Assessing Health and Safety Concerns and Psychological Stressors among Agricultural Workers in the U.S. Midwest

K. Arora, M. Cheyney, F. Gerr, D. Bhagianadh, J. Gibbs, T. R. Anthony

HIGHLIGHTS

- Chemicals, equipment/tools, and health outcomes were the greatest perceived health and safety concerns among surveyed agricultural workers.
- Finances, climate/weather, and farm workload and management were the greatest perceived psychological stressors among surveyed agricultural workers.
- Among mail survey respondents, response rates for prepaid monetary incentives were double that of promised monetary incentives.
- There was considerable overlap in the pattern of survey responses across mail and in-person respondents.
- In-person data collection facilitated access to underrepresented groups of agricultural workers.

ABSTRACT. *There is limited research exploring agricultural workers' own perspectives on the relative importance of the hazards and stressors they experience. There is also a lack of evidence on whether this reporting differs by method of elicitation. Finally, very little research exists on how to improve mail survey response rates among agricultural workers. We examined health and safety concerns and psychological stressors among Midwestern farmers. We assessed whether these reports varied by survey mode (mail survey versus in-person survey). The efficacy of two different types of incentives to enhance mail survey response rates among agricultural workers was also investigated. In 2018, a needs assessment survey was developed and mailed to a random sample of farm owner-operators in Iowa, Ohio, and Missouri, with randomly assigned prepaid or promised monetary incentives. In-person surveys were conducted among farm owner-operators and hired workers at three regional farm shows in Iowa, Minnesota, and Nebraska. The mail survey response rates were compared by incentive type. Content analysis was used to generate themes associated with health and safety concerns and psychological stressors, which were then*

Submitted for peer review in August 2019 as manuscript number JASH 13660; approved for publication as a Research Article by the Ergonomics, Safety, & Health Community of ASABE in December 2019.

The authors are **Kanika Arora,** Assistant Professor, Department of Health Management and Policy, University of Iowa, **Marsha Cheyney,** Research Support Manager, Department of Occupational and Environmental Health, **Fredric Gerr,** Professor, Department of Occupational and Environmental Health, **Divya Bhagianadh,** Graduate Research Assistant, Department of Health Management and Policy, **Jenna Gibbs,** Research Coordinator, Department of Occupational and Environmental Health, and **T. Renée Anthony,** Professor, Department of Occupational and Environmental Health, College of Public Health, University of Iowa, Iowa City, Iowa. **Corresponding author:** Kanika Arora, 145 N. Riverside Drive, Suite N238, Iowa City, IA 52242; phone: 319-384-3817; e-mail: kanika-arora@uiowa.edu.

  ISSN 1074-7583 https://doi.org/10.13031/jash.13660

ranked by frequency counts. Chi-square tests were used to analyze variation in the distribution of these themes by survey mode. The response rate for the $1 prepaid incentive was double that of the $10 promised incentive. Content analysis identified 13 health and safety concerns and eight psychological stressors. Chemicals, equipment/tools, and health outcomes were the most frequently noted health and safety concerns. Finances, climate/weather, and farm workload and management were the most frequently noted psychological stressors. Although there was considerable overlap in survey responses across mail and in-person respondents, important differences by sample and survey mode characteristics were observed. The results can support a variety of stakeholders in prioritizing and developing interventions and educational resources to address health and safety concerns and psychological stressors among Midwestern farmers. Our findings also contribute to the evidence base on primary data collection methods for agricultural workers.

Keywords. *Farmers, Health and safety, Needs assessment, Stressors, Survey incentives.*

Agriculture is one of the most hazardous industries in the U.S. According to the U.S. Bureau of Labor Statistics (BLS), the fatal occupational injury rate in agriculture is seven times the pooled fatality rate of all other industries in the country (BLS, 2018). Contemporary farm environments regularly expose workers to unique combinations of physical, biological, and chemical risks. These exposures are associated with respiratory diseases (Greskevitch et al., 2008; Hoppin et al., 2014), hearing loss (Gomez et al., 2001), livestock-related infectious diseases (Rautiainen and Reynolds, 2002), acute and chronic poisoning (Damalas and Koutroubas, 2016), skin disorders (Feldman et al., 2009; Vallejos et al., 2008), and musculoskeletal injuries (Weigel et al., 2014; Fethke et al., 2014). There is also a growing recognition of psychological hazards associated with working in agriculture. When compared with other populations, farmers report higher levels of depression and anxiety (Sanne et al., 2004) and have an increased risk of suicide (Ringgenberg et al., 2018). Substance abuse is another emergent concern. In a survey conducted by American Farm Bureau (Thornton and Jerome, 2017), 74% of farmers and farmworkers reported having been "directly impacted" by the opioid crisis, compared with 45% of other rural adults.

Existing research on health and safety risks in farming has mainly focused on the prevalence of specific diseases among the agricultural population. There has been limited work examining agricultural workers' own perspectives on the relative importance of the hazards and stressors they experience. Although a few studies have investigated perceived needs among farm workers in the U.S., those studies have primarily focused on a small number of counties, narrow subgroups of farmers (such as beginning, small-scale, or migrant farmers), and in some cases, exclusively on labor, and safety needs (Dill et al., 2012; Sullivan, 2011; Kearney et al., 2014; Anthony et al., 2008; Byler et al., 2013; Goodwin and Gouldthorpe, 2013; de Castro et al., 2014).

