


Rural and Agricultural Natural Disaster Stress and Recovery: A Comparison

Kristin K. Gaffney, Sharon Medcalf, Ellen Duysen & Christopher Wichman

To cite this article: Kristin K. Gaffney, Sharon Medcalf, Ellen Duysen & Christopher Wichman (2023) Rural and Agricultural Natural Disaster Stress and Recovery: A Comparison, Journal of Agromedicine, 28:4, 797-808, DOI: [10.1080/1059924X.2023.2230987](https://doi.org/10.1080/1059924X.2023.2230987)

To link to this article: <https://doi.org/10.1080/1059924X.2023.2230987>

 [View supplementary material](#) 

 Published online: 02 Jul 2023.

 [Submit your article to this journal](#) 

 Article views: 94

 [View related articles](#) 

 [View Crossmark data](#) 



Rural and Agricultural Natural Disaster Stress and Recovery: A Comparison

Kristin K. Gaffney^a, Sharon Medcalf^b, Ellen Duysen^c, and Christopher Wichman^d

^aDepartment of Biostatistics, University of Arkansas for Medical Sciences, Little Rock, Arkansas, USA; ^bDepartment of Epidemiology, University of Nebraska Medical Center, Omaha, Nebraska, USA; ^cDepartment of Environmental, Agricultural and Occupational Health, University of Nebraska Medical Center, Omaha, Nebraska, USA; ^dDepartment of Biostatistics, University of Nebraska Medical Center, Omaha, Nebraska, USA

ABSTRACT

This study used a novel survey instrument to evaluate the hypothesis that U.S. agricultural producers have significantly different stress and recovery experiences following acute-onset natural disaster compared to their non-agricultural counterparts. Participants were recruited through local organizations and targeted email and social media in communities in Arkansas and Nebraska that had experienced violent tornadoes in 2014 and/or severe flooding in 2019. The survey instrument incorporated the Brief Resilience Scale, the Revised Impact of Event Scale referencing two time points, the Posttraumatic Growth Inventory-Short Form, and original questions. Demographic, exposure, stress, and recovery measures were analyzed in SAS with Chi-square tests, t-tests, Wilcoxon tests, and multiple linear regression modeling to test for differences between agricultural and non-agricultural groups in resilience, event exposure, stress symptoms in the week after the event, stress symptoms in the month before the survey, a calculated recovery ratio, and posttraumatic growth. Analysis sample ($N = 159$) contained 20.8% agricultural occupation, 71.1% female, and 49.1% over age 55. No significant differences were found between agricultural and non-agricultural participants when comparing resilience, stress, or recovery ratio measures. Unadjusted posttraumatic growth score was significantly lower in the agriculture group ($P = .02$), and an occupation group by sex interaction was significantly associated with posttraumatic growth score ($P = .02$) when controlled for number of initial posttraumatic stress symptoms in the adjusted model, with agricultural women showing lower growth. Overall, there was no evidence of significant difference in disaster stress and recovery between agricultural and rural, non-agricultural groups in this study. There was some evidence that women in agriculture may have lower levels of recovery. Data indicated that rural residents continue to experience post-traumatic-type symptoms up to 8 years beyond the acute-onset natural disaster events. Communities should include strategies to support mental and emotional health in their preparedness, response, and recovery plans with intentional inclusion of agricultural populations.

KEYWORDS

Agriculture; mental health; natural disaster; rural; stress


Introduction

Living through a natural disaster can range from inconvenient or disruptive to terrifying, traumatic, and life changing. Since 1980, 355 natural disasters individually exceeding a billion dollars in cost (2023 cost-adjusted) and together exceeding 2.5 trillion dollars, not to mention many less costly events, have occurred in the U.S., affecting all 50 states.¹ Even more concerning is the increasing frequency of these devastating events. The average number of billion-dollar weather disasters per decade in the U.S. has steadily risen from 3.3 per year in the 1980s (average annual total \$21.0 billion) to

13.1 in the 2010s (\$95.0 billion). The last 3 years (2020–2022) averaged 20 events per year (\$149.2 billion annually).¹ Extreme weather impacts property, infrastructure, and health with individual effects such as posttraumatic stress, depression, and substance use.² Because of the connection between agriculture and weather, it is important to understand whether agricultural populations have unique risk or resilience affecting mental and emotional health status when faced with natural disaster.

In 2019, 3.6 million people in the U.S., or 1.8% of the workforce, were directly employed in

CONTACT Ellen Duysen  Ellen.duysen@unmc.edu  Department of Environmental, Agricultural and Occupational Health, 984388 Nebraska Medical Center, Omaha, NE, 68198-4388 USA

 Supplemental data for this article can be accessed online at <https://doi.org/10.1080/1059924X.2023.2230987>.

farming, forestry, and fishing activities.³ Existing research highlights potential mental health effects for disaster survivors,² but little is known regarding experiences specific to U.S. agricultural producers faced with acute-onset natural disasters such as floods and tornadoes.

An extensive literature review provided limited information on natural disaster stress and recovery in U.S. agricultural populations. Greater depressive symptoms were reported in residents of small towns and rural communities than in larger cities or farm populations following 1993 Midwest floods.⁴ Fishing captains in the Northeast experienced increased psychological distress following widespread fishery failure, a slow-onset disaster.⁵ Research has been conducted examining the mental health needs of veterinarians following natural disasters and the potential to employ this group as a mental health resource in disaster-affected agricultural settings.⁶ Increased occupational stress in agricultural producers has been associated with drought during the growing season.⁷

Other studies have measured disaster stress or depression symptoms in rural but not specifically agricultural settings, most often looking for associations to identify individuals at greater risk of mental health conditions post-disaster, but measures of recovery and interventions to promote recovery were not included.^{8–12} Although some research on international agricultural populations has been published, primarily related to drought in Australia, conclusions may not be generalizable to U.S. populations due to differences in culture, social networks, or community infrastructure. In addition, analysis from slow-onset disasters like drought may not generalize to acute-onset events.

