

5-2023

Examining the Effects of Experiencing a Tornado on Rates of Suicide

Jessica Lowder
University of Nebraska Medical Center

Tell us how you used this information in this [short survey](#).

Follow this and additional works at: https://digitalcommons.unmc.edu/coph_slce



Part of the [Public Health Commons](#)

Recommended Citation

Lowder, Jessica, "Examining the Effects of Experiencing a Tornado on Rates of Suicide" (2023). *Capstone Experience*. 243.

https://digitalcommons.unmc.edu/coph_slce/243

This Capstone Experience is brought to you for free and open access by the Master of Public Health at DigitalCommons@UNMC. It has been accepted for inclusion in Capstone Experience by an authorized administrator of DigitalCommons@UNMC. For more information, please contact digitalcommons@unmc.edu.

Examining the Effects of Experiencing a Tornado on Suicide Rates

Jessica Lowder, M.P.H.

Epidemiology

University of Nebraska Medical Center

Committee

Chair:

Keith Hansen, M.B.A. Instructor, Department of Epidemiology, Co-Director of the Center for Preparedness Education, Co-Director of the Association of Healthcare Emergency Preparedness Professionals

Committee Members:

Leslie Scofield, M.P.H Instructor, Department of Epidemiology, Director of First Responder Education

Kristina Kintziger, PhD Associate Professor, Department of Environmental, Agricultural & Occupational Health

Abstract

Background: Suicide rates in the United States have been on the rise in recent years. As of 2020, suicide was the 12th leading cause of death in the country. Climate change has also contributed to an increase in tornadoes. Studies have found that experiencing a natural disaster is associated with an increase in suicide rates. Studies examining suicide rates and tornadoes, specifically, are virtually nonexistent.

Methods: The exposure groups were those living in three different tornado-affected regions. The comparison group consisted of those living in the larger geographical region. Mortality data was obtained from the CDC, tornado-related data was collected from FEMA, and additional covariates were obtained from FEMA's National Risk Index. Stratified time trends and Chi-square analyses were used to determine whether there is a relationship between experiencing a tornado and increased suicide rates.

Results: Time trends showed that nearly every group examined experienced an increase in suicide rates during the year that the tornadoes occurred. Chi-square analyses found that there is a relationship between year and gender, as well as year and race, among those who died by suicide. There are also associations between several Risk Index measures and race and urbanization status.

Conclusion: Based on the time trends, it can be tentatively concluded that experiencing a tornado is associated with an increase in suicide. However, the significant Chi-square results may be due to other factors and future research is needed to conclusively state that there is a relationship between suicide and tornadoes.

Table of Contents

Chapter 1: Introduction.....	5
Mental Health and Disasters	
Specific Aims	
Chapter 2: Background and Literature Review.....	7
Background	
Literature Review	
Limitations and Gaps in Existing Literature	
Rationale	
Chapter 3: Data and Methods.....	13
Study Design and Population	
Variables and Data Sources	
<i>Exposure</i>	
<i>Outcome</i>	
<i>Covariates</i>	
Analytic Plan	
Chapter 4: Results.....	19
Descriptive Data	
<i>Study Population</i>	
<i>Social Vulnerability and Community Resilience</i>	
Main Results	
<i>Time Trends</i>	
<i>Covariate Associations Among Suicide Deaths</i>	
Other Analyses	
Chapter 5: Discussion.....	31
Key Results	
Strengths and Limitations	
Summary	
Cited Literature.....	37
Biography and CV.....	41

Tables and Figures Key

Table 1: Tornado Events.....	13
Table 2: National Risk Index Estimates.....	17
Table 3: Study Population Demographics by Region and Year.....	20
Table 4: Risk and Community Resilience Ratings by Region.....	21
Figure 1: Mortality Time Trends by Region.....	23
Figure 2: Mortality Time Trends by Region and Gender.....	25
Figure 3: Mortality Time Trends by Region and Race.....	27
Figure 4: Mortality Time Trends by Region and Urbanization.....	28
Table 5: Covariate Chi-Square Statistics.....	29
Table 6: Risk Rating Chi-Square Statistics.....	30

Chapter 1: Introduction

Mental Health and Disasters

Many studies have found that there is an association between natural disasters and negative mental health outcomes. Most people will recover quickly following a disaster. Some may even experience post-traumatic growth, which is an increase in “the belief in their ability to manage future challenges”.²⁸ However, others will experience negative mental health outcomes or develop psychological disorders, namely post-traumatic stress disorder (PTSD), depression, and anxiety.²⁸ A meta-analysis conducted by Beaglehole et al. found that there are increases in the rates of psychological distress, psychiatric disorder, depression, and post-traumatic stress disorder after a disaster.⁵ “Between one third and one half of those impacted by disasters will develop mental distress in the post-disaster period”.²⁰ Another study conducted by Adams et al. stated that 10-20% of adults who experience a disaster will develop significant mental health problems.¹ Adolescents are also at risk. Studies examining mental health outcomes in adolescents following a natural disaster “have generally reported higher prevalence estimates of mental health disorders than have been reported in adult samples”.¹

Tornadoes, specifically, have been found to contribute to increased rates of mental illness, particularly PTSD. A study conducted following the 2011 Alabama tornadoes found that 22.1% of the adult effected population showed symptoms of PTSD.²¹ Another study examined the mental health of 288 adolescents and their parents one year after several tornadoes struck southern Minnesota in 1998. Approximately 18% of parents and 13% of adolescents displayed symptoms of PTSD.²¹ A study conducted in rural Oklahoma in 2000, one year after a severe tornado, found that approximately 25% of school-aged children met the *DSM-IV* criteria for

PTSD.¹ The study conducted by Adams et al. found that, following the 2011 tornado outbreak, “approximately 1 in 15 adolescents met criteria for PTSD and more than 1 in 13 met criteria for MDE”, or major depressive episode.¹

Specific Aims

Studies have found an increase in mental illness following natural disasters. However, there are few studies examining the relationship between mental health and tornadoes, particularly among adults. There is also limited research on whether these negative mental health outcomes result in an increased rate of suicide. Therefore, the aim of this research is to determine whether there is an increase in the rate of suicide after a tornado has occurred. Given the evidence of increased mental illness symptoms following a disaster, it is hypothesized that the rate of suicide will also increase following a tornado when compared to the pre-disaster suicide rate, as well as compared to the rest of the region that did not experience a tornado.

Chapter 2: Background and Literature Review

Background

In recent years, the United States has seen a dramatic increase in rates of suicides and non-fatal suicidal behaviors. A study conducted between 2015 and 2018 found that non-fatal suicidal behaviors, which are defined as suicidal ideation, plans, and attempts, increased significantly. “From 2015 to 2018, there was a 16.0% increase in suicide ideation, 18.6% increase in suicide planning, and 11.6% increase in suicide attempts.”³¹ In 2020, 12.2 million adults aged 18 and older reported experiencing serious thoughts of suicide, 3.2 million adults reported making suicide plans, and 1.2 million adults attempted suicide.³⁰ Several studies have identified an “ideation-to-action” framework in which “suicidal ideation, suicide planning, and suicide attempt form a continuum of suicidal thoughts and behavior, all serving as precursors to death by suicide with each point along the continuum predicting a successive step (e.g., suicidal ideation predicting suicide plan, which predicts suicide attempt)”.²³

Rates of suicide have increased in tandem with rates of non-fatal suicidal behaviors. “The total age-adjusted suicide rate in the United States increased 35.2% from 10.4 per 100,00 in 2000 to 14.2 per 100,000 in 2018, before declining to 13.9 per 100,000 in 2019 and declining again to 13.5 per 100,000 in 2020.”³⁰ In 2020, suicide was the 12th leading cause of death in the country, claiming 45,979 lives.³⁰ This equals an average of 130 suicides per day, or 1 death every 11 minutes.^{3,9} “Suicide was the second leading cause of deaths among individuals between the ages of 10-14 and 25-34, the third leading cause of death among individuals between the ages of 15-24, and the fourth leading cause of deaths among individuals between the ages of 35 and 44.”³⁰

There are several proven risk factors that contribute to suicidal behaviors and death by suicide, including prolonged stress, stressful life events, serious physical health conditions, a sense of hopelessness, loss of relationships, and a lack of access to healthcare.^{2,8} These risk factors can be caused, in part, by experiencing a natural disaster. Disasters can cause the loss of loved ones, homes, employment opportunities, and entire communities, which could then contribute to suicidal behaviors in disaster survivors.