There is also wide variation in the methods used to elicit these concerns. Some studies have used in-person methods such as focus groups, interviews, and telephone surveys (Sullivan, 2011; Anthony et al., 2008; Goodwin and Gouldthorpe, 2013; Kearney et al., 2014; de Castro et al., 2014), while others have explored farmer needs via mail and web surveys (Dill et al., 2012; Lizer and Petrea, 2007; Byler et al., 2013). In light of previous findings on the salience of cultural attitudes toward health and healthcare access among rural residents (Spleen et al., 2014), it is unclear if the mode of eliciting these concerns leads to

variation in the identified needs. Although mail surveys are generally better able to ensure anonymity, such surveys have historically displayed lower response rates for all demographic groups, including farmers (Mangione, 2014; Pennings et al., 2002; Church, 1993). Several studies have demonstrated that the provision of prepaid (or up-front) monetary incentives is a crucial factor in improving response rates for mail surveys (relative to no incentives or promised/delayed incentives), with larger incentives leading to higher response rates (Jobber et al., 2004; Pennings et al., 2002; Edwards et al., 2002; Singer et al., 1999; Church, 1993; James and Bolstein, 1992). However, this method can add significant cost to a project. At the same time, there have been few systematic attempts at examining differences in response rates by the size of the monetary incentives included in prepaid and promised designs. Further, agricultural workers (especially farm owner-operators) typically operate on a different time scale than those in other industries. They take out loans at the beginning of the year and wait for their "paycheck" until after harvest. Thus, relative to other populations, they may view a larger promised payment more favorably than a smaller prepaid incentive. To our knowledge, no previous study has examined the effect of prepaid and promised incentives (of varying monetary values) on mail survey response rates specifically among agricultural workers.

In this article, we report the results of a needs assessment survey among agricultural workers in multiple Midwestern states, examining differences between two survey modes: mail and in-person. For mail survey respondents, we also compared the effectiveness of prepaid versus promised incentives in enhancing farm workers' willingness to participate in the study. We assessed open-ended survey responses using content analysis methods and ranked the main categories of health and safety concerns and psychological stressors among surveyed farm workers. We also analyzed the distribution of these concerns by survey mode to examine whether concerns and stressors varied by method of elicitation.

Methods

Survey Instrument

A survey was developed to assess safety and health concerns of agricultural workers in the U.S. Midwest. Several agricultural health and safety specialists provided input on conceptualizing and developing the survey questions. The final instrument contained two open-ended questions on health and safety concerns and psychological stressors: "What is your greatest health and safety concern on the farm?" and "Over the past year, what has caused you the most stress?" For health and safety concerns, respondents were asked to provide at least three concerns ranked in order of importance. The survey also asked individuals to describe resources and current coping strategies to help address identified concerns and psychological stressors. Other questions included queries on past-year injuries, age, gender, location, years in farming, produce type, farming status, and social media use. The survey was pilot tested in-person by ten agricultural workers in the region. Based on their feedback, some questions were modified and new questions were added. The final survey is available from the authors.

Sample

For the purposes of this study, an agricultural worker is defined a person who ever worked on a farm in at least a part-time capacity. This includes farm owner-operators and hired workers. During June to September 2018, the survey was administered to a sample of farm owner-operators via a mail method using a list of farm owner-operator addresses from a private vendor, and to a mixture of farm owner-operators and hired workers via an in-person method. This

approach allowed us to accomplish the dual goals of comprehensively capturing the health and safety concerns and stressors experienced by a wide range of agricultural workers while also investigating the differences in responses between the two survey modes.

For the mail survey, a list of residential addresses for 2,590 farm owners and/or operators in Iowa, Missouri, and Ohio was purchased from a private vendor. This list was not restricted by farm size or commodity type. The surveys were mailed in two batches to account for farming seasonality. In batch 1, surveys were mailed to 1,920 farm owner-operators during June and July 2018. We empirically tested the response rates for two forms of monetary incentives: (1) a $1 prepaid incentive in the form of a dollar bill inserted with the mailing, and (2) a $10 promised incentive in the form of a check to be sent to the respondent upon receiving a completed response to the survey. The details of this promised incentive were described in bold font in the cover letter attached to the survey. A total of 960 surveys were mailed with each incentive, and 320 surveys were mailed in each of the three states. Thus, for batch 1, in each state, half the respondents were randomized to receive the prepaid incentive and the other half received the promised incentive. The second batch of surveys was mailed in September 2018 to 670 additional farm owner-operators in the same three states. In batch 2, all surveyed individuals received a prepaid incentive of $1 with the mailing (i.e., there was only one incentive). In this second batch, 223 surveys were mailed in Iowa and in Missouri, and 224 surveys were mailed in Ohio.

In addition to the mail surveys, and across the same time period, a purposive sample of a broad range of agricultural workers was recruited at farm shows to complete the survey in-person. Farms shows are public events exhibiting equipment, livestock, and sports and recreation associated with agriculture and animal husbandry. These shows typically host "safety and health tents" where advocates provide outreach to farmers on preventing injury and illness on the farm. At three farm shows (Minnesota Farm Fest, Minnesota; Farm Progress Show, Iowa; and Husker Harvest Days, Nebraska), study staff first asked show participants whether they ever worked on a farm in at least a part-time capacity. If the participants responded yes, they were invited to complete a paper copy of the same needs assessment survey sent in the mail. Participants who accepted this invitation then completed the survey and handed it back to the study staff. If a participant turned in an incomplete survey, study staff queried the participant on whether the unanswered questions were intentionally skipped or if the questions were unclear. In the latter case, clarification was provided by the staff, following which the participant had the opportunity to complete the questions. In such cases, the staff reiterated that completing all questions was voluntary. Each respondent who completed the survey at a farm show was compensated with either a blank 8 GB flash drive or a pair of cold-weather gloves.