The Central States Center for Agricultural Safety and Health (CS-CASH) in Omaha, Nebraska, supported the Rural Natural Disaster Stress and Recovery (RNDSR) survey development and study. This research aimed to assess disaster mental health experiences related to acute-onset natural disasters in U.S. rural and agricultural populations to provide evidence for disaster preparedness, response, and recovery to support mental and emotional health. We hypothesized that agricultural producers have different disaster stress and recovery experiences compared to rural non-agricultural counterparts. Anecdotally, agricultural

producers – farmers, ranchers, and fishers – have a reputation for strength and resilience, so we might expect them to experience less stress and greater recovery.^{13,14} However, they have a particular dependence on weather along with an elevated suicide rate,¹⁵ so we also consider the possibility of greater disaster mental health risk.

Methods

Human subjects protection

The University of Nebraska Medical Center (UNMC) Office of Regulatory Affairs approved the Rural Disaster Stress and Recovery Study as exempt research under IRB #729–21-EX. While human subjects were involved in the survey study, no identifying protected health information was collected.

Study design

We collected and analyzed survey data from agricultural and non-agricultural populations in targeted disaster-affected rural communities in a cross-sectional observational study of a voluntary convenience sample. Only acute-onset natural disaster events such as flood, tornado, or fire were included. Slow-onset natural disasters such as drought, manmade disasters such as chemical accident or war, and disease outbreaks such as COVID-19 were excluded.

An *a priori* sample size estimate of 128 was calculated (G*Power 3.1.96) based on alpha = 0.05, power = 0.80, and a medium effect size $d = 0.5$ in a *t*-test for two independent samples with allocation ratio 1:1 between agricultural and non-agricultural subgroups, allowing for 20% incomplete surveys.

Study populations

Agricultural and non-agricultural populations affected by natural disasters in Arkansas and Nebraska were targeted for participation in this research, based on all authors' personal knowledge, relationships, and networking in impacted communities. On April 27, 2014, an EF-4 tornado (winds 166–200 mph) struck Mayflower

(population 1,984)¹⁶ and Vilonia (4,288)¹⁶ in Faulkner County, Arkansas, with 16 fatalities,¹⁷ and 400–500 homes were destroyed along a 41-mile path.¹⁸ This county and others were also affected by destructive Arkansas River flooding in May–June 2019, part of a \$3.3 billion event.¹

In Nebraska, the town of Pilger (240)¹⁶ and the surrounding region were struck by two EF-4 tornadoes on June 16, 2014, with 20 injuries and 2 fatalities;¹⁹ other tornadoes occurred nearby during the same outbreak. The town and vicinity of North Bend (1,279)¹⁶ experienced significant damage to infrastructure, property, and agricultural operations from Platte River flooding in March 2019, a disaster that cost over \$11 billion.¹

The RNDSR survey was delivered in English via targeted communities' local social media pages, email and postal mail to agricultural organization member lists, personal contact in local communication hubs, agricultural newsletters and social media, and local media reports. CS-CASH collaborated with community partners, including extension agents, farm association representatives, health department official, newspaper manager, and community center director. Study data were collected from December 2021 through February 2022 and managed using the REDCap electronic data capture tools hosted at the University of Nebraska Medical Center (UNMC). Service and support was provided by the Research Information Technology Office (RITO), which is funded by the UNMC Vice Chancellor for Research.

Survey components

Validated survey instruments measuring resilience, stress, and recovery that had been tested in diverse and disaster-affected populations were adapted for the RNDSR survey (Appendix A). The Brief Resilience Scale (BRS) was designed and validated to “assess resilience as bouncing back from stress.”²⁰ Respondents indicated their level of agreement with six statements about their typical responses to stressful events. The scale was scored by averaging values of 1–5 assigned to Likert-type responses. Three of the six items were reverse scored.

The Revised Impact of Event Scale (IES)²¹ is a screening tool for posttraumatic stress disorder (PTSD) but was used here as a tool for counting commonly experienced intrusion (re-experiencing) and avoidance posttraumatic stress symptoms without accounting for frequency or intensity of those symptoms. Minor modifications to the survey instructions were made, but no changes were made to questions. This scale has been used and tested in diverse populations after stressful events, including post-disaster, and was designed for use at any length of time after a stressful event.²¹

Subjects completed the Revised IES based on their memory of presence or absence of 15 possible posttraumatic stress symptoms in the first 7 days following their primary disaster event.²² Subjects were also given the option to select *Don't recall* for each symptom. The Revised IES was scored here as number of symptoms reported.

Subjects then completed the Revised IES scale again regarding the same 15 possible event-related symptoms occurring in the 30 days prior to completing the survey. The time difference of 30 days for the present scale versus 7 days for the past allowed for the expected trend of reduced symptoms over time while capturing symptoms still experienced even if less frequent.

The Posttraumatic Growth Inventory – Short Form (PTGI-SF)²² is a self-report measure of recovery as positive personal growth rather than reduced posttraumatic stress symptoms. Subjects chose the degree to which 10 specific positive changes occurred in their life due to the stressful event, from *Not at all* to *Very great degree* (six options scored 0–5). The PTGI-SF score was the sum of responses, ranging from 0 to 50.

