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## Examining the Relationship between Drought and Mental Health Outcomes of Depression and Anxiety in the U.S.

Robyn J. Cathey  
*Georgia State University*

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## Abstract

Examining the relationship between drought and mental health outcomes of depression and anxiety in the U.S.

By

Robyn J. Cathey

December 4, 2017

**BACKGROUND:** Drought is likely linked to depression and anxiety through environmental and economic factors. Having a better understanding of this relationship would assist public health officials and policy-makers in future drought preparedness and mitigation strategies.

**METHODS:** Depression and anxiety data were collected for 36 states from HCUPnet, an online system of hospital inpatient and emergency department information. Drought data were collected from the U.S. Drought Monitor, a weekly monitor integrating multiple drought indices to produce a single index, for 2011-2014. Proportions were calculated for state hospital mental health discharges from total state hospital discharges. Annual state drought data was dichotomized based on a 30% areal drought threshold for drought exposure conditions. Repeated measures ANOVA was used for analysis of the relationship between states' depression and anxiety discharges and states' drought exposure.

**RESULTS:** The effect of time on depression was significantly different for states in the exposed and unexposed condition,  $F(3, 32) = 4.22, p = 0.01$ . The effect of time on anxiety was not different for states in the exposed and unexposed drought conditions,  $F(3, 32) = 1.92, p = 0.15$ . Post-hoc comparisons using four paired samples t-tests indicated a significant effect of drought exposure on depression comparing exposed drought condition with unexposed drought condition during 2011, 2012, 2013 and 2014. A significant effect of drought exposure condition on anxiety comparing exposed drought condition with unexposed drought condition during 2011, 2012, 2013 and 2014.

**CONCLUSION:** Depression and anxiety discharges differed over time and between states in the exposed and unexposed drought conditions from 2011-2014. Depression and anxiety discharges were higher for states in the unexposed drought condition. Further research would refine the examination of this relationship.

Examining the relationship between drought and mental health outcomes of depression and anxiety in the U.S.

by

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B.S., Albany State University

A Capstone Submitted to the Graduate Faculty  
of Georgia State University in Partial Fulfillment  
of the  
Requirements for the Degree

MASTER OF PUBLIC HEALTH

ATLANTA, GEORGIA  
30303

APPROVAL PAGE

Examining the relationship between drought and mental health outcomes of depression and anxiety in the U.S.

by

Robyn J. Cathey

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## Author's Statement Page

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Robyn J. Cathey

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Signature of Author

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## Introduction

Climate change is one of the most well-known and destructive threats to human health of the 21<sup>st</sup> century (Costello et al., 2009; Myers & Patz, 2009). Global and U.S. temperatures are rising steadily and subsequently influencing human health (Berry et al., 2010; Karl et al., 2009). The proliferation of more frequent and severe natural disasters is a direct result of ongoing climate change (Berry et al., 2011; Bi & Parton, 2008; Garcia & Sheehan, 2016). Drought is a type of natural disaster, brought on by recurrent periods of prolonged dryness and deficits in precipitation leading to a scarcity of water (Heim, 2002; Vins et al., 2015; Wilhite and Glantz, 1985). Drought has been characterized as a complex and far-reaching disaster (Coelho et al., 2004). A great portion of the U.S. nearly always experiences drought conditions. In 2012 the U.S. experienced one of its most costly natural disasters and weather-related events via a drought and heat wave, affecting the Western, Midwestern, and Southern regions, totaling about \$31 billion (National Climatic Data Center, 2017). The aims of this research study were to examine the relationship between drought and depression and anxiety, and to better understand the public health implications of the relationship between drought and depression and anxiety.

There is a need for more quantitative research focusing on drought and various mental health outcomes, such as depression and anxiety. The annual prevalence rate of depression and anxiety in the general population is expected to increase, on average, from 10% to 20% in response to a natural disaster (Chand & Murthy, 2008). The few studies that do exist on drought and mental health have not provided much empirical evidence on drought and depression and anxiety (Dean & Stain, 2010; Hossain et al., 2008; Keshavarz, Karami, & Vanclay, 2013; Vins et al., 2015). Previous studies pertaining to drought and mental health have been mostly qualitative, and mainly focused on emotional and psychological distress but not depression or anxiety. In a

study on the impact of drought and mental health by Edwards et al. (2015), the main findings indicated that the rate of mental health problems was significantly higher in areas in drought than areas not in drought, however specific mental health illnesses were not considered. In a second study examining the association between drought and distress by O'Brien et al. (2014), extreme drought was associated with increased distress. Additional literature by Vins et al. (2015) and Zamani et al. (2006) have been systematic reviews over drought and mental health illnesses. Although drought has been linked to general mental health, pertaining to distress and worry, at the present time there is a gap in the literature concerning the relationship between drought and specific mental health illnesses (Folger & Cody, 2014; Stanke et al., 2013; Vins et al., 2015; Bourque & Willox, 2014).