Analytical Strategy

For mail survey respondents, response rates were compared by state. For batch 1, response rates were also compared by type of monetary incentive. Descriptive statistics were used to characterize the combined sample of mail and in-person survey respondents. Qualitative directed content analysis (Hsieh and Shannon, 2005) was used to code themes in the open-ended responses for the two questions on self-identified health and safety concerns and psychological stressors. Quantitative descriptive analysis was used to compare the distribution of the coded themes by survey mode. These steps are described as follows.

Step 1: Qualitative Coding of Open-Ended Responses

The content analysis coding team was comprised of three researchers with backgrounds in program evaluation, health policy, and agricultural health and safety. The team used an iterative

coding process to produce taxonomies of coded themes from the survey responses. To begin, potential themes were deductively borrowed from existing literature on agricultural health and safety concerns as well as from the results of a previous needs assessment analysis performed by the authors in 2014. This approach provided a generic frame to begin coding of the survey data. Using initial themes, team members independently reviewed the same randomly selected sample of 50 responses to the two open-ended questions and assigned descriptive labels to each response.

Using the constant comparison method, these labels were then sorted into emergent categories based on how various labels related to each other. Emergent categories were then organized and grouped into meaningful clusters or themes. Each team member independently coded responses, and then the full team of three members met to check for agreement on their emergent categories and themes. At this stage, team members also decided if additional categories or themes needed to be designated. After coding and comparing the first sample of 50 responses, the team engaged in an iterative process of coding additional sets of randomly selected open-ended responses for both questions.

In the next step, the preliminary categories and themes for both questions were discussed with three additional researchers (with backgrounds in agricultural safety, industrial hygiene, and occupational medicine). Based on these discussions, the core team members again reviewed and sorted the responses into identified topics to generate confirmed categories and themes. The full group of researchers met again to discuss and concur with the final themes and the clustering of categories within each theme. Using this process, the researchers engaged in approximately six rounds of coding samples of data and subsequent team discussions before ultimately reaching almost total consensus on the coding. Through this process, 13 themes associated with health and safety concerns and eight themes associated with psychological stressors were identified. A cluster of emergent categories comprising each theme was also identified.

Step 2: Quantitative Analysis of Coded Themes

The coded health and safety concerns and psychological stressors were examined using Stata 15 (StataCorp LLC, College Station, Tex.). For both constructs, each emergent category derived from the content analysis was assigned a numerical value. Because respondents could note concerns and stressors aligning with multiple emergent categories, and because no respondent noted more than four discrete categories, four variables were created denoting these categories. Four variables were created for health and safety emergent categories, and an additional four variables were created for psychological stressor emergent categories. Based on these coded categories, binary variables were created for the 13 health and safety concerns themes and eight psychological stressor themes, and respondents were assigned values (0 = no, 1 = yes) for each theme.

Because a respondent could report multiple themes under both constructs, two continuous variables were constructed that counted the total number of health and safety concerns and psychological stressors provided by each respondent. Continuous years in farming was categorized into three levels of farming experience: beginning (<10 years), experienced (10 to 30 years), and established (>30 years).

Descriptive statistics were used to examine sample characteristics. Frequency tabulations of coded clusters of health and safety concerns and psychological stressors were analyzed. Chi-square statistics were used to determine significant associations between coded clusters and survey mode. An independent samples t-test was conducted to examine

whether the average number of health and safety concerns and psychological stressors differed by survey mode.

Results

Table 1 presents the numbers of mail and in-person survey responses received. It also describes the mail survey response rate by type of incentive and location. Of the 2,590 surveys mailed, 338 completed surveys were returned. The response rate for batch 1 was approximately 12%. Those who received a prepaid incentive of $1 were twice as likely to return a completed survey compared to those who received a promised incentive of $10 (16% versus 8%). Despite being mailed close to harvest time in the region, the response rate for batch 2 (in which all individuals received a prepaid incentive of $1) was very similar to the response rate for those receiving the $1 incentive in batch 1.

In addition to the mail survey, 202 surveys were completed in-person at three farm shows. While a majority of the respondents at each farm show reported farming in the state in which the event was held, a few individuals noted farming elsewhere. At Minnesota Farm Fest, four individuals in the sample stated that they farmed in states other than Minnesota: Iowa ($N = 1$) and South Dakota (3). At the Farm Progress Show, six individuals in the sample stated that they farmed in states other than Iowa: Illinois ($N = 1$), Indiana (1), Nebraska (1), Minnesota (2), and Michigan (1). At Husker Harvest Days, nine individuals in the sample stated that they farmed in states other than Nebraska: North Dakota ($N = 2$), South Dakota (2), Kansas (4), and Colorado (1). Overall, the two survey approaches produced a study sample size of 540 agricultural workers.

Sample characteristics of the mail and in-person survey respondents are provided in table 2. Overall, the mean age of the agricultural workers in our sample was 59 years, and about 10% of the respondents were female. Compared to the in-person respondents, the mail respondents were on average 13 years older and more likely to be male. Although 82% of the mail respondents were farm owner-operators, only 52% of the in-person respondents reported the same status. With regard to farming tenure, a greater percent of mail respondents (59%) were "experienced" relative to in-person respondents (45%). The mail respondents also reported "managing others on the farm" more frequently than in-person

Table 1. Completed mail and in-person survey responses.