Demographic data were collected. Age, sex, race or ethnicity, rural or urban residence, specific disaster event, agricultural occupation, and presence of dependents in the home were independent categorical variables. Rural was defined as residence in a location of population less than 10,000, following the U.S. Census Bureau's proposed definition based on the 2020 U.S. Census.²³ Choices for primary occupation were *Farm, Ranch, Fishery*, and *Not in Agriculture*, and the first three were combined into a single Agriculture occupational group in data preparation due to sample size limitations.

No distinction was made between farmworker and farm owner/operator.

Exposure questions evaluated direct or indirect impact, property loss, displacement, financial hardship, injury to self or family member, and fear for life of self or family member. These were summed for a single exposure score where perceived direct impact was 2 points, indirect was 1, no impact was 0, and all other exposures were 1 point for presence or 0 for absence. This method combining perceptions and objective experiences was adapted from the literature.^{9,11} Qualitative open field responses and a novel Resource Use and Effect inventory to be described in a separate report were also collected.

Statistical analysis

Statistical analysis was performed in SAS Studio 3.8 (Enterprise Edition) (Cary, NC, USA). Descriptive statistics and graphs were produced to review population characteristics and scale score distributions. Chi-square tests for equal proportion and *t*-tests for independent means were conducted to identify significant differences between agricultural and non-agricultural occupational groups. Wilcoxon non-parametric tests

were also used for confirmation where outcomes and residuals were not normally distributed. Linear and multiple regressions were used to test association of occupational group with outcome scores while controlling for covariates, including age group, sex, race or ethnicity, disaster type, exposure level, dependents in home and years since event. An additional outcome Recovery Ratio (RR), the proportional reduction in symptom count from time of event to present was calculated as $\frac{IES_{past} - IES_{now}}{IES_{past}}$ and tested with the same procedures. A significance level of $\alpha = 0.05$ was used for all hypothesis testing. Across all comparisons, post hoc power was 0.94–0.98 for detecting a large effect, and 0.59–0.71 for medium effect.

Results

Sample size and population

The full data set included 216 records, which was reduced to 159 for analysis. Subjects were flagged for completeness of each scale, defined as at least 5/6 exposure questions completed, 5/6 BRS, 13/15 Revised IES, and 8/10 PTGI-SF. Only individuals with completed scales were included at each stage

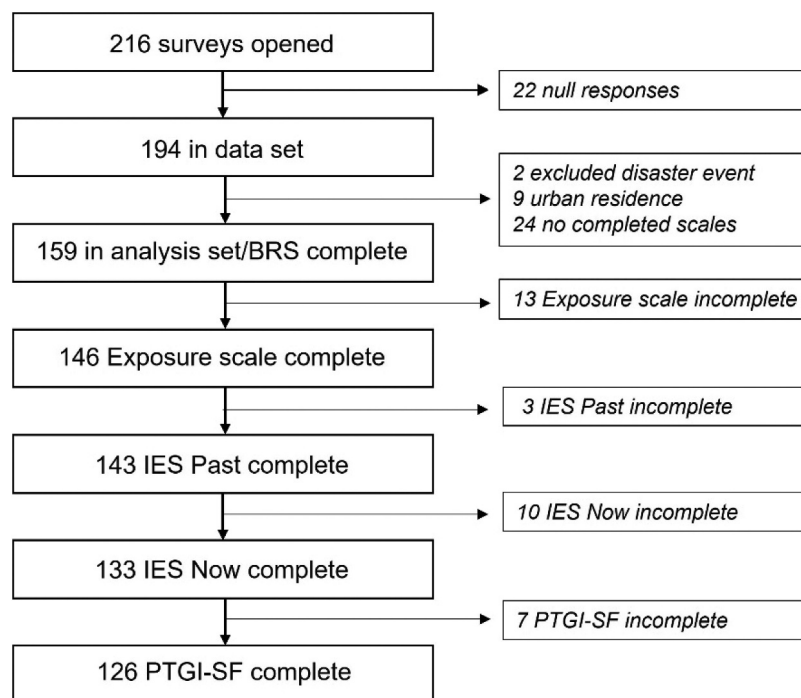


Figure 1. Sample size flow for rural and agricultural natural disaster stress and recovery study.

Table 1. Demographic summary of participants in data analysis set of the rural and agricultural natural disaster stress and recovery study ($N = 159$).

Demographic	Number	Percentage (%)
Age (years)		
19–20	4	2.5
21–25	6	3.8
26–35	17	1.7
36–45	29	18.2
46–55	25	15.7
56–65	34	21.4
Over 65	44	27.7
Sex		
Female	113	71.1
Male	46	28.9
Race or Ethnicity		
White	144	9.6
Other	9	5.7
Unreported	6	3.8
Residence		
Not in town	60	37.7
Town <10,000	92	57.9
Urbana	4	2.5
Unreported ^a	3	1.9
Occupation		
Not in agriculture	116	73.0
Agriculture	33	2.8
Unreported	10	6.3
Dependents in home		
Yes	62	39.0
No	92	57.9
Unreported	5	3.1
Disaster Type ^b		
Tornado	93	58.5
Flood	52	32.7
Other acute event	3	1.9
No disaster ^c	9	5.7
Unreported	2	1.3
Disaster State		
Arkansas	82	51.6
Nebraska	62	39.0
Other state	1	.6
Unreported ^c	14	8.8
Disaster Year		
2014	90	56.6
2019	52 ^b	32.7
Other year	6 ^c	3.8
Unreported ^c	11 ^a	6.9

^aFour participants who identified urban residence and three who did not report rural/urban location were included because they were determined to be closely tied to rural locations through open field responses and targeted survey distribution.

^bSixteen participants (10.1%) reported being affected by more than one natural disaster; they were asked to select the event that affected them most and answer the rest of the survey with that event in mind. Only one event per participant was included in event data.