A majority of the existing literature on climate and natural disaster research has comprehensively linked hurricanes, floods, heat waves, and earthquakes to psychological well-being and mental health illnesses (Berry et al., 2010; Albrecht et al., 2014; Dean & Stain, 2010; Hall & Scheltens, 2005; Fritze et al., 2008; Stain et al., 2011). It has been well documented that the mental health outcomes related to natural disasters include anxiety and mood disorders, acute stress and post-traumatic stress disorders, depression, drug and alcohol abuse, and feelings of grief, hopelessness and suicidal ideation (Berry et al. 2010; Coyle & Susteren, 2012; Fritze et al., 2008; Stanke et al. 2012; Swim et al., 2011). Mental health outcomes of natural disasters vary by the disaster type, speed of onset and magnitude (Fritze et al., 2008). For example, disasters with a rapid onset and great in magnitude, such as Hurricane Katrina in 2005, are associated with acute stress and post-traumatic stress disorders, depression and suicide (Coyle & Susteren, 2012). Mental health outcomes associated with drought include depression and anxiety (Berry et al., 2010; Coelho et al., 2004).

Drought likely impacts mental health, given the numerous stressors associated with drought. After the onset of a drought, there are water shortages which cause crop damage (Adlong, 2015). When crop damage is great, agricultural businesses close, employees lose jobs and debt is accrued (Adlong & Dietsch, 2015; Barreau, 2007; Sartore et al., 2007). Material resources and services can become depleted, often forcing members of the community to migrate. Such circumstances lead to financial hardship, loss of people, place and property, and broken social networks (Albrecht et al., 2007; Bourque & Willox, 2014; Coelho et al., 2004; Fritze et al., 2008). It is anticipated that chronic stress, as a result of environmental and socio-economic degradation, links drought with depression and anxiety (Barreau, 2007; Vins et al., 2015).

Measuring drought and monitoring its mental health impacts has proven to be difficult (NOAA, 2017; Vins et al., 2015; Zamani et al., 2006). During the course of a drought, it may take years before water supply becomes deficient and additional years after prolonged deficits before resurgence and stabilization of water supply (Barreau et al., 2017). As of 2000, a minimum 6.6% and a maximum 55% of the total land area in the U.S. experienced moderate or greater levels of drought (Folger & Cody, 2014). Recognizing the development and onset of drought, and understanding the risks and impacts would facilitate quick recovery in affected areas (Stanke et al., 2013).

This study examined the relationship between drought and depression and anxiety. Having a better understanding of this relationship would improve future drought preparedness and mitigation strategies by assessing the distribution and severity of drought-related depression and anxiety outcomes (McMichael, 2011). We would also be able to identify vulnerable populations, and improve coping skills and resilience (Blashki, 2011). This paper contributes to

the literature by quantifying the impact of drought on mental health outcomes of depression and anxiety. In the current study, we hypothesized that states exposed to more severe drought conditions would have higher rates of annual depression and anxiety outcomes.

## **Methods**

### **Participants**

This study was conducted using a convenience sample of 36 states from the Healthcare Cost and Utilization Project's (HCUP) HCUPnet (see **Table 1**). HCUPnet is an online system of U.S. hospital inpatient and emergency department information. It was established by way of a Federal-State-Industry collaboration and funded by the Agency for Healthcare Research and Quality (HCUP, 2017). States were chosen for analyses based on the availability of state-level data on annual depression and anxiety counts on HCUPnet. Inclusion criteria were U.S. states with anxiety and depression counts available for four consecutive years (2011-2014). States were excluded if they were missing depression and anxiety information for any year during the selected time period.

### **Procedures**

This study used secondary, state-level data from HCUPnet and the U.S. Drought Monitor (USDM). Annual state inpatient data on depression and anxiety were obtained from HCUPnet and annual drought data were obtained from the USDM. The USDM was a collaborative effort by the National Drought Mitigation Center at the University of Nebraska-Lincoln, The United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. It is a weekly drought monitor that integrates data from multiple drought indices to produce a single measure of assorted drought conditions (e.g. meteorological, agricultural, hydrological).