	Batch 1	Batch 2
Mailing period	June-July 2018	September 2018
Total surveys mailed	1,920	670
Overall response rate to mailed surveys	12% ($N = 228$)	16% ($N = 110$)
Response rate by incentive:		
$1 prepaid incentive with survey (batch 1 denominator = 960; batch 2 denominator = 670)	16% ($N = 151$)	16% ($N = 110$)
$10 promised incentive after survey receipt (batch 1 denominator = 960)	8% ($N = 77$)	N/A
Response rate by state:		
Iowa (batch 1 denominator = 640; batch 2 denominator = 223)	16% ($N = 105$)	20% ($N = 45$)
Missouri (batch 1 denominator = 640; batch 2 denominator = 223)	10% ($N = 64$)	13% ($N = 29$)
Ohio (batch 1 denominator = 640; batch 2 denominator = 224)	9% ($N = 59$)	16% ($N = 36$)
In-person surveys:		
Minnesota Farm Fest (Minnesota)	80 surveys completed	
Farm Progress Show (Iowa)	37 surveys completed	
Husker Harvest Days (Nebraska)	85 surveys completed	
Study sample size	540 (338 mail; 202 in-person)	

Table 2. Sample characteristics.

		Overall	Mail	In-Person
Number of respondents (*N*)		540	338	202
Mean age ±SD (years)		59 ±15	64 ±13	51 ±16
Female (%)		10	3	20
Farm owner-operator (%)		71	82	52
Past-year injury (%)		15	14	16
Farming experience (%):	Beginning	8	3	16
	Experienced	54	59	45
	Established	38	38	39
Type of production (%):	Dairy	6	6	6
	Livestock	54	53	55
	Forage	27	33	17
	Poultry	6	3	9
	Grain	78	78	79
Farming status (%):	Full-time	60	64	55
	Part-time	29	27	32
	Manage others on farm	11	14	5
	Have an off-farm job	25	24	27

respondents (14% versus 5%). In contrast, a greater proportion of in-person respondents were "beginning" farmers and were more likely to work on the farm in part-time status. In general, a majority of the respondents were engaged in grain and livestock farming. Overall, 15% of the overall sample reported being injured in the previous year.

Themes for Health and Safety Concerns

Of the 540 survey participants, 121 (22%) provided no response to the open-ended question on health and safety concerns. A majority of these missing responses were attributable to mail respondents. In particular, 223 (66%) mail respondents provided complete (i.e., not blank) answers to this question, compared to 196 (97%) in-person respondents. The data used in the content analysis for this construct were provided by 419 survey participants.

The qualitative coding process yielded 13 themes for health and safety concerns. A description of these themes is presented in table 3, including the emergent categories clustered under each theme. The survey permitted a respondent to describe concerns aligning with more than one theme (for instance, a respondent could report concerns under "chemicals" as well as "equipment/tools"). Thus, a total of 1,012 concerns were identified, yielding an average of 2.41 (SD = 0.86) concerns per respondent. The average (and SD) number of health and safety concerns among mail respondents and in-person respondents was 2.45 (0.92) and 2.37 (0.80), respectively. The difference was not statistically significant ($t = 0.96$; $df = 417$; $p = 0.34$).

Further, a respondent could report multiple emergent categories within a single theme. For example, a respondent could note "safety in handling chemicals" and "pesticide drift" as two discrete emergent categories clustered under the same theme ("chemicals"). The frequency count of themes did not double-count individuals if their responses addressed multiple emergent categories within the same theme.

Table 3. Content analysis of health and safety concerns among agricultural workers.[a]

Themes	*N*	%	Emergent Categories
1. Chemicals	178	42	Safety in handling (M:57, I:43); Effect of chemicals on health (M:11, I:3); Pesticide drift (M:5, I:1); How to use and store farm chemicals (M:4, I:1), "Chemicals" (M:31, I:26).
2. Equipment/tools	175	42	Entanglement/rotating shaft hazards (M:15, I:27); Operating machinery (M:18, I:8); Injury from equipment (M:10, I:5); Equipment maintenance/old or faulty equipment (M:8, I:6); ATVs/snowmobiles (M:1, I:8); "Equipment" (M:52, I:35).
3. Health outcomes	149	36	Respiratory issues (M:42, I:59); Noise and hearing loss (M:11, I:15); Stress (M:16, I:1); Cancer (M:9, I:1); Behavioral health/depression (M:6, I:1); Pain (M:2, I:3); Other chronic conditions (M:5, I:1); Acute illnesses (M:1, I:5).
4. General farm safety	109	26	Farm accidents (M:26, I:27); Carelessness/distractions (M:10, I:6); Trespassers and wild animals (M:7, I:3); Electrical concerns (M:3, I:7); PPE safety equipment (M:3, I:18); Non-PPE safety equipment (M:3, I:10).
5. Livestock	76	18	Safety while working with livestock (M:40, I:27); Animal health and transfer of animal illnesses to humans (M:4, I:4)
6. Roadway and tractor safety	71	17	Sharing the road with other drivers (M:12, I:11); Driving with machinery/overweight loads/loose bales (M:18, I:7); Old infrastructure (M:3, I:3); Lighting and marking of farm vehicles (M:0, I:6); Tractor runovers/rollovers (M:6, I:14).
7. Confined space safety	61	15	Physical tasks in grain bins (M:9, I:7); Grain loading and unloading (M:1, I:5); Grain bin equipment (M:1, I:4); Entrapment in grain bin (M:1, I:3); Manure pit safety (M:4, I:3); "Confined spaces" (M:10, I:21).
8. Farm management	53	13	Lack of experienced and reliable workers/need for training (M:7, I:10); Work load/physical intensity/isolation (M:10, I:2); Emergency preparedness (M:2, I:3); Regulations (M:4, I:2); Information and awareness, financial issues (M:15, I:4).
9. Environment	40	10	Pollution (M:6, I:4); Heat exposure (M:6, I:8); Water: flooding, lack of (M:2, I:3); Weather (M:8, I:3); Falling trees (M:1, I:0).
10. Falls and mobility	34	8	Non-grain bin related falls and slips, heavy lifting, "mobility," "cleaning gutters," "ladders" (M:21, I:13).
11. Children on the farm	31	7	"Child safety," "small children on the farm," "grandchildren around equipment" (M:11, I:21).
12. General health	26	6	"Health" (M:5, I:4); Access to care/affordability of health insurance (M:17, I:0).
13. Aging	9	2	"My age," "aging," "age-related clumsiness" (M:8, I:1).

