participants to identify from a list their primary reasons for not wearing PPE. There were two items with multiple choice options for (1) where farmers learned about PPE, and (2) preferred sources of health information. The final item asked for suggestions on improving farmers' safety and health.

The mailed survey was administered using the Dillman tailored design method to maximize response rates (Dillman, Smyth, & Christian, 2009). An advance letter explained the study purpose offering invitation to participate. One week later, the survey packet was mailed with a self-addressed, stamped envelope. This yielded $n = 117$ responses. The third contact was a reminder postcard to nonrespondents sent 1 week later, and yielded an additional $n = 64$ responses. Final contact with nonrespondents was 2 weeks after the postcard reminder and included another survey packet and self-addressed, stamped envelope. This resulted in $n = 99$ responses. Total sample of enrollment was $N = 280$.

Analytic strategy

Frequencies and percentages were calculated for each item and by age groups for younger (i.e., GenX/Millennials, <50 years old) versus older (i.e., Mature/Baby Boomers 50 years and older). Comparisons of demographics, attitudes, knowledge and practices between age groups were made using exact Pearson chi-square tests, exact Cochran-Armitage trend tests, Wicoxon rank-sum tests, and *t* tests, as appropriate. Proportions of respondents giving the "correct" response to knowledge questions were also compared using exact Pearson chi-square tests. Practice responses (i.e., percent of time wearing PPE) were compared against all other measures using Wilcoxon rank-sum, Kruskal–Wallis, or Jonckheere-Terpstra tests, as appropriate, for categorical variables. Spearman correlation coefficients were used for comparisons involving continuous variables. All *p*-values <.05 were considered significant. Quantitative analysis was done using SAS v9.3 (The SAS Institute, Cary, NC, USA). Open-ended items were analyzed qualitatively for themes determined by grouping similar responses and then reporting them by their frequency. Major themes included the highest number stating a similar subject or topic response (Bradley, Curry, & Devers, 2007).

Results

Of 298 surveys returned 18 were unusable (i.e., blank, deceased). The final response rate was 28.0% ($N = 280/1000$). The American Association for Public Opinion Research (2015) response rate formula number two was used, which is a conservative approach and counts all targeted households in the survey as eligible. This was judged to be appropriate based on the high stability of farm households (i.e., not moving or changing jobs frequently). The final

TABLE 1. *Farm and Respondent Characteristics*

	Younger farmers		Older farmers		
	N	*M* (*SD*) or %	*N*	*M* (*SD*) or %	*p*-value
Farm ownership					
Family or individual	49	87.8	222	91.4	.247
Partnership		4.1		5.9	
Incorporated under state law		4.1		0.9	
Other[a]		4.1		1.8	
Production activities					
Corn crops	48	93.8	214	88.8	.433
Soybean crops		81.3		81.8	1.000
Raise hogs/pigs		29.2		18.7	.116
Raise cattle/calves		52.1		46.7	.526
Other[b]		18.8		15.4	.663
Farm acreage					
Owned	47	253 (384)	222	577 (1147)	<.001
Leased from others		571 (572)		371 (560)	.004
Leased to others		31 (190)		75 (378)	.022
Total acreage in operation		883 (861)		927 (1232)	.876
Livestock on hand					
Total hogs/pigs[c]	13	1700 (2198)	39	2300 (3338)	.561
Total cattle/calves[d]	24	189 (301)	95	239 (458)	.338
Respondent status					
Principal operator or senior partner	49	98.0	223	93.3	.347
Secondary operator		2.0		2.7	
Other[e]		0.0		4.0	
Respondent age (in years)	49	42 (6)	229	61 (8)	<.001
Respondent race					
White	49	100.0	229	99.6	1.000
American Indian or Alaska Native		0.0		0.4	
Respondent ethnicity					
Hispanic/Latino	48	2.1	228	0.9	1.000
Non-Hispanic/Latino		97.9		99.1	
Respondent gender					
Male	49	100.0	229	95.6	.218
Female		0.0		4.4	
Smoking status					
Current	48	8.3	222	5.4	.066
Former		8.3		22.5	
Never		83.3		72.1	

Notes. [a]Estate, trust, prison farm, American Indian Reservation, retired.
[b]Alfalfa, dairy, wheat, sheep, horses, poultry.
[c]Limited to those who report raising hog/pigs.
[d]Limited to those who report raising cattle/calves.
[e]Retired, landlord.

response rate, close to the assumed 30% response rate, was used to determine target sample size.