## Measures

**Depression.** HCUPnet assesses depression based on each state's annual count of hospital discharges with a diagnosis of depression, classified by International Classification of Diseases-9th revision-Clinical Modification as code 311 Depressive disorder, not elsewhere classified. For the state-level outcome measure of depression, we calculated proportions for states' annual depression discharges out of the states' annual count of total hospital discharges for all diagnoses. These proportions were used to measure the portion of all state-level hospital admissions attributable to depression.

**Anxiety.** HCUPnet assesses anxiety based on each state's annual count of hospital discharges with a diagnosis of anxiety, classified by Clinical Classification Software for ICD-9-CM as code 651 Anxiety disorder. For the state-level outcome measure of anxiety, we calculated proportions for states' annual anxiety discharges out of the states' annual count of total hospital discharges for all diagnoses. These proportions were used to measure the portion of all state-level hospital admissions attributable to anxiety.

**Drought.** The cumulative USDM combines individual drought categories to measure the total percent of an area experiencing aggregated levels of multiple drought intensities. The USDM defined levels of drought intensity are *D0*, which is abnormally dry and coming into or coming out of drought; *D1*, which is moderate drought with some crop damage and slight shortages of water; *D2*, which is severe drought with some agricultural losses, water shortages and restriction; *D3*, which is extreme drought with great agricultural losses, as well as expansive water shortages; and *D4*, which is exceptional drought with substantial agricultural loss, and shortages of bodies of water provoking a crisis (see **Table 2**) (U.S. Drought Monitor). For

example, cumulative drought category D0-D4 is a state's percent area experiencing abnormally dry or worse drought intensity.

We examined cumulative drought category D2-D4, which is a state's percent area experiencing severe drought or worse (D2 or worse). The Theory of Runs by Yevjevich, (1967) has been used in previous drought studies to characterize drought in time series (Paulo & Pereira, 2006; Sheffield & Wood, 2007). It characterizes a regional or areal drought as the percentage of the total region or area reaching a specified threshold (Guerrero-Salazar & Yevjevich, 1975). According to previous literature, the most common areal drought threshold is 50 percent total land area or 30 percent total land area within a twelve month timeframe (Paulo & Pereira, 2006). We classified exposed states using an areal drought threshold of 30 percent. For the state-level exposure measure, states' drought status was dichotomized based on whether or not at least 30 percent of the total land area was exposed to D2-D4 cumulative drought category within a twelve month timeframe. States with  $\geq 30\%$  of the total land area experiencing cumulative intensities of severe to exceptional drought (D2-D4) in a given year were categorized as being in the exposed drought condition, and states with  $< 30\%$  of the total land area experiencing cumulative intensities of D2-D4 in a given year were categorized as being in the unexposed drought condition. There were 17 states in the exposed and 19 states in the unexposed drought conditions.

### **Analytic Plan**

To examine the relationship between drought exposure condition and depression and anxiety, a repeated measures analytic approach was used in the study to account for the correlation within each states' outcome observations taken across time (Warton et al., 2016). A repeated measures ANOVA was conducted to compare the relationship between drought

exposure and mean depression and anxiety hospital discharge proportions of states in the exposed and unexposed conditions. If the results of the repeated measures ANOVA were significant, individual t-tests were conducted to further investigate significant mean differences between exposed and unexposed states for each year, 2011-2014. Analyses were conducted using SAS 9.4.

## Results

### Descriptive Information

Descriptive information on the means, minimum and maximum depression and anxiety proportions for each exposure condition and time-point is summarized in Table 3. From Table 3, it can be seen that the unexposed drought condition had higher mean and maximum proportions of depression and anxiety across all four years. The exposed drought condition had higher minimum proportions of depression and anxiety across all four years. Standard deviations were similar for both conditions across all four years. Partial correlations for the error terms of mean depression proportions and mean anxiety proportions are shown in Table 4. Controlling for drought exposure condition, the proportions for each outcome was strongly correlated from 2011-2014, however the strength of correlations decreased from 2011-2014. The weakest correlations can be seen between 2011 and 2014 for both depression and anxiety. All correlations were significant for depression and anxiety time-points.