In addition to an increase in suicide rates, the U.S. has experienced an increasing number of tornadoes in recent years due, in large part, to climate change.^{27,29} Research has shown that the frequency of days each year with multiple tornadoes has increased, which yields higher casualties than days where only one tornado occurs in an area. It has also been found that “Tornado Alley”, the geographic area in which the majority of tornadoes occur, is shifting from the Midwest to the Southeast.²⁷ Unlike the majority of tornadoes that appear in the Midwest, Southeastern tornadoes can occur at any time of day. This increases the likelihood of nighttime tornadoes, which prevent people from easily seeing the tornado coming and responding appropriately.⁶ Communities in Southeastern states are less likely to be adequately prepared, leading to higher casualty rates.^{6,27} These ongoing changes in tornado activity put communities at risk for significant damage, which then puts survivors at risk of developing mental illness symptoms and suicidal behaviors.

Literature Review

Several studies have shown that there is an increase in the rate of suicide and suicidal behaviors after a disaster has occurred. One study conducted in 2017, two months after Hurricane Harvey made landfall, examined suicidal ideation among those who were living in the counties most impacted by the storm. The researchers found that approximately 10 percent of the subjects reported experiencing suicidal ideation, nearly 2.5 times the national average.¹⁹ A study conducted by Horney et al. examined the suicide rates following severe storms, flooding, hurricanes, and severe ice storms. They found that, in the three years following a natural disaster, the overall suicide rate increased during the first and second years and decreased in the third year.²⁰ A systematic literature review conducted by Kőlves et al. reported that, following Hurricane Andrew in 1992, there was an “increase in homicide-suicides during the 6 months after the disaster” and there was a slight increase in youth suicides. In a one-year follow-up following Hurricane Katrina, there was a significant increase in suicidal ideation and plans. Those who had been displaced by the hurricane experienced “high levels of suicidal ideation and suicide attempts compared to the State and national levels”.²⁴

Conversely, some studies have shown that there is either a decrease or no discernable difference in suicides and suicidal behaviors after a disaster. A study examining the influence of the September 11, 2001 terrorist attacks found that the overall suicide rate in New York City declined over a 17-year period, with the attacks having no influence on the rate.²⁶ The study conducted by Kőlves et al. stated that, following the Northridge earthquake in California, there was a marked decrease in suicides for the three years following the disaster compared to the three years prior to the earthquake. There were also two papers that found a decrease in reported

suicidal ideation and plans in the five to eight months following Hurricane Katrina.²⁴ A study examining all federal disaster events in the United States between 1982 and 1989, encompassing 377 disaster-affected counties, found that there was not a significant difference in suicide rates between the 36 months pre-disaster and 48 months post-disaster.⁴

One article stated that these contrasting findings may be due to disasters having competing effects on suicide rates. “Economic and social dislocation may increase the rate of suicide, but the “pulling together” effect may mitigate or even reduce suicides”.⁴ This concept is demonstrated in one of the studies highlighted in the systematic review conducted by Kølves et al. Following the 2009 Red River Flood in North Dakota, “greater amounts of time spent volunteering in flood recovery efforts were associated with increased feelings of belonging and decreased feelings of burdensomeness”.²⁴

Disaster mental health professionals have identified several phases that a community can experience after a disaster, which provides additional evidence to support this theory. The Honeymoon phase takes place immediately after the disaster has occurred, coinciding with an increased availability of government and volunteer assistance. The community bonds through the shared disaster experience, as well as giving and receiving assistance. Rates of suicidal behaviors decrease due to the availability of support services.²⁸ The Disillusionment phase, which immediately follows the Honeymoon phase, “is characterized by disappointment as disaster assistance agencies and volunteer groups pull out of the community and hopes for restoration to pre-disaster emotional and physical wellness go unmet.”²⁸ During this phase, resentment can arise when survivors receive unequal assistance or less impacted neighboring communities have returned to normal. This weakens the sense of community and negatively impacts the mental

health of community members, leading to a rise in suicidal behaviors. The one-year anniversary of the disaster commonly occurs during this period, which also has a negative impact on the mental health of the survivors.²⁸ Finally, is the Reconstruction phase, which can often last years after a disaster event. During this period, survivors are attempting to rebuild their lives and the rates of suicide and suicidal behaviors return to pre-disaster levels.²⁸

Limitations and Gaps in Existing Literature

The mixed findings of recent studies have highlighted the need for more research, particularly when examining tornadoes. There are a very limited number of studies that have been conducted after a tornado, with the majority focusing on depression and PTSD symptoms.^{1,21,25} Additionally, a large portion of this research exclusively analyzed mental illness among children and adolescents.^{1,21,25}

The current research regarding natural disasters and suicide largely focuses on earthquakes and hurricanes.²⁴ Studies examining the relationship between experiencing a tornado and suicide are almost non-existent. A literature review analyzing tornado specific mental illness research found only one study discussing suicidal behaviors. That study found that “about 5% of 2,000 adolescents who experienced the Joplin and Tuscaloosa tornadoes in the spring of 2011 reported suicidal thoughts.”²⁵ Research analyzing the relationship between experiencing a tornado and completed suicide has yet to be made available. This leaves public health and healthcare professionals at a disadvantage when preparing for and responding to a tornado.

Rationale

In addition to attempting to fill a gap in the limited existing literature, climate change and its influence on natural disasters was a determining factor in this project. As previously discussed, the U.S. is experiencing a shift in tornado activity. This makes the results of this project more important than ever, as it will allow public health, mental health, and emergency preparedness professionals to prepare for and respond to tornadoes more effectively. If this study provides evidence of an association between experiencing a tornado and suicide, more resources can be directed to the effected communities during the emergency response and recovery periods. Mental health professionals can work to interrupt the suicide ideation-to-action framework early on, potentially preventing suicides from occurring. If this study finds that experiencing a tornado does not have a significant impact on suicide rates, the limited emergency response resources can be directed elsewhere, where they are more needed.

Chapter 3: Data and Methods

Study Design and Population

Three tornado events were examined, all of which occurred in late January and early February of 2017 in the Southern United States. Each of the tornado events received a disaster declaration from the Federal Emergency Management Agency (FEMA) and was provided with individual assistance. FEMA individual assistance provides financing for families and individual homes and properties, as opposed to public assistance, which provides financing for public infrastructure such as roads and bridges. Examining events that qualify for individual assistance allows for suicide rate comparisons based on the amount of economic damage sustained by individuals effected by the tornadoes.

Table 1: Tornado Events				
Location	Date	Individual Assistance	Approved Individual Assistance Applications	Public Assistance
Mississippi ¹⁴ 4 Counties	Jan. 20-21, 2017	\$3,338,999.67	577	\$10,458,936.05
Georgia ¹² 8 Counties	Jan. 21-22, 2017	\$2,962,689.95	593	\$22,970,819.68
Louisiana ¹³ 2 Counties	Feb. 7, 2017	\$3,006,480.74	588	\$0

This project used a combination of ecological and retrospective cohort study designs. The study population was everyone who lived in the U.S. South between 2016 and 2019. The exposure group for this study was those who were living in the tornado-affected counties of Georgia, Louisiana, and Mississippi. The comparison group was those who were living in the South during the study period, including the tornado-affected regions.

Variables and Data Sources

Exposure

The definition of exposure for this study was experiencing a tornado. A variable was not created for the exposure because it was not needed. The Georgia, Louisiana, and Mississippi regions contained exclusively tornado impacted counties and all tornado events occurred in early 2017.^{13,14,15} Thus, all analyses were based on region and year, rather than a specific exposure variable.