^cNine of the missing event-related values were participants who had not experienced a disaster and completed only the BRS.

of the analysis. Sample size completing the last scale was 126. See Figure 1 for sample size flow.

See Table 1 for demographic and disaster event details. The proportion of male to female was significantly different in the agricultural group (17–16) compared to the non-agricultural group (23–93) on chi-square test ($P < .001$); therefore, sex was controlled for in further occupational group analysis.

Outcomes

The agricultural and non-agricultural occupational groups were compared on each scale covering an aspect of a stress and recovery cycle (Figure 2), where each statistical null hypothesis was for no difference in mean or median score by occupational group.

Resilience

On independent samples t -test, there was not a significant difference ($P = .385$) in mean BRS between agricultural (3.27, 95% confidence interval [CI] 2.97–3.57, $N = 33$) and non-agricultural groups (3.42, CI 3.26–3.58, $N = 116$). There was a significant difference ($P = .021$) in mean BRS by sex between males (3.62, CI 3.38–3.86, $N = 46$) and females (3.27, CI 3.11–3.44, $N = 113$); however, both fell in a range of normal resilience.²⁴ On analysis of covariance (ANCOVA), the difference in mean BRS by occupational group was not statistically significant when controlled for sex ($P = .135$). Age group, race or ethnicity, event state, dependents in home, and presence or absence of disaster event were not significant as covariates.

Event exposure

Exposure scores were calculated for 146 subjects; 122 (83.6%) reported, in their opinion, being directly affected by the disaster, and 24 (16.4%) indirectly. There were 82 (56.6%) who reported losing property, 75 (51.4%) were displaced from their home, 69 (47.9%) experienced financial hardship due to the event, 3 (2.1%) reported injury to self or family member, and 78 (53.4%) feared for their life or a family members. Overall distribution of exposure score was approximately normal (mean 3.94, CI 3.69–4.19), but the agricultural subgroup ($N = 28$) showed a more uniform distribution. Agriculture median was 3.00 (interquartile range [IQR] 3.00; $N = 28$) compared to non-agriculture 4.00 (IQR 2.00; $N = 111$), which was significant on Wilcoxon test ($P = .015$), so exposure score was included as a covariate in further analysis.

Stress symptoms

IES past score (first 7 days after event) was approximately normally distributed with overall mean 6.89, CI 6.39–7.39, minimum 0.00 and maximum 14.00 ($N = 143$). It had a negative Pearson correlation (-0.35 , $P < .001$) with BRS score and a positive correlation (0.49 , $P < .001$) with exposure score. Subjects marked a total of 4.3% of IES past symptoms as *Don't Recall*, and 0.8% of responses were missing. One hundred thirty-six subjects (95.1%) were able to recall *Yes* or *No* for at least 13 of the 15 symptoms, and only 1 did not recall more than half.

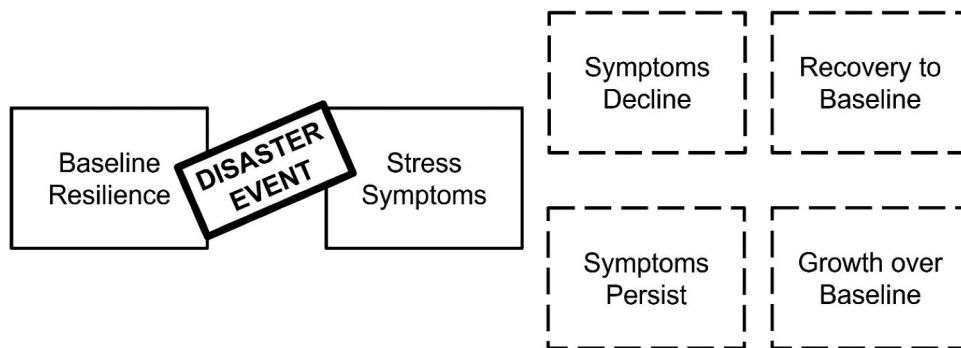


Figure 2. Disaster stress and recovery cycle as proposed by authors.

Unadjusted, IES past score was significantly different by occupational group on *t*-test ($P = .025$; $N_{\text{Agriculture}} = 28$, $N_{\text{Non-agriculture}} = 109$). On multiple linear regression modeling, IES past score was significantly associated with sex ($P < .001$), exposure score ($P < .001$), and BRS score ($P = .021$). With these covariates, occupational group was not significant ($P = .584$). Age group, race or ethnicity, event type, dependents in home, and residence in or out of town also were not significant. Interactions were tested but rejected for insignificance. Assumptions of linearity, independence, normality, and equal variance were satisfied for the linear regression model. A Poisson regression model of symptom count was rejected for poor performance.

Symptom decline or persistence

Current stress symptoms. IES now score (past 30 days prior to taking survey) had an overall right skewed distribution with median 3.00 (IQR 5.00, $N = 133$). Wilcoxon testing was insignificant for different median IES now score by occupational group ($P = .73$; $N_{\text{Agriculture}} = 26$, $N_{\text{Non-agriculture}} = 101$). Subjects marked a total of 1.0% of IES now symptoms as *Don't Recall*, and 0.5% of responses were missing. There were 131 subjects (98.5%) able to recall *Yes* or *No* for at least 13 of 15 symptoms, and only 1 did not recall more than half. There were 112 (84.2%) who reported at least one disaster-associated symptom in the 30 days before taking the survey. On linear regression modeling with residual normality, occupational group was not significant ($P = .081$) when controlled for IES past, BRS, and exposure scores.

