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Rural and Agricultural Natural Disaster Stress and Recovery Study: Identifying Experiences and Community Preferences

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Abstract

Objective: The Rural Natural Disaster Stress and Recovery study surveyed flood and tornado affected residents (N=159 for analysis) in Arkansas and Nebraska, U.S., to address three hypotheses: 1) agricultural producers have different stress and recovery experiences compared to non-agricultural counterparts, 2) rural residents prefer community resources over external resources for disaster stress relief, and 3) communities can provide effective emotional health supports after disaster. **Methods:** Demographics, exposure, stress, and recovery measures, and a resource use and effect inventory were analyzed in SAS with Chi-square tests, t-tests, Wilcoxon tests, and multiple linear regression modeling to identify differences between agricultural and non-agricultural groups. Qualitative analysis of open field survey responses summarized community preferences for disaster stress reduction. People, groups, and activities common in post-disaster settings were evaluated for stress effects. **Results:** The agricultural subgroup did not have significantly different resilience, stress, or recovery ratio measures compared to the rural, non-agricultural subgroup. Posttraumatic growth score was significantly lower in the agriculture group on t-test ($p = 0.02$), and an occupation group by sex interaction was significantly associated with posttraumatic growth score in multiple linear regression ($p = 0.02$) with agricultural women showing lower scores. A majority of participants reported things they did for themselves or help from their community was most effective for decreasing disaster stress. Friends and neighbors and family were most frequent resources used, but group from neighboring community, personal faith activities, and helping others reduced stress more often. Repairing property and following news or social media most frequently increased stress. Family, friends, faith, neighbors, and community were top choices to decrease stress in a future disaster.

Keywords: natural disaster, rural, agriculture, stress, mental health, recovery

Acknowledgments

I would like to thank my family for testing the RNDSR survey and praying I would finish this work, my Capstone Committee for their guidance and encouragement, Ms. Ellen Duysen of CS-CASH for believing this study could happen, numerous experienced researchers and community partners who helped with this project, and the 194 survey respondents who shared a little piece of their lives and trusted me with their stories.

Abbreviations

BRS	Brief Resilience Scale
CI	Community Impact
IES	Impact of Event Scale
IPU	Impact Per Use
PTGI-SF	Posttraumatic Growth Inventory - Short Form
RNDSR	Rural Natural Disaster Stress and Recovery
RR	Recovery Ratio
RUE	Resource Use and Effect

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1. Introduction

1.1 Problem

Living through a natural disaster can range from inconvenient or disruptive to terrifying, traumatic, and life changing. Existing research highlights potential mental health effects for disaster survivors (Goldmann & Galea, 2014). Agricultural producers – farmers, ranchers, and fishers – have a reputation for strength and resilience but also have a particular dependence on the ways of nature along with an elevated suicide risk (Arif et al., 2021). Unfortunately, little is known about stress and recovery experiences of U.S. agricultural producers faced with acute natural disasters such as floods and tornadoes.

The Central States Center for Agricultural Safety and Health (CS-CASH) in Omaha, Nebraska, identifies causes of illness and injury in a seven-state farming population in order to promote prevention in this population through relevant education and communication methods (UNMC, n.d.). CS-CASH, a National Institute of Occupational Safety and Health (NIOSH) center conducting research and community outreach, supported the Rural Natural Disaster Stress and Recovery (RNDSR) survey development and study to understand and improve opportunities for enhancing preparedness and response to acute events in rural and agricultural settings. The RNDSR survey was distributed in disaster-affected communities in Arkansas and Nebraska, U.S.

1.2 Aims and Hypotheses

This study analyzed survey data and interpreted results from agricultural and non-agricultural populations primarily in and around disaster-affected communities described in Section 3.2. The key aims of this study were 1) to assess disaster mental health experiences in U.S. rural and agricultural populations, and 2) to identify community preferences for recovery. Three hypotheses were tested: 1) agricultural producers have different stress and recovery experiences compared to rural non-agricultural counterparts, 2) rural residents prefer community resources over external resources for disaster stress relief, and 3) communities can provide effective emotional health supports after disaster.

1.3 Significance

Extreme weather impacts property, infrastructure, and health, the latter including effects such as posttraumatic stress, depression, and substance use (Goldmann & Galea, 2014). This analysis may provide evidence for disaster preparedness, response, and recovery planning to support mental and emotional health in rural and agricultural populations. In addition, community resources most used and perceived to be effective for reducing disaster-related stress were identified, further informing community plans.

2. Background

2.1 Disaster Prevalence

In 2021, the United States had 20 natural disasters individually exceeding a billion dollars in cost (NOAA, 2022). Since 1980, 310 billion-dollar events (2021 cost-adjusted) have occurred in this country, affecting all 50 states (NOAA, 2022). In addition, every year there are numerous less costly disasters.

Natural disasters in heavily populated areas may attract more attention, but with 97% of U.S. land area and 19.3% of the population outside urban areas, it is important to consider the effects of natural disasters on rural populations (United States Census Bureau (USCB), 2019). In 2019, 3.6 million people, or 1.8% of the workforce, were directly employed in farming, forestry, and fishing activities (USDA, 2021). Because of the connection between agriculture and weather events, it is in the public interest to understand whether agricultural populations have unique risk or resilience affecting mental and emotional health status when faced with natural disaster.

2.2 Stress and Recovery in Agricultural and Rural Populations

Literature reviewed from the PubMed and PsycINFO databases provided limited information on natural disaster stress and recovery in U.S. agricultural populations. Ginexi et al. (2000) reported greater depressive symptoms in small towns and rural communities than in larger cities or farm populations following 1993 Midwest floods. Supports for mental health recovery were not described, and this paper is over 20 years old. Scyphers et al. (2019) found increased levels of psychological distress among fishing captains in the Northeast following widespread fishery failure, a chronic disaster. It is disputed whether the failure is natural or man-made. Wasson and Wieman (2018) proposed that mental health concerns of veterinarians should be considered in disaster preparedness education, and that veterinarians could serve as a mental health resource in disaster-affected agricultural settings. No stress or recovery data were provided. Berman et al. (2021) identified an association between increased occupational stress and drought for agricultural producers.

Thirteen additional papers since 2003 addressed natural disaster stress, recovery, or related community resources in U.S. rural, but not specifically agricultural, populations. Banks et al. (2016) used a survey instrument, observational assessment, and in-person interview with 12 rural Kentucky residents affected by flooding in 2013 to understand community resilience. They found faith, cultural values, and social support to be protective, while adversity and pre-existing health concerns were risk factors, concluding that existing community resources played a significant role in resilience (Banks et al., 2016). Afifi et al. (2014) used personal interviews with 26 Kansas tornado survivors to identify communal coping and faith as important strategies for managing uncertainty around disaster; however, the sample was disproportionately female, which may have biased results. Aderibigbe et al. (2003) used a random telephone survey of hurricane-affected rural residents in North Carolina, found clergy to be an important community resource for support, and recommended they be trained to recognize stress symptoms and refer for care.

Other studies used a variety of instruments to measure disaster stress or depression symptoms in rural or non-urban 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 (Eisenman et al., 2015; Gros et al., 2012; Polusny et al., 2008; Polusny et al., 2011; West et al., 2013). West et al. (2013) found that greater losses were associated with increased distress, but the effect was moderated with higher community support in non-urban settings post-hurricane.

More recently, Bunnell et al. (2017) found that a web-based mental health intervention was utilized at similar rates in rural and urban/suburban families affected by 2011 tornadoes in Alabama and Mississippi. This study did not analyze effectiveness of the intervention, only rates of use. Abrams (2018) developed a disaster preparedness education plan for rural health care providers that included a brief mental health domain for identifying stress behaviors, applying psychological first aid, and becoming knowledgeable of post-disaster mental health resources (p. 79). This study relied on health care provider preparedness research and did not include population stress or recovery data. These papers demonstrate a limited scope of research in rural disaster mental health.

In addition to the general lack of data on agricultural populations and natural disaster mental health, other issues limit generalizability of results. First, while some papers have considered disaster mental or emotional health measures in rural populations, it is unknown whether agricultural producers have unique risk or resilience factors. Second, data on stress and chronic disaster such as fishery failure or drought may not be generalizable to acute disaster events such as flood, tornado, or fire. Third, 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 cultural and structural differences.

2.3 Rationale

Evidence-based public health practice requires knowledge of science-based interventions and community preferences (Kohatsu et al., 2004). There is a need to study both community experiences and preferences to inform disaster preparedness, response, and recovery plans for mental and emotional health support. Analysis of survey data from targeted communities examined whether agricultural populations experience different resilience, stress, or recovery in an acute natural disaster context compared to their rural non-agricultural counterparts. Differences may result in adaptive approaches to disaster preparedness and response in agricultural populations.

Systems thinking provides a framework for leveraging lay and non-professional resources alongside professional services, a useful option for rural communities with limited access to mental health professionals. This study attempted to identify resources that have been most effective and preferred for stress reduction from the community perspective. Discovered knowledge may inform approaches to disaster preparedness, response, and recovery in rural and agricultural settings to improve the mental and emotional health of affected populations.

3. Methods

3.1 Study Design

This was a cross-sectional observational study of a voluntary convenience sample in targeted rural communities that have been affected by natural disaster. Data was collected through self-report on a survey tool online or on paper. For this project, only acute natural disaster events such as flood, tornado, or fire were included in analysis. Long-lasting natural disasters such as drought, manmade disasters such as chemical accident or war, and disease outbreaks such as COVID-19 were excluded.

3.2 Study Communities

On April 27, 2014, an EF-4 tornado (winds 166-200 mph) struck primarily Mayflower (population 1,984) (USCB, n.d.) and Vilonia (4,288) (USCB, n.d.) in Faulkner County, Arkansas, with 16 fatalities (Marshall et al., 2014) and 400 to 500 homes destroyed along a 41-mile path (NASA, 2014). Faulkner and other counties were also affected by destructive Arkansas River flooding in May-June 2019, part of a $3.3 billion event across Oklahoma and Arkansas (NOAA, 2022). Mayflower was also the site of a large crude oil pipeline spill in 2013 (The United States Department of Justice, 2015), and Vilonia had been struck by an EF-2 tornado in 2011.

In Stanton County, Nebraska, the town of Pilger (240 (USCB, n.d.)) and its vicinity were struck by two EF-4 tornadoes on June 16, 2014, with 20 injuries and 2 fatalities (National Weather Service, n.d.); other tornadoes also occurred in the area during the same severe weather outbreak. The town and vicinity of North Bend (1,279) (USCB, n.d.) in Dodge County, Nebraska, were heavily impacted by Platte River flooding in March 2019, part of a Midwest flood event that cost over $11 billion (NOAA, 2022). The community experienced significant damage to infrastructure, property, and agricultural operations.

3.3 Recruitment

Data from the RNDSR survey were collected in December 2021-February 2022 in the disaster-affected communities in Arkansas and Nebraska described in Section 3.2 through collaboration among CS-CASH, county extension agents, and local leaders and contacts. CS-CASH distributed paper surveys to targeted zip codes associated with the disaster events in Nebraska and posted a link to the Research Electronic Data Capture (REDCap) online version to social media. Extension agents and farm associations in Arkansas distributed the virtual link via social media and weekly e-newsletter. Local contacts also distributed paper surveys or links on a more targeted basis within their communities based on networking and knowledge of individuals affected by the disaster events, either personally or through community hubs such as churches and businesses. A newspaper and community center in Nebraska also publicized the survey.

3.4 Survey Components

Validated scales measuring resilience, stress, and recovery were chosen for prior use in diverse and disaster-affected populations and adaptability to the current setting. The Brief Resilience Scale (BRS) is designed and validated to "assess resilience as bouncing back from stress" (Smith et al., 2008). Respondents indicate their level of agreement with 6 statements about their typical responses to stressful events. The scale is scored by averaging values of 1 to 5 assigned to Likert-type responses. Three of the 6 items are reverse scored. The authors interpret scores of 1.00-2.99 as low, 3.00-4.30 as normal, and 4.31-5.00 as high resilience (Smith et al., 2013). The BRS score is an independent variable for analysis. Windle et al. found the BRS to be in the top 3 of 19 resilience scales (2011).

The Revised Impact of Event Scale (IES) (Horowitz et al., 1979) is a screening tool for posttraumatic stress disorder (PTSD) but is used here as a tool for counting commonly experienced posttraumatic stress symptoms without accounting for frequency or intensity of those symptoms. It may also be divided into two validated subscales (Intrusion and Avoidance symptom clusters) although these are not analyzed in this paper. Minor modifications to 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 is designed for use at any length of time after a stressful event (Horowitz et al., 1979).

Subjects completed the Revised IES scale based on their memory of 15 possible posttraumatic stress symptoms in the first 7 days following their primary disaster event. While the recollection of a symptom's occurrence is reasonable (Bauer et al., 2017), the recollection of frequency for a time point 3 to 8 years in the past may not be. For this reason, scoring was modified to reflect only presence or absence, and not frequency, of each symptom. Subjects were also given the option to select *Don't recall* for each symptom. The Revised IES was scored here by summing the 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 allows for the expected trend of reduced symptoms over time while capturing symptoms still experienced even if less frequent.

Revised IES scale scores and a related calculated variable (Recovery Ratio, the proportional reduction in score between past and now) may function as dependent or independent variables depending on the hypothesis being tested. When evaluated for association with demographic or exposure variables, they were dependent.

The Posttraumatic Growth Inventory – Short Form (PTGI-SF) (Cann et al., 2010) is a self-report measure of recovery as positive personal growth rather than reduced posttraumatic stress symptoms. It is a 10-item scale asking subjects to choose the degree to which a specific positive change occurred in their life due to the stressful event. They select from 6 choices ranging from *Not at all* to *Very great degree*, which are assigned values 0 to 5. The PTGI-SF is scored by summing the responses resulting in a range of 0 to 50. Scores are relative without cut points. PTGI-SF score was a dependent variable for analysis.

Demographic data were also collected. Age group, sex, race or ethnicity, rural or urban residence, specific disaster event, agricultural occupation, and presence of dependents in the home were all independent categorical variables. The age groups were stratified to be able to flag respondents who were likely minors at the time of their disaster event. Race and ethnicity categories were taken from recommendations based on the 2020 U.S. Census (Versta Research, 2020). Rural was defined as residence in a location of population less than 10,000, following the proposed definition based on the 2020 U.S. Census (Bureau of the Census, 2021). Urban was greater than 10,000. Occupation choices were *Farm*, *Ranch*, *Fishery*, and *Not in Agriculture,* and the first three were also combined into a single Agriculture occupational group in data preparation.

Exposure questions evaluate 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 are summed for a single exposure score where perceived direct impact is 2 points, indirect is 1, no impact is 0, and all other exposures are 1 point for presence or 0 for absence. This method combining perceptions and objective experiences was adapted from the literature (Polusny et al., 2008; West et al., 2013). Exposure variables and score were independent variables.

A novel qualitative inventory of Resource Use and Effect (RUE) yields quantitative variables assigned to qualitative responses to describe how 22 people, groups, or activities affected respondents' disaster stress after the event: decreased (value -1), no effect (0), increased (1), or did not use (no value). This inventory was analyzed for frequency of item use, aggregate sum of scores representing relative difference in number reporting increased stress and decreased stress, and an aggregated impact on stress effect with a calculated impact per use (IPU) score representing the difference in proportion of users reporting increase and those reporting decrease. The IPU score accounts for the number of people reporting use but no stress effect in that the absolute value of the score will be limited to one minus the proportion of no-effect users. It is meant to account for both the frequency of use and the aggregate stress effect. A separate categorical question provides information about most effective type of internal community or external help for reducing stress. For purposes of hypothesis testing, use, effect, and preference variables functioned as dependent or independent depending on the research question.

Qualitative open field responses about subjects' typical responses to stressful events, specific natural disaster experience, and first choices for stress reduction if faced with a future event provide information about community preferences. Although only a single survey was deployed, it took advantage of a mixed methods format by using both validated scales and open field responses.

3.5 Data Preparation

The raw RNDSR data set was exported from REDCap to a .CSV file, then imported to SAS and explored for errors, discrepancies, and missing data. No inconsistent or extreme values were identified. Surveys originally received as paper responses and entered in REDCap by the principal investigator were validated against the original paper surveys. New variables were added where open field responses indicated a disaster event other than the four targeted events. Data values were recoded or formatted as needed to facilitate analysis. Because no field was marked as required in the data collection process, careful consideration was given to the amount and treatment of missing data during analysis.

All questions were made optional for two reasons. First, for ethical reasons the investigator preferred to give participants the freedom to decide which questions to answer, which may also encourage continued engagement upon reaching a difficult or uncomfortable question. Second, due to the length of the survey (100 questions) and time required to complete (10-15 minutes), it was felt that partial responses were preferred over no response and would still yield useful information if a subject did not complete. The investigator was satisfied with the number of responses at each stage of the survey.

The data set included 216 records, of which 22 were identified and removed as null responses with no questions answered. Of the remaining 194, 2 were excluded for non-targeted event (drought as chronic disaster, COVID-19 as epidemic), 9 for urban residence that could not be tied to a rural community, and 24 for no completed scales. These subjects remained in the full data set of 194 but flagged for exclusion or incomplete scale. Total analysis sample size was 159, including 4 urban responses that were closely tied to the rural community through open field answers, i.e., college student away from rural home, or business owner commuting from a larger city.

