THE EFFECT OF EXTREME WEATHER ON MORTALITY: EVIDENCE FROM THE UNITED STATES

by

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Dedication

To my family

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Abstract

This paper estimates the impact of extreme weather on mortality rates associated with 5 specific causes and total mortality across the counties in the United States, period of 1979-2002. Using the county-level panel data I explored how significantly the deviations in the temperatures and precipitation impact mortality rates specifically cardiovascular, respiratory, neoplasms, transport injuries, self-harm and interpersonal mortalities. By using a comprehensive methodological framework that points to the standardized z-scores to identify the significant weather anomalies, uses average temperature bins to explore the non-linear effects and sets the temperature thresholds to see the consequences of extreme heat and cold. This study enhances our understanding of climate health. Key findings show that average temperature ranges between <0°F -60°F have a significant impact on total and cardiovascular mortalities. The extreme maximum and minimum temperatures are significantly associated with motor vehicle accidents, likely due to tire blowouts and wet ice road conditions. This research contributes to the understanding of how extreme weather affects health, offering important insights into how such conditions impact mortality.

Keywords: mortality rates, temperature, precipitation, extreme deviations.

1. Introduction

As we all know, climate is the key ingredient in the earth's complex systems that sustain or spoil human health. Climate experts and environmental experts predict that the earth’s climate will be hotter and more humid, resulting in extreme weather conditions: more extreme conditions during summer (hotter and more humid), but less extreme conditions during winter (less cold and less dry). Thus, mortality rates are likely to increase during the summer months but decrease during the winter months (Barreca 2012). These changes are expected to adversely affect human health. Although previous research has estimated the potential health costs of higher temperatures (Gaffen and Ross 1999), and rising humidity levels (Barreca 2012). In this study, we examined the impact of monthly Extreme deviations by using the standardized Z-scores of temperatures and precipitation on Specific causes of death in the United States. We used county-level panel data to estimate the effect of extreme deviations of weather and precipitation on monthly mortality rates with specific causes of death over 24 years (1979-2002).

According to the UN’s Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report, climate change is likely to affect human health directly through changes in temperature and precipitation and indirectly through changes in the ranges of disease, and other channels (IPCC Working Group II, 2007). Both high and low temperatures in the cold cities are associated with the cardiovascular deaths (Schwartz, Samet, and Patz 2004). Large metropolitan areas are not adopted to the extreme heat waves especially in the higher altitudes(Luber and McGeehin 2008).There is a lack of clarity regarding the overall impact of climate change on mortality. The cardiovascular and respiratory systems are primarily affected by exposure to extreme temperatures and humidity levels, which raises the risk of mortality (Barreca 2012).

Our contribution from this paper to the literature is to do a comprehensive analysis of the weather variables from the standard temperature and precipitation, using average temperature bins for capturing the non-linearity and temperature thresholds to see the extreme cold and heat and also adding the new methodological approach by using the standardized Z-scores to quantify extreme deviations in temperature and rainfall specifically on health outcomes across the counties in the United States. While previous studies focus only on the particular methodology whether it might be bins strategy or temperature thresholds, this research specifically analyses the impacts of extreme deviations, and a more precise understanding of how significant extreme deviations influence health outcomes. A limited set of health outcomes are utilized in previous studies like overall mortality and cardiovascular and respiratory, in this paper building upon those we extended neoplasms, transport injuries, and deaths from self-harm and interpersonal violence. This research provides a comprehensive overview of the impacts of climate extremes on various health outcomes. This research includes the demographic and socioeconomic variables for understanding how population, per capita income and employment characteristics affect the relationship between extreme weather and mortality.

The mortality data used in our analysis is constructed from the National Center of Health Statistics (NCHS) Multiple Cause of Death files (MCOD), I constructed county-level mortality counts per 100,000 inhabitants by using the annual population estimates from the US Census Bureau. We used the total mortality and five specific causes of death: cardiovascular, Neoplasm, Respiratory, Transport injuries, Self-harm, and interpersonal violence which are related to temperatures. Reading data are built from the GHCN weather station daily readings dataset into monthly values by the National Oceanic and Atmospheric Administration (NOAA). The key weather variables of interest are average, maximum, and minimum temperatures and precipitation. Using monthly average temperature values created temperature bins ranging from <0°F to >90°F with 10°F intervals, additionally we checked for months with temperatures below 30°F and above 80°F. and we calculated standardized Z-scores for extreme events by using mean and standard deviations for specific to each year and month across all the counties. Demographics and socio-economic variables are Population from the US Census Bureau, per-capita income, and Employment from the Bureau of Economic Analysis.

The main components of my identification strategy are Using the panel fixed effects model, I include the county-by-month fixed effects and year-by-month fixed effects, and standard errors clustered by county and year-by-month in all our model specifications. Firstly, to see the standard impact of temperatures and precipitation on the mortality rates. The second one is to capture the non-linearity of temperatures using the bin strategy with 10°F intervals. The third is the impact of temperature thresholds months below 30°F and above 80°F. The Fourth approach is to analyze how extreme deviations impact the mortality rates by using the standardized Z-scores. Through comprehensive analysis, my research aims to inform and support public health strategies and policy making, ensuring that communities are better prepared and stronger for health challenges present by climate change.

2. Literature Review

Exploring the relationship between temperatures and mortality, there are many studies related to the effect of weather on mortality and the health-related issues. (Barreca 2012), (Braga, Zanobetti, and Schwartz 2002), (Deschênes and Greenstone 2007) these studies analyzed the role of temperature on mortality by specific cause of death using the different weather data levels. The results of these studies highlight that temperatures have a significant impact on mortality and health-related issues. Previous studies have noted that colder temperatures have the larger impact on mortality when compared to hot temperatures. Hot temperatures are more likely to affect the health of the people who are near to death known as harvesting (O Deschênes E Moretti et al,2007). Extreme temperatures are a little more dangerous those might put pressure on the who already have diseases like cardiovascular and respiratory. Cold and breezing air might put pressure on the lungs during inhalation (W. J. M. MARTENS et al 1998).