Recovery Ratio. RR distribution was left-skewed and non-normal (median 0.40, IQR 0.75, $N = 131$). A non-parametric Wilcoxon test was not significant ($P = .510$) for equal RR median between agricultural (0.29, IQR 0.67, $N = 25$) and non-agricultural (0.40, IQR 0.71, $N = 100$) subgroups.

Subjects were also classified into IES past score rank groups above and below median to determine whether RR differed significantly between the groups with fewer initial symptoms and more initial symptoms. On Wilcoxon test, there was no evidence of a different RR between the median rank groups ($P = .180$). There were 17 participants who reported more symptoms in the month before the survey than in the week following the event, resulting in negative RRs. Of these participants, eight ranked in the lower half of IES past scores and nine were in the upper half.

On multiple linear regression, only BRS score was significantly associated with RR ($P = .001$), but BRS was not a good predictor of RR ($R^2 = 0.073$). Occupational group was not significant ($P = .231$) when controlled for BRS on regression or when controlled additionally for sex and exposure score ($P = .370$). Other covariates tested but excluded for insignificance were years since event, IES past score, age group, rural/urban, dependents in home, event type, exposure score, race or ethnicity, and sex. Normality of residuals was adequately satisfied for the model.

Posttraumatic growth

Of the subjects, 126 completed the PTGI-SF with overall mean score 26.56 (CI 24.18–28.09) of a possible 50 points, with approximately normal distribution. The agriculture group mean was 21.08 (CI 16.41–25.75) with minimum 0, maximum 36, and $N = 24$. The non-agriculture group mean was 27.67 (CI 25.38–29.96) with minimum 2, maximum 47, and $N = 97$. On unadjusted *t*-test, there is evidence that means are significantly different for agricultural and non-agricultural groups ($P = .012$; Table 2). Non-parametric Wilcoxon testing to confirm, due to distribution by subgroups, had $P = .014$, further evidence for significant difference in central measure between the groups.

Table 2. Unadjusted *t*-test for PTGI score by occupational group (agricultural vs. non-agricultural).

Analysis Variable : PTGI Score				
Parameter	Estimate	Standard Error	t Value	P value
Intercept	27.67	1.15	24.09	<.0001
Occupational group	-6.59	2.58	-2.55	.0119

Table 3. Adjusted linear regression model for PTGI score.

Analysis Variable : PTGI Score				
Parameter	Estimate	Standard Error	t Value	P value
Intercept	12.85	2.86	4.50	<.0001
Occupational group: Agriculture	2.59	3.93	0.66	.5116
Occupational group: Not agriculture	0.00	.	.	.
Sex: Female	3.48	2.77	1.26	.2117
Sex: Male	0.00	.	.	.
IES Past score	1.68	0.35	4.77	<.0001
Interaction: Agriculture * Female	-11.20	4.90	-2.28	.0242
Interaction: Agriculture * Male	0.00	.	.	.
Interaction: Not agriculture * Female	0.00	.	.	.
Interaction: Not agriculture * Male	0.00	.	.	.

Table 4. Descriptive statistics for occupational groups by sex. Effect of sex differs by occupational group.

Analysis Variable : PTGI Score									
Occupational Group	Sex	N	Mean	Median	Std Error	Lower Quartile	Upper Quartile	Minimum	Maximum
Not agriculture	Male	19	20.89	22.00	2.75	10.00	31.00	2.00	40.00
	Female	78	29.32	32.00	1.21	22.00	37.00	4.00	47.00
Agriculture	Male	10	23.50	20.50	3.02	14.00	32.00	12.00	36.00
	Female	14	19.36	23.50	3.23	9.00	31.00	0.00	32.00

On multiple linear regression, PTGI score and IES past score were significantly positively associated ($P < .001$), and an occupational group by sex interaction was identified where women in agriculture had a significantly lower mean PTGI score ($P = .024$) (Table 3). Main effects were included in the model for occupational group and sex. Linearity, independence, normality, and equal variances were adequately satisfied on diagnostic plots. Model main effects of years since event, age group, IES now score, RR, exposure score, event type, and BRS score were rejected for insignificance. Occupation group interactions with these variables and with IES past score were also tested but insignificant.

When the analysis was re-run for only females by occupational group, the agricultural group (mean 19.4, CI 12.4–26.3, $N = 14$) scored significantly lower ($P = .004$) on PTGI-SF compared to non-agricultural (29.3, CI 26.9–31.7, $N = 78$) when controlled for IES past score (as indicated by the regression model) on analysis of covariance (ANCOVA). An unadjusted Wilcoxon test was conducted due to the small subgroup size and showed a significant difference ($P = .005$) in central measure (agriculture: median 23.5, IQR 22; non-agriculture: 32.0, IQR 15). Descriptive statistics to compare occupational group by sex PTGI scores are provided (Table 4).

Discussion

Stress and recovery around a disaster can be pictured as a cycle of baseline resilience, then the event, followed by stress symptoms, symptom decline and/or persistence, recovery toward baseline, and personal growth (Figure 2). Individuals may not experience all aspects, but all are considerations for comparing experiences.

Key results

We hypothesized that agricultural producers have different disaster stress and recovery experiences compared to their rural, non-agricultural counterparts across the stress and recovery cycle. We did not specify the direction of difference. In a systematic review, agricultural producers demonstrated higher occupational control and self-efficacy, which are potentially protective for mental health,²⁵ so they might be expected to score higher in resilience and recovery, and lower in posttraumatic stress, compared to non-agricultural residents. One researcher anticipated high resilience among farmers but found low resilience on analysis.^{26,27} A number of studies have shown that factors such as pesticide exposure, financial stressors, and weather concerns contribute to

higher mental health risk in general for agricultural occupations than non-agricultural, but other studies have shown lower risk or no difference in risk.²⁸

In the present study, no significant difference was identified between the agriculture and non-agriculture groups in resilience on BRS or post-traumatic stress symptom count on IES past. There was also no evidence of difference in recovery toward baseline on Recovery Ratio, which incorporated the IES now score into a proportional reduction in symptom count. The PTGI-SF qualitatively measured positive post-event growth and found an unadjusted significant difference between the agriculture and non-agriculture groups, as well as a sex by occupational group interaction on regression modeling.