### Depression

Results of the repeated measures ANOVA examining the effect of Time on mean depression proportions showed that Time had a significant effect on states' mean depression proportions,  $F(3, 32) = 80.69, p = <.0001$  (**Table 5**). This finding suggests that there was a

significant difference in the mean proportions of states' annual depression discharges from 2011-2014. Depression discharges increased over time for both drought exposure conditions (see **Figure 1**). Further, we considered whether or not differences in mean depression proportions over each year was dependent on drought exposure condition. Results of the repeated measures ANOVA examining the effect of interaction between Time and Exposure to the drought condition on mean depression proportions showed that Time\*Exposure had a significant effect on states' mean depression proportions,  $F(3, 32) = 4.22, p = 0.01$  (**Table 5**). This finding suggests that there was a significant difference in the mean proportions of states' annual depression discharges between states in the exposed and unexposed drought conditions from 2011-2014. Results of the repeated measures ANOVA examining the effect of Exposure to the drought condition on mean depression proportions showed that Exposure condition had a significant effect on states' mean depression proportions,  $F(1, 34) = 4.43, p = <0.04$  (**Table 6**). This finding suggests that there is a significant difference in the mean proportion of depression discharges between the exposed and unexposed drought conditions.

### **Anxiety**

Results of the repeated measures ANOVA examining the effect of Time on mean anxiety proportions showed that Time had a significant effect on states' mean anxiety proportions,  $F(3, 32) = 64.25, p = <.0001$  (**Table 5**). This finding suggests that there was a significant difference in the mean proportions of states' annual anxiety discharges from 2011-2014. Anxiety discharges increased over time for both drought exposure conditions (see **Figure 2**). Further, we considered whether or not differences in mean anxiety proportions over each year was dependent on drought exposure condition. Results of the repeated measures ANOVA examining the effect of interaction between Time and Exposure to the drought condition on mean anxiety proportions



showed that Time\*Exposure did not have a significant effect on states' mean anxiety proportions,  $F(3, 32) = 1.92, p = 0.15$  (**Table 5**). This finding suggests that there was not a significant difference in the mean proportions of states' annual anxiety discharges between states in the exposed and unexposed drought conditions from 2011-2014. Results of the repeated measures ANOVA examining the effect of Exposure to the drought condition on mean anxiety proportions showed that Exposure condition had a significant effect on states' mean anxiety proportions,  $F(1, 34) = 9.64, p < 0.004$  (**Table 6**). This finding suggests that there is a significant difference in the mean proportion of anxiety discharges between the exposed and unexposed drought conditions.

### **Post-hoc analyses**

Post-hoc comparisons using four paired samples t-tests for depression showed that during 2011 mean proportions of hospital discharges were not significantly different in states in the unexposed drought condition ( $M = 0.07, SD = 0.01$ ) compared to states in the exposed drought condition ( $M = 0.06, SD = 0.01$ ),  $t(34) = 1.17, p = 0.25$ ; during 2012 mean proportions of hospital discharges were significantly different in states in the unexposed drought condition ( $M = 0.09, SD = 0.02$ ) compared to states in the exposed drought condition ( $M = 0.08, SD = 0.02$ ),  $t(34) = 2.14, p = 0.04$ ; during 2013 mean proportions of hospital discharges were significantly different in states in the unexposed drought condition ( $M = 0.10, SD = 0.02$ ) compared to states in the exposed drought condition ( $M = 0.08, SD = 0.02$ ),  $t(34) = 2.24, p = 0.03$ ; during 2014 mean proportions of hospital discharges were significantly different in states in the unexposed drought condition ( $M = 0.10, SD = 0.02$ ) compared to states in the exposed drought condition ( $M = 0.09, SD = 0.02$ ),  $t(34) = 2.42, p = 0.02$  (See **Table 7**).

Post-hoc comparisons using four paired samples t-tests for anxiety showed that during 2011 mean proportions of hospital discharges were significantly different in states in the unexposed drought condition ( $M = 0.07$ ,  $SD = 0.02$ ) compared to states in the exposed drought condition ( $M = 0.06$ ,  $SD = 0.01$ ),  $t(34) = 2.79$ ,  $p = 0.01$ ; during 2012 mean proportions of hospital discharges were significantly different in states in the unexposed drought condition ( $M = 0.09$ ,  $SD = 0.02$ ) compared to states in the exposed drought condition ( $M = 0.07$ ,  $SD = 0.02$ ),  $t(34) = 3.17$ ,  $p = 0.003$ ; during 2013 mean proportions of hospital discharges were significantly different in states in the unexposed drought condition ( $M = 0.11$ ,  $SD = 0.02$ ) compared to states in the exposed drought condition ( $M = 0.08$ ,  $SD = 0.02$ ),  $t(34) = 3.07$ ,  $p = 0.004$ ; during 2014 mean proportions of hospital discharges were significantly different in states in the unexposed drought condition ( $M = 0.12$ ,  $SD = 0.03$ ) compared to states in the exposed drought condition ( $M = 0.09$ ,  $SD = 0.02$ ),  $t(34) = 2.71$ ,  $p = 0.01$  (See **Table 7**).