To understand the impact of temperature on mortality several studies have provided essential insights that shape the framework and methods of my research. (O Deschênes M Greenstone et al,2011) used the NCHS county-level annual mortality data from 1968 to 2002. Categorized the daily average temperature into bins and included the measures of energy consumption for cooling and heating days. Estimated the panel fixed effects on daily county-level mortality rates by using county, state, and year-(Martens 1998)fixed effects. Findings show that days above 90F and below 40F have increased mortality rates, and days above 80F and below 40F have a high utilization of residential energy consumption. Predicted that due to climate change, there will be 3% increase in mortality by the end of the century using the Hadley model.

(Barreca 2012) extended the analysis of Deschênes and Greenstone using the monthly county-level mortality data from 1973 to 2002 by creating the temperature bins using daily average temperature, and residential energy consumption and included the interactions of the humidity. Findings are temperatures above 90F are associated with an increase in mortality. Not much change in the results after including the humidity as the interaction. No systematic relationship between residential energy consumption and humidity interactions between high temperatures and humidity are insignificant. Projections using climate change predictions from the Hadley CM3 model suggest slight overall declines in mortality rates by the end of the 21st century, but with significant regional variations. Hot and humid areas are expected to see increases in mortality rates, while cold and dry areas might experience declines.

Barreca et.al (2013) After the county-level analysis Barreca further did the monthly mortality rates on the temperature at the state level in the United States from 1900 to 2004. Same temperature bins and residential energy consumption as the key variables. Estimated using the fixed effects of state-by-month, year-by-month, and quadratic time trends. Results says that alone usage of the air conditions explains 90% of the decline in days above 90F on mortality.

Larsen (Larsen 1990) investigates the impact of short-term temperature fluctuations on mortality in six states of the United States from 1921 to 1985. The study uses the monthly mortality rates per 1000 inhabitants and aims to determine if unusually Cold or warmer temperatures are associated with higher mortality. Larsen used distributed lag models to capture both immediate and delayed effects of temperature fluctuations on mortality and analyzed the seasonal patterns by each calendar month's mortality. Major findings are unusually cold temperatures from January to June and September to December are linked to higher mortality. Warmer than usual temperatures are also linked to higher mortality. Particularly southern states like North Carolina and Mississippi are very sensitive to variations in temperatures in winter months. While Larsen's paper focuses on short-term temperatures, my study extends this by analyzing the impact of extreme deviations in weather conditions on specific causes of mortality.

Gomez (Arceo-Gomez and López-Feldman 2024)focuses on the students' academic performance in Mexico by using the causal effects of extreme temperatures, specifically on how annual temperature exposures influence standard test scores in Spanish and math among school-aged children in a country facing significant climate risk and socio-economic challenges. They used the 5.5 million students' data aged between 1 to 15 years who took the ENLANCE examination in Mexico from 2007 to 2013 In weather variables they have included average temperature 365 days before the exam, cumulative precipitation for those 365 days and Temperature anomalies for the long-term trends. Estimated by using the year-fixed effects for three models' average temperature, average temperature bins, and temperature anomalies for long-term trends. The average temperature model shows that an increase in 1C hotter decreases in the Spanish and math test scores. The second model with temperature bins shows that when the temperature is below 17C, the test scores increase in both Spanish and math. On the other hand, the performance decreases if the temperature is between 25-29C. Finally last model with the temperature anomalies standard deviation increases the month before the examination decreasing the scores in both Spanish and math. While Eva's focus is on academic outcomes at the individual student level, mine is at the individual county level on the specific causes of the mortality it will help identify regions most at risk and tailor adaptive measures accordingly.

(Deschênes and Moretti 2009) analyzed the short-term and impacts of extreme temperature on daily mortality rates and role of geographical mobility in life expectancy utilized the daily mortality rates at the county level from 1972 to 1988. By using the temperature indicator variables measured the number of average temperature days below 30F and above 80F. By adapting geographical mobility and air conditioning to measure the influence of temperature with average county-level Ac coverage. For controlling the unobserved heterogeneity and capture the dynamic effects of temperature on mortality panel fixed effects including the county, year, month and up to 30 days lagged temperature effects. Results say that heat-related mortality days with temperatures above 80F are associated with the immediate impact of high temperatures causing deaths among people who are at a high risk of dying. Cold-related mortality indicates that there is an impact on human health after 30 days of the temperature events. People who moved from the colder northeast to the warmer southwest have a decrease in exposure to extreme cold and increased their life expectancy.

3. Data Sources and Variables

We Used three data sources to build the panel data set from 1979-2002 over 24 years of data for every month in the year. Firstly, mortality data used in our analysis is from the Vital Statistics National Center of Health Statistics (NCHS) with Multiple Cause of Death files (MCOD), The Global Historical Climatology Network (GHCN) Daily dataset is the primary source of weather station data from the National Oceanic and Atmospheric Administration (NOAA), and Demographics data on Population, per-capita income, Employment from the US census bureau.

3.1 Sources of Data

Multiple Causes of Death: Mortality data used in our analysis is from the vital statistics National Center of Health Statistics (NCHS) with Multiple Cause of Death files (MCOD). The multiple cause of death files have Total data on deaths with specific causes of death that occurred in the United States. For our analysis, we took the data from 1979-2002 with the International Classification of Diseases Codes (ICD-9 &10) for 382 counties. ICD codes are the standardized codes used globally to promote international comparability in mortality statistics collection, processing, classification, and presentation and are also used as the format for reporting the cause of mortality on death certificates. Causes of the deaths are turned into medical codes using the specifications from ICD which is published by the World Health Organization (WHO). ICD codes help improve the accuracy of the death statistics by systematically selecting the main cause of death from the list of health conditions. The cause taken from the death certificate is called the underlying cause of death and the remaining other causes mentioned in the death certificate are called non-underlying causes of death, both are combinedly called the multiple causes of death.

Climate data: Global Historical Climatology Network (GHCN) Daily dataset is the primary source of monthly weather data from the National Oceanic and Atmospheric Administration (NOAA) for 24 years 1979-2002. GHCN daily dataset is created by calculating various networks of the weather stations. In climate data, we used Minimum, maximum, and average temperatures and precipitation.