3.6 Analysis Plan

Statistical analysis was performed in SAS Studio 3.8 (Enterprise Edition) (Cary, NC). Complete SAS Code is available in Appendix A. Descriptive statistics and graphs were produced to review demographic characteristics of the sample population as well as distributions of scale scores. 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 regression 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.

Qualitative analysis was used to tabulate open field responses of first choices for reducing stress if subjects were to experience another disaster in the future. A deductive approach was used with a framework of internal community resources versus resources external to the community. A grounded aspect was involved in looking for other themes or patterns. Because of the brevity and specific nature of the responses, a single rater conducted the informal evaluation. Other open field responses about resilience, the disaster event, stress, recovery, and resources were reviewed to provide context to individual scores and group inference.

Frequency plots were used to visualize participants' perceptions of effective types of help for decreasing disaster stress. From the RUE inventory, use percentage for each item was calculated as subjects reporting a stress increase, decrease, or no effect divided by the number of respondents to the question. Aggregate effect sums for each item were obtained for comparing perceived effect of people, groups, and activities as resources for reducing stress. The sum represents the difference between the number of people who felt the item decreased their stress and those who felt the item increased their stress. Those who reported no effect were represented indirectly since the absolute value of the sum was limited by the number who report an effect. Subjects who responded *Did not use* to an item were flagged for non-use, and their responses were included in the sample size but not the use percentage or aggregate sum.

The impact per use (IPU) score is the quotient of the aggregate effect sum divided by use count for each resource. It represents the difference between proportions of users reporting an associated decrease in stress and users reporting an increase, limited by the proportion of users reporting no effect. An IPU = -1 indicates all users reported decreased stress, and an IPU = 1 indicates all users reported increased stress. Practically speaking, a negative number closer to -1 suggests more frequently experienced stress reduction. The Community Impact (CI) score was calculated similarly but accounts for non-users by dividing the aggregate sum by total respondents for that item regardless of use status.

4. Results

4.1 Study Population

The online survey link was distributed through social media on Facebook community pages and agricultural group pages with approximately 7000 followers. Approximately 240 paper surveys were distributed. In response, 171 online surveys were opened with 149 started, and 45 paper surveys were returned. This is a response rate of 149/7000 = 2.1% online and 45/171 = 18.8% paper.

For each scale of the survey, subjects were flagged for completeness – defined as at least 5/6 exposure, 5/6 BRS, 13/15 Revised IES, and 8/10 PTGI-SF – so that only individuals with completed scales were included at each stage of the analysis. Sample size completing the last scale was 126. The RUE inventory did not require completion as there was no individual scoring.

The paper survey format allowed more freedom with responses than online format. On paper, some subjects marked two selections for questions that only allowed one selection online. These questions were left blank when entered in REDCap but noted in a separate data set by participant_ID so that no information would be lost. This issue will be addressed further in the results, section 4.2.8, and discussion, section 5.1.3.

One hundred fifty-nine subjects completed at least one scale and were included in the comparative analysis. Distribution of age was 19-20 years (4, 2.5%), 21-25 (6, 3.8%), 26-35 (17, 10.7%), 36-45 (29, 18.2%), 46-55 (25, 15.7%), 56-65 (34, 21.4%) and Over 65 (44, 27.7%). The sample was 71.1% female (113) and 28.9% male (46). Of those reporting race or ethnicity, 94.1% chose White (144) and 5.9% Other (9); 6 did not report. Thirty-eight and five-tenths percent (60) reported not living in a town and 59.0% (92) living in a town less than 10,000 population. Of those who reported primary occupation, 33 (22.2%) selected agriculture and 116 (77.9%) not in agriculture; 10 did not report. Fifty-nine and seven-tenths percent (92) reported no dependents in the home at the time of the disaster while 40.3% (62) reported dependents; 5 did not report.

Eighty-two subjects reported disaster events in Arkansas (56.6%), 62 in Nebraska (42.8%), 1 in another state, and 14 did not report their state. Ninety subjects reported an event in 2014 (60.8%), 52 in 2019 (35.1%), 6 in another year, and 11 did not report a year. Event types were 93 tornado (62.8%), 52 flood (35.1%), 3 other qualifying type, and 11 no event specified. Nine of the missing event-related values were subjects who had not experienced a disaster and completed only the BRS. Sixteen 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 subject was included in event data.

The proportion of male to female was significantly different in the agricultural group (17 to 16) compared to the non-agricultural group (23 to 93) on chi-square test, $p < 0.001$. Sex was controlled for in further occupational group analysis.

4.2 Outcome Data

4.2.1 BRS

BRS score distribution was left skewed with a single mode at 4.00, mean 3.37, and standard deviation (SD) 0.86, but had adequate sample size for t-testing. On independent samples t-test, there was not a significant difference (p=0.385) in mean BRS between agricultural (3.27, SD 0.86, N=33) and non-agricultural groups (3.42, SD 0.87, N=116) (Figure 1). There was a significant difference (p=0.021) in mean BRS between males (3.62, SD 0.81, N=46) and females (3.27, SD 0.87, N=113) (Figure 2); however, the BRS authors indicate all scores from 3.00 to 4.30 represent normal resilience (Smith et al., 2013). When ANCOVA was performed in PROC GLM, the difference in mean BRS by occupational group was not statistically significant when controlled for sex (p=0.135). Age group, race or ethnicity, event state, dependents in home, and presence or absence of disaster event also were not significant. A post hoc achieved power of 97% to detect a large effect size with ANCOVA was calculated in G*Power 3.1.9.6 (Universitat Kiel, Germany). Power of the uncontrolled t-test was 98% to detect a large effect size and 71% for medium effect size.

Figure 1

Distribution of BRS score by Agricultural and Non-agricultural Occupational Groups

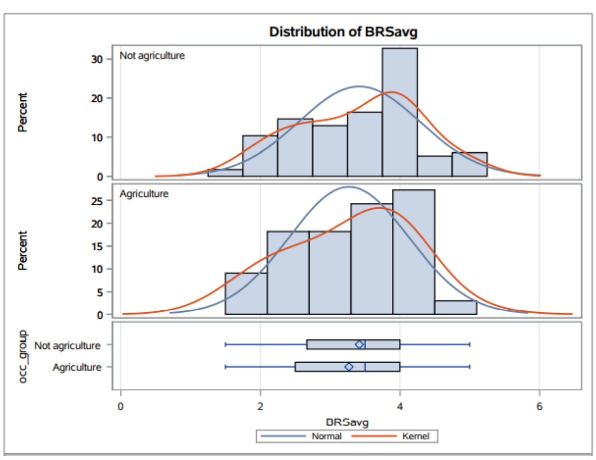
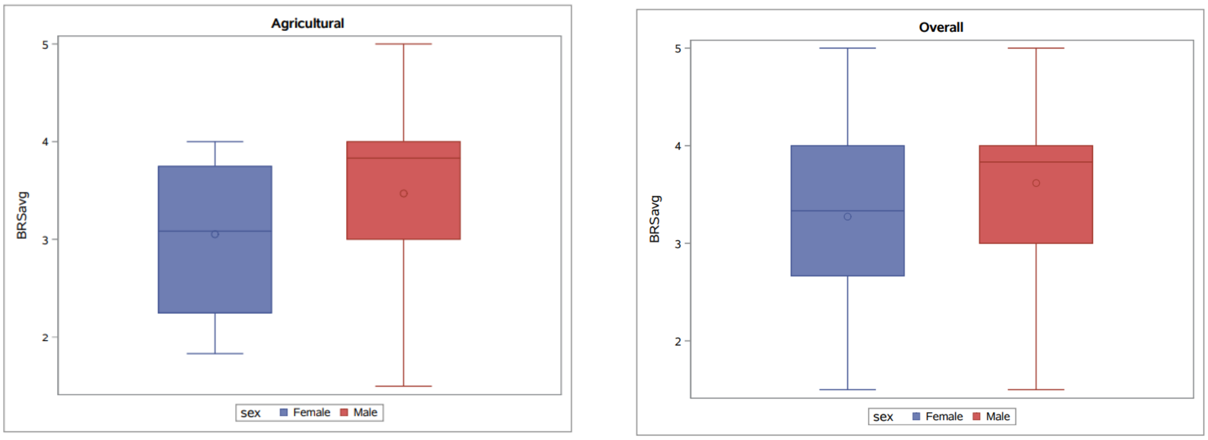


Figure 2

Distributions of BRS Score in Agricultural Group by Sex, and Overall Sample by Sex



4.2.2 Exposure

Exposure scores were calculated for 146 subjects. One hundred twenty-two (83.6%) reported, in their opinion, being directly affected by the disaster and 24 (16.4%) indirectly. Eighty-two (56.6%) lost 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 member's. While the overall distribution of the exposure score was approximately normal with mean 3.94 and SD 1.53, the agricultural subgroup showed a more uniform distribution (median 3.00) (Figure 3). For this reason, hypothesis testing for equal medians was performed with the Wilcoxon test in PROC NPAR1WAY. Agriculture median was 3.00 compared to non-agriculture 4.00. There is evidence of a significant difference in median exposure score between the groups ($p = 0.015$) (Figure 4), and exposure score was included as a covariate in further analysis. Exposure score had a significant negative Pearson correlation with BRS score (-0.29, $p<.001$).

Figure 3

Distributions of Exposure Score on Histogram by Occupational Group

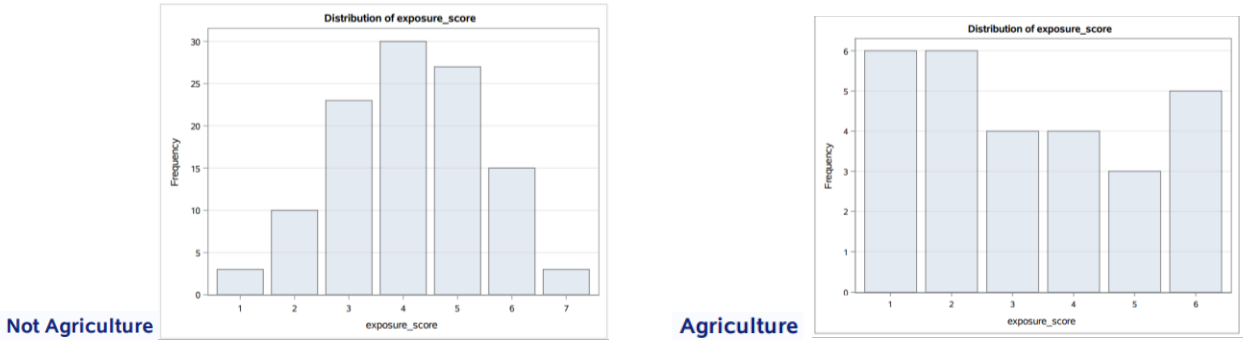
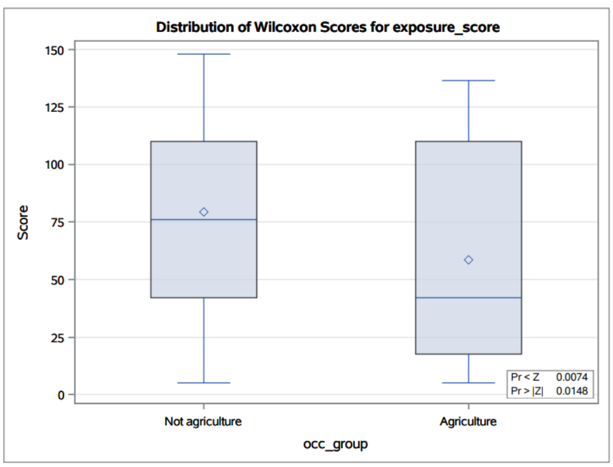


Figure 4

Significant Wilcoxon Test Showing Inequality of Median Exposure Score by Occupational Group

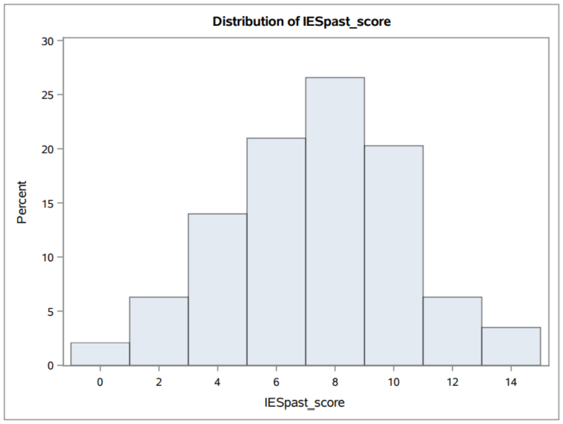


4.2.3 IES Past

IES past score (first 7 days after event) was approximately normally distributed with overall mean 6.89, SD 3.01, minimum 0.00 and maximum 14.00 (N = 143) (Figure 5). 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 one did not recall more than half.

Figure 5

Sample Distribution of IES Past Score



Multiple linear regression modeling with manual backward selection in PROC GLM resulted in a significant association of IES past score with sex (p < 0.001), exposure score (p < 0.001), and BRS score (p = .021). With these covariates, Occupational group was not significant (p = 0.584) (Table 1). Age group, race or ethnicity, event type, dependents in home, and residence in or out of town also were not significant in the model, which explained only 37% of the variation in IES past score (R-square = 0.366). Interactions were also tested in PROC GLMSELECT but were rejected for insignificance. Assumptions of linearity, independence, normality, and equal variance were satisfied for the linear regression model. A Poisson regression model was fit with IES past score as a count outcome; however, this model performed poorly on AIC comparison and still did not include agricultural group as a significant effect.

Table 1

Occupational Group (Agriculture or Not Agriculture) Is Not Significantly Associated with IES Past Score in a Multiple Linear Regression Model

Source	DF	Type III SS	Mean Square	F Value	Pr > F
sex	1	81.1926226	81.1926226	13.80	0.0003
exposure_score	1	161.8511854	161.8511854	27.51	<.0001
BRSavg	1	30.5686305	30.5686305	5.20	0.0242
occ_group	1	1.7770382	1.7770382	0.30	0.5835

4.2.4 IES Now

IES now score (past 30 days prior to taking survey) had a right skewed distribution with median 3.00 and Interquartile Range (IQR) 5.00 (N = 133) (Figure 6). For the agricultural group, median was 3.00 (IQR 5.00, N = 26). For the non-agricultural group, median was 4.00 (IQR 5.00, N = 101) (Figure 7). Wilcoxon testing was insignificant for different median IES now score by occupational group (p = 0.73). Subjects marked a total of 1.0% of IES now symptoms as *Don't Recall*, and 0.5% were missing responses. One hundred thirty-one subjects (98.5%) were able to recall *Yes* or *No* for at least 13 of 15 symptoms, and only one did not recall more than half. One hundred twelve (84.2%) reported at least one disaster-associated symptom in the 30 days before taking the survey.

Figure 6

Sample Distribution of IES Now Score

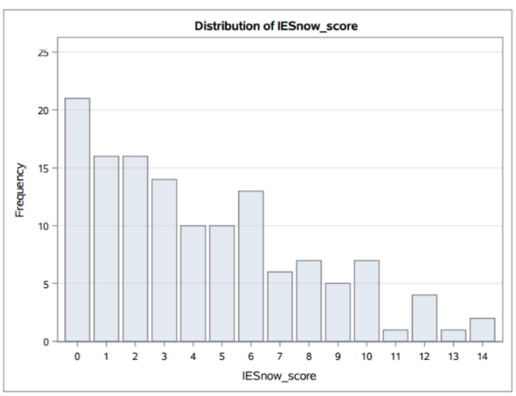
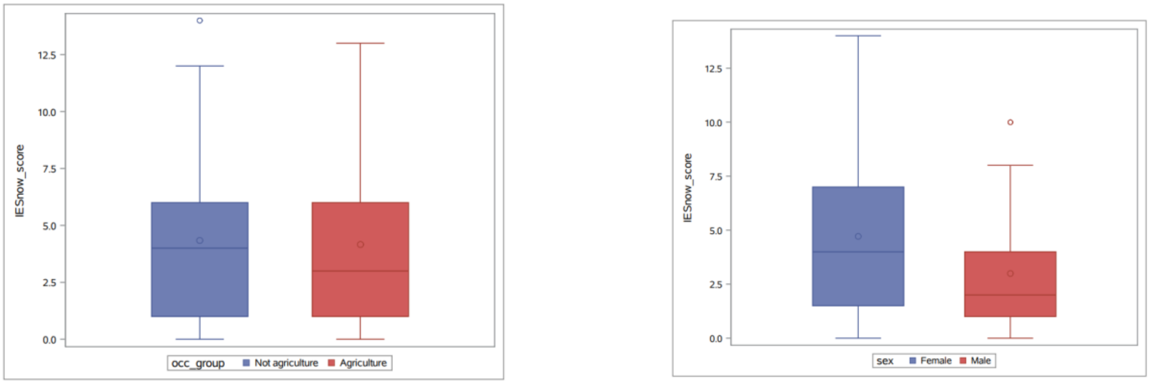


Figure 7

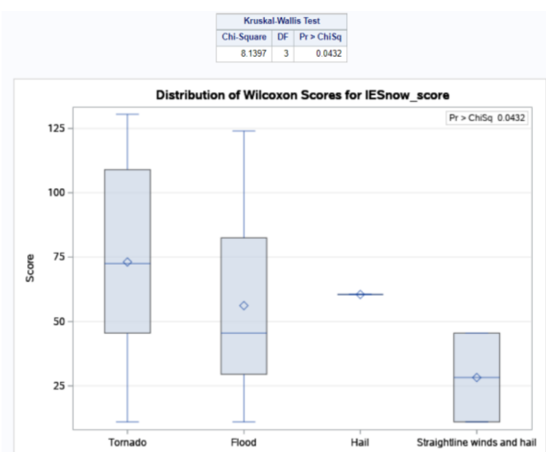
Distributions of IES Now Score by Occupational Group and by Sex



Wilcoxon testing showed median IES now score was significantly different (p = 0.016) by years since event where 3 years since event had lower median score (2.0, IQR 4.5) than 8 years since event (4.0, IQR 6.0). A Kruskal-Wallis non-parametric test was significant (p = 0.043) for different medians by event type, where tornado (4.0, IQR 6.0) was higher than flood (2.0, IQR 4.0) (Figure 8). Median IES now score also differed significantly (p = 0.017) by sex (Male 2.0, IQR 3.0; Female 4.0, IQR 5.5).