### Discussion

The present study focused on the relationship between drought and specific mental health illnesses, depression and anxiety. For each year from 2011-2014 we examined potential differences in state-level hospital depression and anxiety discharges between states with higher and lower percentages of the total area experiencing severe to exceptional drought severity. By conducting a repeated measures ANOVA for the mean proportion of states' depression and anxiety discharges recorded for each year, we concluded that proportions differed over time and between drought exposure conditions. The main findings were informative, however they did not support the study hypothesis that states exposed to more severe drought conditions would have higher rates of annual depression and anxiety outcomes.

For depression and anxiety, annual mean proportion of hospital discharges increased over time for states in both drought exposure conditions. Increases in depression and anxiety across all states over time are likely concurrent with shifts in the U.S. climate (Bourque & Willox, 2014). Although mean proportions of both examined mental health outcomes increased over time, only changes in mean proportions of depression significantly differed between the two drought exposure conditions over time. Additionally, mean proportions of depression and anxiety discharges differed between the states in the exposed and unexposed drought conditions. Differences in drought-related outcomes are likely produced by variations in a location's geography, climate, groundwater availability and demographics.

The results of interest in this study, testing whether mean proportions of depression and anxiety discharges were higher for states in the exposed drought condition compared to states in the unexposed drought condition, were disappointing. Although all states increased in mean depression and anxiety proportions, states in the unexposed drought condition had higher mean proportions of depression and anxiety from 2011-2014. This finding was contradictory to the study hypothesis and findings of previous studies. Edwards et al. (2015) examined the impacts of drought in rural and regional Australia, and found that if the study population had not been exposed to drought then mental health incidence would be 10.5% less than observed. Similarly, Barreau et al. (2017) examined the impacts of drought in two California counties, and found that households exposed to drought reported symptoms of acute stress and considered migration.

There are a few possible explanations for the results in this study deviating from what we hypothesized. Unmeasured factors differentiating states in the exposed drought condition from states in the unexposed drought condition could not be captured from the data used in the analyses. It is likely that regional-, state- or county-level differences in demographic,

environmental, economic and societal factors may better explain our findings (Barreau et al., 2017). Populations residing within states that were in the unexposed drought condition could be predisposed to higher incidence of depression and anxiety, unrelated to the drought condition, due to inaccessible mental health services or refusal to use such services (Bourque & Willox, 2014; Sartore et al., 2007). Another consideration is the possibility of populations of individuals with drought-related depression or anxiety migrating from states in the exposed drought condition to states in the unexposed drought condition (Edwards et al., 2015).

This study contributes to the existing literature by improving the understanding of the complex relationship between drought and various mental health illnesses, specifically depression and anxiety. Results have shown that examining this relationship at an aggregated level does not allow researchers to observe the scope of the impact of drought on mental illnesses (Barreau et al., 2017). Although we did not have clinically significant findings, they do highlight the need for further studies examining additional factors which may determine a population's vulnerability to drought-related depression and anxiety (Chand & Murthy, 2008; McMichael, 2011). Results also showed that the number of U.S. hospital discharges related to depression and anxiety are rising steadily which may be attributed to other factors, potentially in addition to drought.

There are several major limitations of this study. The analyses were restricted to the use of aggregated data from HCUPnet and the USDM. The unit of analysis being at the state-level, data in the study only considered overall mental health outcomes and drought exposure for states not for patients or locales within those states. The use of individual-level data would have enabled us to consider covariates related to drought exposure such as the environmental and economic factors previously mentioned. The loss of information due to collapsing the data to the

state level may not have provided enough information to detect statistically significant differences in depression and anxiety between populations exposed and unexposed to drought. Measuring drought at the state level is not especially informative due to drought status and its associated impacts varying for different localities and populations (Barreau et al., 2015; O'Brien et al., 2014). It is likely that conducting this study using drought data for counties, cities or regions and mental health data collected for patients with additional covariates, across a shorter time-frame (e.g., months or weeks), may have been more robust to statistical analysis.

Future research should examine the relationship between drought and specific mental health illnesses using drought data for smaller areas, recorded at multiple time-points within a wider range of time, and patient-level data with associated covariates (e.g. income, urban vs. rural place of residence) (Bourque & Willox, 2014). Researchers should consider the variation in drought conditions and impacts between different regions or counties within a state. There may also be a delay from the time of drought onset until drought conditions and mental health outcomes become apparent (Zamani et al., 2002). Future research should examine the time it may take for drought and mental health outcomes to emerge, by level severity. The findings of this study demonstrate the need for more in depth research into drought and specific mental health outcomes. They are also indicative that a comprehensive study may emphasize the link between drought and mental health.