Socio-economic data: Demographic factors like per capita income, and employment (number of jobs) are the yearly estimates from the Bureau of Economic Analysis which we repeated for every month in each year. Population is also a yearly estimate from the US Census Bureau. (summary statistics in table 3.4)

3.2. Measurement of Variables

Measure of Health Outcomes: I utilized the daily mortality data from the Vital Statistics National Centre of Health Statistics (NCHS) for 1979-2002. The mortality rate data includes both the date of death and the detailed causes of death. I have aggregated counts of the day of death for each specific cause of death by county, year, and month. Using the International Classification of Diseases, the National Center for Health Statistics (NCHS) has systematically recoded specific causes of death. ICD-9 codes were used from 1979 to 1998, and ICD-10 codes were used from 1999 to 2002. These ICD specifications are used to assign names to the causes of death. I have established variables by grouping related causes of death that may influenced by weather conditions.

How we combined the Causes of death: First, to provide a thorough picture of mortality trends, we have constructed a **Total Mortality** in this study, which includes rates from all causes of death. We have divided the selected causes of death into five categories after determining the overall mortality rate. Five categories are: **Cardiovascular mortality** is a combination of heart-related and circulatory-related mortality. In heart-related mortality rates include Ischemic heart disease, Hypertensive heart disease with or without renal disease, and other heart disease mortality rates. Circulatory mortality rates include Atherosclerosis, Hypertension with or without renal disease, and other diseases of arteries, arterioles, and capillaries. **Respiratory mortality** included the death counts from Influenza and pneumonia, Tuberculosis, Chronic obstructive pulmonary diseases, and allied conditions. **Neoplasms mortality** is created by including cancer-related deaths, Malignant neoplasms of the Breast, Respiratory and intrathoracic, Digestive, and Genital organs. By combining Suicide and Assault (Homicide) deaths, **Self-Harm and Interpersonal violence**. Deaths from **Motor vehicle accidents** are separately analyzed. Upon establishing these cause-of-death categories, we used annual population estimates at the county level from the U.S. Census Bureau to calculate mortality rates per 100,000 inhabitants. (Summary statistics table 3.1 & 3.2)

Measure of climate variability and change: The Global Historical Climatology Network (GHCN-D) records the daily temperature readings. The highest and lowest temperature readings of the day at each station over the month was collected by the volunteers or automated machines. After the collection, the reading was to be sent to the National Center of Environmental Information (NCEI). Scientists in the NCEI will check the data and omit the systemic errors. Then they will calculate the monthly averages of maximum, minimum, and average temperatures by using the daily mean, maximum, and minimum temperatures. Monthly precipitation totals are also derived from GHCN data, aggregating daily measurements of rainfall and snowfall to determine the total precipitation for the month. County-level values for temperatures and precipitation are derived from area-weighted averages of grid point estimates that are interpolated from the weather station. The resolution of the grid is 5*5Km. This grid provides full coverage in all regions, including smaller areas. The averaging method ensures that every geographic area contributes equally to the final values by considering the size of each area within a county. When direct data is unavailable climatologically aided interpolation fills the gaps. (Summary statistics table 3.3)

Measure of temperature bins and threshold levels below 30°F and above 80°F:

Temperature Bins: To effectively capture non-linearity and how different ranges of temperatures affect health outcomes, I have created the 10 temperature bins with 10°F intervals ranging from <0°F to >=80°F by using the average monthly temperature values.

Below 30°F and Above 80°F: I have created two dummy variables to examine the impact of extreme temperature conditions on mortality rates. These variables identify the months with significant deviations from the usual average temperature range, with highs and lows below 30°F and above 80°F. Creating these variables allows us to see the correlation between extreme heat and cold temperatures on mortality. (Summary statistics table 3.5)

Measure of Extreme Deviations: To identify the extreme deviations, I have calculated the Z-scores by taking the mean and standard deviations for the maximum, minimum, and average temperatures, and precipitation across all counties for a particular year and month.

$$Z_{it} = \frac{X_{it} - \bar{X}_t}{SD_{it}}$$

Where X_{it} is the Temperature or precipitation, $\bar{X}_t$ is the mean of a particular year and month across counties, and SD_{it} is the standard deviation of a particular year and month across counties**.** (Summary statistics table 3.6)

After calculating the z-scores according to the (Li et al. 2019) greater than (+2.5)and less than (-2.0) are called extreme maximum and extreme minimum respectively. Considering the counts on the z-score bins (Summary statistics table 3.7) we constructed the extreme deviations variables for extreme maximum, extreme average, and extreme precipitation by taking the z-scores greater than (+2.5), and extreme minimum temperature is constructed considering the z-scores less than (-2.0).

4. Empirical model

We used four different panel fixed effects models to see the impact of Extreme weather conditions, specifically extreme deviations and precipitation levels on the various causes of death of monthly mortality data. We used monthly panel data over 24 years from 1979-2002 for this analysis.

For the robustness of our results, we included both county fixed effects and year-by-month fixed effects in our models. County fixed effects controls for time-invariant heterogeneity across the counties, for instance, availability and quality of the hospital facilities, sanitation levels, drought conditions, pollution levels and industrial activities. These factors could effects the effect the relationship between weather and mortality because they vary across the regions and impact the outcome variables.

Year-by-month fixed effects are used to control for any temporal shocks that could effect the outcome variables uniformly across the counties in a given month for instance seasonal variations, and healthcare policies. By including the time-fixed effects we can see the exact impact of weather on mortality.

4.1 Model Specifications

In our primary model, we estimated using minimum, maximum, and average temperatures and precipitation on the total and various causes of mortality, to control unobserved heterogeneity we used the county-fixed effects and time-fixed effects.

$$y_{ict} = \beta_1 t_{ct} + \beta_2 p_{ct} + X_{cy} + \alpha_c + \gamma_t + \epsilon_{ict}$$

Where y_{ict} is the monthly mortality rates per 100,000 inhabitants i is the various causes of the mortality, c is the county, t is time, $\beta_1 t$ represents minimum, maximum, and average temperatures, $\beta_2 p$ represents the precipitation, X_{cy} is the yearly per capita income of the county, where α_c is the county fixed effects and γ_t is the time-fixed effects ϵ_{ict} is the error term that captures all the unobserved influences on mortality.