Outcome

The outcome variable in this study was death by suicide. Mortality data were obtained from the Center for Disease Control and Prevention (CDC) using their 1999-2020 Underlying Cause of Death database.⁷ The cause of death used in the search was ‘Suicide’, found under Injury Intent and Mechanism. Data were obtained for the years 2016, 2017, 2018, and 2019.

To keep mortality data anonymous, the CDC suppresses values when they are between 0 and 9. Because the number of suicides was so small in the tornado-affected regions, multiple queries were used to gather the data to prevent the suppression of values. One query was used to obtain the number of deaths by region, year, and gender, another query by region, year, and race, another by region, year, and urbanization, and the final query by region and year. The same method was used to obtain mortality data for Census Region 3: South. This region consists of Alabama, Arkansas, Delaware, the District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia,

and West Virginia. To prevent the statistical program used in the analysis from misinterpreting the relationships of death and population values with covariates that were not included in a particular CDC query, the values for each query were separated into individual variables. Death and population values for the gender query, for example, were under different variable names than the values for the race query.

Because the mortality numbers for this study were so low, the CDC suppressed many of the values, particularly when searching for data by race and urbanization. However, the total number of deaths for each query was available. Back-calculation was used to fill in the suppressed data for analysis then re-suppressed for presentation. Binary variables were created to prevent the back-calculated values from being categorized incorrectly. In the race categories, values categorized as ‘White’ were not suppressed, but ‘American Indian or Alaska Native’, ‘Asian or Pacific Islander’, and ‘Black or African American’ were. Thus, a new variable was created called ‘Non-White’ to encompass all the back-calculated values. In the urbanization categories, values categorized as ‘Large Central Metro’, ‘Large Fringe Metro’, ‘Medium Metro’, and ‘Small Metro’ were not suppressed, while ‘Micropolitan (Nonmetro)’ and ‘NonCore (Nonmetro)’ were. New binary variables were then created based on the U.S. Census Bureau’s 2013 classification method.²² ‘Large Central Metro’, ‘Large Fringe Metro’, ‘Medium Metro’, and ‘Small Metro’ were combined to create a variable called ‘Urban’, while ‘Micropolitan’ and ‘NonCore’ were combined to create a variable called ‘Rural’. This allowed all the back-calculated values to be accounted for in the appropriate category.

Covariates

Covariates for this project were gender, race, urbanization, age, social vulnerability, community resilience, and tornado risk. Gender, race, and urbanization categorizations were included as part of the mortality data obtained from the CDC. However, age could not be included due to the small population in the tornado-affected regions, which caused all the mortality values to be suppressed when reduced to such small categories.

The National Risk Index was used to obtain data regarding the regions' Social Vulnerability Index (SVI), community resilience, expected annual loss (EAL), and risk scores, as well as tornado specific risk and EAL scores. "Social vulnerability is the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate deaths, injury, loss, or disruption of livelihood".¹⁷ "Community resilience is the ability of a community to prepare for anticipated natural hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions."¹⁰ Expected annual loss "represents the average economic loss in dollars resulting from natural hazards each year", accounting for the loss of people, buildings, and agriculture.¹² A community's risk score is determined using an equation that encompasses SVI, community resilience, and EAL scores. SVI and EAL scores are proportional to a community's risk, while the community resilience score is inversely proportional to the risk. A higher SVI or EAL score results in a higher risk score, but a higher community resilience score results in a lower risk score.^{10,11,12,17} The tornado specific risk score represents "a community's relative risk for tornadoes when compared to the rest of the United States".¹⁸ The tornado specific EAL score represents "a community's relative level of expected building and population loss each year due to tornadoes when compared to the rest of the United States".¹⁸

The National Risk Index does not have year-specific data available so data from the most recent year, 2021, was used. County-level data was obtained for each of the regions that experienced a tornado and for all the states in the South. The data contained numerical scores for each measure, as well as ratings of ‘Very Low’, ‘Relatively Low’, ‘Relatively Moderate’, ‘Relatively High’, and ‘Very High’. For this project, mean scores were taken for each region of interest and converted to ratings. The equation used for this conversion was not available, so estimates from the original county-level data were used to create upper and lower limits for each rating category. The limits for the categories are shown in Table 2.

Table 2: National Risk Index Estimates					
Variable	Very Low	Relatively Low	Relatively Moderate	Relatively High	Very High
Risk	<8	8 to <13	13 to <23	23 to <38	≥38
EAL	<11	11 to <17	17 to <27	27 to <44	≥44
SVI	<25	25 to <36	36 to <44	44 to <58	≥58
Community Resilience	<50	50 to <53	53 to <55	55 to <57	≥57
Tornado Specific Risk	<9	9 to <16	16 to <25	25 to <40	≥40
Tornado Specific EAL	<10	10 to <18	18 to <26	26 to <40	≥40

Analytic plan

Frequencies and percentages were used to display the distribution of the study population across the regions and years of interest. Time trends displaying mortality rates were used to determine whether there was a visible difference in the number of suicides in 2017, the year that the tornadoes occurred, compared to other years. Stratified time trends were used to examine the differences in suicide mortality rates among different groups. Chi-square tests weighted by the

number of deaths were used to determine whether there is an association between experiencing a tornado and suicide, as well as examine relationships among covariates. The alpha level used in the Chi-square analyses was 0.05. Time trends were created using Microsoft Excel. All other analyses were conducted using SAS.

Chapter 4: Results

Descriptive Data

Study Population

Table 3 shows the distribution of the study population by region and year. In Georgia, the population was equally distributed across all demographics. The population was approximately 52% female, 49% non-White, and 52% rural for each year of the study period. The population in Louisiana was also equally distributed, with the exception of urbanization. The population was approximately 52% female and 50% non-White. The tornado-affected counties did not receive a rural designation, so 100% of the population lived in an urban area. Mississippi had an equal percentage of males and females, 48% and 52%, respectively. The distribution among the race and urbanization variables, however, is significantly lower than either Georgia or Louisiana, with 36% of the population identifying as non-White and 34% living in a rural area. The distribution of the population for the entire South was even more unequal, with approximately 51% being female, 26% identifying as non-White, and 16% living in a rural area.

Table 3: Study Population Demographics by Region and Year							
Georgia							
	Total	Female	Male	Non-White	White	Rural	Urban
2016	231,685 100.00%	121,172 52.30%	110,513 47.70%	113,513 48.99%	118,172 51.01%	120,920 52.19%	110,765 47.81%
2017	230,774 100.00%	120,684 52.30%	110,090 47.70%	113,418 49.15%	117,356 50.85%	120,739 52.32%	110,035 47.68%
2018	231,729 100.00%	121,545 52.45%	110,184 47.55%	115,124 49.68%	116,605 50.32%	120,187 51.87%	111,542 48.13%
2019	228,313 100.00%	119,689 52.42%	108,624 47.58%	112,669 49.35%	115,644 50.65%	120,110 52.61%	108,203 47.39%
Louisiana							
	Total	Female	Male	Non-White	White	Rural	Urban
2016	531,633 100.00%	276,083 51.93%	255,550 48.07%	263,662 49.59%	267,971 50.41%	- 0.00%	531,633 100.00%
2017	531,520 100.00%	276,889 52.09%	254,631 47.91%	265,371 49.93%	266,149 50.07%	- 0.00%	530,573 100.00%
2018	530,573 100.00%	276,695 52.15%	253,878 47.85%	264,475 49.85%	266,098 50.15%	- 0.00%	530,573 100.00%
2019	530,933 100.00%	277,363 52.24%	253,570 47.76%	264,313 49.78%	266,620 50.22%	- 0.00%	530,933 100.00%
Mississippi							
	Total	Female	Male	Non-White	White	Rural	Urban
2016	226,893 100.00%	117,914 51.97%	108,979 48.03%	82,168 36.21%	144,725 63.79%	77,755 34.27%	149,138 65.73%
2017	225,032 100.00%	116,872 51.94%	108,160 48.06%	81,557 36.24%	143,475 63.76%	76,155 33.84%	148,877 66.16%
2018	224,731 100.00%	116,785 51.97%	107,946 48.03%	81,780 36.39%	142,951 63.61%	75,317 33.51%	149,414 66.49%
2019	224,338 100.00%	116,868 52.09%	107,470 47.91%	81,546 36.35%	142,792 63.65%	74,125 33.04%	150,213 66.96%
South							
	Total	Female	Male	Non-White	White	Rural	Urban
2016	122,319,574 100.00%	62,380,925 51.00%	59,938,649 49.00%	31,178,283 25.49%	91,141,291 74.32%	19,729,183 16.13%	102,590,391 83.87%
2017	123,658,624 100.00%	63,042,096 50.98%	60,616,528 49.02%	31,751,766 25.68%	91,906,858 74.32%	19,714,267 15.94%	103,944,357 84.06%
2018	124,753,948 100.00%	63,613,086 50.99%	61,140,862 49.01%	32,208,189 25.82%	92,545,759 74.18%	19,716,289 15.80%	105,037,659 84.20%
2019	125,580,448 100.00%	64,050,066 51.00%	61,530,382 49.00%	32,530,510 25.90%	93,049,938 74.10%	19,696,951 15.68%	105,883,497 84.32%