Farm operations and demographics

Overall, the vast majority of respondents were white, non-Hispanic, males with an average age of 57.4 years. Fewer than 15% of respondents were younger. Among all respondents, most were principal or senior partners from family/individual operations. Most raised corn and soybeans and had an average of 916.4 total acres in operation. The average size of animal operations is described in Table 1.

Comparisons by age group showed that older farmers owned significantly more land ($M = 577$ acres vs. 253 acres, $p < .001$) and leased more land to others ($M = 75$ acres vs. 31 acres, $p = .022$),

TABLE 2. *Attitude, Knowledge and Practice Regarding Respiratory Health and Safety by Age Group*

	Younger farmers		Older farmers		
	N	*M* (*SD*)	*N*	*M* (*SD*)	*p*-value
Attitude					
Q1. It is important to always wear a mask in dusty conditions[a]	48	1.6 (0.6)	224	1.7 (0.7)	.485
Knowledge					
Q2. Masks should be N95 approved to reduce health risks from dust[a]	47	2.5 (0.8)	215	2.4 (0.8)	.414
Q3. Masks need to be correctly fitted to each person[a]	46	2.1 (0.8)	193	2.1 (0.8)	1.000
Q4. Dust exposure from animals (hogs, livestock) can result in serious respiratory conditions[a]	47	2.0 (0.7)	221	1.9 (0.7)	.207
Q5. Only farmers exposed to grain dust are at risk for developing respiratory health problems[a]	47	4.0 (0.9)	224	3.9 (1.0)	.297
Q6. Harmful toxins produced by molds and bacteria are only present in grain dust and not dust from animals (hogs, livestock)[a]	48	3.9 (0.9)	223	3.7 (1.0)	.279
Q7. Smoking, asthma, and allergies increase the risk for complications associated with inhaled grain dust[a]	48	1.9 (0.7)	222	1.8 (0.7)	.511
Q8. Continual exposure to dust can result in chronic obstructive pulmonary disease[a]	47	2.1 (0.7)	224	2.0 (0.8)	.345
Practice					
Percentage of time you wear a mask in dusty conditions	48	64 (33)	209	45 (36)	.001

Notes. [a]Responses were coded as 1 = "Strongly Agree", 2 = "Agree", 3 = "Don't know/No opinion", 4 = "Disagree", 5 = "Strongly Disagree". Comparisons between groups used exact Cochran-Armitage trend tests.

TABLE 3. *Attitude, Knowledge and Practice Regarding Hearing Health and Safety by Age Group*

	Younger farmers		Older farmers		
	N	*M* (*SD*)	*N*	*M* (*SD*)	*p*-value
Attitude					
Q1. It is important to always wear hearing protection in noisy conditions[a]	49	1.9 (0.7)	222	1.9 (0.7)	.816
Knowledge					
Q2. It is important that hearing protection be fitted correctly[a]	49	2.0 (0.6)	220	2.0 (0.7)	1.000
Q3. Continual noise exposure from animals (hogs, livestock) can result in serious hearing loss[a]	49	2.3 (0.8)	220	2.3 (0.9)	1.000
Q4. Only farmers exposed to machinery noise are at risk for hearing loss[a]	49	3.9 (0.7)	222	3.8 (1.0)	.448
Q5. Continual, unprotected exposure to noise can result in serious hearing loss[a]	49	1.8 (0.6)	219	1.8 (0.6)	1.000
Q6. Exposure to solvents, pesticides, antibiotics increases the risk of hearing loss when there is also constant exposure to loud noise[a]	49	3.1 (0.7)	222	2.8 (0.7)	.005
Practice					
Percentage of time you wear hearing protection in noisy environments	49	54 (33)	206	39 (35)	.005

Notes. [a]Responses were coded as 1 = "Strongly Agree", 2 = "Agree", 3 = "Don't know/No opinion", 4 = "Disagree", 5 = "Strongly Disagree". Comparisons between groups used exact Cochran-Armitage trend tests.

while younger famers were significantly more likely to lease more land from others (M = 571 acres vs. 371 acres, p = .004) (Table 1).