The **second model** is done by using the temperature bins to see how non-linear effects show an impact on health outcomes and to capture the impact of temperature across the different ranges.

$$y_{ict} = \sum_{j=1}^{n} \beta_j \, tbins_{jct} + \beta_2 p_{ct} + X_{cy} + \alpha_c + \gamma_t + \epsilon_{ict}$$

Where $tbins_{jct}$ are calculated using the average monthly temperatures and the number of months categorized into bin j, which has bins from < 0°F to >=80°F with 10°F intervals, a total of 10 bins. The reference level selected is a bin with 60°F to 70°F which is considered to represent the average temperature.

In the third approach, for measuring the impact of the extremely cold and the extremely hot months on mortality, we calculated the months below 30°F and months above 80°F using the dummy variables.

$$y_{ict} = \beta_1 m_{ct}^{ch} + \beta_2 p_{ct} + X_{cy} + \alpha_c + \gamma_t + \epsilon_{ict}$$

Where the β_1 is coefficient estimating the impact of these extremely cold and hot conditions on mortality, m^{ch} represents the months with the cold and hot conditions. This model helps to know how the specific temperature thresholds significantly show an impact on mortality.

In our final approach, the focus of this model is to assess whether extreme conditions significantly affect mortality rates beyond the general influence of average weather patterns. We used standardized z-scores to see the impact of extreme deviations in temperatures and precipitation on mortality.

$$y_{ict} = \beta_1 et_{ct} + \beta_2 ep_{ct} + X_{cy} + \alpha_c + \gamma_t + \epsilon_{ict}$$

Where *et* in the equation represents the extreme temperatures and *ep* represents the extreme precipitations. We incorporated z-score dummies to specifically identify and analyze the impact of outliers on mortality rates. By setting a threshold of z-scores greater than or equal to 2, we focused on extreme deviations from typical weather patterns.

5. Results & Discussion

As I mentioned above in the empirical framework my results section is structured into four - subsections. The first subsection focuses on Standard climate variables for analyzing the fundamental impacts. The second subsection uses the bins strategy to effectively capture the nonlinearity in temperature data. The third sub-section focuses on temperature thresholds; average temperature months below 30F and above 80F. and the final approach is to see the impact of extreme weather deviations on the specific causes of death. All four methodologies in the analysis apply county fixed effects, year-by-month fixed effects, and standard errors clustered by both county and time to ensure robustness. Our results are divided into two sets for clarity: the first set excludes counties with populations below 100,000 to concentrate on areas with higher population densities (tables 5.1-5.14), and the second set includes these counties tables (appendix tables 1-14), giving a comprehensive view of how climate impacts vary across different population sizes.

Standard climate variables: This section initially started regression models with Maximum temperature, minimum temperature, average temperature, and precipitation variables individually which are shown in the 1,2,3 columns of the tables from 5.1 to 5.6. In the next two columns (4,5) we included the precipitation to see the joint effects of both temperatures and the precipitation. Results show that across the models with maximum temperature on total mortality, cardiovascular mortality, and Motor vehicle accidents are showing a significant impact whereas; Maximum temperature on total mortality shows significant increase in the mortality rates at the 5% level which indicates that higher temperatures may increase risk of death. Additionally, there is a significant association at the 0.1% level between maximum temperatures and motor vehicle accidents, possibly due to increased incidents like tire blowouts in hot conditions. Given that my data extends only until 2002, it is important to recognize that maximum temperatures have continued to rise since then. For example, in San Bernardino County, California, the maximum recorded temperature increased from 102.8°F in 2002 to 105.1°F in 2023—a rise of 2.3°F. This increase in temperature suggests that there may also be a corresponding rise in mortality rates, estimated at 1.46% for total mortality, 0.54% for cardiovascular mortality, and 0.358% for motor vehicle accident mortality. Regarding minimum temperatures, the analysis reveals a significant association with self-harm mortalities, evident at the 0.1% level. This suggests that lower temperatures may adversely affect individuals with mental health challenges. Conversely, lower temperatures are linked to a decrease in mortality rates for total mortality, cardiovascular issues, neoplasms, and motor vehicle accidents, indicating that cooler conditions may reduce the risks associated with these causes of death. Average temperatures show a significant impact on motor vehicle accidents and self-mortalities which indicates a sudden increase in the average temperatures will increase the self-harm mortalities and the mortalities at 0.1% and 10% levels significantly. Considering that my data extends only until 2002, it's important to note that since then, average temperatures have continued to rise. For example, San Bernardino County in California recorded an average temperature of 89.3°F in 2002, which has since increased to 91.3°Fin 2023. This 2°F increase suggests that there might also be a corresponding rise in mortality rates at 0.01%. Precipitation has varied effects individually and along with the temperatures. Precipitation is significantly associated with respiratory mortalities consistently across all the models, suggesting that higher precipitation levels may increase conditions leading to respiratory deaths. For the other 5 dependent variables, precipitation shows a negative impact across all the models, indicating that it may reduce mortality rates across these categories in all models.

Bins strategy: For the effective capture of non-linearity on specific causes of death, we analyzed the models using the average temperature bins ranging from <0°F to >=80°F total of 10 bins with 10°F intervals(Barreca 2012). This approach helped to identify the specific temperature ranges that significantly impact the mortality rates. For all regressions with the bins, we used 60°F -70°F bin as a reference point. I did three models using the average temperature bins one is individual, the next included the bins along with precipitation and the third included the socio-economic indicator per capita income along with precipitation and average temperature bins. Findings revealed that average temperature bins ranging between <0°F -60°F are significantly associated with the total and cardiovascular mortalities which indicates that the number of average temperature months increases in the above bin ranges, increases the total cardiovascular mortality rates. These results closely align with the existing literature,(Barreca 2012) states that below 50°F are associated with significant increases in the total and cardiovascular mortality rates. Average temperature bins <0°F and bins ranging from 30°F to 80°F are significantly associated with respiratory mortalities while only <0°F is associated with the neoplasm mortality which indicates that an increase in a number of cold temperatures months below 0°F has a harmful impact on respiratory and neoplasms mortality. Additionally, self-harm mortality is highly associated with average temperature bins above 80°F, showing a strong correlation with increased mortality rates. When it comes to motor vehicle accidents bins ranging from <0°F to 80°F show negative impact, initially standard average temperatures exhibit a highly significant positive relationship with motor vehicle accidents. This highlights the non-linear nature of temperature effects, where the impact on mortality varies significantly across different temperature ranges, underscoring the complexity of the relationship between temperature and health outcomes.