Social Vulnerability and Community Resilience

Table 4 shows the mean ratings, by region, of the risk of experiencing natural disasters, expected annual loss (EAL) due to natural disasters, social vulnerability (SVI), community resilience, the risk of experiencing a tornado, and the EAL due to a tornado. The tornado-affected region in Georgia had a very low EAL rating, relatively low risk and tornado EAL ratings, and relatively moderate SVI, community resilience, and tornado risk ratings. The tornado-affected Louisiana region had a relatively low SVI rating, a relatively moderate tornado risk rating, relatively high risk, EAL, and tornado EAL ratings, and a very high community resilience rating. The tornado-affected region in Mississippi had a relatively low SVI rating and relatively moderate risk, EAL, community resilience, tornado risk, and tornado EAL ratings. The South had risk and EAL ratings of relatively low and relatively moderate SVI, community resilience, tornado risk, and tornado EAL ratings.

Table 4: Risk and Community Resilience Ratings by Region				
	Georgia	Louisiana	Mississippi	South
Risk	Relatively Low	Relatively High	Relatively Moderate	Relatively Low
EAL	Very Low	Relatively High	Relatively Moderate	Relatively Low
SVI	Relatively Moderate	Relatively Low	Relatively Low	Relatively Moderate
Resilience	Relatively Moderate	Very High	Relatively Moderate	Relatively Moderate
Tornado Specific Risk	Relatively Moderate	Relatively Moderate	Relatively Moderate	Relatively Moderate
Tornado Specific EAL	Relatively Low	Relatively High	Relatively Moderate	Relatively Moderate

Main Results

Time Trends

Figure 1 displays the time trends of mortality rates by region using the total number of suicides per year. The tornado-affected counties in Georgia, Louisiana, and Mississippi showed obvious changes over time while the South stayed relatively steady. The Georgia region's baseline suicide mortality rate in 2016 was 13.38 per 100,000. The prevalence drastically increased in 2017 and 2018 to 15.17 per 100,000 and 17.69 per 100,000, respectively. The suicide mortality rate then decreased in 2019 to 14.02 per 100,000. The Louisiana region's baseline suicide mortality rate was 11.66 per 100,000 in 2016. There was a sharp increase in 2017 to 14.11 per 100,000, followed by a steady decrease in 2018, with a rate of 12.82 per 100,000, and 2019, with a rate of 11.68 per 100,000. The Mississippi region's baseline suicide mortality rate was 11.46 per 100,000 in 2016. There was an increase in 2017 to 14.66 per 100,000, followed by a decrease in 2018 to 10.68 per 100,000. 2019 showed another sharp increase to 14.26 per 100,000. The South had a baseline suicide mortality rate of 15.66 per 100,000 in 2016. The rate remained relatively steady throughout the next three years, at 14.96 per 100,000 in 2017, 15.31 per 100,000 in 2018, and 14.91 per 100,000 in 2019.

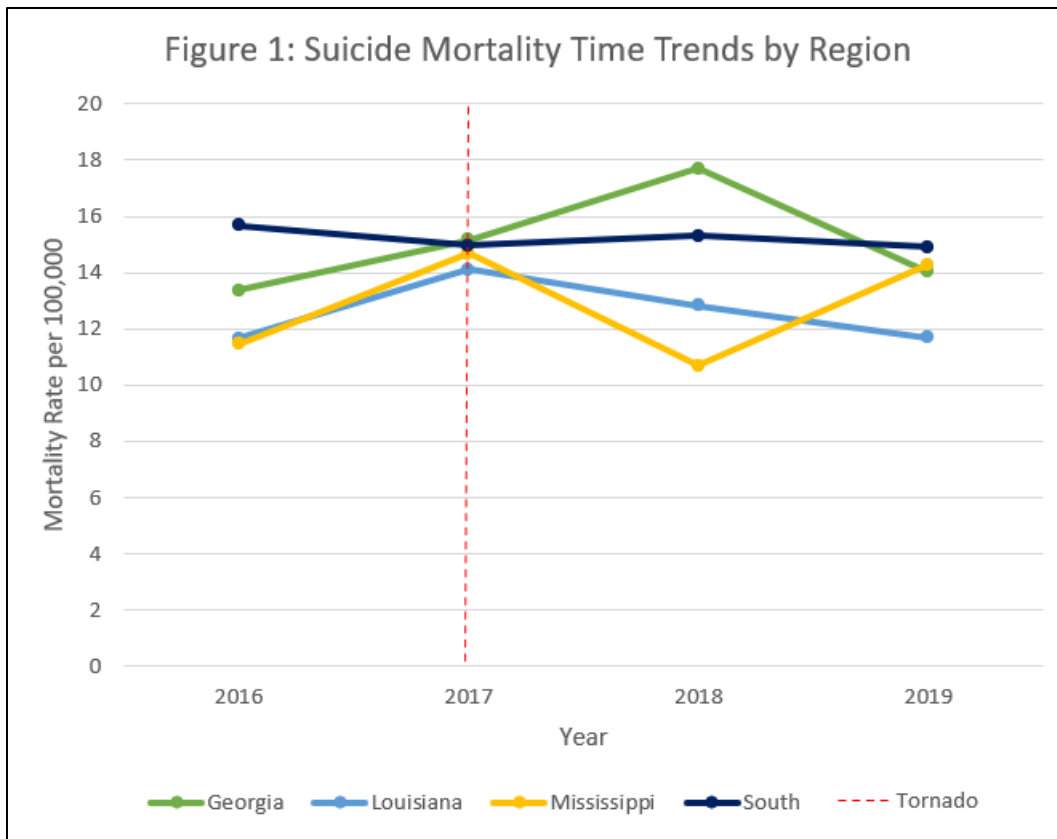


Figure 2 shows the time trends of the suicide mortality rates stratified by gender. The male population in the Georgia tornado-affected region had a baseline mortality rate of 21.72 per 100,000 in 2016. The rate increased to 26.34 per 100,000 in 2017, then to 27.23 per 100,000 in 2018. The rate then decreased slightly to 25.78 per 100,000 in 2019. The female population in the Georgia region had a baseline mortality rate of 5.78 per 100,000 in 2016. This decreased slightly in 2017 to 4.97 per 100,000. This was followed by an increase in 2018 to 9.05 per 100,000, then another decrease to 3.34 per 100,000 in 2019. The male population in the Louisiana tornado-affected region had a baseline suicide mortality rate of 19.57 per 100,000 in 2016, followed by a slight increase in 2017 to 22.78 per 100,000. The suicide rate then steadily decreased in 2018 and 2019 to 19.30 per 100,000 and 18.54 per 100,000, respectively. The female population in the Louisiana region had a baseline mortality rate of 4.35 per 100,000 in

2016, which increased to 6.14 per 100,000 in 2017 and 6.87 per 100,000 in 2018. This was followed by a slight decrease in 2019 to 5.41 per 100,000. The male population in the Mississippi tornado-affected region had a baseline suicide mortality rate of 18.35 per 100,000 in 2016. This increased to 26.81 per 100,000 in 2017, followed by a decrease to 18.53 per 100,000 in 2018, then another increase to 25.12 per 100,000 in 2019. The female population in the Mississippi region had a baseline mortality rate of 5.09 per 100,000 in 2016. This decreased to 3.42 per 100,000 in 2017, then increased slightly in 2018 and 2019 to 3.43 per 100,000 and 4.28 per 100,000, respectively. The male population of the South had a baseline suicide mortality rate in 2016 of 22.57 per 100,000. This increased to 23.80 per 100,000 in 2017 and 24.47 per 100,000 in 2018. There was then a slight decrease to 23.80 per 100,000 in 2019. The female population of the South had a baseline suicide mortality rate of 6.51 per 100,000 in 2016. The rate decreased in 2017 to 6.46 per 100,000, followed by an increase to 6.50 per 100,000 in 2018, then another decrease in 2019 to 6.36 per 100,000.