[a] "*N*" is the frequency count for a particular theme, and "%" is the proportion of respondents who reported concerns associated with that theme. The frequency counts for each emergent category within each theme are provided in parentheses and disaggregated by the numbers of mail (M) and in-person (I) respondents.

As shown in table 3, concerns associated with chemicals and equipment/tools were the two most frequently coded health and safety concerns across all respondents (42% each). These were followed by health outcomes (36%), general farm safety (26%), livestock (18%), roadway and tractor safety (17%), confined space safety (15%), and farm management (13%). The remaining themes (environment, falls and mobility, children on the farm, general health, and aging) were noted by 10% or fewer respondents.

Next, we examined whether the distribution of health and safety concerns varied by method of elicitation. For each of the 13 themes, a chi-square test was performed to determine if the survey mode (mail or in-person) was associated with the report of a particular health and safety concern. In general, there was considerable overlap among the mail and

in-person respondents for the most frequently identified health and safety concerns. There were few statistically significant differences in the choice of health and safety concerns by survey mode. In particular, relative to in-person respondents, a greater percentage of mail respondents noted chemicals (47% vs. 37%; $p = 0.04$), general health (10% vs. 2%; $p = 0.00$), and aging (4% vs. 1%; $p = 0.03$) as concerns. In contrast, relative to mail respondents, a greater percentage of in-person respondents noted general farm safety (31% vs. 22%; $p = 0.02$), confined space entry (19% vs. 11%; $p = 0.02$), and children on the farm (10% vs. 5%; $p = 0.04$) as concerns. Within each group, concerns associated with chemicals, equipment/tools, and health outcomes remained the top three concerns.

For themes in which statistically significant differences were noted, we examined the count of disaggregated categories by survey mode, as shown for the emergent categories in table 3. For chemicals, mail respondents were more likely than in-person respondents to note concerns associated with health effects of using chemicals. For general health, only mail respondents noted concerns associated with access to care and affordability of health insurance. For general farm safety, a greater number of in-person respondents reported "PPE [personal protective equipment] safety equipment" and "non-PPE safety equipment" relative to mail respondents. Although there was no statistically significant difference between mail and in-person respondents in the likelihood of reporting the health outcomes concern, the disaggregated categories in table 3 show that mail respondents were more likely to note categories associated with "stress" and "behavioral health/depression" within this theme. Conversely, in-person respondents were more likely to note concerns associated with "respiratory issues."

Themes for Psychological Stressors

Complete responses to the open-ended question on psychological stressors were provided by 501 survey respondents (93%). Response rates were similar between the mail (92%) and in-person (94%) respondents. The qualitative coding process identified eight themes for psychological stressors. A description of these themes is presented in table 4, including the associated emergent categories comprising each theme. A total of 574 stressors were identified across respondents, yielding an average (SD) of 1.15 (0.48) stressors per respondent. Overall, the average (SD) number of stressors among mail respondents and in-person respondents was 1.21 (0.52) and 1.05 (0.40), respectively, and this difference was statistically significant ($t = 3.62$; $df = 499$; $p < 0.001$).

As shown in table 4, financial stressors were the most frequently reported psychological stressors (45%) among all surveyed agricultural workers. Within this theme, "markets/commodity prices" was the most frequently noted emergent category. Climate/weather was the second most frequently noted stressor (22%), followed by stressors grouped under the general theme of workload and management (16%). The remaining stressor themes (family/personal, farm-specific activities and equipment, health and safety, regulations and politics, and aging) were reported by fewer than 10% of respondents. Even though the open-ended questions queried about stressors broadly, most stressor themes were associated with farm-related issues.

For each of the eight themes, a chi-square test was performed to determine if the survey mode was associated with the report of a particular stressor. Similar to the health and safety concerns analysis, there was considerable overlap among key stressors irrespective of the survey mode. Statistically significant differences between survey modes were noted for the following stressor themes: climate/weather, workload and management, family/personal,

Table 4. Content analysis of psychological stressors among agricultural workers.[a]

Themes	*N*	%	Emergent Categories
1. Financial	224	45	Markets/commodity prices (M:106, I:55); Input cost (M:17, I:3); Health insurance cost (M:10, I:1); Maintenance cost (M:3, I:1); Production risks (M:2, I:1); Product knowledge (M:1, I:0); "Financial," "lack of income," "unable to pay bills" (M:37, I:19).
2. Climate/weather	109	22	Drought/lack of rain (M:14, I:5); Flood/too much rain (M:3, I:2); "Climate/weather," "snow storms," "cold," "heat" (M:70, I:18).
3. Workload and management	80	16	Work load/physical intensity/isolation (M:13, I:25); Time management (M:12, I:14); Shortage of labor/employee relationships (M:12, I:3); Communication (M:4, I:4).
4. Family/personal	42	8	Children/childcare (M:0, I:10); Transition/succession (M:6, I:2); Health of family members (M:3, I:5); Death of family members (M:4, I:1); "Family," "personal," "pets" (M:4, I:8).
5. Farm-specific activities and equipment	42	8	Livestock (M:15, I:5); Equipment (safety, operation, breakdown, aging, failure) (M:7, I:6); Chemicals (M:5, I:0); Grain bins (M:1, I:3).
6. Health and safety	38	8	Farm-related health and safety (M:9, I:6); Chronic diseases and pain (M:4, I:1); Mental health (M:2, I:1); "My health," "safety," "get tired quickly," "no energy" (M:11, I:4).
7. Regulations and politics	29	6	New administration and policies (trade, tariffs, farm bill) (M:17, I:1); Regulations/compliance (M:6, I:0); Health insurance policies (M:1, I:0); "Politics," "policy" (M:6, I:1).
8. Aging	10	2	Aging parents/siblings (M:2, I:1), "Aging," "I am too old," "my aging body" (M:7, I:0).