Temperature Thresholds; Months below 30°F and above 80°F: In this method, I constructed dummy variables for average temperatures in months below 30°F and above 80°F. Along with the dummy variables I include the precipitation in for all the dependent variables. As I presented, results in (table 5.8) months with average temperatures above 80°F are significantly associated with total mortality, cardiovascular, respiratory, and self-harm mortalities. Specifically, an increase in the number of higher temperature months above 80°F is linked to a rise in the risk of mortality: 0.1% for total mortality, 1% for cardiovascular mortality, 5% for respiratory mortality, and 1% for self-harm mortality. In contrast, precipitation during these high-temperature months generally shows a significant negative impact on the five dependent variables, except for respiratory mortality. For respiratory mortality, precipitation alongside high temperatures shows a significant positive impact at the 10% level, indicating that the combination of high temperatures and precipitation can exacerbate respiratory health risks. For colder temperatures (Table 5.7), months with average temperatures below 30°F show a negative impact on respiratory and motor vehicle accident mortalities, indicating that such colder months are associated with decreases in mortality rates. While precipitation combined with colder months shows a positive impact on respiratory mortality, this effect is not statistically significant.

Extreme deviations on mortality: In this approach, we utilized the standardized z-scores to analyze the impact of extreme weather events. Z-scores represent the number of standard deviations an observation is from the mean which is useful in identifying and analyzing the significance of extreme deviations in the temperatures and precipitation. After calculating the z-scores, Based on the methodology outlined by (Li et al. 2019) extreme weather variables were defined as follows: extreme maximum temperatures, extreme average temperatures, and Extreme precipitation are greater than (+2.5) Z-scores, and extreme minimum temperatures are less than (-2.0) z-scores. Regression models were done of extreme temperatures and extreme precipitations along with the combination of standard temperatures and precipitations. The results, as shown in Tables 5.9-5.14, indicate that extreme maximum temperatures are significantly associated with an increase in motor vehicle accidents at the 0.1% level. This suggests that as the number of months with extreme high temperatures rises, there is a greater likelihood of motor vehicle accidents, potentially due to tire blowouts. Similarly, extreme maximum temperatures have a slight positive impact on cardiovascular mortality, although this effect is not statistically significant. For instance, extreme temperatures may increase the strain on individuals with pre-existing heart conditions. Conversely, extreme maximum temperatures show a significant negative impact on respiratory mortalities. On the other hand, extreme minimum temperatures are significantly associated with motor vehicle accidents at the 5% level. This relationship is particularly relevant in areas with wet ice, where slippery conditions can lead to tire skidding and road accidents. Extreme average temperatures, however, are negatively associated with respiratory and total mortalities, indicating that sudden increases in extreme average temperatures do not significantly affect respiratory or overall mortality rates. Finally, extreme precipitation, when combined with extreme temperatures, has a significant negative impact on total and cardiovascular mortality. While extreme precipitation shows a slight positive impact on motor vehicle accidents, these results are not statistically significant.

As a robustness check for my research, I used one alternative approach to validate the model's reliability and to see the consistency of the results. The robustness check is applied to county and year-by-month fixed effects with standard errors clustered at the only county level. This modification did not lead to any notable changes in the outcomes, as detailed in the Appendix (Tables R1 to R14).

6. Conclusion

My research explores the complex relationship between extreme weather events on total mortality and other way 5 specific causes of death across 382 counties across the United States. Using a robust methodological approach from standard temperatures, Bins strategy for capturing non-linearity, temperature thresholds, and standardized z-scores to quantify extreme deviations in temperature and precipitation. Our main goal is to see how extreme deviations in temperatures and precipitation affect health outcomes across different counties.

The key findings of the analysis revealed that standard maximum temperatures are significantly associated with total, cardiovascular, and respiratory mortalities. Minimum and average temperatures are harmful to motor vehicles and the self-harm mortalities. The use of average temperature bins from <0°F to 80°F uncovered the non-linear nature of temperature effects on mortality. Specifically bins ranging from <0°F to 80°F are highly correlated with the total and cardiovascular mortalities. colder temperature bins (<0°F) were significantly associated with respiratory and neoplasm mortalities, while higher temperature bins above 80°F were linked to increased self-harm mortality. Colder average temperature months below 30°F were found to have a slight positive impact but not statistically significant. Months with average temperatures above 80°F are significantly associated with increased mortality rates, particularly for total mortality, cardiovascular, respiratory, and self-harm causes. This highlights the critical public health risks posed by rising temperatures, with estimated increases in mortality rates corresponding to these temperature elevations. Extreme maximum temperatures are significantly correlated with the motor vechicle accidents likely due to tire blowouts and slight increase in the cardiovascular mortalities but statistically insignificant. Conversely, extreme minimum temperatures were also significantly associated with motor vehicle accidents, particularly in conditions involving wet ice. Extreme average and precipitation shows negative impact on the respiratory and neoplasms mortality.

This research encountered some limitations that are in consideration are: The mortality data utilized from the period 1979-2002. While this dataset provides extensive historical insight, recent data would be more indicative of current health trends and a better understanding of the ongoing effects of climate change on public health due to recent shifts in climatic conditions. Although this research covers all regions of the United States, notably some states like Arizona, known for extreme heat conditions. Adding states like Arizona and other extreme temperature states will see great improvement in the analysis of higher temperature impacts due to their unique climatic conditions. Although the dataset has 382 counties which is approximately the 70% United States population according to the 2000 census. Expanding the analysis to include more counties would improve the results and give a detailed examination of the extreme weather effects across various geographical areas.