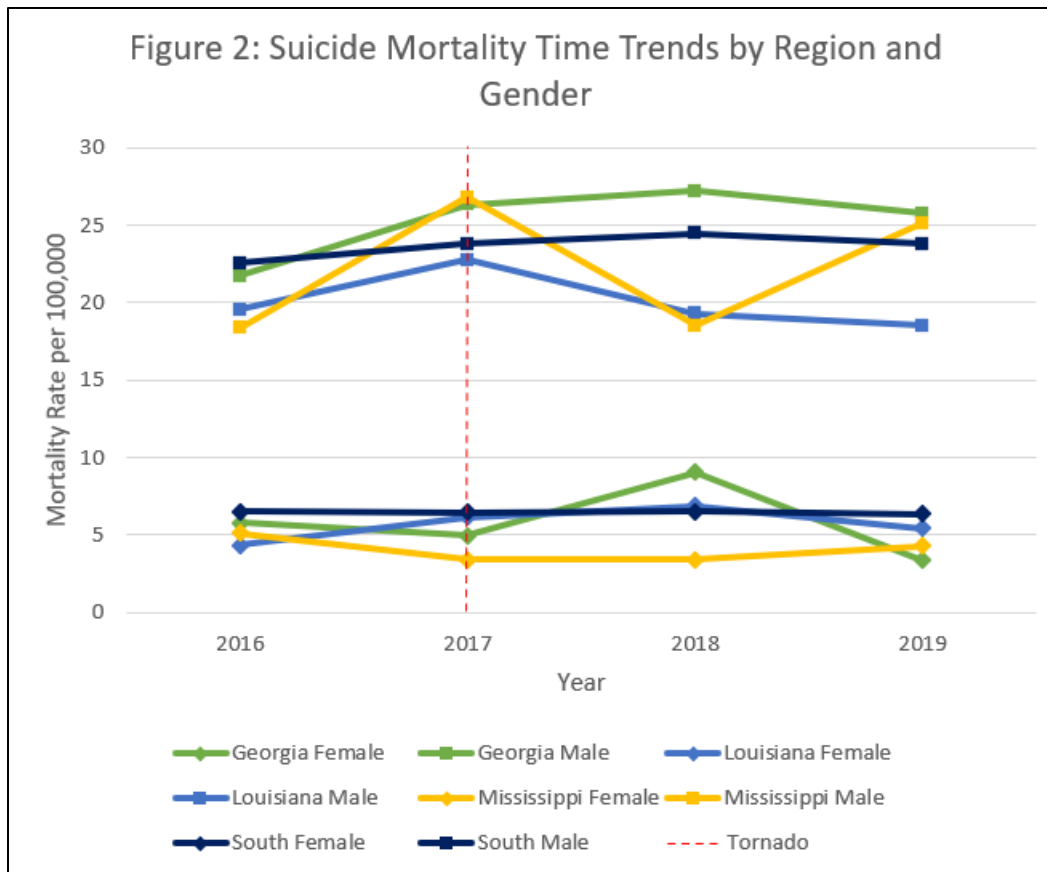


Figure 3 shows the time trends of suicide mortality rates stratified by race. The White population in the Georgia tornado-affected region had a baseline suicide mortality rate of 19.46 per 100,000 in 2016. This was followed by a drastic increase to 26.42 per 100,000 in 2017 and 30.02 per 100,000 in 2018. There was then a decrease to 25.08 per 100,000 in 2019. The non-White population in the Georgia region had a baseline mortality rate of 7.05 per 100,000 in 2016. This decreased to 3.53 per 100,000 in 2017, then increased in 2018 to 5.21 per 100,000, and decreased again to 2.66 per 100,000 in 2019. The White population in the tornado-affected Louisiana region had a baseline mortality rate of 17.91 per 100,000 in 2016, which then increased to 20.29 per 100,000 in 2017 and 20.67 per 100,000 in 2018. This was followed by a decrease to 16.88 per 100,000 in 2019. The non-White population in the Louisiana region had a baseline suicide mortality rate of 5.31 per 100,000 in 2016. This increased to 7.91 per 100,000 in

2017, followed by a decrease in 2018 to 4.92 per 100,000, and another increase to 6.43 per 100,000 in 2019. The White population in the tornado-affected Mississippi region had a baseline mortality rate of 15.20 per 100,000 in 2016, which increased to 20.21 per 100,000 in 2017. This decreased in 2018 to 13.99 per 100,000, then increased to 19.61 per 100,000 in 2019. The non-White population in the Mississippi region had a baseline mortality rate of 4.87 per 100,000 in 2016. This remained relatively steady over the next three years, to 4.90 per 100,000 in 2017, 4.89 per 100,000 in 2018, and 4.91 per 100,000 in 2019. The White population in the South had a baseline suicide mortality rate of 17.19 per 100,000 in 2016. This increased slightly over 2017 and 2018 to 17.87 per 100,000 and 18.22 per 100,000, respectively. There was then a slight decrease in 2019 to 17.66 per 100,000. The non-White population in the South had a baseline mortality rate of 6.17 per 100,000 in 2016. The rate increased steadily over the next three years, to 6.55 per 100,000 in 2017, 6.93 per 100,000 in 2018, and 7.01 per 100,000 in 2019.