Figure 8

Kruskal-Wallis Test Shows Evidence of Significant Difference in Median by Event Type

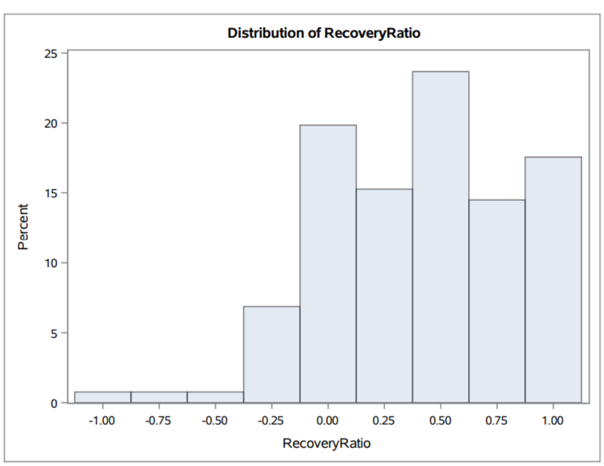


4.2.5 Recovery Ratio

Because of RR's left-skewed, non-normal shape of the distribution (median 0.40, IQR 0.75, N = 131) (Figure 9), a non-parametric Wilcoxon test for equal RR median between agricultural (0.29, IQR 0.67) and non-agricultural (0.40, IQR 0.71) subgroups was performed and found not significant ($p = 0.510$). Subjects were also classified into IES past score rank groups above and below median (PROC RANK with TIES = LOW, median = 7.0) to determine whether RR differed significantly between the groups with fewer initial symptoms and more initial symptoms. On Wilcoxon testing, there was not evidence of a different RR between the median rank groups ($p = 0.180$). Multiple linear regression with manual backward elimination found only BRS score to be significantly associated with RR ($p = 0.001$), but BRS was not a good predictor of RR ($R^2 = 0.073$). Covariates tested but excluded for insignificance were years since event, IES past score, age group, rural/urban, dependents in home, event type, occupational group, exposure score, race or ethnicity, and sex. Normality of residuals was adequately satisfied for the model.

Figure 9

Overall Sample Distribution of Recovery Ratio



Seventeen participants reported more symptoms in the month before the survey than in the week following the event, resulting in negative RRs (Table 2). 8 of these participants ranked in the lower half of IES past scores, and 9 were in the upper half.

Table 2

Participants Reporting Negative Recovery Ratio

Negative Recovery Ratio

Occupation	IES now	IES past	Recovery Ratio	Years since event	Event type
Not agriculture	12	9	-0.333	8	Tornado
Agriculture	5	4	-0.250	8	Tornado
Not agriculture	12	11	-0.091	8	Tornado
Not agriculture	14	13	-0.077	8	Tornado
Not agriculture	9	8	-0.125	8	Tornado
Not agriculture	14	12	-0.167	8	Tornado
Agriculture	7	5	-0.400	8	Tornado
Not agriculture	6	5	-0.200	8	Tornado
Not agriculture	12	11	-0.091	8	Tornado
Not agriculture	10	6	-0.667	8	Tornado
Not agriculture	12	10	-0.200	8	Tornado
Not agriculture	10	9	-0.111	8	Tornado
Not agriculture	4	3	-0.333	3	Flood
Agriculture	10	8	-0.250	3	Flood
.	7	6	-0.167	3	Flood
Not agriculture	4	3	-0.333	3	Flood
Agriculture	2	1	-1.000	3	Flood

4.2.6 PTGI-SF

One hundred twenty-six subjects completed the PTGI-SF with overall mean score 26.56, SD 11.59 of a possible 50 points, with approximately normal distribution (Figure 10). The agriculture group mean was 21.08, SD 11.06, with minimum 0 to maximum 36 for N = 24. The non-agriculture group mean was 27.67, SD 11.37, with minimum 2 to maximum 47 for N = 97 (Figure 11).

Figure 10

Overall Sample Distribution of PTGI-SF Score (N = 126)

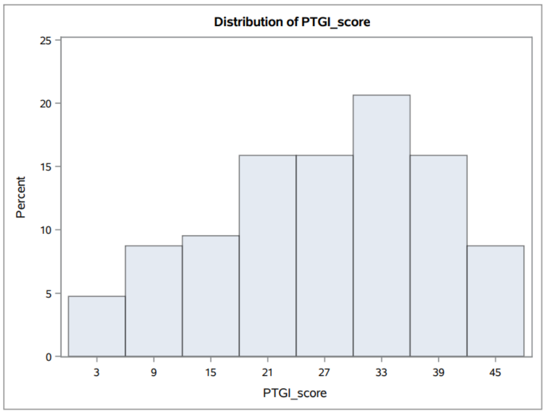
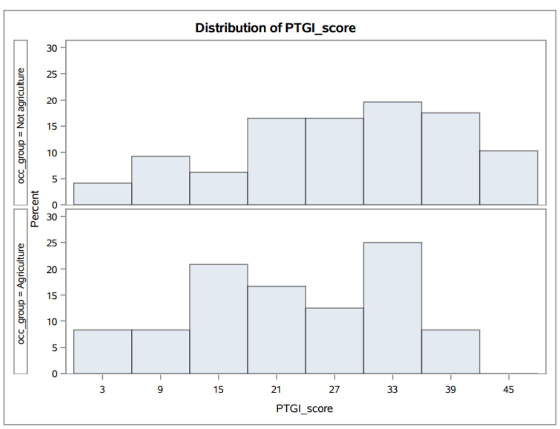


Figure 11

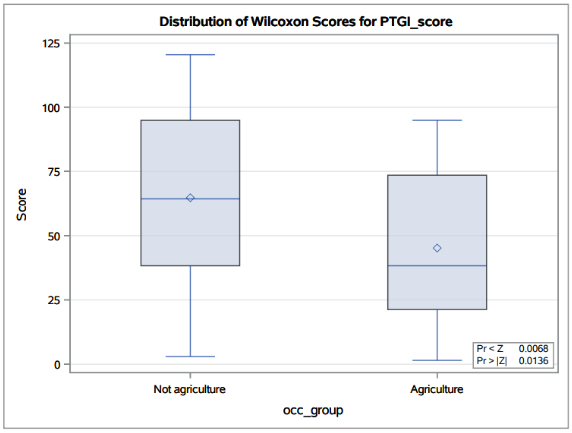
Distributions of Mean PTGI-SF Score by Agriculture Group (N = 24) and Not Agriculture Group (N = 97)



On independent samples t-test, there is evidence that means are significantly different for agriculture and not agriculture groups (p = 0.012). Non-parametric Wilcoxon testing to confirm, due to distribution by subgroups, had p = 0.014, further evidence for significant difference in central measure between the groups (Figure 12).

Figure 12

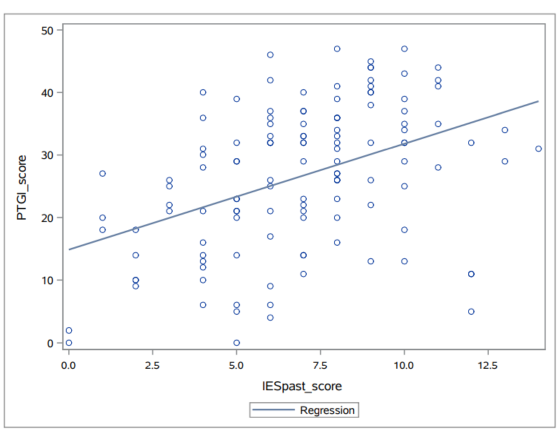
Significant Wilcoxon Test Showing Unequal Median PTGI-SF Score by Occupational Group



On t-test comparing male (mean 22.32, SD 10.95, N = 31) and female (mean 27.94, SD 11.51, N = 95), there was evidence of significant difference in PTGI score by sex ($p = 0.019$), also confirmed by Wilcoxon test ($p=0.009$). PTGI was significantly positively correlated with exposure score ($\rho = 0.286$, $p = 0.001$), IES past score ($\rho = 0.423$, $p < 0.001$) (Figure 13), and IES now score ($\rho = 0.275$, $p = 0.002$).

Figure 13

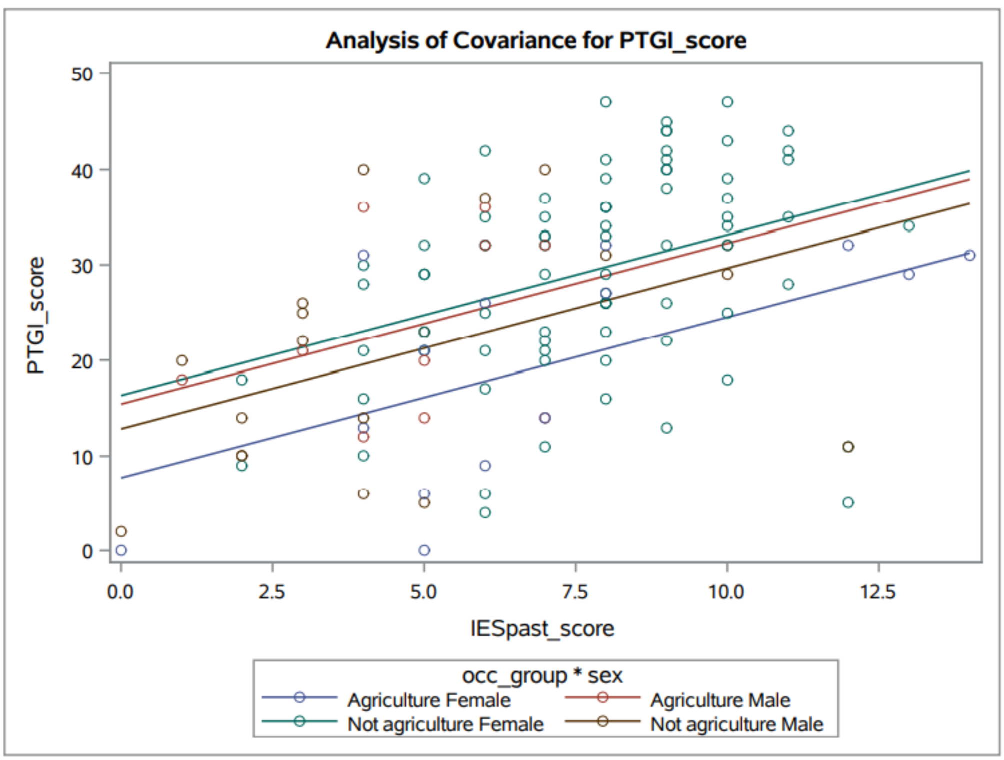
Scatter Plot with Regression Line Showing Positive Correlation Between IES Past Score and PTGI-SF Score



Multiple linear regression model building in PROC GLM by manual backward selection found association between PTGI score and IES past score (p<.001) and occupational group by sex interaction (p=.024) (Figure 14); main effects were included in the model for occupational group and sex. Linearity, independence, normality, and equal variances were adequately satisfied on diagnostic plots. Occupation group interactions with RR, years since event, IES now score, age group, event type, exposure score, IES past score, and BRS score were removed from the model for insignificance. Years since event, age group, IES now score, RR, exposure score, event type, and BRS score main effects were also removed from the model for insignificance.

Figure 14

Greater Difference in PTGI-SF Scores by Sex in Agriculture Group Than Not Agriculture Group



When the analysis was re-run for only females by occupational group, the agricultural group (N = 14) scored significantly lower on PTGI-SF compared to non-agricultural (N = 78) when controlled for IES past score on ANCOVA ($p = 0.004$). Wilcoxon test also showed a significant difference ($p = 0.005$).

4.2.7 First Choices

Subjects were asked, “If you experienced another natural disaster in the future, what people, groups, or activities would you turn to first in order to decrease your stress? List up to 3.” Answers to this open field question were informally analyzed with a lightly structured approach distinguishing between community and external resources, understanding that participants could take cues from the resource use and effect inventory and subsequent questions. Seventy-one participants (16 agriculture, 55 not agriculture) provided a cumulative total of 152 qualitative responses. Top categories were Family (32), Friends (21), God and church(19), Outside relief groups(15), Neighbors (12), and Community (12).

Although the hypothesis did not specify anything about differences between agricultural and non-agricultural population preferences, differences were noted. Sixteen of the 71 open field respondents selected Farm as primary occupation, approximately proportional to the overall survey sample proportion. Neighbors (7) ranked first among agricultural participants, followed by Family (5), Church (4), and Friends (4). For non-agricultural, Family (27), Friends (17), God and church (14), and Outside relief groups (12) were most frequent. Non-agricultural subjects mentioned employer/workplace/co-workers 6 times, referring to the people at work, not the activity of working. Agricultural respondents made no mentions of people or activities related to occupation.

Besides categories of assistance for decreasing stress, other themes were noted. Although the RUE inventory included people, groups, and activities, as did the wording of the open field question, subjects mentioned primarily people and groups, with only 2 references to activities of planning ahead, 1 to volunteering, and 1 to caring for others. Throughout all responses, the word "my" was used 13 times, suggesting a personal connection to the people. There were only 2 references to healthcare professionals, but they were phrased as "my doctor" and "my therapist," indicating a pre-existing relationship. Some individuals included descriptive words of the type of people they would turn to, such as "organized," "disciplined," "conservative," and "people who had experience with it."

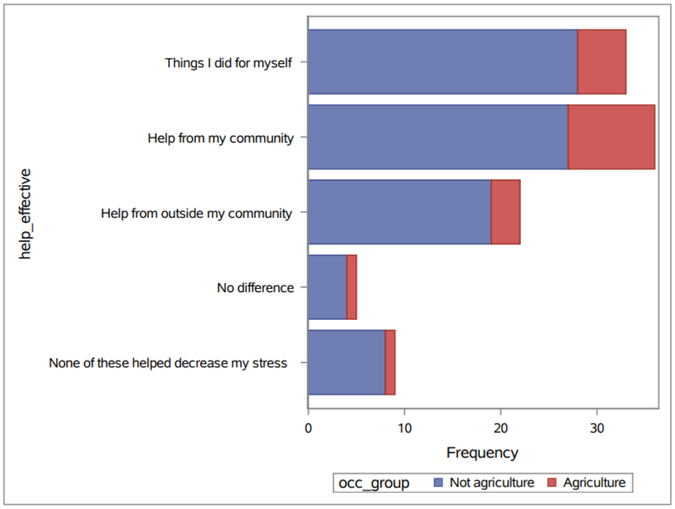
Meeting physical needs associated with disaster relief was intertwined with decreasing stress. Specific mentions were made of meals, food, and water provided by the Red Cross and Salvation Army, and the designation of outside relief groups and organized groups of local volunteers as first choices for decreasing stress could be understood as referring to the traditional response and relief actions those groups engage in rather than anything specifically intended to relieve mental or emotional stress.

4.2.8 Most Effective Help

One hundred nine participants answered the question, "What kind of help was most effective for reducing your stress?" with a single answer as allowed by the online version of the survey. They selected from 5 options: *Things I did for myself*, *Help from my community*, *Help from outside my community*, *No difference*, and *None of these helped decrease my stress*. Participants most frequently selected *Help from my community* (35.8%), followed by *Things I did for myself* (31.2%) and *Help from outside my community* (20.2%). Stratified by occupational group, agricultural residents selected *Help from my community* most often, and non-agricultural selected *Things I did for myself* and *Help from my community* almost evenly (Figure 15).