7. Figures and Tables

7.1 Figures

Figure 3.1 Z-Score bins

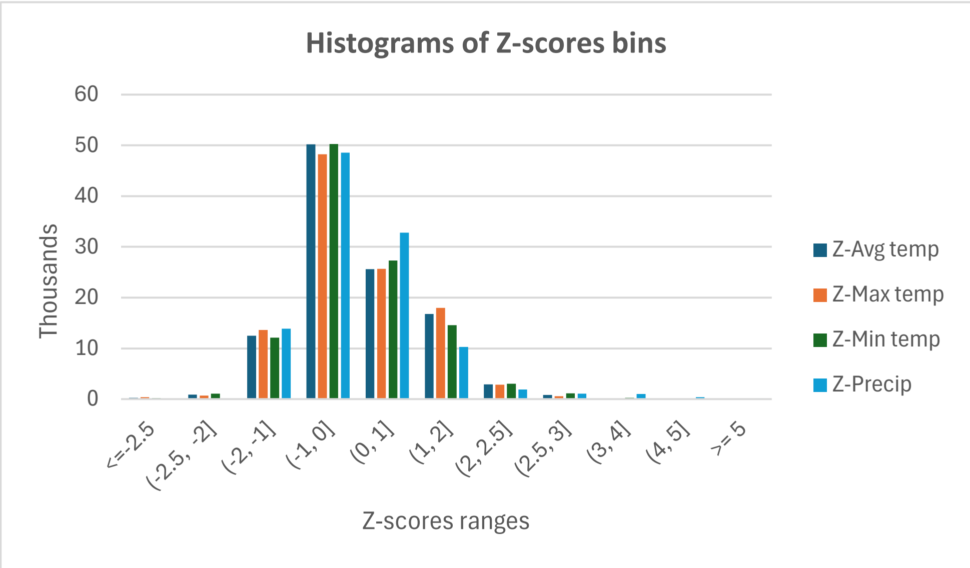
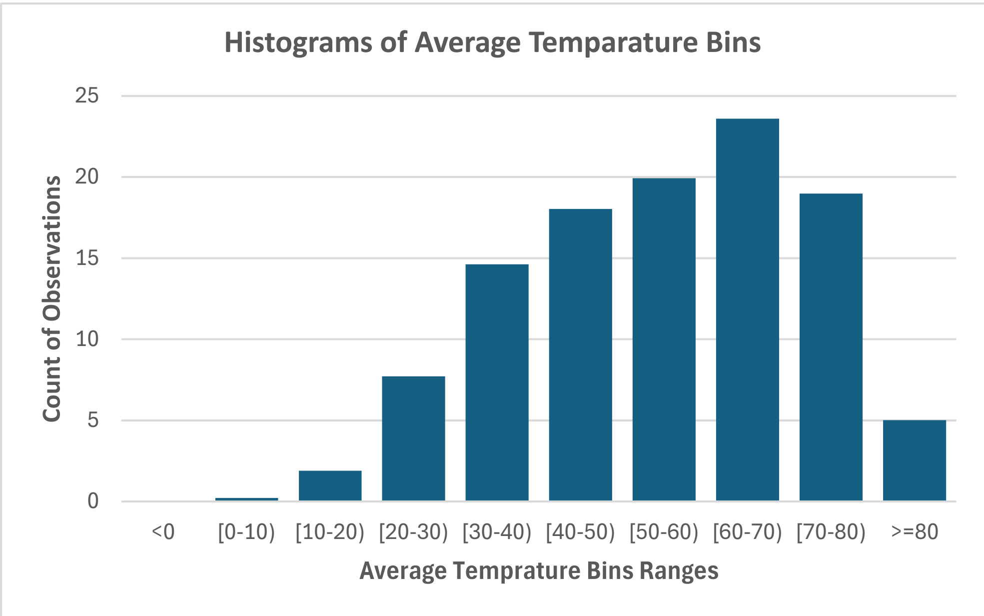


Figure 3.2 Average temperature bins



7.2Descriptive Statistics Tables

Table 3.1 summary statistics of the mortality rates per 100,000 inhabitants(with <100,000)

Variables Names	N	Mean	Sd	Min	Max
Total mortality	110016	96.50	428.69	0.41	14487.63
Cardiovascular mortality	110016	33.42	133.22	0.00	5064.78
Respiratory mortality	110016	6.94	31.35	0.00	1731.03
Neoplasms mortality	110016	15.34	55.02	0.00	2130.49
Motor-vehicle accidents	100729	2.46	17.82	0.07	869.57
Self-harm mortality	110016	2.46	17.14	0.00	988.70

Table 3.2 summary statistics of the mortality rates per 100,000 inhabitants (>=100,000)

Variables Names	N	Mean	Sd	Min	Max
Total mortality	107711	70.58	24.99	0.41	561.34
Cardiovascular mortality	107712	25.37	11.58	0.00	280.74
Respiratory mortality	107712	5.17	2.71	0.00	46.94
Neoplasms mortality	107712	12.06	4.85	0.00	78.34
Motor-vehicle accidents	98857	1.54	0.99	0.07	11.07
Self-harm mortality	107712	1.59	1.22	0.00	80.28

Table3.3 summary statistics of climate variables

Variables names	N	mean	sd	min	max
Max temp	110016	65.15	17.84	5.60	105.80
Min temp	110016	44.18	16.17	-20.80	79.20
Avg temp	110016	54.67	16.90	-7.60	91.00
Precipitation	110016	3.40	2.46	0.00	33.21

Table3.5 summary statistics of Average temperature bins and Thresholds

Bins Ranges	Count of Observations	Mean	Sd	Min	Max
[60-70)	23591	0.2144	0.4104	0.00	1.00
<0	10	0.0001	0.0095	0.00	1.00
[0-10)	224	0.0020	0.0451	0.00	1.00
[10-20)	1890	0.0172	0.1299	0.00	1.00
[20-30)	7723	0.0702	0.2555	0.00	1.00
[30-40)	14614	0.1328	0.3394	0.00	1.00
[40-50)	18038	0.1640	0.3702	0.00	1.00
[50-60)	19925	0.1811	0.3851	0.00	1.00
[70-80)	18982	0.1725	0.3778	0.00	1.00
>=80	5019	0.0456	0.2087	0.00	1.00
Thresholds					
Months Below 30F	9847	0.0895	0.2855	0.00	1.00
Months Above 80F	4888	0.0444	0.2060	0.00	1.00