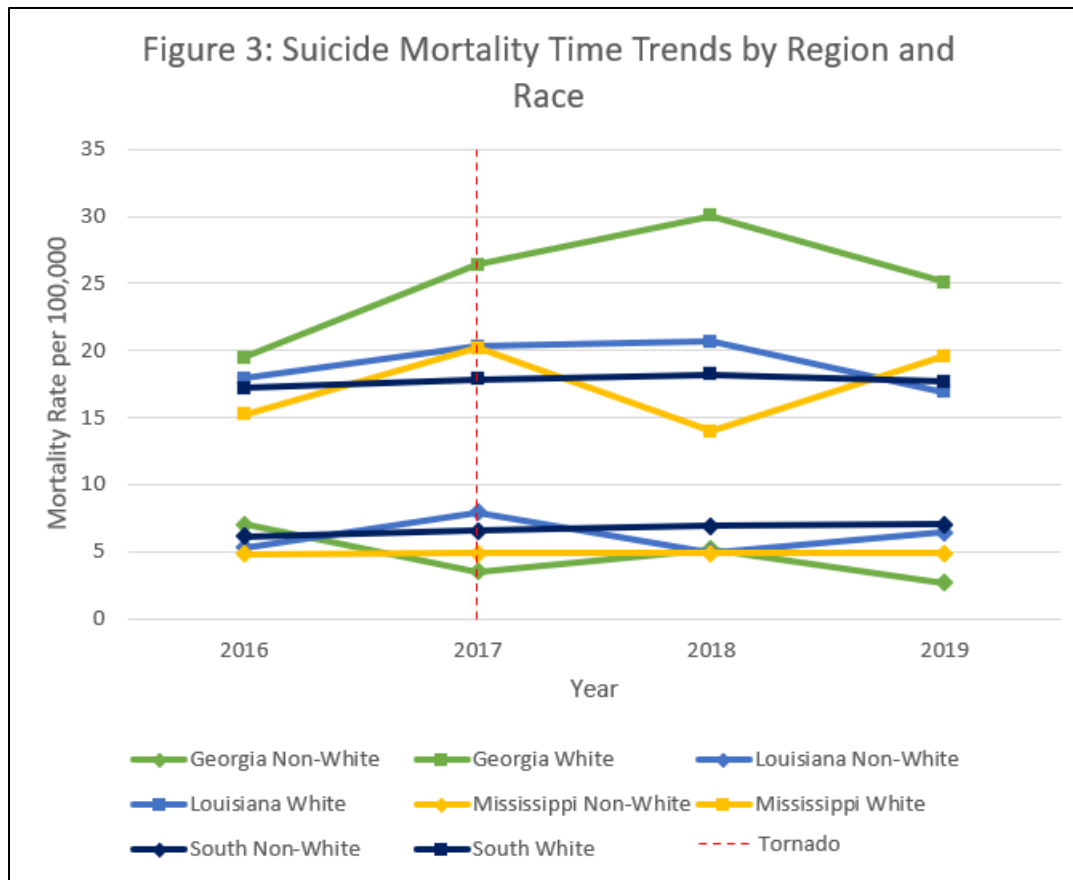
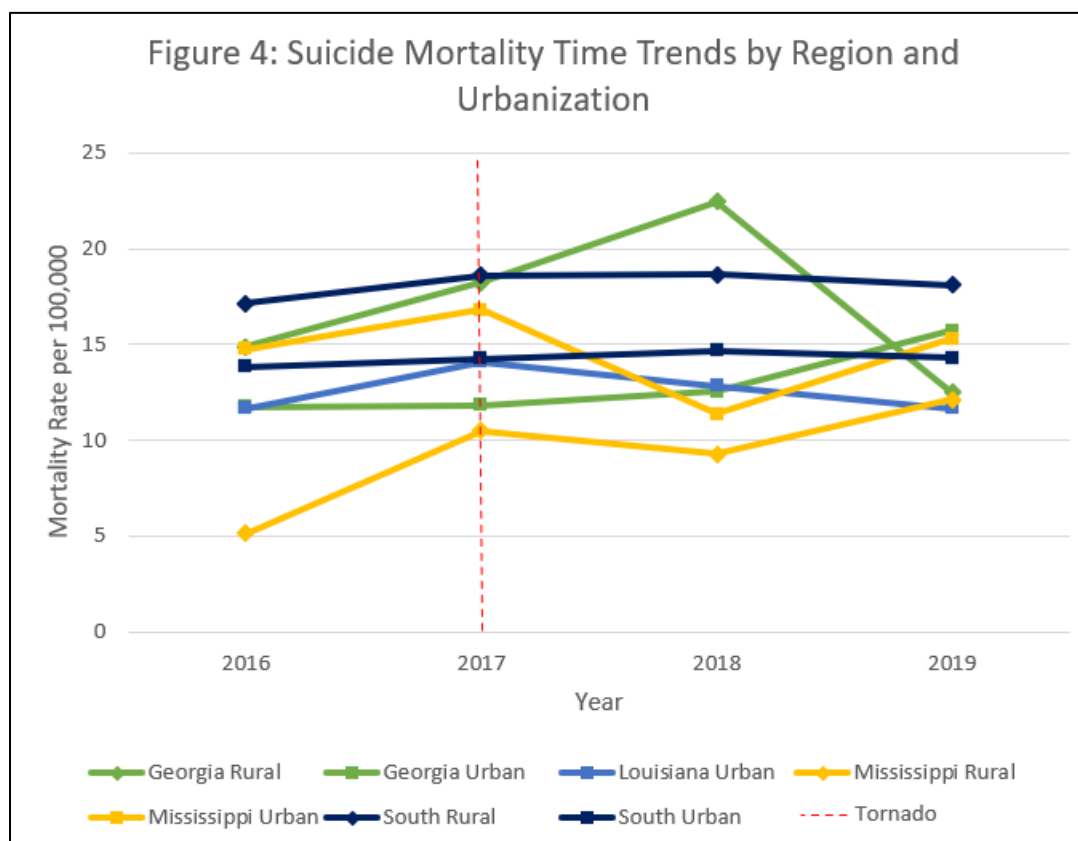


Figure 4 displays the time trends of suicide mortality rates stratified by urbanization. The baseline mortality rate in 2016 for those living in a rural area of the tornado-affected Georgia region was 14.89 per 100,000. This increased to 18.22 per 100,000 in 2017 and 22.46 per 100,000 in 2018. There was then a sharp decrease in 2019 to 12.49 per 100,000. The baseline mortality rate for those living in an urban area of the Georgia region in 2016 was 11.74 per 100,000. The rate slowly increased over the next three years, to 11.81 per 100,000 in 2017, 12.55 per 100,000 in 2018, and 15.71 per 100,000 in 2019. The tornado-affected Louisiana region consists solely of urban areas, so the suicide mortality rate is the same as the entire region. The baseline mortality rate in 2016 was 11.66 per 100,000, followed by an increase in 2017 to 14.11 per 100,000. The mortality rate then decreased in 2018 and 2019 to 12.82 per 100,000 and 11.68 per 100,000, respectively. The baseline 2016 suicide mortality rate for those living in a rural area

of the tornado-affected Mississippi region was 5.14 per 100,000. This increased to 10.50 per 100,000 in 2017, followed by a slight decrease in 2018 to 9.29 per 100,000, then another increase in 2019 to 12.14 per 100,000. The baseline mortality rate in 2016 for those living in urban areas of the Mississippi region was 14.75 per 100,000, which increased to 16.79 per 100,000 in 2017. This was followed by a decrease to 11.38 per 100,000 in 2018 and another increase in 2019 to 15.31 per 100,000. The baseline 2016 suicide mortality rate for those living in rural areas of the South was 17.14 per 100,000. This increased to 18.62 per 100,000 in 2017 and 18.65 per 100,000 in 2018, followed by a slight decrease in 2019 to 18.11 per 100,000. The baseline mortality rate for those living in urban areas of the South in 2016 was 13.85 per 100,000. There was a slight increase over the next two years, to 14.27 per 100,000 in 2017 and 14.68 per 100,000 in 2018, followed by a decrease to 14.31 per 100,000 in 2019.



Covariate Associations Among Suicide Deaths

Chi-square statistics were created using frequency tables of the variables of interest, weighted by suicides. Thus, the results of the analyses are exclusively applied to those who died by suicide. The association between year and region ($p=0.8583$) was not statistically significant, providing evidence that there is not a relationship between year and region among those who died by suicide. The association between year and gender ($p=0.0035$) was statistically significant, indicating a relationship between year and gender among suicide deaths. However, the relationship between region and gender ($p=0.4336$) was not statistically significant, suggesting that there are no associations between these variables. The relationships between year and race ($p=0.0016$) and region and race ($p<0.0001$) were statistically significant, indicating that these associations do exist. The relationship between year and urbanization ($p=0.2368$) was not statistically significant, indicating that there is not an association. Finally, the association between region and urbanization ($p<0.0001$) was statistically significant, suggesting that there is a relationship between region and urbanization among suicide deaths.

Table 5: Covariate Chi-Square Statistics				
	Region	Gender	Race	Urbanization
Year	0.8583	0.0035	0.0016	0.2368
Region	-	0.4336	<0.0001	<0.0001

Other Analyses

Some other findings worth noting are the Chi-square statistics of the risk ratings. Tornado specific risk ratings were not included in this table because all the regions had the same mean rating, so a Chi-square analysis was not possible. Among those who died by suicide, gender did not have a statistically significant relationship with any of the risk ratings. However, race and

urbanization displayed statistically significant associations with all the risk ratings. This suggests that risk ratings may have an influence on suicide rates depending on a person's race and urbanization status, but not their gender.