Figure 15

Perceived Most Effective Help for Decreasing Disaster Stress by Occupational Group



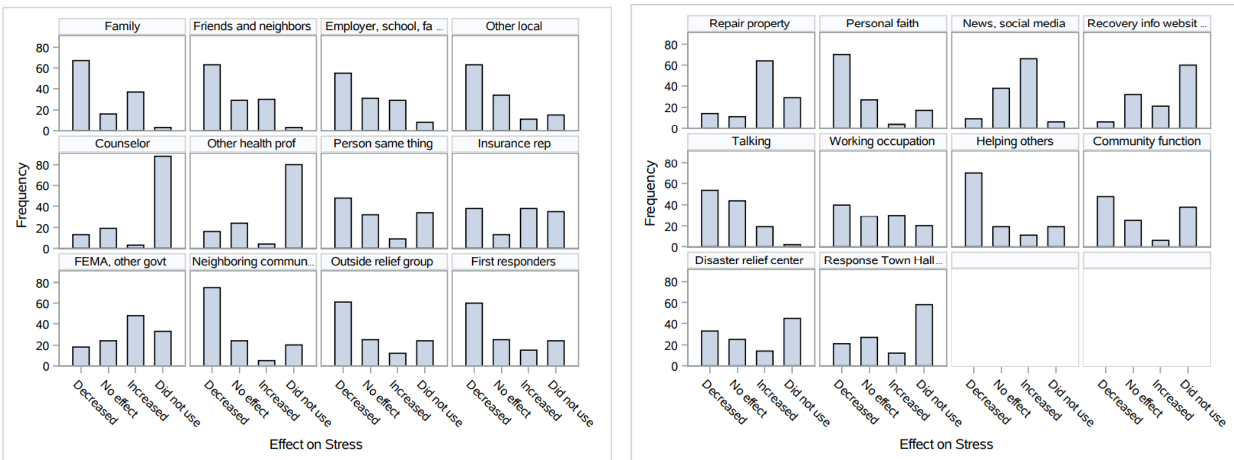
On the paper survey, 9 additional subjects selected multiple choices totaling 9 *Help from my community*, 8 *Help from outside my community*, and 4 *Things I did for myself*. One additional subject provided a handwritten response, "Being able to help others." These responses were not included in the analysis data set.

4.2.9 RUE Inventory

On the Resource Use and Effect inventory, the top 5 people, groups, and activities reported as resources by use percentage were *Talking about the event* (98.3%), *Friends and neighbors* (97.6%), *Family* (97.6%), *Following news or social media about the event* (95.0%), and *Employer, school, or faith community (leader or group)* (93.5%). The lowest 5 were *Visiting local disaster relief center* (61.5%), *Attending emergency response town hall meeting* (50.9%), *Finding stress or recovery information on websites* (49.6%), *Other health professional* (35.5%), and *Counselor or therapist* (28.5%). Figure 16 provides a visual representation of the relative use and effect of all 22 people, groups, and activities listed on the RUE.

Figure 16

Relative Frequency of Use and Stress Effect for 22 Resources After Natural Disaster



Note. Panel 1 is people and group resources. Panel 2 is activity resources.

From the aggregate effect sum, the top 5 relative stress decreasing resources were *Group from neighboring community* (-70), *Personal faith activities such as prayer, meditation, or readings* (-66), *Helping others in my community* (-59), *Other local leader or group (business, city council, civic club, clean-up volunteers, etc.)* (-52), and *Outside relief group* (Red Cross, Farm Rescue, etc.) (-49). The Impact per use (IPU) score representing the aggregate effect sum divided by the number of users, and Community Impact (CI) score representing aggregate effect sum divided by total respondents, produced similar results but also brought *Community function (fundraiser, commemoration, school activity, etc.)* into the top 5 through the IPU (Table 3). This was a resource utilized less frequently but with high proportion of decreasing stress to increasing stress (Figure 16).

The bottom five resources with aggregate stress neutrality or increase were the same for all 3 effect scores with only the last 2 reversed in IPU rankings: *Insurance representative(s)* (Sum 0, IPU 0.000, CI 0.000), *Finding stress or recovery information on websites* (15, 0.254, 0.126), *FEMA, Farm Service Agency, or other government group* (30, 0.333, 0.244), *Repairing, replacing, or rebuilding my own property* (50, 0.562, 0.424), and *Following news or social media about the event* (57, 0.504, 0.479). Complete use and effect scores and ranks are available in Appendix B.

Table 3

Top 5 People, Group, and Activity Resources for Perceived Disaster Stress Reduction by 3 Effect Scores

Rank	Aggregate Effect Sum	IPU	CI
1	Group from neighboring community (-70)	Group from neighboring community (-0.673)	Group from neighboring community (-0.565)
2	Personal faith activities such as prayer, meditation, or readings (-66)	Personal faith activities such as prayer, meditation, or readings (-0.653)	Personal faith activities such as prayer, meditation, or readings (-0.559)
3	Helping others in my community (-59)	Helping others in my community (-0.590)	Helping others in my community (-0.496)
4	Other local leader or group (business, city council, civic club, clean-up volunteers, etc.) (-52)	Community function (fundraiser, commemoration, school activity, etc.) (-0.532)	Other local leader or group (business, city council, civic club, clean-up volunteers, etc.) (-0.423)
5	Outside relief group (Red Cross, Farm Rescue, etc.) (-49)	Outside relief group (Red Cross, Farm Rescue, etc.) (-0.500)	Outside relief group (Red Cross, Farm Rescue, etc.) (-0.402)

5. Discussion

5.1 Key Results

5.1.1 Hypothesis 1

The first hypothesis was agricultural producers have different stress and recovery experiences compared to their rural, non-agricultural counterparts. Stress and recovery following a disaster can be pictured as a cycle of baseline resilience, immediate stress symptoms, a variable length period of symptom decline and persistence, recovery to baseline, and potentially personal growth above baseline levels. These may not occur linearly but are all considerations in comparing stress and recovery experience between occupational groups. Agricultural producers have a reputation for strength and resilience, so they would be expected to score higher in resilience and recovery, but lower in post-traumatic stress, compared to non-agricultural residents.

The BRS measured resilience and found no significant difference between agriculture and non-agriculture groups when controlled for sex. Women overall had a significantly lower BRS than men. The IES past score counted intrusion and avoidance posttraumatic stress symptoms for the week following the event and found no significant difference between agriculture and non-agriculture groups when controlled for sex, exposure score, and BRS. The IES now score was incorporated into Recovery Ratio, which evaluated the proportional reduction in symptom count over time and also found no significant difference between the two occupational groups.

The PTGI-SF qualitatively measured positive post-event growth and found a significant difference between the agriculture and non-agriculture groups on t-test and Wilcoxon test, as well as with a sex by occupational group interaction in the multiple linear regression model when controlled for IES past score. Overall, contrary to the hypothesis, there is not strong evidence that agricultural producers have different stress and recovery experiences compared to rural, non-agricultural residents, and it should not be assumed that the agricultural population has a unique resilience or immunity to post-disaster stress effects.

In fact, the results suggest that women in agriculture may have lower mean scores and overall distributions on BRS, Recovery Ratio, and PTGI-SF although the skewed nature of some of the subgroup data along with a small sample size makes this difficult to interpret. The implication is that women in agriculture may have greater risk of lower resilience, long-lasting stress symptoms, and relatively lower posttraumatic growth, the exact opposite of the expectation. Although this could be the result of a baseline difference in how qualitative scales are perceived, even that could raise a question of why women in agriculture may feel less confident about their ability to recover, or less positive about personal growth out of difficulties. The stress and recovery experiences in this subpopulation merit further study as well as particular attention in disaster preparedness and recovery planning.

5.1.2 Hypothesis 2

The second hypothesis was rural residents prefer community resources over external resources for disaster stress relief. Based on this analysis by number of mentions in the first choices open field, rural residents do prefer community resources over external resources for decreasing disaster-related stress. Family, Friends, and God and church were the top 3 choices and accounted for 72/152 mentions. Outside relief groups were mentioned fourth-most at 15, followed by Community and Neighbors totaling 24 more. A list of resources mentioned by survey participants is provided in Appendix C to encourage disaster stress and recovery education and preparedness in or through these people and groups. Broadly viewed, family, friends, God and church, neighbors, community, and local volunteers or organized local groups are locally accessible to rural residents. The workplace, local businesses, utility providers, and first responders are already present in the community as avenues through which stress-relieving approaches can be developed. All these were mentioned. It was assumed that subjects would list their preferences as their first choices and that their preferences were not strictly hypothetical but were informed by their real disaster experiences.

Help from outside the community was also appreciated for effectively reducing stress, and *Outside groups* was ranked 5 of 22 in all 3 effect scores on the RUE inventory. While rural residents may often prefer community resources – based on their most frequent first choices for stress reduction – they do not necessarily dislike outside groups and recognize the great supportive role that these groups – both disaster relief organizations and more informal groups like high school teams or church groups – played in helping their community recover. Open field responses highlighted this contribution. One subject wrote, "The out of state group came and worked when we were physically and mentally exhausted. We will be forever grateful for everyone that helped us."

5.1.3 Hypothesis 3

The third hypothesis was communities can provide effective emotional health supports after disaster. Based on the RUE inventory, it is clear that communities can provide support that is perceived to decrease stress through many people, groups, and activities. In this context "effective" only referred to a respondent's perception of what was helpful and was not tied to recovery measures.

The number of people who selected multiple responses for most effective help (paper surveys) indicates that multiple types of help are effective, and this opens great opportunity for improving disaster mental health support in affected rural communities. While participants did select many resources as effective for decreasing stress, a majority had also experienced multiple disaster-associated symptoms in the month before the survey. In fact, the number of subjects with a negative RR was surprising since the expectation is for symptoms to diminish over time, and these subjects were 3- or 8-years post-event at the time of the survey. Half of them had scored over the median IES past score and half below, so original number of symptoms was apparently unrelated to the negative RR. Overall, median rank group was not significantly associated with RR, leading to the conclusion that proportional reduction in symptom count was unrelated to the initial number of symptoms. The RUE inventory provides evidence that many interactions and activities following a disaster, such as required by insurance claims or repairing property, may increase or compound the stress that began with the event itself, so the physical recovery becomes an ongoing source of stress.

A surprising result from the RUE was that 28.5% of participants had seen a counselor or therapist, but the IPU ranked only tenth, just below *Person who had been through the same or similar thing* and *Talking about the event*, and just above *Other health professional.* This suggests that mental health services were accessible but not widely perceived as effective for decreasing stress.

5.2 Implications for Disaster Preparedness, Response, and Recovery

In rural and agricultural settings, communities should elevate baseline knowledge about disaster stress symptoms and management before an event strikes. Schools should educate students and families about stress they may experience from a disaster event or the subsequent community disruption and clean-up. Faith groups should discuss foundational beliefs and practices for coping with traumatic events, including disaster. Community organizations and local businesses should be recruited to disseminate posttraumatic stress information as a part of preparedness plans. Agricultural residents should be specifically included in plans accessible by both men and women.

Most resources in this study were marked as both increasing stress and decreasing stress, especially the most frequently experienced items such as *Talking about the event*, *Friends and neighbors*, and *Family*. Intentional strategies should be employed to move the balance toward decreasing stress more frequently, or at least moving the increased stress to no effect. For example, how can physical recovery processes such as insurance claims, FEMA assistance, and rebuilding minimize stress? Media training and social media strategies can be initiated that are sensitive to disaster survivors while communicating clear and positive messages that help them move forward instead of focusing on their distress. The IPU score can also be useful for identifying resources that can be expanded or leveraged as they are most frequently associated with stress reduction.

Both the scale and open field answers show that rural residents continue to experience posttraumatic type symptoms up to 8 years beyond acute natural disaster events. The broad persistence of symptoms also suggests that community level plans to support emotional health would be beneficial over a longer period of time – even years.

Finally, recognizing that counselors, therapists, and other health professionals were not consistently reported to help decrease stress, they may benefit from additional training related to and informed by disaster-affected rural populations. Mental health services remain an important resource, but consistent effectiveness was not demonstrated in this survey.

5.3 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. By using a combination of existing scales, a novel inventory, and open field qualitative questions, 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 garner responses. In addition to uncertainty 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 local knowledge of who may have been affected. In the analysis data set, females were over-represented, particularly in the non-agricultural group. Sex was controlled for in statistical modeling but was not evaluated as a factor in the RUE inventory or open field responses. It is also possible that 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 (National Center for PTSD, 2022). Response differences between online and paper survey formats have been detailed in sections 3.5 and 4.2.8. Finally, the study included severe acute natural disasters – primarily tornado and flood – in the South Central and Midwestern U.S. Results may not be generalizable to disasters of other types or intensities, or to diverse geographic communities with unique culture and resources. However, broad categories of resources identified in this study should have parallels in most communities, and agricultural populations should be specifically included in preparedness or mitigation plans for managing post-disaster stress.

The RNDSR survey has inherent limitations. Exposure questions, BSR scale, PTGI-SF, and RUE inventory all have qualitative components that introduce variability into the data.

Whether it is a participant's own definition of "directly affected," "financial hardship," or "increased stress," or a personality that precludes selecting "strongly agree" or "strongly disagree," quantitative analysis of qualitative data requires caution. The goal is to look for trends and patterns more than to assign interpretations to 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. This was addressed by adding the option to select *Don't Recall*; however, only 4.3% responses were marked as *Don't Recall* and only 0.8% missing. There is evidence of strong and long-lasting recall around disaster events (Bauer et al., 2017) to support delayed inquiry. The Revised IES is also limited to questions about intrusion (reexperiencing) and avoidance posttraumatic stress symptoms without addressing posttraumatic hyperarousal symptoms or any other mental health indicators such as depression, anxiety, or substance abuse. Frequency, intensity, and life disruption of symptoms was not accounted for, only presence or absence. The findings in this study that a majority of participants reported at least one disaster-associated symptom in the month before the survey does not preclude the possibility of additional or more severe emotional or mental health challenges.

5.4 Ethics in Disaster Mental Health Research

Goldmann and Galea (2014) addressed challenges in disaster mental health research but focused on methodological and logistical concerns along with researcher safety issues. SAMHSA (2016) specifically addressed ethical issues including effects on participants but concluded the risk was minimal. The present study was deemed low-risk and determined to be exempt from Institutional Review Board oversight. Even this low-risk survey disclosed the potential risk of survey questions causing distress, and in fact one subject reported, "Filling this out was stressful, as you can tell. Bad memories.” Doing research among vulnerable disaster-affected populations, especially immediately following the disaster, is ethically problematic, can distract from the essential operations of response, and is likely to miss individuals experiencing avoidant posttraumatic symptoms. Practice-based research that is providing care would be more ethically responsible in disaster settings. Delayed study, as reported here, reduces ethical risks and has the benefit of evaluating long-term outcomes.

6. Conclusion

Future study of the present data set for associations between subgroups, types of assistance deemed most effective for decreasing stress, and individual stress and recovery measures could provide further guidance to communities looking to enhance their disaster preparedness or recovery. The role of perception versus more objective measures is an interesting topic for future development, including the role perception plays in how problematic a symptom is or how likely an individual is to recognize a symptom. Additional efforts should be made to study effects in agricultural populations where a larger sample size can participate. The RNDSR survey is easily adaptable to additional disaster settings for future research projects.

While the comparison between agricultural and rural, non-agricultural groups did not yield statistically significant differences overall, the RNDSR study revealed information that is practically significant. Participants commonly experienced posttraumatic symptoms in the days and years following an acute natural disaster event but recognized that people, groups, and activities available in rural settings helped to decrease their stress. Communities have many opportunities to leverage and build on existing resources to strengthen their natural disaster emotional health preparedness, response, and recovery.

7. Human Subjects

The 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.

8. Data management

Study data were collected and managed using the REDCap electronic data capture tools hosted at the University of Nebraska Medical Center. Service and support is provided by the Research Information Technology Office (RITO), which is funded by the Vice Chancellor for Research.