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**Table 1.**  
*States' Annual Depression and Anxiety Summaries for Proportions of Related Diagnoses*

		Mental Health Outcomes by Year							
Drought Condition	State ( <i>n</i> = 36)	Depression				Anxiety			
		2011	2012	2013	2014	2011	2012	2013	2014
Exposed ( <i>n</i> = 17)	Arizona	0.06	0.08	0.08	0.08	0.06	0.08	0.09	0.10
	Arkansas	0.06	0.08	0.09	0.09	0.05	0.07	0.08	0.09
	California	0.05	0.05	0.06	0.06	0.04	0.05	0.06	0.07
	Colorado	0.09	0.10	0.11	0.11	0.07	0.08	0.09	0.10
	Florida	0.06	0.08	0.08	0.09	0.06	0.09	0.10	0.11
	Iowa	0.08	0.09	0.10	0.10	0.05	0.07	0.08	0.08
	Kansas	0.07	0.08	0.09	0.10	0.06	0.08	0.09	0.11
	Missouri	0.09	0.10	0.11	0.12	0.08	0.11	0.13	0.14
	Nebraska	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06
	Nevada	0.05	0.06	0.06	0.07	0.05	0.06	0.07	0.08
	New Mexico	0.06	0.08	0.08	0.08	0.05	0.07	0.08	0.09
	Oklahoma	0.07	0.09	0.10	0.10	0.06	0.08	0.10	0.10
	Oregon	0.09	0.10	0.11	0.11	0.07	0.09	0.10	0.11
	South Carolina	0.06	0.08	0.09	0.09	0.06	0.08	0.09	0.10
	Texas	0.05	0.06	0.07	0.07	0.05	0.06	0.07	0.08
	Utah	0.06	0.06	0.06	0.07	0.05	0.06	0.07	0.09
	Wyoming	0.06	0.07	0.09	0.10	0.04	0.05	0.07	0.08
Unexposed ( <i>n</i> = 19)	Hawaii	0.03	0.03	0.03	0.04	0.03	0.04	0.04	0.05
	Illinois	0.06	0.07	0.08	0.09	0.06	0.08	0.09	0.10
	Indiana	0.08	0.10	0.11	0.12	0.07	0.09	0.11	0.12
	Kentucky	0.07	0.10	0.11	0.12	0.08	0.11	0.13	0.17
	Maine	0.06	0.08	0.08	0.09	0.07	0.10	0.11	0.11
	Maryland	0.08	0.10	0.10	0.11	0.07	0.09	0.10	0.11

Massachusetts	0.08	0.10	0.11	0.11	0.08	0.11	0.12	0.14
Michigan	0.08	0.10	0.11	0.12	0.07	0.10	0.11	0.12
Minnesota	0.08	0.10	0.10	0.10	0.08	0.11	0.12	0.13
New Jersey	0.05	0.06	0.07	0.07	0.05	0.07	0.08	0.09
New York	0.06	0.07	0.08	0.08	0.05	0.07	0.08	0.09
North Carolina	0.06	0.08	0.10	0.11	0.06	0.09	0.11	0.13
North Dakota	0.08	0.11	0.12	0.12	0.06	0.09	0.10	0.12
Rhode Island	0.08	0.10	0.12	0.14	0.09	0.12	0.14	0.17
Tennessee	0.07	0.09	0.09	0.10	0.07	0.09	0.11	0.12
Vermont	0.09	0.12	0.13	0.12	0.07	0.10	0.11	0.12
Washington	0.07	0.09	0.10	0.10	0.10	0.09	0.08	0.06
West Virginia	0.07	0.11	0.12	0.12	0.09	0.13	0.15	0.15
Wisconsin	0.08	0.11	0.11	0.12	0.07	0.10	0.11	0.13

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*Note. Values for mental health outcomes represent proportions of discharges related to depression and anxiety out of all hospital discharges. Individuals may be counted for both depression and anxiety.*

**Table 2.**  
*U.S. Drought Monitor Categories and Descriptions*

Category	Description	Potential Effects
D0	Abnormally Dry	Onset of drought; dryness and slow growth of crops Nearing the end of drought: Some water shortages and slight damage to crops
D1	Moderate Drought	Damaged crop; water deficits in streams, reservoirs and wells; potential water-use restrictions
D2	Severe Drought	Losses of crops, major water shortages and water restrictions
D3	Extreme Drought	Wide-spread loss of crops, and water shortages and restrictions
D4	Exceptional Drought	Exceptional loss of crops and water deficit emergencies