[a] "*N*" is the frequency count for a particular theme, and "%" is the proportion of respondents who reported concerns associated with that theme. The frequency counts for each emergent category within each theme are provided in parentheses and disaggregated by the numbers of mail (M) and in-person (I) respondents.

and regulations and politics. Specifically, relative to in-person respondents, a greater percentage of mail respondents reported climate/weather (27% vs. 13%; $p < 0.001$) and regulations and politics (9% vs. 1%; $p < 0.001$) as stressors. On the other hand, relative to mail respondents, in-person respondents were more likely to note stressors associated with workload and management (23% vs. 12%; $p < 0.001$) and family/personal themes (13% vs. 5%; $p < 0.001$). Although only 6% of all respondents reported stressors associated with the regulations and politics theme, almost all of these responses were provided by mail respondents, as shown in the emergent categories in table 4. With regard to workload and management, stress associated with agricultural work (workload, physical intensity, and working in isolation) was more extensively reported by in-person respondents, whereas mail respondents appeared to experience greater stress due to shortage of trained labor and maintenance of employee relationships. Within the family/personal stressor theme, only in-person respondents noted children/childcare. For both groups, stressors associated with financial concerns, climate/weather, and workload and management comprised the top three themes. For in-person respondents, the family/personal theme replaced workload and management in the top three themes.

Discussion

Using two survey modes, this study explored the responses of Midwestern agricultural workers to two open-ended survey questions on (1) health and safety concerns on the farm and (2) the nature of psychological stressors experienced in the past year. The response rate for the mail survey ranged from 8% to 16% depending on the type of monetary compensation provided to the survey population. Specifically, the response rate for those who

received a prepaid one-dollar incentive was double the response rate for those who received a promised $10 incentive. Although systematic reviews examining strategies for enhancing response rates have generally found prepaid monetary incentives to be more effective than promised incentives (Edwards et al., 2007), it remains unclear if this relationship is moderated by the monetary value of the incentives. The results of this study contribute to the evidence base by finding that, despite the lower monetary value ($1 versus $10), the provision of a moderate prepaid incentive was associated with a higher response rate. Further, this study is also the first to examine the relationship between the form of monetary compensation and mail survey response rate for an agricultural population. We find that the effectiveness of prepaid incentives (relative to promised incentives) can be generalized to farm owner-operators in the U.S. Midwest as well.

Qualitative coding methods identified 13 themes for health and safety concerns on the farm and eight themes for psychological stressors. Chemicals, equipment/tools, and health outcomes were the most frequently reported health and safety concerns among agricultural workers in this region. With regard to psychological stressors, financial concerns were the most frequently reported theme across all respondents. Although commodity prices were potentially a constant stressor among agricultural workers, it is important to place this finding in the context of recent economic issues related to tariff conflicts between the U.S. and China. In part, as a consequence of this conflict, the per-bushel commodity prices for soybeans dropped 10% during the survey period in comparison to prices in 2017. Thus, it is possible that this particular downturn was associated with a high frequency of "financial" concerns reported by this sample.

After financial concerns, participants identified climate/weather as the next most important stressor. With the exception of localized flash floods, neither Iowa nor Missouri experienced substantial flooding during the survey period. However, the Ohio River flooded in February 2018. We examined drought data from the National Integrated Drought Information System (NIDIS, 2019) during the survey period and found that although drought affected 3% of Ohio and 23% of Iowa, approximately 60% of Missouri was affected by drought (with 55% to 63% of land reported to be "abnormally dry" and about 7% to 17% in "moderate drought" stage). The survey responses aligned with the severity differences. Although about 22% of Ohio farmers and 20% of Iowa farmers noted climate/weather as a psychological stressor, about 40% of Missouri farmers noted this stressor.

Despite significant differences in the sample characteristics across mail and in-person survey respondents, there was considerable overlap in the distribution of health and safety concerns and psychological stressors across both groups. Most remaining differences in themes across mail and in-person respondents could be attributed to two aspects: sample characteristics and survey mode characteristics, as discussed below.

A greater proportion of mail respondents were older, were farm owner-operators, and were also more likely to report concerns associated with emergent categories such as exposure to chemicals, cost of healthcare, shortage of labor, and aging. In contrast, in-person respondents, who were relatively younger and less experienced, were more likely to report concerns associated with children on the farm and childcare, workload, and the physically intense nature of farming.

The differences across groups for certain themes and categories may also relate to the unique features of each survey mode. For instance, it is possible that mail respondents more frequently noted health and safety concerns under "stress" and "behavioral health/depression" due to a greater degree of anonymity and time available when completing the mail survey. We also found that, for both health and safety concerns and psychological stressors, mail respondents

reported a greater number of discrete themes on average, although the result was statistically significant only for psychological stressors. It is possible that in-person respondents were influenced by health and safety material displayed at the farm show booths. Specifically, educational information on safety equipment (including respirators and hearing protection) and confined space entry was on display at all three farm shows, which may have increased the likelihood of identifying them as potential concerns.