Contrary to our hypothesis, this study found there is not strong evidence that agricultural producers have different overall experiences compared to rural, non-agricultural residents across the proposed disaster stress and recovery cycle. The agricultural participants did not exhibit a unique resilience or immunity to post-disaster stress effects. However, since women overall had significantly lower BRS score and higher IES past symptom count, and women in agriculture specifically reported lower posttraumatic growth, the results suggest that women in agriculture may be at risk of relatively lower resilience and lower posttraumatic growth compared to men in agriculture. Differences could exist due to baseline perceptions on qualitative scales, which still raise a question of why women in agriculture may report less confidence about recovery and lower personal growth after acute-onset disaster. A small sample size also could have influenced results. However, this finding is consistent with international studies that identified higher stress and lower resilience for agricultural women compared to men.²⁷ Farm women may have greater stress due to performing multiple roles in farm work, off-farm work, and home responsibilities including childcare.²⁹ Natural disasters disrupt social networks due to displacement and interrupted routines. Similar disruption was noted in the COVID-19 pandemic and may disproportionately affect farm women.³⁰ Higher general stress may be associated with higher disaster stress and diminished

recovery although this study was not designed to detect such a relationship. The stress and recovery experiences of women in agriculture merit further study and attention in disaster preparedness and recovery planning.

Implications for disaster preparedness, response, and recovery

While we exceeded the total sample estimate with 159 in the data analysis set, the allocation ratio was closer to 1:4 than the planned 1:1. For this reason, we completed a post hoc power calculation based on the actual group sizes at each comparison. Post hoc power for a medium effect size $d = 0.5$ ranged from 59% to 71%, and for a large effect size $d = 0.8$ from 94% to 98%. Though acknowledging concerns about the value of post hoc power analysis,³¹ we believe the sample size was adequate for identifying a large difference between agricultural and non-agricultural groups. It is unlikely that small-to-medium effects would require differential policies or programs, so this study provides evidence for including agricultural residents in general community response and recovery plans.³² As noted, women in agriculture may benefit from targeted strategies.

In this study, some rural residents reported posttraumatic-type symptoms persisting up to 8 years beyond acute-onset natural disaster events. Community-level actions mindful of disaster-related emotional health could be beneficial over an extended period of time. In another study, 2 years post-flood, rural community members described long-term stresses and how some response activities supported or hindered resilience.³² International studies of long-term disaster mental health may provide insight as to the types of symptoms that may occur, who may be at risk, and steps communities can take to promote recovery.^{33–35}

Strengths and limitations

A strength of this study was the comprehensive approach to evaluating a cycle of disaster stress and recovery experiences in rural populations with intentional efforts to include agricultural residents. Using a combination of existing scales, data

represented a story of community experiences over time although it was collected at a single time point. Another strength was the presence of committed local individuals to recruit participants in the targeted communities, an important factor in rural culture.

Limitations centered around study and survey design. The study used a voluntary convenience sample prone to selection bias, and rural disaster-affected populations, especially agricultural, are challenging to reach and may be uncertain about participating in outside research. Local collaborators indicated that internet access and use is unreliable for survey distribution in this population. Paper surveys were mailed based on affected ZIP codes and local knowledge of affected residents. In the analysis data set, females were over-represented, particularly in the non-agricultural group; however, sex was controlled in statistical modeling. Multiple household members could have completed the survey, potentially introducing correlation in the data although family members may also experience different stress and recovery patterns.³⁶ Finally, the study included severe acute-onset natural disasters – primarily tornado and flood – in the South Central and Midwestern U.S. Results may not generalize to disasters of other types or intensities, or to diverse geographic communities with unique culture and resources.

The RNDSR survey has inherent limitations. Exposure questions, BRS, and PTGI-SF have qualitative components subject to variability. Whether a participant's own definition of "directly affected" or "financial hardship," or a personality unlikely to "strongly agree" or "strongly disagree," quantitative analysis of qualitative data requires caution. Trends and patterns bear more weight than specific numeric values or individual scores.

The use of the Revised IES was modified to ask about symptoms occurring years before during the week following a disaster event and is subject to recall bias. To address this, we added the option *Don't Recall*; however, only 4.3% of response items were marked as *Don't Recall*, and only 0.8% were missing. There is evidence of strong and long-lasting recall around disaster events³⁷ to support delayed inquiry. The Revised IES is also limited to questions about intrusion (re-experiencing) and avoidance posttraumatic stress symptoms without

addressing hyperarousal posttraumatic symptoms or any other mental health indicators such as depression, anxiety, or substance abuse. Frequency, intensity, and life disruption of symptoms were not accounted for, only presence or absence of symptoms. The findings in this study do not preclude the possibility of additional or disparate severity of emotional or mental health challenges by occupational subgroup.

This study broadly targeted affected individuals through both agricultural and general community sources, but the survey did not distinguish between farmworkers and farm owner/operators, and the study was not designed to capture experiences of a mobile population. It is likely that the agricultural participants were primarily owners. Migrant farmworkers, in particular, are recognized as a vulnerable population for whom stress factors and mental health risks are not well understood.^{38,39} Future study to evaluate migrant farmworkers' natural disaster stress and recovery is warranted with attention to mobile lifestyle and language preferences.