Respiratory health and safety

About a quarter (N = 71) of all respondents were ever smokers (i.e., smoked 100+ cigarettes in their lifetime), and only a few (N = 16) were current smokers. There was a higher percentage of ever smokers among the older farmers (29.9% vs. 16.7%) but the difference in smoking status did not quite reach statistical significance (p = .066) Among all respondents, few reported respiratory conditions (i.e., 2.1% COPD, 5.0%

asthma, 4.3% sinus disease, 1.1% nasal symptoms) (Table 1).

A majority of respondents were aware of dust PPE (i.e., masks/respirators) for reducing dust exposures (95.9% younger, 96.9% older). The primary venue for learning about dust PPE differed by age groups. Older respondents relied significantly more on agricultural shows/events ($p = .007$), flyers/brochures ($p = .005$), and newspapers/ads ($p = .051$) while younger respondents relied significantly more on "other sources" ($p < .001$). For all respondents listing "other sources," most cited their own personal knowledge and experience. Least cited sources were television, e-mail/web-based, and radio (Figure 1).

Overall, respondents estimated wearing dust PPE less than half of the time ($M = 48.5\%$, $SD = 36.3$) during exposures. Younger respondents reported wearing dust PPE significantly more frequently than older respondents ($p = .001$). The most frequently cited reasons for not wearing dust PPE among younger respondents in order of importance were "forget," "not necessary," and "other." Among older respondents, reasons included in order of importance "forget," "uncomfortable," and "do not like to" (Figure 2). The only significant difference in response between the two groups was for "other" responses, which were higher among younger respondents ($p = .018$). A major theme among those who answered "other" was that masks/respirators were unavailable when needed. The second theme was that respondents did not think masks/respirators were "effective" in dusty conditions.

Most respondents agreed (97.9% younger, 91.5% older) that wearing dust PPE was important; however, there were Knowledge gaps about dust PPE (see Table 2).

More than half (57.5% younger, 53% older) did not correctly agree or said "Don't know/No opinion" about whether masks/respirators should be N95 approved. About one quarter (23.9% younger, 26.5% older) did not correctly agree or said "Don't know/No opinion" about masks/respirators needing to be fit to each person.

Approximately 15% did not correctly agree that dusts from animal confinement were a source of exposure. There were roughly one quarter of respondents who did not correctly agree or said "Don't know/No opinion" about harmful molds and bacteria being present in dusts from animal confinement. There were about 10% that did not correctly agree that smoking, asthma, and allergies increased complications associated with inhaled grain dusts. About one quarter (27.7% younger, 21% older) did not correctly agree or said "Don't know/No opinion" about continual dust exposure possibly resulting in COPD.

Hearing health and safety

More than half (56.4%) of all respondents reported mild to severe hearing loss. Among those who

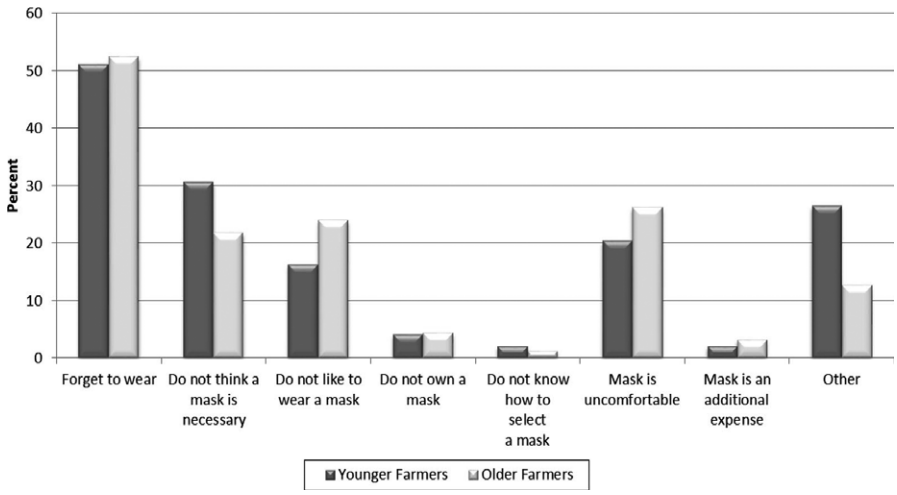

Figure 1. Younger and Older Midwestern Farmers' Venues for Learning About Wearing a Mask in Dusty Conditions (Multiple Responses Allowed)