The results of this study align with previously reported U.S. farmer surveys. For instance, a cross-sectional analysis of 128 farmers in eastern North Carolina also identified concerns related to weather, problems with machinery, market prices for crops/livestock, and healthcare costs as "very stressful" factors among farmers (Kearney et al., 2014). Similarly, a study investigating health and safety concerns among Hmong farmers found that handling and operating heavy machinery, heat and cold stress, and respiratory exposures were priority concerns noted by study participants (de Castro et al., 2014). The present study contributes to the literature by highlighting additional concerns and stressors experienced by the agricultural population, including those associated with chemicals, a variety of health outcomes (including behavioral health and depression), as well as family and personal factors. Further, this study allowed an in-depth examination of each of these broad themes through the analysis of associated emergent categories.

This study differs from previous investigations in that it provided respondents an open-ended field in which to note their concerns instead of a predetermined list of options. While this approach facilitated the capture of rich qualitative data, it also may have led to a lower response rate if a survey question was confusing and participants required assistance when answering the question. One way to enhance question clarity in future studies is to use two separate questions on "health" and "safety" concerns (instead of one combined question). Future studies can use this evidence-based list of farmer concerns as preset options for closed-ended questions in their survey designs. Finally, by conducting surveys at farm shows in addition to the mail method, we were able to access multiple subgroups of agricultural workers (e.g., hired workers, beginning farmers, and female farmers) who are difficult to access by mail or who are found at low frequencies among random samples of agricultural workers.

Although every attempt was made to design the study to maximize the generalizability of our findings, a variety of factors limit our ability to extrapolate the findings across regions with similar agricultural operations. First, the participants were limited to only a few states. Second, because the mail survey response rates were below 20%, the concerns of farm owner-operators who did not to respond to the survey may differ from participants in ways unknown to the researchers. However, the similarities in the responses to the mail and in-person surveys, even though the characteristics of the participants differed, provide some validity that many of the findings on concerns and stressors are relevant across the Midwest. Another potential study limitation is the possibility that respondents interpreted the question on psychological stressors differently. While the intent of the question was to query the respondents on all possible stressors, the phrasing of the question may have led some respondents to note only one specific cause of stress (especially because the following question asked them to rate the level of stress caused by "this" stressor). Thus, the results on the average number of stressors among agricultural workers should be interpreted with caution. Finally, we were unable to disaggregate migrant/seasonal workers from resident, year-round workers.

Conclusion

The results of this study can support a variety of stakeholders, including extension agents, producer groups, and occupational health advocacy groups, in prioritizing and developing interventions and educational resources to address health and safety concerns and psychological stressors among agricultural workers in the U.S. Midwest. We also expect our findings to contribute to the methodological evidence base on primary data collection techniques for agricultural workers in particular and for rural residents in general.

Acknowledgement

This publication was supported in part by grant number U54 OH 007548, funded by the Centers for Disease Control and Prevention. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the Centers for Disease Control and Prevention or the Department of Health and Human Services.

References

Anthony, M., Williams, J. M., & Avery, A. M. (2008). Health needs of migrant and seasonal farmworkers. *J. Comm. Health Nursing, 25*(3), 153-160. https://doi.org/10.1080/07370010802221768

BLS. (2018). National Census of Fatal Occupational Injuries in 2017. USDL-18-1978. Washington, DC: Bureau of Labor Statistics. Retrieved from https://www.bls.gov/news.release/pdf/cfoi.pdf

Byler, L. I., Kiernan, N. E., Steel, S., Neiner, P., & Murphy, D. J. (2013). Beginning farmers: Will they face up to safety and health hazards? *J. Extension, 51*(6), 6FEA10.

Church, A. H. (1993). Estimating the effect of incentives on mail survey response rates: A meta-analysis. *Public Opin. Qtly., 57*(1), 62-79. https://doi.org/10.1086/269355

Damalas, C. A., & Koutroubas, S. D. (2016). Farmers' exposure to pesticides: Toxicity types and ways of prevention. *Toxics, 4*(1), 1. https://doi.org/10.3390/toxics4010001

de Castro, A. B., Krenz, J., & Neitzel, R. L. (2014). Assessing Hmong farmers' safety and health. *Workplace Health Safety, 62*(5), 178-185. https://doi.org/10.1177/216507991406200502

Dill, S., Shear, H., Beale, B., & Hanson, J. (2012). Maryland beginning farmer needs assessment. University of Maryland Extension. Retrieved from https://www.extension.umd.edu/sites/extension.umd.edu/files/_docs/programs/newfarmer/BFSComparativeNeedsAssessmentFULL.pdf

Edwards, P. J., Roberts, I. G., Clarke, M. J., DiGuiseppi, C., Pratap, S., Wentz, R., & Kwan, I. (2002). Increasing response rates to postal questionnaires: Systematic review. *BMJ, 324*(7347), 1183. https://doi.org/10.1136/bmj.324.7347.1183

Edwards, P. J., Roberts, I. G., Clarke, M. J., DiGuiseppi, C., Wentz, R., Kwan, I., ... Pratap, S. (2007). Methods to increase response rates to postal questionnaires. *Cochrane Database System. Rev.,* (2), Article MR000008. https://doi.org/10.1002/14651858.MR000008.pub3

Feldman, S. R., Vallejos, Q. M., Quandt, S. A., Fleischer Jr., A. B., Schulz, M. R., Verma, A., & Arcury, T. A. (2009). Health care utilization among migrant latino farmworkers: The case of skin disease. *J. Rural Health, 25*(1), 98-103. https://doi.org/10.1111/j.1748-0361.2009.00205.x