Table3.6 Counts of the Z-score bins

Z-scores ranges	**Z-Avg temp**	**Z-Max temp**	**Z-Min temp**	**Z-Precip**
less than and equal-2.5	270	388	206	0
(-2.5, -2]	885	689	1070	69
(-2, -1]	12474	13615	12137	13868
(-1, 0]	50197	48263	50299	48548
(0, 1]	25580	25650	27316	32790
(1, 2]	16792	17959	14590	10271
(2, 2.5]	2905	2839	3043	1874
(2.5, 3]	842	567	1119	1085
(3, 4]	71	46	236	1018
(4, 5]	0	0	0	364
greater than 5	0	0	0	129
Total	110016	110016	110016	110016

Table3.7 Summary statistics of the extreme events

Variables Names	N	Mean	Sd	Min	Max
Min Temp(Z)	110016	0.00	1.00	-3.33	3.75
Max Temp(Z)	110016	0.00	1.00	-4.40	3.66
Avg Temp(Z)	110016	0.00	1.00	-3.84	3.41
Precipitation(Z)	110016	0.00	1.00	-2.49	8.46
Extreme Min T (Z<=-2.0)	110016	0.011	0.107	0.00	1.00
Extreme Max T (Z>+2.5)	110016	0.005	0.074	0.00	1.00
Extreme Avg T (Z>+2.5)	110016	0.008	0.090	0.00	1.00
Extreme Precipitation T(Z>+2.5)	110016	0.023	0.151	0.00	1.00

Table3.4 summary statistics of Demographic variables

Variables Names	N	Mean	Sd	Min	Max
Population	110016	422.11	628.26	0.68	9705.91
Per capita income	110016	20.23	8.37	4.82	93.19
Employment (Total jobs)	109944	246.93	389.74	0.31	5405.81

7.3 List of Results Tables

Table 5.1 Effect of Weather on Total Mortality

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Max Temp	0.0621*				0.0638*			0.0614*		
	(0.0255)				(0.0271)			(0.0266)		
Min Temp	-0.130***				-0.132***			-0.1317***		
	(0.0263)				(0.0299)			(0.0294)		
Avg Temp		-0.0584**		-0.0543**					-0.0558**	
		(0.0185)		(0.0188)					(0.0187)	
Precipitation			-0.0680**	-0.0531*	0.0050		-0.0768**	0.0062	-0.0509*	-0.075***
			(0.0236)	(0.0242)	(0.0262)		(0.0234)	(0.0252)	(0.023)	(0.0221)
Avg T< 0F						0.9063	0.5360			0.9879
						(1.195)	(1.233)			(1.391)
Avg T 0-10F						2.048.	1.791			1.833.
						(1.109)	(1.105)			(1.107)
Avg T 10-20F						1.501*	1.304.			1.409*
						(0.6627)	(0.6691)			(0.6415)
Avg T 20-30F						1.716**	1.571**			1.609**
						(0.5352)	(0.5369)			(0.5256)
Avg T 30-40F						1.961***	1.895***			1.976***
						(0.4338)	(0.4333)			(0.4381)
Avg T 40-50F						1.409***	1.421***			1.493***
						(0.2926)	(0.2886)			(0.2817)
Avg T 50-60F						0.7216***	0.7309***			0.7876***
						(0.1761)	(0.1732)			(0.1645)
Avg T 70-80F						-0.2643	-0.2017			-0.2192
						(0.1870)	(0.1840)			(0.1734)
Avg T >=80F						0.1395	0.2861			0.2282
						(0.4138)	(0.3989)			(0.3722)
Per capita income								-0.7406**	-0.7408**	-0.7413**
								(0.2684)	(0.2684)	(0.2685)
N	*1,07,423*	*1,07,423*	*1,07,423*	*1,07,423*	*1,07,423*	*1,07,423*	*1,07,423*	*1,07,423*	*1,07,423*	*1,07,423*
R2	*0.89885*	*0.89876*	*0.8987*	*0.89877*	*0.89885*	*0.89884*	*0.89888*	*0.90303*	*0.90296*	*0.90307*

***** p<0.001, ** p<0.01, * p<0.05, p<0.1. Bin:60-70F as the reference Note: county fe, year by month fe, S.E clustered at the county and time*

Table 5.2Effect of Weather on Cardiovascular Mortality

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
Max Temp	0.0204				0.0239.			0.0229.		
	(0.0132)				(0.0141)			(0.0137)		
Min Temp	-0.0649***				-0.0696***			-0.0692***		
	(0.0130)				(0.0150)			(0.0144)		
Avg Temp		-0.0401***		-0.0387***					-0.0393***	
		(0.0096)		(0.0098)					(0.0096)	
Precipitation			-0.028*	-0.0174	0.0103		-0.0255*	0.0107	-0.0165	-0.025*
			(0.0118)	(0.0121)	(0.0132)		(0.0116)	(0.0126)	(0.0114)	(0.0109)
Avg T< 0F						1.021***	0.8982***			1.081**
						(0.2356)	(0.1257)			(0.3604)
Avg T 0-10F						1.828*	1.743*			1.760*
						(0.7559)	(0.7521)			(0.7521)
Avg T 10-20F						1.242**	1.177**			1.220**
						(0.3775)	(0.3805)			(0.3694)
Avg T 20-30F						1.099***	1.051***			1.066***
						(0.2773)	(0.2732)			(0.2649)
Avg T 30-40F						0.8552***	0.8333***			0.8663***
						(0.2289)	(0.2293)			(0.2293)
Avg T 40-50F						0.5945***	0.5983***			0.6278***
						(0.1641)	(0.1612)			(0.1554)
Avg T 50-60F						0.3336**	0.3366**			0.3596***
						(0.1034)	(0.1024)			(0.0940)
Avg T 70-80F						-0.1487	-0.1279			-0.1350
						(0.1079)	(0.1066)			(0.0980)
Avg T >=80F						0.0366	0.0853			0.0619
						(0.2266)	(0.2205)			(0.2001)
Per capita income								-0.2999*	-0.3*	-0.3*
								(0.1432)	(0.1432)	(0.1432)
N	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*
R2	*0.86303*	*0.86294*	*0.86278*	*0.86295*	*0.86303*	*0.86294*	*0.86296*	*0.86623*	*0.86615*	*0.86616*

**** p<0.001, ** p<0.01, * p<0.05, p<0.1. Bin:60-70F as the reference Note: county fe, year by month fe, S.E clustered at the county and time*