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Appendix A

SAS Code

```
*********************************ACCESSDATA1.SAS***********************;
*Break the large data set into smaller data sets by each scale;
*while manipulating, reformatting variables, adding variables like scale scores;
*then merge them back together by participant_id as required for analysis;
*sets to include demographics, BRS, Exposure, IESpast, IESnow, PTGI, ResourceUse, and Qual;

********************************DATA SET WORK***********************;
/* Access data set*/
libname stress '/home/u45095762/DisasterStressRecovery';
OPTION validvarname=v7;
*force SAS variable naming from Excel variable names;
%LET choosefile=/home/u45095762/DisasterStressRecovery/RuralNaturalDisaster_DATA_2022-03-13_2058.csv;
*this is the real data set 2022-03-13;
*/home/u45095762/DisasterStressRecovery/RuralNaturalDisaster_DATA_2021-11-30_1515.csv;
*test data;
%LET newfile=disaster;

PROC IMPORT DATAFILE="&choosefile" DBMS=CSV OUT=stress.&newfile REPLACE;
    GETNAMES=yes;
    GUESSINGROWS=max;
run;

/*copy the permanent table for manipulation and analysis*/
data dis_whole;
    set stress.disaster;
run;

/*view variable list*/
proc contents data=dis_whole varnum;
run;

/* identify null obs by filtering for missing agegroup and sex - */
/* opened the survey but didn't begin - for exclusion from data set - */
/*  visually confirm observations are empty in work.dis_empty */
data dis_empty;
    set dis_whole;
    where age_group=. and sex=.;
run;

/*remove the empty observations from the original data set*/
data dis_not_empty;
    merge dis_whole (in=whole) dis_empty(in=empty);
    by participant_id;

    if whole=1 and empty=0;
run;

/*divide not_empty data set into subsets for prep and scoring*/
*sets to include demographics, BRS, Exposure, IESpast, IESnow, PTGI, Resource, and Qualitative;

data dis_demographics (keep=participant_id redcap_survey_identifier
        disaster_stress_and_recovery_tim age_group sex race event___1-event___6
        event_addl event_select rural_urban occupation dependents
        disaster_stress_and_recovery_com);
    set dis_not_empty;
run;

data dis_BRS (keep=participant_id q9a q9b q9c q9d q9e q9f);
    set dis_not_empty;

data dis_exposure (keep=participant_id direct property_loss displaced
        fin_hardship injured fear_life);
    set dis_not_empty;

data dis_IESpast (keep=participant_id q18a q18b q18c q18d q18e q18f q18g q18h
        q18i q18j q18k q18l q18m q18n q18o);
    set dis_not_empty;

data dis_IESnow (keep=participant_id q19a q19b q19c q19d q19e q19f q19g q19h
        q19i q19j q19k q19l q19m q19n q19o);
    set dis_not_empty;

```

```
data dis_PTGI (keep=participant_id q21a q21b q21c q21d q21e q21f q21g q21h q21i
        q21j);
    set dis_not_empty;

data dis_Resource (keep=participant_id q23a q23b q23c q23d q23e q23f q23g q23h
        q23i q23j q23k q23l q24a q24b q24c q24d q24e q24f q24g q24h q24i q24j
        help_effective);
    set dis_not_empty;

    /*include demographics for context in qualitative data set*/
data dis_qual (keep=participant_id age_group sex race rural_urban occupation
        event_addl resilience_open event_open open_stress open_recovery
        open_stress_effect first_choices open_decrease_stress);
    set dis_not_empty;
run;

/*view variable lists for the subsets - could put these subsets in stress library instead of work*/
proc contents data=_all_ varnum nodetails;
run;

*********************************ACTIONS****************************************;
/*Send qual data to excel sheet for anal*/
proc export data=dis_qual
    dbms=xlsx
    outfile="/home/u45095762/DisasterStressRecovery/disaster_qual.xlsx"
    replace;
run;
/*check sample of qual data*/
proc print data=dis_qual (obs=5);
    title 'Open Field Responses';
run;

title;

/*check completeness - verify these did not complete any scales*/
proc print data=dis_not_empty;
    where participant_id=5 or participant_id=20 or participant_id=31 or
        participant_id=50 or participant_id=52 or participant_id=55 or
        participant_id=64 or participant_id=65 or participant_id=68 or
        participant_id=74 or participant_id=80 or participant_id=103 or
        participant_id=107 or participant_id=111 or participant_id=113 or
        participant_id=117 or participant_id=119 or participant_id=126 or
        participant_id=130 or participant_id=136 or participant_id=142 or
        participant_id=146 or participant_id=151 or participant_id=152;
    title 'Did not complete any scales?';
run;

title;

/* check rural_urban=3 4 */
/* evaluate these subjects for inclusion if qual info indicates sufficient */
/* tie to rural, add exclude flag to dis.demographics for subjects not meeting this criteria */
proc print data=dis_qual;
    where rural_urban=3 or rural_urban=4;
    title 'Check urban responses for inclusion';
run;

title;

/* issues on paper surveys */
/* import excel data set noting the paper surveys with multiple selections */
/*  on single-select questions or other issues */
options validvarname=v7;

proc import
        datafile='/home/u45095762/DisasterStressRecovery/Paper Survey Issues.xlsx'
        dbms=xlsx out=dis_paperissues replace;
    getnames=yes;
run;

proc sort data=dis_paperissues;
    by participant_id;
run;
```

```
/*This data set - dis_paperissues- is ready to be merged back with a main data set as needed*/
/*number who marked multiple on help_effective*/
proc freq data=dis_paperissues;
    table help_effective_multi;
run;

proc print data=dis_qual;
where participant_id=63;
run;



************************************************DEMOGRAPHICS2.SAS*****************************;
*****************DATA SET WORK - DEMOGRAPHICS****************;

/*build formats*/
proc format;
    value agegroupfmt 1='19-20' 2='21-25' 3='26-35' 4='36-45' 5='46-55' 6='56-65'
        7='Over 65' 8='Prefer not to answer';
    value sexfmt 0='Male' 1='Female' 8='Prefer not to answer';
    value racefmt 1='Asian or Pacific Islander' 2='Black or African American'
        3='Hispanic or Latino' 4='Native American or Alaskan Native'
        5='White or Caucasian' 6='Multiracial or Biracial' 7='Not listed'
        8='Prefer not to answer';
    value racegrpfmt 1='White or Caucasian' 2='Other';
    value ruralfmt 1='Not in town or city' 2='Town < 10,000'
        3='City 10,000-49,999' 4='City 50,000 or more';
    value rural_groupfmt 0='Not Rural' 1='Rural';
    value occfmt 1='Farm' 2='Ranch' 3='Fishery' 4='Not in agriculture';
    value occ_groupfmt 0='Not agriculture' 1='Agriculture';
    value depfmt 0='No dependents' 1='Dependents';
run;

data dis_demographics_clean;
    set dis_demographics;
    format age_group agegroupfmt. sex sexfmt. race racefmt. rural_urban
        ruralfmt. rural_group rural_groupfmt. occupation occfmt. dependents
        depfmt. occ_group occ_groupfmt. racegrp racegrpfmt.;
    label event___1='2014 tornado AR' event___2='2014 tornado NE'
        event___3='2019 flood AR' event___4='2019 flood NE' event___5='other event'
        event___6='no event';

    /*Create occ_group to combine all ag*/
    if 1 LE occupation LE 3 then
        occ_group=1;
    *ag=1;
    else if occupation=4 then
        occ_group=0;
    *non-ag=0;
    else if occupation=. then
        occ_group=.;

    /*Create rural_group to combine rural or urban*/
    if rural_urban=1 or rural_urban=2 then
        rural_group=1;
    *rural=1;
    else if rural_urban=3 or rural_urban=4 then
        rural_group=0;
    *not rural = 0;

    /*Bin other race*/
    if race=5 then
        racegrp=1;
    else if race=1 or race=2 or race=3 or race=4 or race=6 or race=7 then
        racegrp=2;

    /*identify subjects with multiple disaster events*/
    multiple_events=sum(of event___1-event___5);
run;

/*view variables*/
proc contents data=dis_demographics_clean varnum;
```

```
run;

/*separate out event_year, event_type, event_state*/
/*add variable for years since event*/
data dis_demographics_clean;
    set dis_demographics_clean;
    length event_type $30;

    if multiple_events >1 then
        multiflag=1;
    *flagging multiple events;
    *format event_year dateyear4.;

    if multiflag NE 1 then
        do;

            if event___1=1 then
                do;
                    event_year=2014;
                    event_type="Tornado";
                    event_state="AR";
                end;

            if event___2=1 then
                do;
                    event_year=2014;
                    event_type="Tornado";
                    event_state="NE";
                end;

            if event___3=1 then
                do;
                    event_year=2019;
                    event_type="Flood";
                    event_state="AR";
                end;

            if event___4=1 then
                do;
                    event_year=2019;
                    event_type="Flood";
                    event_state="NE";
                end;
        end;
    else if multiflag=1 then
        do;

            if event_select=1 then
                do;
                    event_year=2014;
                    event_type="Tornado";
                    event_state="AR";
                end;

            if event_select=2 then
                do;
                    event_year=2014;
                    event_type="Tornado";
                    event_state="NE";
                end;

            if event_select=3 then
                do;
                    event_year=2019;
                    event_type="Flood";
                    event_state="AR";
                end;

            if event_select=4 then
                do;
                    event_year=2019;
                    event_type="Flood";
                    event_state="NE";
```

```
                end;
        end;
    years_since_event=2022-event_year;
    *add variable;

    if event_year=2014 and (age_group=1 or age_group=2) then
        minor_flag=1;
    else if event_year=2019 and age_group=1 then
        minor_flag=1;
run;

/*identify subjects who selected another event as primary event*/
proc print data=dis_demographics_clean;
    where event___5=1 and (event_select=5 or event_select=.);
    var participant_id event___5 event_addl event_select;
    title 'Additional events reported that were selected';
run;

title;

/*based on results of proc print, manually assign year, type, state
for subjects who selected another event as primary event*/
data dis_demographics_clean;
    set dis_demographics_clean;

    if participant_id=39 or participant_id=40 or participant_id=109 or
        participant_id=121 or participant_id=130 then
            do;
            event_year=2011;
            event_type="Tornado";
            event_state="AR";
        end;
    else if participant_id=18 then
        do;
            event_year=2015;
            event_type="Tornado";
            event_state="IL";
        end;
    else if participant_id=79 then
        do;
            event_year=2014;
            event_type="Hail";
        end;
    else if participant_id=85 or participant_id=89 then
        do;
            event_year=2014;
            event_type="Straightline winds and hail";
        end;
    else if participant_id=87 then
        do;
            event_year=2019;
            event_type="Flood";
            event_state="NE";
        end;
    else if participant_id=119 then
        do;
            event_type='Tornado';
            event_state='AR';
        end;
    else if participant_id=149 then
        do;
            event_year=2012;
            event_type='Fire';
            event_state='CA';
        end;
    else if participant_id=152 then
        do;
            event_year=2019;
            event_type='Tornado';
            event_state='AR';
        end;
    else if participant_id=153 then
        do;