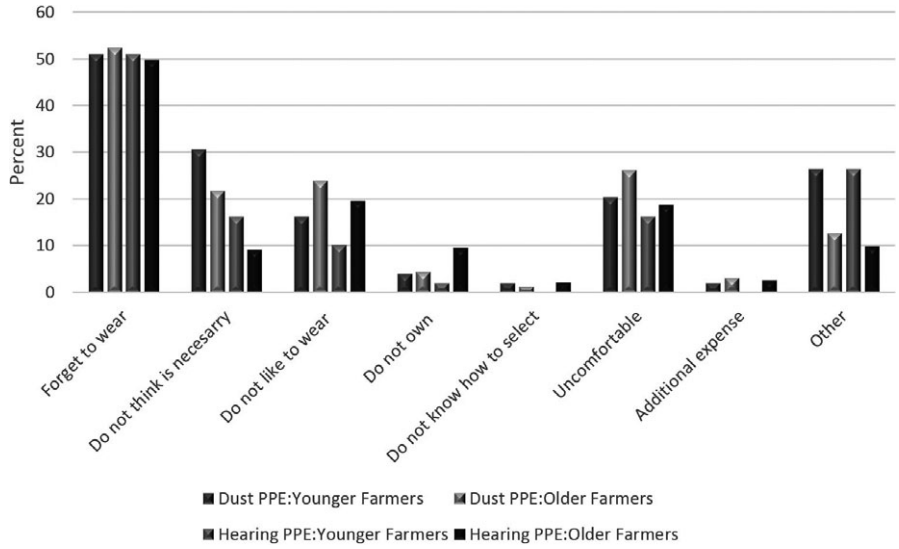

Figure 2. Younger and Older Midwestern Farmers' Reasons for Not Wearing Dust or Hearing PPE (Multiple Responses Allowed)

reported mild/severe hearing loss, more than half (61.5% younger, 50.3% older) said that although they had a hearing problem they did not wear hearing aids. When it came to treatment of hearing problems, only a small proportion (15.4% younger, 9.7% older) said they had seen a health provider for a hearing problem the previous year.

Most respondents were aware of hearing PPE (i.e., ear plugs/muffs) for preventing hearing loss. Older respondents were significantly more likely than younger respondents to get their information from agricultural shows/events ($p < .001$), flyers/brochures ($p = .008$) and newspapers/ads ($p = .053$). Younger respondents were significantly more likely to say "other" was their primary source of information ($p = .002$). Least cited sources for both age groups were television, e-mail/web; and radio. Among respondents answering "other," the major theme was using "common sense" and personal knowledge.

Respondents estimated wearing hearing PPE less than half of the time during exposures to noisy environments. Younger respondents reported wearing hearing PPE significantly more often than their older counterparts ($p = .005$). Primary reasons for not wearing it included "forget," "do not like to wear," and "not comfortable") (Figure 2). Younger respondents were significantly more likely than older respondents to give a response of "other" as a reason for not wearing hearing PPE ($p = .004$), and the primary reason given was that ear plugs/muffs were unavailable when needed, or they were only needed briefly.

Most respondents agreed that wearing hearing PPE was important during noise exposures and most correctly agreed that continual, unprotected noise could lead to hearing loss (see Table 3). There were about 20% of respondents who correctly agreed that ear plugs/muffs required proper fitting. Approximately the same percentage incorrectly agreed or said "Don't know/No opinion" about machinery being the only hazardous noise source. More than one-third did not correctly agree or said "Don't know/No opinion" about animal noise possibly being a hazardous source of noise. More than three-fourths of respondents (89.8% younger, 73.9% older, $p = .024$) said "Don't know/No opinion" or disagreed incorrectly that exposures to ototoxicants (i.e., solvents, pesticides, and antibiotics) increased the risk of hearing loss.

Health information

Participants identified their preferred sources of health information (as opposed to PPE information) from a list of possible choices. Most frequently cited for both age groups included magazines, local newspapers/journals; local resources such as elevator operators or retail vendors; and Agricultural fairs. The least cited source was web-based sites.