Table 6: Risk Rating Chi-Square Statistics			
	Gender	Race	Urbanization
Risk	0.2972	<0.0001	<0.0001
EAL	0.4336	<0.0001	<0.0001
SVI	0.7627	<0.0001	<0.0001
Resilience	0.5567	<0.0001	<0.0001
Tornado EAL	0.7207	<0.0001	<0.0001

Chapter 5: Discussion

Key Results

This study found that there was an increase in suicide mortality rates in all three tornado-affected regions in 2017, the year in which the tornadoes occurred, when compared to the previous year. By contrast, the suicide mortality rate for the South decreased between 2016 and 2017. These differences could be associated with experiencing a tornado and managing the aftereffects of the disaster. However, the differences in suicide rates over the years were not statistically significant, as shown by the Chi-square analysis of the association between year and region ($p=0.8583$).

When examining the stratified mortality time trends, the male population in all regions of interest displayed dramatically higher suicide rates overall than the female population. This finding is consistent with the current literature, which states that, “in 2020, men died by suicide 3.88x more than women”.³ The time trend also showed that men experienced more dramatic changes in suicide rates while rates among women remained relatively steady across all four years. There were several increases in suicide rates in 2017, particularly among men, providing evidence of a potential association between gender and increased suicide rates following a tornado. This relationship is reinforced by the results of the Chi-square analysis, which shows a statistically significant association between gender and year among those who died by suicide ($p=0.0035$). However, this association could be explained by increases and decreases in suicide rates in the years following the disasters. The male population in the Georgia region and the South, for example, had increases in 2018, while the Louisiana and Mississippi regions showed dramatic decreases in suicide rates the same year.

The stratified time trends also showed dramatic differences in the suicide rates of White and non-White populations, with the population identifying as White displaying an overall higher mortality rate in all regions of interest. This finding is consistent with current literature, which found that “in 2020, the highest U.S. age-adjusted suicide rate was among Whites”.³ Only one group of subjects, those who identify as non-White and were living in the Georgia region, experienced a decrease in the suicide rate in 2017, while all other groups had an increase in rates. The populations who identified as White also had much larger changes in suicide rates across all four years when compared to those who identified as non-White. These trends suggest that there may be a relationship between race and suicide after experiencing a tornado. Further evidence of this association is provided by the statistically significant Chi-square results of race and year among those who died by suicide ($p=0.0016$). Similar to the association between year and gender, this significant value may be due to additional changes in suicide rates in 2018 and 2019. The White population in Georgia experienced a second large increase in suicide rates in 2018, followed by a large decrease in 2019, while the White population in Mississippi experience a drop in suicide rates in 2018, followed by a drastic increase in 2019. These drastic changes in mortality rates could influence the results of the Chi-square analysis.

The stratified mortality time trend for urbanization did not display any obvious patterns, suggesting that there is not a relationship between suicide and rural vs. urban designations. All the mortality rates showed an increase from 2016 to 2017, followed by several decreases in 2018. This may be due to experiencing a tornado, or it may be explained by the overall trend of increasing suicide rates in the South. The results of the Chi-square analysis also indicate that there is not a significant relationship between urbanization and year among those who died by suicide ($p=0.2368$).

Ultimately, nearly every group examined during this project showed an increase in suicide rates in 2017, the year in which the tornadoes occurred. Several populations also showed increases in 2018, followed by decreases in 2019, which is consistent with current findings on other disasters.^{20,28} Thus, it can tentatively be concluded that there is an association between experiencing a tornado and increased suicide rates. Additional research is needed to confirm that this relationship exists, as well as the extent to which suicide rates increase following a tornado.

Strengths and Limitations

The most important strength of this project is that it is one of the first studies to examine the relationship between experiencing a tornado and suicide rates. Many other studies have analyzed the association between disasters and suicide rates, but the literature published at present regarding tornadoes is virtually nonexistent. This makes the current study an important steppingstone for further research in this area. The practical applications of the findings presented in this study are also considerable strengths. Emergency preparedness, public health, and mental health professionals can use this information to provide the appropriate care to survivors of tornadoes.

An additional strength of this research is the reproducibility and the large study population. This study is easily reproducible for future researchers to confirm the results. The large study population provided a valuable comparison group, particularly when analyzing time trends. However, future studies should be expanded to include more areas impacted by tornadoes. This would allow for a more in-depth analysis of suicide rates following a tornado, providing more conclusive results.

One limitation is that the tornado-affected areas had small populations and suicides are relatively uncommon. This caused mortality values to be suppressed by the CDC, which then limited the extent to which the deaths could be analyzed. Race and urbanization variables had to be condensed to properly include suicide values. Thus, the results cannot be applied to specific racial groups or urbanization categories. The effected populations being so small also prevented age groups from being included in the analysis. The mortality values were suppressed for nearly every age group, so none of the age groups could be appropriately analyzed.

Another notable limitation of this project is that the National Risk Index only shows the most recent data. This prevents the analysis of the relationship between suicides and risk ratings across the study period. The resilience or social vulnerability of a community can change over time but because there is not sufficient data, there is no way to know whether these changes influence suicide rates. The use of estimates in the conversion of risk scores to risk ratings is an additional limitation. It is possible that the categorizations used in this project are incorrect. Thus, National Risk Index data proved to be of limited value to this study.

Limitations regarding the analysis are that the mortality time trends only examine the prevalence of suicides for four years and some potential confounders and moderators were not included. It is difficult to determine whether there truly was a significant change in the rate of suicide when examining trends over such a short period of time. Future studies that incorporate time trends should have a longer study period to properly analyze changes in suicide mortality rates over time. Future studies should also include additional data regarding potential risk factors, such as pre-disaster mental illness and post-disaster food insecurity, and protective factors, such as religious social capital and feelings of social connectedness.¹⁹

The limitations of this study prove that the results are not generalizable to other populations. The mortality data did not include distinct race, urbanization, or age categories, resulting in the findings being very limited in their application to specific populations. Additionally, the tornadoes that were examined only occurred in the U.S. South. Other geographical areas may have different factors influencing suicide rates.

Conclusion

Suicide rates have increased significantly in the U.S. in the last 20 years.³⁰ Several risk factors for negative mental health outcomes and suicidal behaviors have been identified, many of which can be experienced by survivors following a disaster.^{2,8} There have been many studies examining the effects of experiencing a disaster on suicide rates, which resulted in conflicting findings. However, research investigating the relationship between experiencing a tornado, specifically, and suicide rates is essentially nonexistent. Filling this gap in the literature is essential for those working in the public health, emergency preparedness, and mental health fields, providing the knowledge necessary to effectively serve communities following a tornado.

For this project, a retrospective cohort study design was used to determine if there is a relationship between experiencing a tornado and an increase in suicide rates. All relevant data and background information was obtained from the CDC and FEMA. The study population consisted of those living in the U.S. South, with the tornado-affected regions acting as the exposure group and the entire South, including the effected regions, acting as the comparison group. Stratified time trends were used to examine whether there was a visible increase in suicide

mortality rates. Weighted Chi-square analyses were used to determine whether statistically significant relationships exist between covariates among those who died by suicide.

The results of this study provided evidence that there is an association between experiencing a tornado and an increased rate of suicide. Overall, male populations showed significant increases in suicide rates during the year of the disasters, while female populations displayed relatively small increases. Similarly, White populations showed drastic increases in suicide rates following the tornadoes, while non-White populations experienced small increases during the same year. All populations, regardless of whether they lived in a rural or urban area, showed increases in suicide rates. Ultimately, nearly every group included in this study experienced an increase in suicide rates immediately following the tornadoes. Only three groups had decreases in 2017 – females living in the Georgia and Mississippi regions, and non-White populations living in the Georgia region.

In the two years following the tornadoes, 2018 and 2019, the time trends showed conflicting results. Some populations, such as the White population living in Georgia, showed continued increases in suicide rates. Other populations, such as the White population in Mississippi, showed a large decrease in suicide rates in 2018, followed by another large increase in 2019. These dramatic differences in suicide rates over time could be explained by the community “pulling together” effect and the phases that a community can experience following a disaster, as discussed in the literature review. Future research should include an examination of these effects and other factors, to determine the cause of these dramatic fluctuations in suicide rates.