Fethke, N. B., Merlino, L. A., Gerr, F., Schall Jr., M. C., & Branch, C. A. (2015). Musculoskeletal pain among Midwest farmers and associations with agricultural activities. *American J. Ind. Med., 58*(3), 319-330. https://doi.org/10.1002/ajim.22398

Gomez, M. I., Hwang, S.-A., Sobotova, L., Stark, A. D., & May, J. J. (2001). A comparison of self-reported hearing loss and audiometry in a cohort of New York farmers. *J. Speech Lang. Hearing Res., 44*(6), 1201-1208. https://doi.org/10.1044/1092-4388(2001/093)

Goodwin, J. N., & Gouldthorpe, J. L. (2013). "Small" farmers, big challenges: A needs assessment of

Florida small-scale farmers' production challenges and training needs. *J. Rural Social Sci., 28*(1), 54-79.
Greskevitch, M., Kullman, G., Bang, K. M., & Mazurek, J. M. (2008). Respiratory disease in agricultural workers: Mortality and morbidity statistics. *J. Agromed., 12*(3), 5-10. https://doi.org/10.1080/10599240701881482
Hoppin, J. A., Umbach, D. M., Long, S., Rinsky, J. L., Henneberger, P. K., Salo, P. M., ... Sandler, D. P. (2014). Respiratory disease in United States farmers. *Occup. Environ. Med., 71*(7), 484-491. https://doi.org/10.1136/oemed-2013-101983
Hsieh, H.-F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qual. Health Res., 15*(9), 1277-1288. https://doi.org/10.1177/1049732305276687
James, J. M., & Bolstein, R. (1992). Large monetary incentives and their effect on mail survey response rates. *Public Opin. Qtly., 56*(4), 442-453. https://doi.org/10.1086/269336
Jobber, D., Saunders, J., & Mitchell, V.-W. (2004). Prepaid monetary incentive effects on mail survey response. *J. Bus. Res., 57*(1), 21-25. https://doi.org/10.1016/S0148-2963(02)00280-1
Kearney, G. D., Rafferty, A. P., Hendricks, L. R., Allen, D. L., & Tutor-Marcom, R. (2014). A cross-sectional study of stressors among farmers in eastern North Carolina. *North Carolina Med. J., 75*(6), 384-392. https://doi.org/10.18043/ncm.75.6.384
Lizer, S. K., & Petrea, R. E. (2007). Health and safety needs of older farmers: Part I. Work habits and health status. *Workplace Health Safety, 55*(12), 485-491. https://doi.org/10.1177/216507990705501202
Mangione, T. W. (2014). *Mail surveys: Improving the quality.* Thousand Oaks, CA: Sage Publications.
NIDIS. (2019). U.S. Drought portal. Asheville, NC: National Integrated Drought Information System. Retrieved from https://www.drought.gov/drought/states
Pennings, J. M. E., Irwin, S. H., & Good, D. L. (2002). Surveying farmers: A case study. *Appl. Econ. Persp. Policy, 24*(1), 266-277. https://doi.org/10.1111/1467-9353.00096
Rautiainen, R. H., & Reynolds, S. J. (2002). Mortality and morbidity in agriculture in the United States. *J. Agric. Saf. Health, 8*(3), 259-276. https://doi.org/10.13031/2013.9054
Ringgenberg, W., Peek-Asa, C., Donham, K., & Ramirez, M. (2018). Trends and characteristics of occupational suicide and homicide in farmers and agriculture workers, 1992-2010. *J. Rural Health, 34*(3), 246-253. https://doi.org/10.1111/jrh.12245
Sanne, B., Mykletun, A., Moen, B. E., Dahl, A. A., & Tell, G. S. (2004). Farmers are at risk for anxiety and depression: The Hordaland Health Study. *Occup. Med., 54*(2), 92-100. https://doi.org/10.1093/occmed/kqh007
Singer, E., Van Hoewyk, J., Gebler, N., Raghunathan, T. & McGonagle, K. (1999). The effect of incentives on response rates in interviewer-mediated surveys. *J. Offic. Stat., 15*(2), 217-231.
Spleen, A. M., Lengerich, E. J., Camacho, F. T., & Vanderpool, R. C. (2014). Health care avoidance among rural populations: Results from a nationally representative survey. *J. Rural Health, 30*(1), 79-88. https://doi.org/10.1111/jrh.12032
Sullivan, S. (2011). Cheshire labor and infrastructure needs assessment. Walpole, NH: Cheshire County Conservation District. Retrieved from https://www.sare.org/Learning-Center/SARE-Project-Products/Northeast-SARE-Project-Products/Cheshire-Labor-and-Infrastructure-Needs-Assessment
Thornton, M., & Jerome, A. (2017). Farm town strong. Washington, DC: American Farm Bureau Federation. Retrieved from https://www.usda.gov/oce/forum/2018/speeches/AFBF_NFU.pdf
Vallejos, Q. M., Schulz, M. R., Quandt, S. A., Feldman, S. R., Galvan, L., Verma, A., ... Arcury, T. A. (2008). Self report of skin problems among farmworkers in North Carolina. *American J. Ind. Med., 51*(3), 204-212. https://doi.org/10.1002/ajim.20550
Weigel, M. M., Armijos, R. X., & Beltran, O. (2014). Musculoskeletal injury, functional disability, and health-related quality of life in aging Mexican immigrant farmworkers. *J. Immigr. Minor. Health, 16*(5), 904-913. https://doi.org/10.1007/s10903-013-9788-6