Several respondents (n = 97) offered suggestions to improve farmer health and safety. A major theme was viewing farm safety as a matter of personal discretion (e.g., "just use common sense", "think before acting"). Several suggested education be directed toward farm youth (e.g., "older farmers are already set in their ways"). Some suggested insurance providers offer incentives for safe practices. Several said informational brochures should be located at places farmers frequented, or in farm vaccine booklets, with livestock supplies, in machinery booklets or in farm magazines.

Measures associated with PPE usage

Masks/respirators. Higher usage was significantly associated ($p \leq .05$) with (1) soybean farmers; (2) those leasing larger acreages; (3) those with severe hearing loss; (4) those who relied on local resources for health information; and (5) those having correct Knowledge answers to Q2–Q6 (see Table 2). Two Knowledge items did not meet significance (i.e., Q7 "Smoking, asthma, and allergies increase the risk for complications associated with inhaled grain dust" p = .067 and Q8 "Continual exposure to dust can result in chronic obstructive pulmonary disease" p = .271).

Ear plugs/muffs. Usage was significantly associated ($p \leq .05$) with (1) younger age; (2) those who used "other" sources for PPE information; and (3) correct Knowledge and Attitude scores for items Q1–4 (see Table 3). Two items did not meet significance (i.e., Q5 "continual, unprotected exposure to noise can result in serious hearing loss" p = .229; and Q6 "exposure to solvents, pesticides, antibiotics increase the risk of hearing loss when there is also constant exposure to loud noise" p = .559).

Discussion

Respondents were typical of principal farm operators in the U.S. who are mostly White non-Hispanic (99%) males (96%) and older (M = 58.3 years). However, our respondents had larger farm operations in terms of (1) average land acreage in operation (i.e., 872 acres vs. 434 acres in the U.S.), and average size of animal operations (i.e., 2,109 hogs/pigs vs. 1,043 in the U.S.; 227 cattle/calves on hand vs. 99 in the U.S.) (U.S. Department of Agriculture, National Agricultural Statistics Service Census of Agriculture, 2012). This is important because as farm size increases, including density of animal operations, there is a proportional increase in the levels of hazardous noise/dust exposures. Larger agricultural operators (i.e., 11 or more employees) are required to supply employees with PPE; however, smaller operators are not required to do so and are less likely to use PPE (Donham & Thelim, 2006; U.S. Department of Labor, Occupational Safety & Health Administration, 2013).

Overall, findings showed that only about half of respondents in both age groups used PPE during exposures, despite agreeing about its importance to health. This is similar to another study showing that while farmers are generally *aware* of their occupational health risks, they do not necessarily transition this awareness into PPE practices (Kearney, Xu, Balanay, Allen, & Rafferty, 2015). Our findings showed respondents with mostly correct Knowledge scores were more likely to use PPE. However, there were specific Knowledge gaps in both age groups: (1) hazardous exposure sources; (2) long-term health consequences; and (3) proper selection and fitting of PPE. Changing behavior requires an understanding of susceptibility and perceived risks; therefore, addressing these knowledge gaps is important (Khan, Husnain, Mahmood, & Akram, 2013).

Farmers said they relied very little on e-mail/web, radio, or television to learn about PPE. Rather, they depended on learning about it from agricultural shows/events and newspapers. It was troubling to see that so many said they relied primarily on their own "common sense" or "personal knowledge."

Respiratory health and safety

Most respondents agreed that continual exposure to dust could result in COPD, and this is important because farmers who are concerned about specific health problems are more likely to use PPE (Schenker et al., 2002). However, it is also concerning that nearly 20% did not correctly agree about the long-term health consequences of dust and that the same number did not identify animals as a source of hazardous dust exposure. Indeed, twice that number (40%) were not aware that animal dust contained harmful toxins when inhaled. Without such understanding of the health implications and risks, there may be little motivation for wearing PPE.

Respiratory diseases and symptoms associated with agricultural exposures are nearly all preventable with PPE use (Linaker & Smedley, 2002). Yet, many respondents showed knowledge gaps regarding PPE. More than half (55%) did not know masks should be N95 approved and 25% were not aware of correct fitting. Reasons given for not wearing PPE—forgetting and uncomfortable—were consistent with findings from Donham, Kline, Kelly, Lange, & Rautiainen, 2013. One of the more troubling findings from our study was that one-third of younger respondents said it was "not necessary" to wear a mask/respirator. This may or may not be connected to the finding that many younger respondents said they relied on "personal knowledge" to learn about PPE.