```

```
            event_year=2020;
            event_type='Tornado';
            event_state='AR';
        end;
    else if participant_id=154 then
        do;
            event_year=2013;
            event_type='Tornado';
        end;
    else if participant_id=200 then
        do;
            event_year=2019;
            event_type='COVID';
            event_state='NE';
        end;
    else if participant_id=211 then
        do;
            event_year=2012;
            event_type='Drought';
        end;
run;

data dis_demographics_clean;
    *add variable with whole event name;
    set dis_demographics_clean;
    event_all=catx(' ', event_type, event_state, event_year);
run;

/*add exclude_flag for excluded event types after manual inspection*/****************************;
data dis_demographics_clean;
    set dis_demographics_clean;

    if participant_id=200 then
        exclude_flag=1; *excluded for COVID, disease outbreak;
    else if participant_id=211 then
        exclude_flag=1; *excluded for drought, chronic disaster;
    *if sex=0 then exclude_flag=1; *run all analyses for women only;
run;

/*add exclude_flag for subjects not meeting rural criteria*/
/*2nd round of analysis will remove exclude_flag for ids 77, 83, & 214 because farm - did not
change conclusions when included*/
data dis_demographics_clean;
    set dis_demographics_clean;

    if participant_id=49 or participant_id=58 or participant_id=119 or participant_id=124 or
        participant_id=149 or participant_id=154 or participant_id=168 or participant_id=77
        or participant_id=83 or participant_id=214
        then
            exclude_flag=1;
run;

proc print data=dis_demographics_clean;
    where exclude_flag=1;
run;

************************need to do demographics for obs with at least one scale, so BRSflag=1;
**************************and where not marked for exclusion, so exclude flag NE 1;
*************************************************************************************;

************************************BRS3.SAS*****************************************;
*********************************DATA SET WORK - BRS**********************************;

/*Score BRS - Brief Resilience Scale*/
proc contents data=dis_brs;
run;

data dis_brs_scored;
    set dis_brs;

    /*responses to a,c,e are the scores*/
    /*new score for reverse scoring b,d,f*/
    scoreq1=q9a;
```

```
    scoreq3=q9c;
    scoreq5=q9e;
    array reverse_qs (3) q9b q9d q9f;
    array reverse_scores (3) scoreq2 scoreq4 scoreq6;
    array all_qs (6) q9a q9b q9c q9d q9e q9f;
    CountMiss_BRS=0;

    do i=1 to 3;

        if reverse_qs(i)=1 then
            reverse_scores(i)=5;
        else if reverse_qs(i)=2 then
            reverse_scores(i)=4;
        else if reverse_qs(i)=3 then
            reverse_scores(i)=3;
        else if reverse_qs(i)=4 then
            reverse_scores(i)=2;
        else if reverse_qs(i)=5 then
            reverse_scores(i)=1;
        else
            reverse_scores(i)=.;
    end;

    do i=1 to 6;

        if all_qs(i)=. then
            CountMiss_BRS + 1;
    end;

/*      create flag for all BRS questions completed,  */
/*      set to 0 if incomplete, 1 if complete */
/*      (defined as 5 or 6 questions completed) */
    if 0 LE CountMiss_BRS LE 1 then
        BRS_flag=1;
    else
        BRS_flag=0;
    drop i;

    /*final score is mean of the 5 or 6 questions*/
    /*calculated only for subjects flagged for complete BRS*/
    format BRSavg 4.2;

    if BRS_flag=1 then
        BRSavg=mean(of scoreq1-scoreq6); *mean of nonmissing values;
run;

data dis_BRS_scoresonly;
    set dis_BRS_scored;
    drop q9a q9b q9c q9d q9e q9f scoreq1-scoreq6;
run;

/*define macro for inclusion: completed BRS scale, not excluded for urban or event*/
%let include= where BRS_flag = 1 and exclude_flag NE 1;

/*already sorted by participant_id*/
/*merge with demographics to build analysis set*/
data testing;
    merge dis_demographics_clean dis_BRS_scoresonly;
    by participant_id;
run;

****************ACTIONS******************************;
/*Explore data distributions*/
/*check exclusions - 10, 1 also had BRS_flag=0*/
proc freq data=testing;
    tables exclude_flag;
run;
proc print data=testing;
    where exclude_flag=1;
run;

/*confirm BRS_flag is assigned correctly*/
proc freq data=testing;
```

```
    where exclude_flag NE 1;
    table brs_flag CountMiss_BRS;
run;

/*who did not complete any scales?*/
proc print data=testing;
    where exclude_flag NE 1 and BRS_flag NE 1;
run;

/*explore distributions*/
proc freq data=testing;
    *descriptive - events;
    &include;
    *BRS complete and No exclude flag;
    tables event_state event_year event_type event_type*event_state event___6/
        nocum nocol norow plots=freqplot;
run;

proc sgplot data=testing;
&include;
histogram BRSavg;
run;

proc freq data=testing;
    &include;
    tables age_group sex occ_group*sex racegrp rural_urban occupation occ_group
        dependents/nocum nocol norow plots=freqplot;
    label racegrp='Race or ethnicity';
run;

proc freq data=testing;
    *proportions are signif different for occ_group*sex;
    &include;
    tables occ_group*sex/ nocum nocol norow nopercent chisq;
run;

/*BRS by occ_group*/
proc means data=testing maxdec=2;
    &include;
    class occ_group;
    var BRSavg;
    title 'Mean BRS by Occupation';
run;
title;
proc sgplot data=testing;
    &include and occ_group NE .;
    vbox BRSavg/group=occ_group;
run;
proc ttest data=testing plots=qq;
    &include;
    class occ_group;
    var BRSavg;
run;

/*BRS by sex*/
proc means data=testing maxdec=2;
    &include;
    class sex;
    var BRSavg;
run;
proc sgplot data=testing;
    &include and sex NE 8;
    vbox BRSavg/group=sex;
    title 'Overall';
run;
title;
proc ttest data=testing plots=qq; ***********************************;
    &include;
    class sex;
    var BRSavg;
run;

/*BRS by age_group*/
```

```
proc sgplot data=testing;
    &include;
    vbox BRSavg/group=age_group;
run;
proc anova data=testing plots=all;
    *look at this more;
    &include;
    class age_group;
    model BRSavg=age_group;
    means age_group/tukey;
    run;

/*BRS by racegrp*/
proc sgplot data=testing;
    &include;
    vbox BRSavg/group=racegrp;
    format racegrp racegrpfmt.;
run;

/*ag occ_group by sex*/
proc sgplot data=testing;
    &include and occ_group=1 and sex NE 8;
    vbox BRSavg/group=sex;
    title 'Agricultural';
run;

/*non-ag occ_group by sex*/
proc sgplot data=testing;
    &include and occ_group=0 and sex NE 8;
    vbox BRSavg/group=sex;
    title 'Non-agricultural';
run;
title;

/*women by occ_group*/
proc sgplot data=testing;
    &include and sex=1 and occ_group NE .;
    vbox BRSavg/group=occ_group;
    title 'Female';
run;

/*men by occ_group*/
proc sgplot data=testing;
    &include and sex=0 and occ_group NE .;
    vbox BRSavg/group=occ_group;
    title 'Male';
run;

proc print data=testing;
    &include and event_type=' ';
    title 'Missing Event_type';
run;

title;

proc means data=testing sum maxdec=0;
    &include;
    var event___1-event___6 multiflag;
run;

proc freq data=testing;
    &include;
    tables occ_group*event_type;
run;

proc freq data=testing;
    &include;
    tables age_group*sex*occ_group/nocol norow nopercent;
run;

proc freq data=testing;
    &include;
    tables multiflag/nopercent nocol norow nocum;
```

```
run;

proc freq data=testing;
    &include;
    tables racegrp*occ_group/nocol norow nocum;
run;

**********************************TESTING****************************;
/*compare mean BRS between ag (occgroup=1) and non-ag (occgroup=0)*/
/*n>30 in both groups so use ttest but need to control for sex*/
proc ttest data=testing plots=qq;
    &include and occ_group NE .;
    class occ_group;
    var brsavg;
run;

*check for significance by sex? yes, p=.0213;
proc ttest data=testing plots=qq;
    &include;
    class sex;
    var brsavg;
run;

/* *check for difference between event and no event; */
/* *conclude no difference p=.5530; */
proc ttest data=testing plots=qq;
    &include;
    class event___6;
    var brsavg;
run;

proc ttest data=testing plots=qq;
    &include and occ_group NE . and sex=1;
    class occ_group;
    var BRSavg;
    title 'women';
run;

proc ttest data=testing plots=qq;
    &include and occ_group NE . and sex=0;
    class occ_group;
    var BRSavg;
    title 'men';
run;

title;
********************************DEM TABLES - DESCRIPTIVE STATS******************************;

/*population is subjects not excluded who completed at least one scale*/
proc freq data=testing;
    &include;
    table age_group sex racegrp occ_group event_type event___6/nocum
        plots=freqplot;
run;

/*table occ_group by sex*/
proc freq data=testing;
    &include;
    tables occ_group*sex event_type*occ_group/nopercent nocol nocum;
run;

/*bar graph occ_group by sex*/
proc sgplot data=testing;
    &include;
    vbar occ_group/group=sex;
run;

/*bar graph and cross tab event*occ_group*/
proc sgplot data=testing;
    &include;
    hbar event_all/group=occ_group;
run;
```

```
****************************************TESTS*************************************************8;

/*distribution of BRSavg*/
proc univariate data=testing;
    &include;
    *class occ_group;
    *can switch out occ_group or sex for viewing distribution;
    var brsavg;
    histogram;
run;

/*occ_group not signif assoc with BRS but sex is*/
proc glm data=testing plots=diagnostics; *glm because unbalanced cells;
    &include;
    class occ_group sex;
    *event_state age_group dependents racegrp;
    *tried these in model;
    model BRSavg=sex occ_group;
    *p=.135 for occ_group not signif;
    *has interaction graph;
    run;

proc freq data=testing;
    *retrieving N for power calculation;
    &include and sex NE . and occ_group NE .;
    table occ_group;
run;


proc print data=testing;
&include;
run;

/*print table of open field resilience answers with id, occupation, event & BRS score for context*/
data grunt;
merge testing dis_qual;
by participant_id;
run;

data grunt;
set grunt;
&include and resilience_open NE ' ';
keep participant_id occ_group event_all BRSavg resilience_open;
run;
proc print data=grunt noobs;
run;

*********************************************EXPOSURE4.SAS*********************************;
******************************DATA SET WORK - EXPOSURE**************************;

/*View and score exposure*/
proc contents data=dis_exposure;
run;

proc print data=dis_exposure;
run;

proc format;
    value directfmt 2='Direct' 1='Indirect' 0='No impact';
    value exposurefmt 1='Yes' 0='No';
run;

data dis_exposure_scored;
    set dis_exposure;
    array exp_qs (6) direct property_loss displaced fin_hardship injured fear_life;
    CountMiss_exp=0;

    do i=1 to 6;

        if exp_qs(i)=. then
            CountMiss_exp+1;
    end;
    exposure_score=sum (direct, property_loss, displaced, fin_hardship, injured,
```

```
        fear_life);

    /*create flag for all exposure questions completed, set to 0 if incomplete, 1 if complete*/
    /*complete is defined as answering at least 5 of 6 exposure questions, so CountMiss =0 or 1*/
    if 0 LE CountMiss_exp LE 1 then
        exp_flag=1;
    else
        exp_flag=0;
    drop i;
    *format direct directfmt. property_loss displaced fin_hardship injured fear_life exposurefmt.;
run;

/*verify scoring*/
proc print data=dis_exposure_scored;
run;

/*merge exposure scores to testing data set, keep individual exposure variables*/
data testing;
    merge testing dis_exposure_scored;
run;

**********************************ACTION*******************************;
/*summary table of reported exposures*/
proc tabulate data=testing;
    &include and exp_flag=1;
    class direct property_loss displaced fin_hardship injured fear_life
    / style={width=2in};
    table (direct='Effect level' property_loss='Lost property'
        displaced='Displaced from home' fin_hardship='Financial hardship'
        injured='Injury (self or family member)'
        fear_life='Feared for life (self or family member)'), n pctn*f=5.1;
    keylabel n=Count pctn=Percent;
    format direct directfmt. property_loss displaced fin_hardship injured
        fear_life exposurefmt.;
    title 'Reported exposures';
run;

title;

/*verify exposure flag*/
proc freq data=testing;
    &include;
    tables exp_flag;
run;

/*Who did not complete exposure questions*/
/*Trends? primarily older men who had no disaster event, only 4 who reported events, mid age M&F*/
proc print data=testing;
    &include and exp_flag=0;
run;

/*view distributions of individual exposures and score*/
proc means data=testing n median mean std maxdec=2;
    &include and exp_flag=1; *completed exposure;
    var exposure_score;
run;

proc freq data=testing;
    &include and exp_flag=1;
    tables direct property_loss displaced fin_hardship injured fear_life
        exposure_score/plots=freqplot;
run;

/*view for not ag*/
proc freq data=testing;
    &include and exp_flag=1 and occ_group=0;
    table exposure_score/plots=freqplot;
    title 'Not Agriculture';
run;

/*view for ag*/
proc freq data=testing;
    &include and exp_flag=1 and occ_group=1;
```

```
    table exposure_score/plots=freqplot;
    title 'Agriculture';
run;

proc means data=testing n median mean std maxdec=2;
&include and exp_flag=1;
    class occ_group;
    var exposure_score;
run;

proc ttest data=testing;
    *parametric questionable because ag group not very normal;
    &include and exp_flag=1;
    class occ_group;
    var exposure_score;
run;

/* nonparametric because scores not ND in ag group, more uniform */
/* Exposure score is signif diff by occ_group - control for exposure_score */
/* in stress and recovery tests */
proc npar1way data=testing wilcoxon;
    &include and exp_flag=1;
    class occ_group;
    var exposure_score;
run;

/*look at event_type and exposure score*/
proc sgplot data=testing;
    &include and exp_flag=1;
    vbox exposure_score/group=event_type;
    title 'Exposure_score by event type';
run;
title;
data littletest;
    set testing;
    where event_type in ('flood', 'tornado');

    if event_type='flood' then
        event_cat=1;
    else if event_type='tornado' then
        event_cat=0;
run;
proc ttest data=littletest;
    class event_cat;
    var exposure_score;
run;


************************************IESPAST5.SAS***************************************;
**************************DATA SET WORK - IES Past****************************;

/* Score is symptom count*/
data dis_IESpast_scored;
    set dis_IESpast;
    array IESpast (15) q18a q18b q18c q18d q18e q18f q18g q18h q18i q18j q18k q18l
        q18m q18n q18o;
    array IESpast_intrusion (7) q18a q18d q18e q18f q18j q18k q18n;
    array IESpast_avoidance (8) q18b q18c q18g q18h q18i q18l q18m q18o;
    IESpast_score=0;
    IESpast_intr_sub=0;
    IESpast_avoid_sub=0;
    CountDR_past=0;
    CountMiss_past=0;

    /*adding 0's and 1's for IES score, counting missing values (.) and don't recalls(8)*/
    /*flag=1 for complete data, 0 for incomplete*/
    do i=1 to 15;

        if IESpast(i)=8 then
            CountDR_past + 1;
        else if IESpast(i)=. then
            CountMiss_past + 1;
        else
```

```
            IESpast_score=IESpast_score+IESpast(i);
    end;

    if 0 LE CountMiss_past LE 2 then
        IESpast_flag=1;
    *complete defined as answering at least 13 of 15 questions;
    else
        IESpast_flag=0;
    *incomplete;
    drop i;

    do i=1 to 7;

        if IESpast_intrusion(i) NE 8 and IESpast_intrusion(i) NE .
    then
            IESpast_intr_sub=IESpast_intr_sub+IESpast_intrusion(i);
    end;
    drop i;

    do i=1 to 8;

        if IESpast_avoidance(i) NE 8 and IESpast_avoidance(i) NE .
    then
            IESpast_avoid_sub=IESpast_avoid_sub+IESpast_avoidance(i);
    end;
    drop i;
run;

/*distinguish between 0 scores on complete scales and 0 scores on incomplete*/
data dis_IESpast_scored;
    set dis_IESpast_scored;

    if IESpast_score=0 and IESpast_flag=0 then
        do;
            IESpast_score=.;
            IESpast_intr_sub=.;
            IESpast_avoid_sub=.;
        end;
run;

/*verify scoring*/
proc print data=dis_IESpast_scored;
run;

proc sort data=dis_IESpast_scored;
    by participant_id;
run;

/*remove individual questions for merge data set*/
data dis_IESpast_scoresonly;
    set dis_IESpast_scored;
    *drop q18a q18b q18c q18d q18e q18f q18g q18h q18i q18j q18k q18l q18m q18n
        q18o;
    drop q18a--q18o;
run;

/*verify*/
proc print data=dis_IESpast_scoresonly;
run;

/*merge IESpast scores to analysis data set*/
data testing;
    merge testing dis_IESpast_scoresonly;
    by participant_id;
run;

************************************ACTION***********************************;

/*verify IESpast_flag*/
proc freq data=testing;
    &include and exp_flag=1;
    tables iespast_flag;
run;
```

```
/*explore distributions for subjects completed BRS and IESpast*/
proc freq data=testing;
    &include and exp_flag=1 and IESpast_flag=1;
run;

proc means data=testing;
    &include and exp_flag=1 and IESpast_flag=1;
run;

proc means data=testing n median;
    &include and exp_flag=1 and IESpast_flag=1;
    var IESpast_score;
run;

proc univariate data=testing;
    *subscales are very skewed;
    &include and exp_flag=1 and IESpast_flag=1;
    var IESpast_score IESpast_intr_sub IESpast_avoid_sub;
    histogram;
    title 'Distribution of IESpast scores';
run;

/*who did not complete IESpast scale?*/
proc print data=testing;
    &include and exp_flag=1 and iespast_flag=0;
    title 'Did not complete IESpast scale';
run;

title;

/*working towards - is occ_group significantly associated with IESpast_score?*/
/*view distributions of iespast by covars*/
%macro check_covar (grp=);
    proc sgplot data=testing;
        &include and exp_flag=1 and iespast_flag=1;
        vbox IESpast_score/group=&grp;
    run;

%mend check_covar;

%check_covar(grp=occ_group) %check_covar(grp=age_group) %check_covar(grp=sex)
    %check_covar(grp=racegrp) %check_covar(grp=event_type)
    %check_covar(grp=rural_urban) %check_covar(grp=dependents) proc sgplot
    data=testing;
&include and exp_flag=1 and iespast_flag=1;
reg x=BRSavg y=IESpast_score;
run;

/*repeat for intrusion subscore*/
%macro check_covar_i (grp=);
    proc sgplot data=testing;
        &include and exp_flag=1 and iespast_flag=1;
        vbox IESpast_intr_sub/group=&grp;
    run;

%mend check_covar_i;

%check_covar_i(grp=occ_group) %check_covar_i(grp=age_group)
    %check_covar_i(grp=sex) %check_covar_i(grp=racegrp)
    %check_covar_i(grp=event_type) %check_covar_i(grp=rural_urban)
    %check_covar_i(grp=dependents) proc sgplot data=testing;
&include and exp_flag=1 and iespast_flag=1;
reg x=BRSavg y=IESpast_intr_sub;
run;

/*repeat for avoid subscore*/
%macro check_covar_a (grp=);
    proc sgplot data=testing;
        &include and exp_flag=1 and iespast_flag=1;
        vbox IESpast_avoid_sub/group=&grp;
    run;
```

```
%mend check_covar_a;

%check_covar_a(grp=occ_group) %check_covar_a(grp=age_group)
    %check_covar_a(grp=sex) %check_covar_a(grp=racegrp)
    %check_covar_a(grp=event_type) %check_covar_a(grp=rural_urban)
    %check_covar_a(grp=dependents) proc sgplot data=testing;
&include and exp_flag=1 and iespast_flag=1;
reg x=BRSavg y=IESpast_avoid_sub;
run;
****************;

/*assumption of linear relationship?*/
/* weak but ok */

proc reg data=testing;
    &include and exp_flag=1 and iespast_flag=1;
    model IESpast_score=exposure_score;
    run;

/*looking at correlations*/
proc corr data=testing;
    &include and exp_flag=1 and iespast_flag=1;
    var years_since_event BRSavg exposure_score IESpast_score;
run;

proc sgplot data=testing;
    &include and exp_flag=1 and iespast_flag=1;
    reg x=exposure_score y=IESpast_score;
run;

proc sgplot data=testing;
    &include and exp_flag=1 and iespast_flag=1;
    reg x=BRSavg y=IESpast_score;
run;

/* BRS supposedly doesn't change, */
/* but curious about relationship between exposure and current BRS */
proc sgplot data=testing;
    &include and exp_flag=1 and iespast_flag=1;
    reg x=exposure_score y=BRSavg;
run;

**********Checking individual exposure items in place of exposure_score***;

proc glm data=testing;
    *check association with specific exposures in place of exposure_score;
    &include and exp_flag=1 and iespast_flag=1;
    class direct property_loss displaced fin_hardship injured fear_life;
    model IESpast_score=direct property_loss displaced fin_hardship injured
        fear_life;
    run;
    *remove injured;

proc glm data=testing;
    &include and exp_flag=1 and iespast_flag=1;
    class direct property_loss displaced fin_hardship fear_life;
    model IESpast_score=direct property_loss displaced fin_hardship
        fear_life/solution;
    run;
    *remove direct;

proc glm data=testing;
    &include and exp_flag=1 and iespast_flag=1;
    class property_loss displaced fin_hardship fear_life;
    model IESpast_score=property_loss displaced fin_hardship fear_life/solution;
    run;
    *remove property_loss;

proc glm data=testing;
    *this is the best model of specific exposures but r-square only .27;
    &include and exp_flag=1 and iespast_flag=1;
    class direct displaced fin_hardship injured fear_life;
    model IESpast_score=displaced fin_hardship fear_life/solution;
```

```
    run;
*****************************************************************;

**********************MODELING*********************************;
/*first model - controlling for sex and exposure_score based on established differences*/
proc glm data=testing plots=diagnostics;
    &include and exp_flag=1 and IESpast_flag=1;
    class sex occ_group;
    model IESpast_score = occ_group sex exposure_score;
run;
**BUILD MODEL**start with these main effects, no interactions, manual backward selection:;

proc glm data=testing;
    &include and exp_flag=1 and iespast_flag=1;
    class occ_group age_group sex racegrp event_type dependents rural_urban;
    model IESpast_score=occ_group age_group sex racegrp event_type dependents
        rural_urban exposure_score BRSavg;
    run;
    *remove racegrp;
    *remove rural_urban;
    *remove occ_group;
    *remove event_type;
    *remove dependents;
    *remove age_group , p=.0649, r-square=.42;

    /*PREFERRED MODEL for parsimony and lowest AIC*/
proc glm data=testing plots=diagnostics;
    *r-square=.37, final result from manual backward selection;
    *added occ_group back in to check p-value with significant covariates;
    &include and exp_flag=1 and iespast_flag=1;
    class sex; *occ_group;
    model IESpast_score=sex exposure_score BRSavg; *occ_group;
    run;

    /*identical result from stepwise and forward auto selection, AIC=360*/
proc glmselect data=testing;
    &include and exp_flag=1 and IESpast_flag=1;
    class occ_group age_group sex racegrp event_type dependents;
    model IESpast_score=occ_group age_group sex racegrp event_type dependents
        BRSavg exposure_score / selection=stepwise (slentry=.05 slstay=.05)
        details=steps;
run;

/*replace exposure_score with the 3 signif exposures*/
proc glm data=testing;
    &include and exp_flag=1 and iespast_flag=1;
    class sex displaced fin_hardship fear_life;
    model IESpast_score=sex displaced fin_hardship fear_life BRSavg;
    run;
    *remove BRSavg - no longer significant;

proc glm data=testing;
    *this is the best replacement with specific exposures

        but r-square only .357, AIC 360 from glmselect;
    &include and exp_flag=1 and iespast_flag=1;
    class sex displaced fin_hardship fear_life;
    model IESpast_score=sex displaced fin_hardship fear_life;
    run;

/*  also tested main effects with many 2-way interactions */
/*  using proc glmselect for auto stepwise selection with slstay and slentry */
/*  of .05, selected sex exposure_score and exposure_score*BRS_average. When added */
/*  BRS_average back in as main effect, the interaction was no longer significant. */
/*  This resulted in choosing sex, exposure_score and BRS_average, just as selected manually */
/*  when interactions were not tested. */
    /*result of proc glmselect stepwise: sex*exposure_score, sex*BRSavg - AIC 360*/
    /*result of proc glmselect backward: exposure_score, sex*BRSavg - AIC 358*/
proc glmselect data=testing;
    &include and exp_flag=1 and IESpast_flag=1;
    class occ_group age_group sex racegrp event_type dependents;
    model IESpast_score=occ_group age_group sex racegrp event_type dependents
        BRSavg exposure_score occ_group*age_group occ_group*sex occ_group*event_type
```

```
        occ_group*BRSavg occ_group*exposure_score age_group*sex age_group*event_type
        age_group*BRSavg age_group*exposure_score sex*event_type sex*BRSavg
        sex*exposure_score event_type*BRSavg event_type*exposure_score
        BRSavg*exposure_score / selection=stepwise (slentry=.05 slstay=.05)
        details=steps;
run;

/*look at poisson regression for count data*/
proc genmod data=testing;
    *This is the best Poisson model, AIC 676, rejected;
    &include and exp_flag=1 and iespast_flag=1;
    class age_group sex;
    model IESpast_score=age_group sex exposure_score/dist=poisson link=log;
run;
*removed racegrp, occ_group, dependents, event_type, BRSavg;

/* CONCLUSION: None of the models included occ_group as a significant effect. There is not  */
/* evidence that the agricultural population experiences a different number of IES stress */
/* symptoms compared to the rural non-agricultural population. */
**************************subscales - need to redo if want to test this;

/* proc genmod data=testing; *occ_group not signif assoc with IESpast intr subscale; */
/* &include and exp_flag=1 and iespast_flag=1; */
/* class occ_group age_group sex racegrp event_type dependents; */
/* model IESpast_intr_sub= sex exposure_score age_group */
/*   /dist=poisson link=log; */
/* run; */
/* proc genmod data=testing;  */
/* &include and exp_flag=1 and iespast_flag=1; */
/* class occ_group age_group sex racegrp event_type dependents; */
/* model IESpast_avoid_sub= age_group  */
/* exposure_score/dist=poisson link=log; */
/* run; */
*********************************************;

/*check Occ_group and exposure_score only*/
proc genmod data=testing;
    &include and exp_flag=1 and iespast_flag=1;
    class occ_group age_group sex racegrp event_type dependents;
    model IESpast_score=occ_group exposure_score/dist=poisson link=log;
run;
*this was a working model - rejected;
*occ_group not significantly associated with IESpast_score;
******************************look at the subscales;

proc npar1way data=testing wilcoxon;
    &include and exp_flag=1 and iespast_flag=1;
    class occ_group;
    var IESpast_intr_sub;
run;

proc npar1way data=testing wilcoxon;
    &include and exp_flag=1 and iespast_flag=1;
    class Occ_group;
    var IESpast_avoid_sub;
run;

proc glm data=testing;
    &include and exp_flag=1 and iespast_flag=1;
    class age_group;
    model IESpast_intr_sub=age_group;
    run;

proc glm data=testing;
    &include and exp_flag=1 and iespast_flag=1;
    class event_type;
    model IESpast_avoid_sub=exposure_score;
    run;

proc univariate data=testing;
    &include and exp_flag=1 and iespast_flag=1;
    var IESpast_avoid_sub;
    histogram;
```

```
run;

proc means data=testing;
    &include and exp_flag=1 and iespast_flag=1;
    class occ_group;
    var IESpast_intr_sub IESpast_avoid_sub;
run;

***********************************************;

/*create IESpast_group for above median and below median IESpast_score*/
/*create a copy for making the median groups work*/
data rankwork;
    set testing;
    &include and exp_flag=1 and IESpast_flag=1;
run;

proc means data=rankwork n median;
    var IESpast_score;
run;

proc rank data=rankwork groups=2 ties=low out=IESpast_ranks;
    var IESpast_score;
    ranks IESpast_group;
run;

proc freq data=IESpast_ranks;
    tables IESpast_score IESpast_group;
run;

proc sort data=IESpast_ranks;
    by participant_id;
run;

data rankwork2;
    merge testing (in=main) IESpast_ranks (in=past);
    by participant_id;
    *if past=0 then IESpast_group=.;
run;

proc freq data=rankwork2;
    tables IESpast_group;
run;

***********************copy rank groups back to testing2***************;

data testing2;
    set rankwork2;
run;

data grunt2;
    merge testing2 dis_qual;
    by participant_id;
run;
data grunt2;
    set grunt2;
    &include and (event_open NE ' ' or  open_stress NE ' ');
    keep participant_id occ_group event_all event_open exposure_score open_stress
    IESpast_score;
    run;
proc print data=grunt2 noobs;
run;

********************effect of don't recall and missing****************;
/*how many answered yes/no to how many IESpast symptoms?*/
data scratch;
set testing2;
&include and exp_flag=1 and iespast_flag=1;
yesnopast=15-(countdr_past+countmiss_past);
keep yesnopast;
run;
proc print data=scratch;
run;
```

```
proc freq data=scratch order=freq;
tables yesnopast;
run;
proc means data=testing2 n sum;
&include and exp_flag=1 and iespast_flag=1;
var Countmiss_past CountDR_past;
run;


*************************************************IESNOW6.SAS******************************;
**********************************DATA SET WORK - IES Now*************************;

/* Score is symptom count*/
data dis_IESnow_scored;
    set dis_IESnow;
    array IESnow (15) q19a q19b q19c q19d q19e q19f q19g q19h q19i q19j q19k q19l
        q19m q19n q19o;
    array IESnow_intrusion (7) q19a q19d q19e q19f q19j q19k q19n;
    array IESnow_avoidance (8) q19b q19c q19g q19h q19i q19l q19m q19o;
    IESnow_score=0;
    IESnow_intr_sub=0;
    IESnow_avoid_sub=0;
    CountDR_now=0;
    CountMiss_now=0;

    /*adding 0's and 1's for IES score, counting missing values (.) and don't recalls(8)*/
    do i=1 to 15;

        if IESnow(i)=8 then
            CountDR_now + 1;
        else if IESnow(i)=. then
            CountMiss_now + 1;
        else
            IESnow_score=IESnow_score+IESnow(i);
    end;
    drop i;

    /*flag=1 for complete data, 0 for incomplete*/
    if 0 LE CountMiss_now LE 2 then
        IESnow_flag=1;
    *complete defined as answering at least 13 of 15 questions;
    else
        IESnow_flag=0;
    *incomplete ;
    drop i;

    do i=1 to 7;

        if IESnow_intrusion(i) NE 8 and IESnow_intrusion(i) NE .
    then
            IESnow_intr_sub=IESnow_intr_sub+IESnow_intrusion(i);
    end;
    drop i;

    do i=1 to 8;

        if IESnow_avoidance(i) NE 8 and IESnow_avoidance(i) NE .
    then
            IESnow_avoid_sub=IESnow_avoid_sub+IESnow_avoidance(i);
    end;
    drop i;
run;

/*verify scoring*/
proc print data=dis_IESnow_scored;
run;

data dis_IESnow_scoresonly;
    set dis_IESnow_scored;
    drop q19a q19b q19c q19d q19e q19f q19g q19h q19i q19j q19k q19l q19m q19n
        q19o;
run;
```

```
data testing3;
    merge testing2 dis_IESnow_scoresonly;
run;

********************************ACTIONS************************************;
%let include2= where BRS_flag = 1 and exclude_flag NE 1
and exp_flag = 1 and IESpast_flag = 1 and IESnow_flag = 1;

proc means data=testing3;
    &include2;
    var BRSavg exposure_score IESpast_score IESpast_intr_sub IESpast_avoid_sub
        IESnow_score IESnow_intr_sub IESnow_avoid_sub;
run;

proc freq data=testing3;
    &include2;
    tables _all_ occ_group*sex/plots=freqplot;
run;

proc univariate data=testing3;
    &include2;
    var iesnow_score;
    histogram;
run;

/*boxplots for visuals of IESnow scores by groups*/
proc sgplot data=testing3;
    &include2 and occ_group NE .;
    vbox iesnow_score/group=occ_group;

proc sgplot data=testing3;
    &include2;
    vbox iesnow_score/group=sex;

proc sgplot data=testing3;
    &include2;
    vbox iesnow_score/group=event_type;

proc sgplot data=testing3;
    &include2;
    vbox iesnow_score/group=IESpast_group;

proc sgplot data=testing3;
    &include2;
    histogram IESnow_score;
run;

/*Comparing IESnow_score by categorical groups - signif by years since and event_type*/
%macro compare (variable);
    proc npar1way data=testing3 wilcoxon;
        &include2;
        class &variable;
        var IESnow_score;
    run;

    proc means data=testing3 median q1 q3;
        &include2;
        class &variable;
        var IESnow_score;
    run;

%mend;

%compare(occ_group);
%compare(years_since_event);
%compare(sex);
%compare(IESpast_group);
%compare(event_type);

proc reg data=testing3;
    &include2;
    model IESnow_score=exposure_score;
    run;
```

```
    *******************IESNow_score MODELING***************************;

    /*Building model, main effects only, manual backward selection*/
    /*Interactions not tested, following learning from IESpast*/
proc glm data=testing3;
    &include2;
    class occ_group age_group sex racegrp event_type dependents rural_urban;
    model IESnow_score=occ_group age_group sex racegrp event_type dependents
        rural_urban exposure_score BRSavg IESpast_score;
    run;
    *remove dependents;
    *remove event_type;
    *remove rural_urban;
    *remove age_group;
    *remove sex;
    *remove racegrp;
    *remove occ_group;

proc glm data=testing3 plots=diagnostics;
    ********************************
    *r-square=.49;

    /*PREFERRED MODEL for parsimony and highest r-square*/
    &include2;
    model IESnow_score=exposure_score BRSavg IESpast_score;
    run;

    /*Run again with years_since_event - rejected*/
proc glm data=testing3;
    &include2;
    class occ_group age_group sex racegrp rural_urban;
    model IESnow_score=occ_group age_group sex racegrp rural_urban exposure_score
        BRSavg IESpast_score years_since_event;
    run;
    */remove event_type, dependents, years_since_event - STOP;

    /*Run again without IESpast_score - did not test as repeat measure for covar-rejected*/
proc glm data=testing3;
    *r-square=.32;
    &include2;
    model IESnow_score=exposure_score BRSavg;
    run;
    *remove rural_urban, sex, dependents, age_group, event_type, occ_group, racegrp;
    **************RECOVERY RATIO to account for IESPast_score****************;

data testing4;
    *calculate RecoveryRatio only for subjects with both IES scales completed;
    set testing3;

    if IESpast_flag=1 and IESnow_flag=1 then
        RecoveryRatio=(IESpast_score-IESnow_score)/IESpast_score;
run;

proc univariate data=testing4;
    &include2;
    var IESpast_score IESnow_score RecoveryRatio;
    histogram;
run;

proc means data=testing4;
    &include2;
    class IESpast_group;
    var RecoveryRatio;
run;

proc ttest data=testing4 plots=qq;
    *unequal variances - Satterthwaite - no difference!;
    &include2;
    class IESpast_group;
    var RecoveryRatio;
run;

*confirm with nonparametric tests;
```

```
proc npar1way data=testing4 wilcoxon;
    *no difference by occ_group;
    &include2;
    class occ_group;
    var recoveryratio;
run;

proc npar1way data=testing4 wilcoxon;
    &include2;
    class IESpast_group;
    var RecoveryRatio;
run;

proc npar1way data=testing4 wilcoxon;
    &include2;
    class sex;
    var RecoveryRatio;
run;

proc npar1way data=testing4 wilcoxon;
    &include2;
    class event_type;
    var RecoveryRatio;
run;

proc means data=testing4 n median mean std min max q1 q3 maxdec=2;
    &include2;
    class occ_group;
    var RecoveryRatio;
run;

proc univariate data=testing4;
    &include2;
    class occ_group;
    var RecoveryRatio;
    histogram;
run;

proc ttest data=testing4;
    &include2;
    *no difference;
    *computed power for n=100&25 is 60% for medium effect, 94% large effect;
    class occ_group;
    var RecoveryRatio;
run;

proc sgplot data=testing4;
    &include2 and RecoveryRatio NE .;
    vbox RecoveryRatio/group=years_since_event;
run;

proc means data=testing4;
    &include2 and RecoveryRatio NE .;
    class years_since_event;
    var RecoveryRatio;
run;

proc ttest data=testing4;
    &include2 and RecoveryRatio NE .;
    class years_since_event;
    var RecoveryRatio;
run;

proc npar1way data=testing4 wilcoxon;
    *nonparametric;
    &include2;
    class years_since_event;
    var RecoveryRatio;
run;

********************RecoveryRatio model***********************;