**Table 3.***Descriptives for Depression and Anxiety Proportions by Drought Condition and Year*

Year	Drought Unexposed ( $n = 19$ )				Drought Exposed ( $n = 17$ )			
	<i>M</i>	<i>SD</i>	Min	Max	<i>M</i>	<i>SD</i>	Min	Max
<b>Depression</b>								
2011	0.07	0.01	0.02	0.09	0.06	0.01	0.05	0.09
2012	0.09	0.02	0.03	0.12	0.08	0.02	0.05	0.10
2013	0.10	0.02	0.03	0.13	0.08	0.02	0.05	0.11
2014	0.10	0.02	0.04	0.14	0.09	0.02	0.05	0.12
<b>Anxiety</b>								
2011	0.07	0.02	0.03	0.10	0.06	0.01	0.04	0.08
2012	0.09	0.02	0.04	0.13	0.07	0.02	0.05	0.11
2013	0.11	0.02	0.04	0.15	0.08	0.02	0.06	0.13
2014	0.12	0.03	0.05	0.17	0.09	0.02	0.06	0.14

**Table 4.***Partial Correlation Coefficients for 2011-2014 Depression and Anxiety Proportions*

Year	Depression				Anxiety			
	2011	2012	2013	2014	2011	2012	2013	2014
2011	1.00	0.94*	0.90*	0.88*	1.00	0.89*	0.76*	0.60*
2012	0.94*	1.00	0.97*	0.94*	0.89*	1.00	0.96*	0.87*
2013	0.90*	0.97*	1.00	0.98*	0.76*	0.96*	1.00	0.96*
2014	0.88*	0.94*	0.98*	1.00	0.6*	0.87*	0.96*	1.00

*Note. \*p < .001*



**Table 5.**  
*Multivariate Results from Repeated Measures ANOVA*

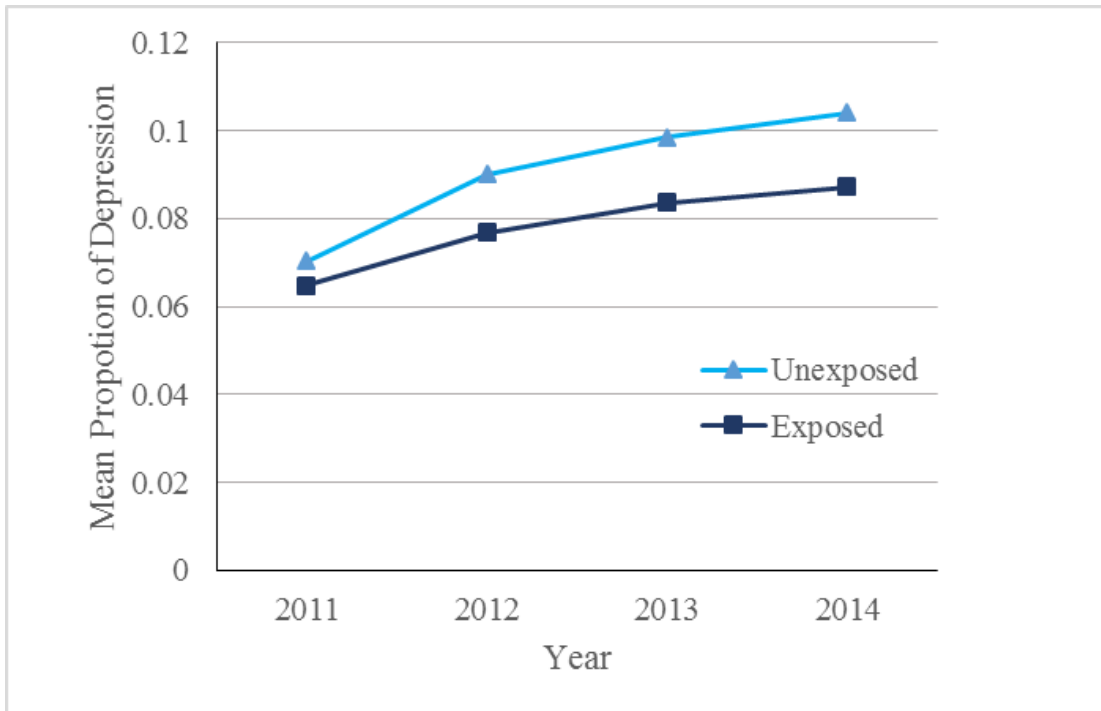
Effect	<i>Wilks' Lamda</i>	<i>F</i>	<i>Num df</i>	<i>Den df</i>	<i>p</i>
Depression					
Time	0.11	80.69	3	32	< .001
Time*Exposure	0.72	4.22	3	32	0.01
Anxiety					
Time	0.14	64.25	3	32	< .001
Time*Exposure	0.85	1.92	3	32	0.15