Hearing health and noise exposure

More than half of respondents reported mild to severe hearing loss; yet, respondents said they wore ear plugs/muffs even less than they wore masks/respirators and the reasons they gave for not wearing were similar to dust PPE—forgetting, did not like to wear, and discomfort. Several identified the reasons as being that the PPE wasn't available or conveniently located when needed. Respondents learned about ear plugs/muffs from different venues based on age: older respondents learned primarily from Ag shows and events and younger respondents again relied on "other sources" which they identified as "common sense" and personal knowledge.

Specific Knowledge gaps included the sources of hazardous noise. Nearly half of respondents did not identify animals as a significant source, and nearly 20% said that machinery was the only source of hazardous noise. Nearly three-fourths of respondents did not correctly agree that the risks for hearing loss are exacerbated with exposure to solvents, pesticides, or antibiotics.

Venues of health information

Respondents greatly valued health information by sources they trusted such as farm magazines and local newspapers, elevator operators, and retail vendors. Suggestions for improving agricultural safety and health included making flyers and brochures available at such sites to enhance availability. E-mail and websites were not a favored source of information.

There were several research limitations. This study was limited to a sample of corn/soybean and/or hog operations, and did not include other types of farm operations such as dairy or cattle ranches. The study was limited to farm owner/operators, not including hired and free farm laborers. Farm operators may place more importance on safety and health than those whom they hire. Farm operators interested in health and safety may have been more likely to respond. There may have also been some self-reporting bias for over- or underestimating personal health conditions and/or PPE use. Respondents may downplay their health conditions and answered the Attitude and Knowledge items with what they perceived to be the socially acceptable response.

Public health nurses in rural communities can use these findings to plan health promotion programs for farmers and their families in the areas of improving knowledge and attitudes about sources of dust exposure, health risks to COPD, and need for protection. In addition, public health nurses can use commonly accessed community resources—county extension agencies, Future Farmers of America, and others—to promote education among younger generations on masks and hearing protection.

It is equally important that public health nurses collaborate with rural primary care providers to make them aware of the need to educate their patients who farm—including their family members—on the health and safety risks of agriculture, including how to reduce those risks with PPE. Such information should become a routine part of rural primary care and with special attention to younger farmers who may rely on their own "common sense" as a reliable source of information.

Carpenter, Lee, Gunderson, and Stueland (2002) found that farmers' decision to use PPE was personal and influenced little by outside parties, which is consistent with this study's findings that farmers rely on local resources such as newspapers and those they know (i.e., elevator operators, retail vendors) for health information. Thus, community-based educators and public health personnel should consider utilizing these local venues to disseminate health and safety education. Enlisting the help of local elevator operators, farm implement dealers, and even farm retailers—where farmers are likely

to interface and spend time—can be an effective venue for distributing flyers and brochures about PPE use and health consequences of hazardous noise and dust exposures. And agricultural shows remain another important venue for education.

Donham and Thelim (2006) found that intensive and consistent education to farmers can increase PPE use. Certainly one of the barriers to changing behavior will be overcoming farmers' reliance on their own "personal discretion" or "common sense" as reliable for preventing hearing loss and respiratory symptoms. Education that can target specific knowledge gaps identified in this study may help increase a sense of personal susceptibility that subsequently increases PPE usage.

GenX/Millenials present the greatest opportunity for education and outreach efforts. Qualitative comments included suggestions to target young families and appeal to the ag-operators' sense of responsibility to his/her family insofar as health.

Future studies should consider the respondents' level of education, role on the farm (i.e., hired laborers, secondary operators) and how to depict women's role as the female responses were unusually low for Midwestern farmers (3.6%). U.S. Department of Agriculture, National Agricultural Statistics Service Census of Agriculture, 2012, reports the percentage to be 14% of total farm operations.

The CS-CASH implemented a 14-month project to educate farmers in the seven-state region about health and safety for respiratory and hearing health, including the need for PPE; exposure sources; long-term health outcomes; and proper selection, fitting, and use of PPE. Their community outreach and education efforts included attending regional farm shows, agricultural conventions, worker safety training and health fairs in each of the seven states for in-person demonstrations and presentations. The CS-CASH evaluation team is longitudinally tracking changes in knowledge, attitudes, and practice to adapt our program efforts based on findings. Ultimately the goal is reduced morbidity through improved safety practices.

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