```

```
/*ridiculously low correlation*/
proc glm data=testing4 plots=diagnostics;
    *R-square .076, BRSavg p=.0014
    &include2;
    model RecoveryRatio=BRSavg occ_group;
    run;
    *remove years_since_event;
    *remove IESpast_score;
    *remove age_group;
    *remove rural_urban;
    *remove dependents;
    *remove event_type;
    *remove occ_group;
    *remove exposure_score;
    *remove racegrp;
    *remove sex;

*how many people had negative recovery ratio?;
proc print data=testing4 noobs label;
    &include2 and IESnow_score > IESpast_score;
    format RecoveryRatio 6.3;
    var occ_group IESnow_score IESpast_score RecoveryRatio years_since_event event_type;
    label occ_group='Occupation' IESnow_score='IES now' IESpast_score='IES past'
    RecoveryRatio='Recovery Ratio' years_since_event='Years since event' event_type='Event type';
    title 'Negative Recovery Ratio';
run;
title;
proc univariate data=testing4;
    &include2 and occ_group=0;
    var IESnow_score RecoveryRatio;
    title 'Not Agriculture';
run;

proc univariate data=testing4;
    &include2 and occ_group=1;
    var IESnow_score RecoveryRatio;
    title 'Agriculture';
run;
title;
**********effect of don't recall and missing*****************************;
/*how many answered how many yes/no to IESnow symptoms*/
data scratch2;
set testing4;
&include2;
yesnonow=15-(countdr_now+countmiss_now);
keep yesnonow;
run;

proc freq data=scratch2 order=freq;
tables yesnonow;
run;
proc means data=testing4 n sum;
&include2;
var Countmiss_now CountDR_now;
run;

proc print data=testing4;
&include and multiflag=1;
var occ_group multiflag;
run;

*************************other;
/*check RecoveryRatio stratified by sex and occ_group*/
proc means data=testing4 n mean median std q1 q3 min max;
    &include2;
    class occ_group sex;
    var RecoveryRatio;
    title 'Recovery Ratio comparison by sex and occ_group';
run;
title;


*****************************************PTGI7.SAS***************************************;
```

```
*********************DATA SET WORK - PTGI******************************;

/*PTGI scoring, include flag for completeness*/
/*complete is defined as completing at least 8 of 10 questions*/
proc contents data=dis_PTGI;
run;

data dis_PTGI_scored;
    set dis_PTGI;
    array PTGI (10) q21a q21b q21c q21d q21e q21f q21g q21h q21i q21j;
    PTGI_score=0;
    PTGI_missing=0;

    do i=1 to 10;

        if PTGI(i) NE . then
            PTGI_score=PTGI_score+PTGI(i);
        else if PTGI(i)=. then
            PTGI_missing + 1;
    end;

    if 0 LE PTGI_missing LE 2 then
        PTGI_flag=1;
    *flag complete if data complete;
    else
        PTGI_flag=0;
    drop i;
run;

*review scoring;

proc print data=dis_PTGI_scored;
run;

*remove individual questions;

data dis_PTGI_scoresonly;
    set dis_PTGI_scored;
    keep participant_id PTGI_score PTGI_missing PTGI_flag;
run;

data testing5;
    merge testing4 dis_PTGI_scoresonly;
    by participant_id;
run;

**************************ACTIONS******************************;

proc freq data=dis_PTGI_scored;
    tables PTGI_missing PTGI_flag;
run;

proc freq data=dis_PTGI_scoresonly;
    tables PTGI_flag;
run;

proc means data=dis_PTGI_scored;
    *class PTGI_missing;
    where 0 LE PTGI_missing LE 2;
    var PTGI_score;
run;

/*view data set*/
proc print data=testing5;
    *figure out the exclusions - are there people who skipped scales
in the middle but completed later ones?;
    where exclude_flag NE 1 and PTGI_flag=1;
run;

proc freq data=testing5;
    where exclude_flag NE 1 and PTGI_flag=1;
run;
```

```
*******************check freq, means, univariate by occ_group;

proc freq data=testing5;
    &include2 and PTGI_flag=1;
    tables occ_group*PTGI_missing occ_group*PTGI_flag/plots=freqplot;
run;

proc means data=testing5;
    &include2 and PTGI_flag=1;
    class occ_group;
    var PTGI_score;
run;

proc univariate data=testing5;
    &include2 and PTGI_flag=1;
    var PTGI_score;
    histogram;
    *normal enough;
proc univariate data=testing5;
    &include2 and PTGI_flag=1;
    class occ_group;
    var PTGI_score;
    histogram;
    *normal enough;
run;

proc ttest data=testing5 plots=qq; *significant p=.0119;
    &include2 and PTGI_flag=1 and occ_group NE .;
    class occ_group;
    var PTGI_score;
run;
proc npar1way data=testing5 wilcoxon; *significant p=.0136;
    &include2 and PTGI_flag=1 and occ_group NE .;
    class occ_group;
    var PTGI_score;
run;

proc sgplot data=testing5;
    *normal enough;
    &include2 and PTGI_flag=1;
    vbox PTGI_score/group=occ_group;
run;

proc sgplot data=testing5;
    *normal enough;
    &include2 and PTGI_flag=1;
    vbox PTGI_score/group=sex;
run;
proc ttest data=testing5 plots=qq; *significant p=.0115;
    &include2 and PTGI_flag=1;
    class sex;
    var PTGI_score;
run;
proc npar1way data=testing5 wilcoxon; *p=.0091 control for sex;
    &include2 and PTGI_flag=1;
    class sex;
    var PTGI_score;
run;



proc corr data=testing5;
    &include2 and PTGI_flag=1;
    var BRSavg exposure_score RecoveryRatio PTGI_score IESpast_score IESnow_score;
run;

proc sgplot data=testing5;
    &include2 and PTGI_flag=1;
    reg y=PTGI_score x=IESpast_score;
run;

*******************model PTGI*********************;
```

```
proc glm data=testing5 plots=diagnostics;
    &include2 and PTGI_flag=1;
    class occ_group sex;
    model PTGI_score=occ_group sex IESpast_score occ_group*sex;
    run;
    *remove occ_group*RecoveryRatio;
    *remove occ_group*years_since_event;
    *remove years_since_event;
    *remove occ_group*IESnow_score;
    *remove occ_group*age_group;
    *remove age_group;
    *remove IESnow_score;
    *remove RecoveryRatio;
    *remove occ_group*event_type;
    *remove occ_group*exposure_score;
    *remove occ_group*IESpast_score;
    *remove exposure_score;
    *remove event_type;
    *remove occ_group*BRSavg;
    *remove BRSavg;

*************************other;
/*check PTGI_score stratified by sex and occ_group*/
proc means data=testing5 n mean median std q1 q3 min max;
    &include2 and PTGI_flag=1;
    class occ_group sex;
    var PTGI_score;
    title 'PTGI comparison by sex and occ_group';
run;
title;


**************************************************RESOURCE8.SAS****************************************;
*************DATA SET WORK - Resource Use and Effect Inventory****************************;

/* Sums were completed below in proc tabulate - calculations then */
/* completed in Excel: */
/* Calculate impact per use - sum all the scores for each item, then divide by  */
/* number of users (-1, 0, or 1). Ratio should range from -1 (all users reported */
/* decreased stress) to 1 (all users reported increased stress). Interpretation  */
/* will be that lower negative numbers were most often associated with  */
/* decreased stress. Also create a horizontal bar graph with a user count for each  */
/* item (total freq of -1, 0, or 1 response). Calculate percent usage, aggregate sum */
proc contents data=dis_resource varnum;
run;

/*view data*/
proc print data=dis_resource;
run;

proc format;
    value usefmt -1='Decreased' 0='No effect'
        1='Increased' 8='Did not use';
run;

/*add labels*/
data dis_resource_clean;
    set dis_resource;
    label q23a='Family' q23b='Friends and neighbors'
        q23c='Employer, school, faith community' q23d='Other local' q23e='Counselor'
        q23f='Other health prof' q23g='Person same thing' q23h='Insurance rep'
        q23i='FEMA, other govt' q23j='Neighboring community'
        q23k='Outside relief group' q23l='First responders' q24a='Repair property'
        q24b='Personal faith' q24c='News, social media' q24d='Recovery info websites'
        q24e='Talking' q24f='Working occupation' q24g='Helping others'
        q24h='Community function' q24i='Disaster relief center'
        q24j='Response Town Hall meeting';
run;

proc freq data=dis_resource_clean;
    tables q23a;
    * _all_;
    format q23a q23b q23c q23d q23e q23f q23g q23h q23i q23j q23k q23l q24a q24b
```

```
        q24c q24d q24e q24f q24g q24h q24i q24j usefmt.;
run;

/*put resource use frequencies in a single table*/
proc tabulate data=dis_resource_clean; *note this does not have the exclude flags;
    class q23a--q24j;
    table (q23a--q24j), n pctn*f=5.1;
    keylabel n='Count' pctn='Percent' sum='total';
    format q23a--q24j usefmt.;
run;

/*creating small data set for each resource with summary numbers to merge back together*/
%macro useflag (qnumber);
    data d&qnumber;
        set dis_resource_clean;
        keep participant_id q&qnumber use&qnumber;

        if -1 LE q&qnumber LE 1 then
            use&qnumber=1;
        else if q&qnumber=8 then
            use&qnumber=0;
    run;

    proc sgplot data=d&qnumber;
        where use&qnumber NE .;
        vbar q&qnumber;
        format q&qnumber usefmt.;
    run;

    proc means data=d&qnumber n sum;
        where use&qnumber=1;
        var q&qnumber;
    run;

%mend;

%useflag(23a);
%useflag(23b);
%useflag(23c);
%useflag(23d);
%useflag(23e);
%useflag(23f);
%useflag(23g);
%useflag(23h);
%useflag(23i);
%useflag(23j);
%useflag(23k);
%useflag(23l);
%useflag(24a);
%useflag(24b);
%useflag(24c);
%useflag(24d);
%useflag(24e);
%useflag(24f);
%useflag(24g);
%useflag(24h);
%useflag(24i);
%useflag(24j);

data testing6;
    merge testing5 dis_resource_clean;
    by participant_id;
run;

/*any difference by occ_group?*/
proc freq data=testing6;
    where exclude_flag NE 1;
    tables occ_group*help_effective;
run;

***********************need to create the var for multiple selections q26 and see how many ag********;

data test100;
```

```
    merge testing5 d23a d23b d23c d23d d23e d23f d23g d23h d23i d23j d23k d23l
        d24a d24b d24c d24d d24e d24f d24g d24h d24i d24j;
    by participant_id;
run;

/*23e is Counselor or therapist   compare outcomes for those who used*/
proc sgplot data=test100;
    where exclude_flag NE 1 and IESpast_flag=1 and IESnow_flag=1 and q23e NE .;
    vbox RecoveryRatio/ group=q23e;
run;

proc freq data=test100;
    where exclude_flag NE 1 and q23e NE .;
    tables q23e; *test by event_state and event_type;
run;
****************************extra;
proc freq data=test100;
    where exclude_flag NE 1 and -1 LE q23e LE 1;
    tables q23e*event_state/fisher;
    run;
proc freq data=test100;
    where exclude_flag NE 1 and -1 LE q23e LE 1;
    tables q23e*event_type/fisher;
    run;
proc freq data=test100;
    where exclude_flag NE 1 and -1 LE q23f LE 1;
    tables q23f*event_state/fisher;
    run;
proc freq data=test100;
    where exclude_flag NE 1 and -1 LE q23f LE 1;
    tables q23f*event_type/fisher;
    run;

*Conclusion - not significantly different proportions of increasing/no/decreasing stress;
*by state or event type;

******************************end extra;
proc ttest data=test100;
    where exclude_flag NE 1 and IESpast_flag=1 and IESnow_flag=1 and q23e NE .;
    class use23e;
    var recoveryratio;
run;

proc sgplot data=test100;
    where exclude_flag NE 1 and IESpast_flag=1 and q23e NE .;
    vbox IESpast_score/ group=use23e;
run;

proc ttest data=test100;
    where exclude_flag NE 1 and IESpast_flag=1 and q23e NE .;
    class use23e;
    var IESpast_score;
run;

proc sgplot data=test100;
    where exclude_flag NE 1 and IESpast_flag=1 and IESnow_flag=1;
    scatter x=IESpast_score y=RecoveryRatio;
run;

proc sgplot data=test100;
    where q23e NE . and exp_flag=1;
    vbox exposure_score / group=use23e;
run;

proc freq data=testing2;
    where exclude_flag NE 1 and direct=2;
    tables _all_/plots=freqplot;
run;

/*sum use flags for utilization count*/
/*sum item score where score NE 8 or corresponding flag = 1*/
/*that is, sum scores only for participants who used the item*/
data aggregate;
```

```
    set test100;
    where exclude_flag NE 1;
    keep q23a--use24j;
run;

/*change 8's (didn't use) to . before summing*/
data aggregate2;
    set aggregate;
    array items (44) q23a--use24j;

    do i=1 to 44;

        if items(i)=8 then
            items(i)=.;
    end;
    drop i;
    label q23a='Family' q23b='Friends and neighbors'
        q23c='Employer, school, faith community' q23d='Other local' q23e='Counselor'
        q23f='Other health prof' q23g='Person same thing' q23h='Insurance rep'
        q23i='FEMA, other govt' q23j='Neighboring community'
        q23k='Outside relief group' q23l='First responders' q24a='Repair property'
        q24b='Personal faith' q24c='News, social media' q24d='Recovery info websites'
        q24e='Talking' q24f='Working occupation' q24g='Helping others'
        q24h='Community function' q24i='Disaster relief center'
        q24j='Response Town Hall meeting';
run;

/* count users for each item, and sum the aggregate scores */
/* copy and paste the means table to excel for ranking sums and */
/* percents and calculating/ranking impact per use */
proc means data=aggregate2 n sum;
    var q23a--use24j;
run;

proc format;
    value $qnumfmt 'q23a'='Family' 'q23b'='Friends and neighbors'
        'q23c'='Employer, school, faith community' 'q23d'='Other local' 'q23e'='Counselor'
        'q23f'='Other health prof' 'q23g'='Person same thing' 'q23h'='Insurance rep'
        'q23i'='FEMA, other govt' 'q23j'='Neighboring community'
        'q23k'='Outside relief group' 'q23l'='First responders' 'q24a'='Repair property'
        'q24b'='Personal faith' 'q24c'='News, social media' 'q24d'='Recovery info websites'
        'q24e'='Talking' 'q24f'='Working occupation' 'q24g'='Helping others'
        'q24h'='Community function' 'q24i'='Disaster relief center'
        'q24j'='Response Town Hall meeting';
run;
/*Can I make a panel plot?*/
/*Need long format data set*/
data resource_long;
set testing6;
&include;
qvalue = q23a; qnum='q23a'; output;
qvalue = q23b; qnum='q23b'; output;
qvalue = q23c; qnum='q23c'; output;
qvalue = q23d; qnum='q23d'; output;
qvalue = q23e; qnum='q23e'; output;
qvalue = q23f; qnum='q23f'; output;
qvalue = q23g; qnum='q23g'; output;
qvalue = q23h; qnum='q23h'; output;
qvalue = q23i; qnum='q23i'; output;
qvalue = q23j; qnum='q23j'; output;
qvalue = q23k; qnum='q23k'; output;
qvalue = q23l; qnum='q23l'; output;
qvalue = q24a; qnum='q24a'; output;
qvalue = q24b; qnum='q24b'; output;
qvalue = q24c; qnum='q24c'; output;
qvalue = q24d; qnum='q24d'; output;
qvalue = q24e; qnum='q24e'; output;
qvalue = q24f; qnum='q24f'; output;
qvalue = q24g; qnum='q24g'; output;
qvalue = q24h; qnum='q24h'; output;
qvalue = q24i; qnum='q24i'; output;
qvalue = q24j; qnum='q24j'; output;
format qnum $qnumfmt.;
```

```
keep participant_id qvalue qnum;
run;

proc sgpanel data=resource_long;
panelby qnum/columns=4 novarname spacing=4;
vbar qvalue/barwidth=.6;
format qvalue usefmt.;
label qvalue='Effect on Stress';
run;

/*other associations?-future questions - don't want to overtest the data*/
proc ttest data=test100;
where exclude_flag NE 1;
class use24i;
var RecoveryRatio;
run;
proc npar1way data=test100 wilcoxon;
where exclude_flag NE 1;
class use24i;
var RecoveryRatio;
run;


***********************************************HELP_EFFECTIVE9.SAS***************************;
*************ANALYZE question 26 for MOST EFFECTIVE TYPE OF HELP*******************;
/* Rural residents prefer community resources over external. */
/* Analyze question 26, var help_effective, show distribution */

/*can merge in dis_paperissues by participant_id*/
/*this is the set with mainly double or triple selections for question 26*/


proc format;
    value helpfmt 0='Things I did for myself' 1='Help from my community'
        2='Help from outside my community' 8='No difference'
        9='None of these helped decrease my stress';
run;

ods noproctitle;

proc freq data=testing6;
    where exclude_flag NE 1 and help_effective NE .;
    table help_effective help_effective*(occ_group sex age_group event_type
        IESpast_group)/plots=freqplot;
    format help_effective helpfmt.;
    title "Most Effective Help";
run;
title;

proc freq data=testing6;
    where exclude_flag NE 1 and help_effective NE .;
    tables help_effective*occ_group/fisher;
    title 'Most Effective Help by occ_group';
    run;
title;

proc sgplot data=testing6;
    where exclude_flag NE 1;
    hbar help_effective;
    format help_effective helpfmt.;
run;

proc sgplot data=testing6;
    where exclude_flag NE 1;
    hbar help_effective/group=occ_group;
    format help_effective helpfmt.;
run;

proc sgplot data=testing6;
    where exclude_flag NE 1;
    hbar help_effective/group=sex;
    format help_effective helpfmt.;
run;
```

```
proc sgplot data=testing6;
    where exclude_flag NE 1;
    hbar help_effective/group=event_type;
    format help_effective helpfmt.;
run;

*Effect of counselor or health professional where used;

proc format;
    value effectfmt -1="Decreased stress" 0="No effect on stress"
        1="Increased stress" 8='Did not use';
run;

proc sgplot data=test100;
    where exclude_flag NE 1;
    hbar q23e;
    format q23e effectfmt.;
run;

proc sgplot data=test100;
    where exclude_flag NE 1;
    hbar q23f;
    format q23f effectfmt.;
run;


****************************************ANALYSIS10.SAS************************************;
*******************EXTRA CURIOSITIES*******************************************;

*ag women had lowest PTGI - did they have high resilience? no, they had lowest BRS;

proc means data=testing6;
class occ_group sex;
var BRSavg PTGI_score;
title 'Ag Women';
run;

proc means data=testing6 maxdec=2;
where exclude_flag NE 1;
class age_group sex occ_group;
var BRSavg PTGI_score;
run;

proc sgplot data=testing6;
where exclude_flag NE 1 and sex=1;
reg x=BRSavg y=PTGI_score/group=occ_group;
run;

*did ag women have different correlations from whole population? - check N;
proc corr data=testing6;
&include and PTGI_flag = 1 and occ_group=1 and sex=1;
var BRSavg exposure_score RecoveryRatio PTGI_score IESpast_score IESnow_score;
title 'Ag Women';
run;
/*compare to whole population - check N*/
proc corr data=testing6;
&include2 and PTGI_flag = 1;
var BRSavg exposure_score RecoveryRatio PTGI_score IESpast_score IESnow_score;
title 'Overall sample';
run;
/*and to not ag women - verify N to be sure we got the right group*/
proc corr data=testing6;
&include2 and PTGI_flag = 1 and (occ_group NE 1 or sex NE 1);
var BRSavg exposure_score RecoveryRatio PTGI_score IESpast_score IESnow_score;
title 'Not Ag Women';
run;
title;


*What about minors? Differences? minor_flag=1 vs missing*/
```

```
*What about people with multiflag? multiple_events=1,2,3 or multiflag=1 vs missing;

/*view open field first_choices for qual analysis*/
proc print data=dis_qual;
where first_choices NE " ";
var occupation first_choices;
run;

************************************END**************************************************;
```