Cited Literature

1. Adams, Z. W., Sumner, J. A., Danielson, C. K., McCauley, J. L., Resnick, H. S., Grös, K., Paul, L. A., Welsh, K. E., & Ruggiero, K. J. (2014). Prevalence and predictors of PTSD and depression among adolescent victims of the Spring 2011 tornado outbreak. *Journal of Child Psychology and Psychiatry*, 55(9), 1047–1055.
<https://doi.org/10.1111/jcpp.12220>
2. American Foundation for Suicide Prevention. (2022, March 30). *Risk factors, protective factors, and warning signs*. American Foundation for Suicide Prevention.
<https://afsp.org/risk-factors-protective-factors-and-warning-signs>
3. American Foundation for Suicide Prevention. (2022, October 14). *Suicide statistics*. American Foundation for Suicide Prevention. <https://afsp.org/suicide-statistics/>
4. Bastiampillai, T., Allison, S., Cubbage, J., Nestadt, P., & Sharfstein, J. (2022, April 26). *US suicide rates and impact of major disasters over the last century*. Psychiatrist.com.
<https://www.psychiatrist.com/pcc/covid-19/us-suicide-rates-impact-major-disasters-last-century/>
5. Beaglehole, B., Mulder, R. T., Frampton, C. M., Boden, J. M., Newton-Howes, G., & Bell, C. J. (2018). Psychological distress and psychiatric disorder after natural disasters: Systematic review and meta-analysis. *The British Journal of Psychiatry*, 213(6), 716-722.
<https://doi.org/10.1192/bjp.2018.210>
6. Borenstein, S. (2022, March 24). *Why the South gets more killer tornadoes at night*. CBS News. <https://www.cbsnews.com/news/tornadoes-at-night-southeast/>

7. Centers for Disease Control and Prevention. (n.d.). *CDC WONDER*. CDC.
<https://wonder.cdc.gov/>
8. Centers for Disease Control and Prevention. (2022, November 2). *Risk and protective factors*. Centers for Disease Control and Prevention.
<https://www.cdc.gov/suicide/factors/index.html>
9. Centers for Disease Control and Prevention (2023, January 9). *Suicide data and statistics*. Centers for Disease Control and Prevention. <https://www.cdc.gov/suicide/suicide-data-statistics.html>
10. Federal Emergency Management Agency. (n.d.). *Community Resilience*. National Risk Index. <https://hazards.fema.gov/nri/community-resilience>
11. Federal Emergency Management Agency. (n.d.). *Determining Risk*. National Risk Index. <https://hazards.fema.gov/nri/determining-risk>
12. Federal Emergency Management Agency. (n.d.). *Expected Annual Loss*. National Risk Index. <https://hazards.fema.gov/nri/expected-annual-loss>
13. Federal Emergency Management Agency. (2022, December 20). *Georgia Severe Storms, Tornadoes, and Straight-line Winds*. FEMA. <https://www.fema.gov/disaster/4297>
14. Federal Emergency Management Agency. (2022, December 20) *Louisiana Severe Storms, Tornadoes, and Straight-line Winds*. FEMA.
<https://www.fema.gov/es/disaster/4300>
15. Federal Emergency Management Agency. (2022, December 20). *Mississippi Severe Storms, Tornadoes, and Straight-line Winds*. FEMA.
<https://www.fema.gov/es/disaster/4295>

16. Federal Emergency Management Agency. (n.d.). *National Risk Index*. National Risk Index. <https://hazards.fema.gov/nri/map#>
17. Federal Emergency Management Agency. (n.d.). *Social Vulnerability*. National Risk Index. <https://hazards.fema.gov/nri/social-vulnerability>
18. Federal Emergency Management Agency. (n.d.). *Tornado*. National Risk Index. <https://hazards.fema.gov/nri/tornado>
19. Fitzpatrick, K. M., & Spialek, M. L. (2020). Suicide ideation and a post-disaster assessment of risk and protective factors among Hurricane Harvey survivors. *Journal of Affective Disorders*, 277, 681-687. <https://doi.org/10.1016/j.jad.2020.08.072>
20. Horney, J. A., Karaye, I. M., Abuabara, A., Gearhart, S., Grabich, S., & Perez-Patron, M. (2021). The impact of natural disasters on suicide in the United States, 2003-2015. *Crisis*, 42(5), 328-334. <https://doi.org/10.1027/0227-5910/a000723>
21. Houston, J. B., Spialek, M. L., Stevens, J., First, J., Mieseler, V. L., & Pfefferbaum, B. (2015). 2011 Joplin, Missouri tornado experience, mental health reactions, and service utilization: Cross-sectional assessments at approximately 6 months and 2.5 years post-event. *PLoS currents*, 7, ecurrents.dis.18ca227647291525ce3415bec1406aa5. <https://doi.org/10.1371/currents.dis.18ca227647291525ce3415bec1406aa5>
22. Knorr, A. C., Ammerman, B. A., Hamilton, A. J., & McCloskey, M. S. (2019). Predicting status along the continuum of suicidal thoughts and behavior among those with a history of nonsuicidal self-injury. *Psychiatry Research*, 273, 514-522. <https://doi.org/10.1016/j.psychres.2019.01.067>

23. Kőlves, K., Kőlves, K. E., & De Leo, D. (2013). Natural disasters and suicidal behaviours: A systematic literature review. *Journal of Affective Disorders*, 146(1), 1–14. <https://doi.org/10.1016/j.jad.2012.07.037>
24. Lee, S., & First, J. M. (2022). Mental health impacts of tornadoes: A systematic review. *International Journal of Environmental Research and Public Health*, 19. <https://doi.org/10.3390/ijerph192113747>
25. Mezuk, B., Larkin, G. L., Prescott, M. R., Tracy, M., Vlahov, D., Tardiff, K., & Galea, S. (2009). The influence of a major disaster on suicide risk in the population. *Journal of Traumatic Stress*, 22(6), 481-488. <https://doi.org/10.1002/jts.20473>
26. Moore, T. W., & DeBoer, T. A. (2019). A review and analysis of possible changes to the climatology of tornadoes in the United States. *Progress in Physical Geography: Earth and Environment*, 43(3), 365-390. <https://doi.org/10.1177/0309133319829398>
27. Morganstein, J. C., & Ursano, R. J. (2020). Ecological disasters and mental health: Causes, consequences, and interventions. *Frontiers in Psychiatry*, 11. <https://doi.org/10.3389/fpsy.2020.00001>
28. National Oceanic and Atmospheric Administration. (2023, February). *U.S. tornadoes*. National Centers for Environmental Information. <https://www.ncei.noaa.gov/access/monitoring/tornadoes/>
29. United States Department of Health and Human Services. (2022, June). *Suicide*. National Institute of Mental Health. <https://www.nimh.nih.gov/health/statistics/suicide>
30. Yockey, R. A., King, K., & Vidourek, R. (2021). Trends in suicidal behaviors among US adults 2015-2018. *Crisis: The Journal of Crisis Intervention and Suicide Prevention*, 42(5). <https://doi.org/10.1027/0227-5910/a000732>

Biography and CV

I am currently working toward my Master of Public Health with a concentration in Epidemiology at the University of Nebraska Medical Center. I received my Bachelor of Science in Microbiology, with a minor in Chemistry, from Weber State University. I hope to use my education, as well as my Capstone experience, to develop my professional career as a Disaster Epidemiologist.

Education

Weber State University

Bachelor of Science – Microbiology

Minor in Chemistry

Graduation: April 2019

University of Nebraska Medical Center

Master of Public Health – Epidemiology

Graduation: May 2023

Skills

SAS

Microsoft 365

Problem Solving

Time Management

Adaptability

Attention to Detail

Organization

Customer Service

Professional Experience

ARUP Laboratories

Laboratory Technologist

April 2019 – October 2021

Weber State University

Testing Proctor

February 2014 – April 2019