**Table 6.**  
*Repeated Measures ANOVA for Between Subjects Effects*

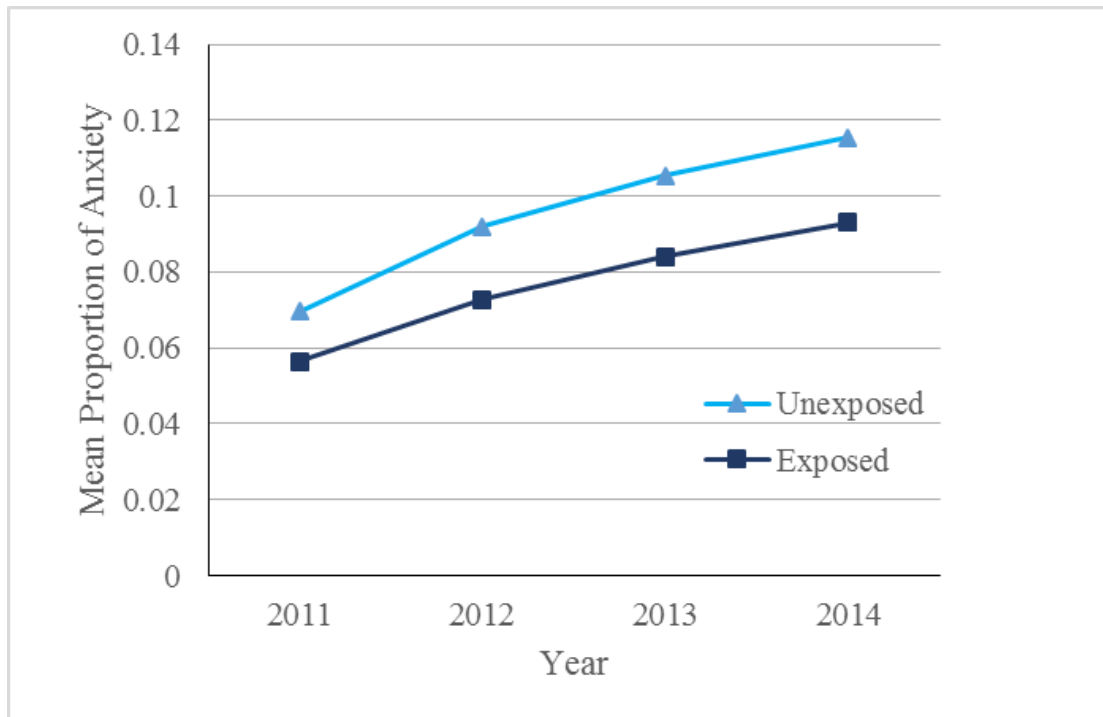
Effect	<i>MS</i>	<i>df</i>	<i>F</i>	<i>p</i>
Depression				
Exposure	0.006	1	4.43	0.04
Error	0.001	34		
Anxiety				
Exposure	0.01	1	9.64	0.004
Error	0.001	34		

**Table 7.***Mean Differences and 95% Confidence Intervals from Post-Hoc t-Tests by Year*

Year	Effect	Compare	Mean Diff	Simultaneous 95% Confidence Limits		<i>t</i> -value	<i>df</i>	<i>p</i>
				Lower	Upper			
Depression								
2011	Exposure	Unexp vs. Exp	0.005	-0.004	0.02	1.17	34	0.25
2012	Exposure	Unexp vs. Exp	0.01	0.0007	0.03	2.14	34	0.04
2013	Exposure	Unexp vs. Exp	0.02	0.001	0.03	2.24	34	0.03
2014	Exposure	Unexp vs. Exp	0.02	0.003	0.03	2.42	34	0.02
Anxiety								
2011	Exposure	Unexp vs. Exp	0.01	0.004	0.02	2.79	34	0.009
2012	Exposure	Unexp vs. Exp	0.02	0.007	0.03	3.17	34	0.003
2013	Exposure	Unexp vs. Exp	0.02	0.007	0.04	3.07	34	0.004
2014	Exposure	Unexp vs. Exp	0.02	0.006	0.04	2.71	34	0.01



**Figure 1.** *Change in Mean Depression Proportions over Time by Drought Exposure*



**Figure 2.** *Change in Mean Anxiety Proportions over Time by Drought Exposure*