Appendix B

Complete Resource Use and Effect Scores and Ranks of 22 People, Groups, and Activities by Use Percentage, Aggregate Effect Sum, Impact Per Use (IPU), and Community Impact (CI) from the Resource Use and Effect Inventory

People, Group, or Activity	*Users*	*Respondents*	*Use %*	*Use % Rank*	*Effect Sum*	*Sum Rank*	*IPU*	*IPU Rank*	*CI*	*CI Rank*
Family	120	123	97.56%	3	-30	11	-0.250	14	-0.244	11
Friends and neighbors	122	125	97.60%	2	-33	10	-0.270	12	-0.264	10
Employer, school, or faith community (leader or group)	115	123	93.50%	5	-26	12	-0.226	15	-0.211	12
Other local leader or group (business, city council, civic club, clean-up volunteers, etc.)	108	123	87.80%	6	-52	4	-0.481	6	-0.423	4
Counselor or therapist	35	123	28.46%	22	-10	15	-0.286	10	-0.081	16
Other health professional	44	124	35.48%	21	-12	14	-0.273	11	-0.097	14
Person who had been through the same or similar thing	89	123	72.36%	15	-39	8	-0.438	8	-0.317	8
Insurance representative(s)	89	124	71.77%	16	0	18	0.000	18	0.000	18
FEMA, Farm Service Agency, or other government group	90	123	73.17%	14	30	20	0.333	20	0.244	20
Group from neighboring community	104	124	83.87%	9	-70	1	-0.673	1	-0.565	1
Outside relief group (Red Cross, Farm Rescue, etc.)	98	122	80.33%	12	-49	5	-0.500	5	-0.402	5
First responders (police, fire, ambulance)	100	124	80.65%	11	-45	6	-0.450	7	-0.363	6
Repairing, replacing, or rebuilding my own property	89	118	75.42%	13	50	21	0.562	22	0.424	21
Personal faith activities such as prayer, meditation, or readings	101	118	85.59%	7	-66	2	-0.653	2	-0.559	2
Following news or social media about the event	113	119	94.96%	4	57	22	0.504	21	0.479	22
Finding stress or recovery information on websites	59	119	49.58%	20	15	19	0.254	19	0.126	19
Talking about the event	117	119	98.32%	1	-35	9	-0.299	9	-0.294	9
Working at my occupation	99	119	83.19%	10	-10	15	-0.101	17	-0.084	15
Helping others in my community	100	119	84.03%	8	-59	3	-0.590	3	-0.496	3
Community function (fundraiser, commemoration, school activity, etc.)	79	117	67.52%	17	-42	7	-0.532	4	-0.359	7
Visiting local disaster relief center	72	117	61.54%	18	-19	13	-0.264	13	-0.162	13
Attending emergency response town hall meeting	60	118	50.85%	19	-9	17	-0.150	16	-0.076	17

Note. Negative scores represent decreased stress. Positive scores represent increased stress.

Appendix C

Frequency of response categories to "If you experienced another natural disaster in the future, which people, groups, or activities would you turn to first in order to decrease your stress? List up to 3."

Family 32

Friends 21

Faith, church, and God 19

Outside relief groups 15

- Red Cross
- Salvation Army
- Samaritan's Purse
- Dream Team
- United Way
- Lutheran Family Services
- Nebraska Extension

Neighbors 12

Community 12

Workplace/employer/co-workers 6

Organized local groups/volunteers 5

- High school
- Scout
- Church
- Rotary

Emergency responders/management 5

First responders 4

Insurance 4

Local business 3

- Equipment rental
- Utilities

Doctor/therapist 2

Activities each with single mention

- Volunteer
- Care for family/friends/homes
- Preplanning (online guidance)
- Have money or somewhere to go