Conclusion

While the comparison between agricultural and rural, non-agricultural groups did not yield statistically significant differences overall, the RNDSR study has implications for disaster management and future research. Agricultural populations should be included alongside non-agricultural counterparts in disaster mental and emotional health supports, and women in agriculture may require specific attention. The long-term persistence of posttraumatic stress symptoms for many individuals should also be a factor in community level disaster recovery plans. Additional efforts should be made to study effects in agricultural populations where a larger sample size can participate and where further comparisons can be made between men and women. The RNDSR survey is easily adaptable to additional disaster settings for future studies.

Acknowledgments

Dr. Jesse Bell, Ms. Linda Emanuel

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

Funding for this research was provided by the Central States Center for Agricultural Safety and Health through a National Institutes of Occupational Safety and Health, Agriculture, Forestry and Fishing grant (U54 OH010162).

Abbreviations

BRS	Brief Resilience Scale
CS-CASH	Central States Center for Agricultural Safety and Health
IES	Impact of Event Scale
PTGI-SF	Posttraumatic Growth Inventory – Short Form
RNDSR	Rural Natural Disaster Stress and Recovery
RR	Recovery Ratio

References

- NOAA National Centers for Environmental Information (NCEI). Billion-Dollar weather and climate disasters. <https://www.ncdc.noaa.gov/billions/>. Updated, 2023. Accessed May 22, 2023
- Goldmann E, Galea S. Mental health consequences of disasters. *Annu Rev Public Health*. 2014;35(1):169–183. doi:10.1146/annurev-publhealth-032013-182435.
- USDA. Ag and food sectors and the economy. [https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/ag-and-food-sectors-and-the-economy/#:~:text=Agriculture%20and%20its%20related%20industries%20provide%2010.9%20percent,these%20jobs%2C%20or%201.3%20percent%20of%20U.S.%20employment](https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/ag-and-food-sectors-and-the-economy/#:~:text=Agriculture%20and%20its%20related%20industries%20provide%2010.9%20percent,these%20jobs%2C%20or%201.3%20percent%20of%20U.S.%20employment.). Updated 2021. Accessed September 16, 2021
- Ginexi EM, Weihs K, Simmens SJ, Hoyt DR. Natural disaster and depression: a prospective investigation of reactions to the 1993 midwest floods. *Am J Community Psychol*. 2000;28(4):495–518. doi:10.1023/A:1005188515149.
- Scyphers SB, Picou JS, Grabowski JH. Chronic social disruption following a systemic fishery failure. *Proc Natl Acad Sci USA*. 2019;116(46):22912–22914. doi:10.1073/pnas.1913914116.
- Wasson E, Wieman A. Mental health during environmental crisis and mass incident disasters. *Vet Clin North Am Food Anim Pract*. 2018;34(2):375–388. doi:10.1016/j.cvfa.2018.02.007.
- Berman JD, Ramirez MR, Bell JE, Bilotta R, Gerr F, Fethke NB. The association between drought conditions and increased occupational psychosocial stress among U.S. farmers: an occupational cohort study. *Sci Total Environ*. 2021;798:149245. doi:10.1016/j.scitotenv.2021.149245.
- Eisenman D, McCaffrey S, Donatello I, Marshal G. An ecosystems and vulnerable populations perspective on solastalgia and psychological distress after a wildfire. *Ecohealth*. 2015;12(4):602–610. doi:10.1007/s10393-015-1052-1.
- Polusny MA, Ries BJ, Schultz JR, Calhoun P, Clemensen L, Johnsen IR. PTSD symptom clusters associated with physical health and health care utilization in rural primary care patients exposed to natural disaster. *J Trauma Stress*. 2008;21(1):75–82. doi:10.1002/jts.20281.
- Polusny MA, Ries BJ, Meis LA, et al. Effects of parents' experiential avoidance and PTSD on adolescent disaster-related posttraumatic stress symptomatology. *J Fam Psychol*. 2011;25(2):220–229. doi:10.1037/a0022945.
- West JS, Price M, Gros KS, Ruggiero KJ. Community support as a moderator of postdisaster mental health symptoms in urban and nonurban communities. *Disaster Med Public Health Prep*. 2013;7(5):443–451. doi:10.1017/dmp.2013.74.
- Gros DF, Price M, Gros KS, Paul LA, McCauley JL, Ruggiero KJ. Relations between loss of services and psychiatric symptoms in urban and non-urban settings following a natural disaster. *J Psychopathol Behav Assess*. 2012;34(3):343–350. doi:10.1007/s10862-012-9290-9.
- Peters J Are farmers too tough? Hoard's Dairyman web site. <https://hoards.com/blog-30807-are-farmers-too-tough.html>. Updated, 2021. Accessed November 27, 2022
- Duvall Z How farmers hold onto hope in the tough times. Farm Bureau Web site. <https://www.fb.org/viewpoints/how-farmers-hold-onto-hope-in-the-tough-times>. Updated, 2019. Accessed November 27, 2022
- Arif AA, Adeyemi O, Laditka SB, Laditka JN, Borders T. Suicide mortality rates in farm-related occupations and the agriculture industry in the United States. *Am J Ind Med*. 2021;64(11):960–968. doi:10.1002/ajim.23287.
- U.S. Census Bureau. Explore Census Data. <https://data.census.gov/cedsci/>. Updated, n.d. Accessed March 31, 2022
- Marshall TP, Robinson J, Kiesling E, Tanner L Damage survey of the Mayflower-Vilonia Arkansas tornado: 27 April 2014. 2014;P162. <https://ams.confex.com/ams/27SLS/webprogram/Paper254346.html>
- NASA Earth Observatory. Tornado damage in mayflower, arkansas. <https://earthobservatory.nasa.gov/images/83612/tornado-damage-in-mayflower-arkansas>. Updated, 2014. Accessed March 30, 2022
- National Weather Service. June 16, 2014 Pilger tornado event. https://www.weather.gov/oax/event_archive_20140616. Updated n.d. Accessed Mar 22, 2022
- Smith BW, Dalen J, Wiggins K, Tooley E, Christopher P, Bernard J. The brief resilience scale:

- assessing the ability to bounce back. *Int J Behav Med.* 2008;15(3):194–200. doi:10.1080/10705500802222972.
21. Horowitz M, Wilner N, Alvarez W. Impact of event scale: a measure of subjective stress. *Psychosom Med.* 1979;41(3):209–218. doi:10.1097/00006842-197905000-00004.
 22. Cann A, Calhoun LG, Tedeschi RG, et al. A short form of the posttraumatic growth inventory. *Anxiety, Stress & Coping.* 2010;23(2):127–137. doi:10.1080/10615800903094273.
 23. Bureau of the Census. Department of commerce. Urban areas for the 2020 census - proposed criteria. *Fed Regist* 2021;86(32):10237–10243. <https://www.federalregister.gov/documents/2021/02/19/2021-03412/urban-areas-for-the-2020-census-proposed-criteria>
 24. Smith BW, Epstein EM, Ortiz JA, Christopher PJ, Tooley EM. The foundations of resilience: what are the critical resources for bouncing back from stress? In: Prince-Embury SS, eds. *Resilience in Children, Adolescents, and Adults.* Springer; 2013:pp. 167–187. doi:10.1007/978-1-4614-4939-3_13
 25. O’Shaughnessy BR, O’Hagan AD, Burke A, McNamara J, O’Connor S. The prevalence of farmer burnout: systematic review and narrative synthesis. *J Rural Stud.* 2022;96:282–292. Invalid date. doi:10.1016/j.jrurstud.2022.11.002.
 26. Jones-Bitton A. Coping skills for stress can be learned. Farmscape Web site. <https://www.farmscape.ca/f2ShowScript.aspx?i=25501&q=Coping+Skills+for+Stress+Can+be+Learned>. Updated, 2016. Accessed August 28, 2022
 27. Jones-Bitton A, Best C, MacTavish J, Fleming S, Hoy S. Stress, anxiety, depression, and resilience in Canadian farmers. *Soc Psychiatry Psychiatr Epidemiol.* 2020;55(2):229–236. doi:10.1007/s00127-019-01738-2.
 28. Daghigh Yazd S, Wheeler SA, Zuo A. Key risk factors affecting farmers’ mental health: a systematic review. *Int J Environ Res Public Health.* 2019;16(23):4849. doi:10.3390/ijerph16234849.
 29. Fraser CE, Smith KB, Judd F, Humphreys JS, Fragar LJ, Henderson A. Farming and mental health problems and mental illness. *Int J Soc Psychiatry.* 2005;51(4):340–349. doi:10.1177/0020764005060844.
 30. Becot FA. Children, work, and safety on the farm during COVID-19: a harder juggling act. *Journal Of Agromedicine.* 2022;27(3):315–328. doi:10.1080/1059924X.2022.2068716.
 31. Zhang Y, Hedo R, Rivera A, Rull R, Richardson S, Tu XM. Post hoc power analysis: is it an informative and meaningful analysis? *Gen Psychiatr.* 2019;32(4):e100069–2019. doi:10.1136/gpsych-2019-100069.
 32. Onstad PA, Danes SM, Hardman AM, et al. The road to recovery from a natural disaster: voices from the community. *Comm Develop.* 2012;43(5):566–580. doi:10.1080/15575330.2012.699081.
 33. Massazza A, Joffe H, Parrott E, Brewin CR. Remembering the earthquake: intrusive memories of disaster in a rural Italian community. *Eur J Psychotraumatol.* 2022;13(1):2068909. doi:10.1080/20008198.2022.2068909.
 34. Wind TR, Kawachi I, Komproue IH. Multilevel social mechanisms of post-disaster depression. *Int J Environ Res Public Health.* 2021;18(2):391. doi:10.3390/ijerph18020391.
 35. Priebe S, Marchi F, Bini L, Flego M, Costa A, Galeazzi G. Mental disorders, psychological symptoms and quality of life 8 years after an earthquake: findings from a community sample in Italy. *Soc Psychiatry Psychiatr Epidemiol.* 2011;46(7):615–621. doi:10.1007/s00127-010-0227-x.
 36. National Center for PTSD. Effects Of Disasters: Risk And Resilience Factors. U.S. Department of Veterans Affairs Web site. https://www.ptsd.va.gov/understand/types/disaster_risk_resilience.asp. Updated 2022
 37. Bauer PJ, Stark EN, Ackil JK, Larkina M, Merrill N, Fivush R. The recollective qualities of adolescents’ and adults’ narratives about a long-ago tornado. *Memory.* 2017;25(3):412–424. doi:10.1080/09658211.2016.1180396.
 38. Haws JK, Andrews AR3, Acosta Canchila MN, Ramos AK. Refining the migrant farmworker stress inventory among latino migrant farmworkers in rural Nebraska. *Rural Ment Health.* 2022;46(2):100–116. doi:10.1037/rmh0000202.
 39. Ramos AK, Su D, Lander L, Rivera R. Stress factors contributing to depression among latino migrant farmworkers in Nebraska. *J Immigr Minor Health.* 2015;17(6):1627–1634. doi:10.1007/s10903-015-0201-5.