Table 5.3 Effect of Weather on Respiratory Mortality

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Max Temp	-0.0012				0.0027			0.0025		
	(0.0052)				(0.0057)			(0.0057)		
Min Temp	0.0024				-0.0029			-0.0028		
	(0.0066)				(0.0071)			(0.0072)		
Avg Temp		0.0010		0.0002					0.0001	
		(0.0039)		(0.0038)					(0.0038)	
Precipitation			0.0099.	0.0098.	0.0114.		0.0056	0.0115*	0.0100.	0.0058
			(0.0055)	(0.0054)	(0.0058)		(0.0052)	(0.0059)	(0.0054)	(0.0052)
Avg T< 0F						0.7593***	0.7865***			0.8231***
						(0.0693)	(0.0656)			(0.0683)
Avg T 0-10F						-0.1734	-0.1545			-0.1511
						(0.1785)	(0.1759)			(0.1772)
Avg T 10-20F						-0.0741	-0.0596			-0.0511
						(0.1445)	(0.1424)			(0.1422)
Avg T 20-30F						-0.0087	0.0020			0.0051
						(0.1162)	(0.1145)			(0.1145)
Avg T 30-40F						0.1775*	0.1823*			0.1889*
						(0.0854)	(0.0847)			(0.0854)
Avg T 40-50F						0.1738**	0.1729**			0.1788**
						(0.0547)	(0.0548)			(0.0551)
Avg T 50-60F						0.0680*	0.0673*			0.0719*
						(0.0333)	(0.0334)			(0.0339)
Avg T 70-80F						0.0674.	0.0628.			0.0614.
						(0.0343)	(0.0335)			(0.0335)
Avg T >=80F						0.1512*	0.1405*			0.1358.
						(0.0725)	(0.0708)			(0.0711)
Per capita income								-0.0598***	-0.0598***	-0.0599***
								(0.0099)	(0.0099)	(0.0099)
N	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*
R2	*0.59444*	*0.59444*	*0.59449*	*0.59449*	*0.5945*	*0.59497*	*0.59499*	*0.59681*	*0.59681*	*0.59731*

*** p<0.001, ** p<0.01, * p<0.05, p<0.1. For average temp bins took 60-70F as the *reference Note: county fe, year by month fe, S.E clustered at the county and time*

Table 5.4 Effect of Weather on Neoplasm Mortality

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
Max Temp	0.0029				-0.0002			-0.0005		
	(0.0040)				(0.0043)			(0.0043)		
Min Temp	-0.0047				-0.0005			-0.0004		
	(0.0043)				(0.0049)			(0.0048)		
Avg Temp		-0.0014		-0.0007					-0.0009	
		(0.0024)		(0.0025)					(0.0024)	
Precipitation			-0.0094*	-0.0092*	-0.0091.		-0.0101*	-0.0090.	-0.0089*	-0.0099*
			(0.0044)	(0.0045)	(0.0050)		(0.0047)	(0.0048)	(0.0042)	(0.0044)
Avg T< 0F						0.3468***	0.2983***			0.3558***
						(0.0287)	(0.0324)			(0.0336)
Avg T 0-10F						0.3173	0.2836			0.2890
						(0.2031)	(0.2033)			(0.2042)
Avg T 10-20F						-0.1038	-0.1297			-0.1162
						(0.1060)	(0.1062)			(0.1028)
Avg T 20-30F						0.0795	0.0604			0.0653
						(0.0862)	(0.0860)			(0.0831)
Avg T 30-40F						0.0889	0.0803			0.0907
						(0.0733)	(0.0727)			(0.0709)
Avg T 40-50F						0.0706	0.0721			0.0814
						(0.0605)	(0.0604)			(0.0579)
Avg T 50-60F						0.0091	0.0103			0.0176
						(0.0432)	(0.0432)			(0.0405)
Avg T 70-80F						-0.0362	-0.0280			-0.0302
						(0.0401)	(0.0396)			(0.0375)
Avg T >=80F						-0.0637	-0.0445			-0.0518
						(0.0827)	(0.0808)			(0.0728)
Per capita income								-0.0944*	-0.0944*	-0.0944*
								(0.0427)	(0.0427)	(0.0427)
N	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*
R2	*0.72022*	*0.72022*	*0.72023*	*0.72024*	*0.72024*	*0.72026*	*0.72028*	*0.72204*	*0.72204*	*0.72208*

*** p<0.001, ** p<0.01, * p<0.05, p<0.1. Bin:60-70F as the reference Note: county fe, year by month fe, S.E clustered at the county and time

Table 5.5 Effect of Weather on Motor vehicle accidents

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Max Temp	0.0156***				0.0131***			0.0131***		
	(0.0018)				(0.0019)			(0.0019)		
Min Temp	-0.0117***				-0.0083***			-0.0083***		
	(0.0021)				(0.0022)			(0.0022)		
Avg Temp		0.0054***		0.0064***					0.0064***	
		(0.0013)		(0.0012)					(0.0012)	
Precipitation			-0.0120***	-0.0136***	-0.0073***		-0.0120***	-0.0073***	-0.0136***	-0.0120***
			(0.0019)	(0.0017)	(0.0017)		(0.0017)	(0.0017)	(0.0017)	(0.0017)
Avg T< 0F						-0.1891	-0.2482			-0.2477
						(0.1631)	(0.1669)			(0.1666)
Avg T 0-10F						-0.2443**	-0.2838***			-0.2836***
						(0.0770)	(0.0778)			(0.0779)
Avg T 10-20F						-0.1933***	-0.2231***			-0.2229***
						(0.0530)	(0.0527)			(0.0526)
Avg T 20-30F						-0.1401***	-0.1620***			-0.1619***
						(0.0346)	(0.0330)			(0.0331)
Avg T 30-40F						-0.1210***	-0.1304***			-0.1302***
						(0.0290)	(0.0279)			(0.0279)
Avg T 40-50F						-0.1130***	-0.1106***			-0.1104***
						(0.0215)	(0.0208)			(0.0208)
Avg T 50-60F						-0.0391**	-0.0375**			-0.0374**
						(0.0143)	(0.0139)			(0.0139)
Avg T 70-80F						-0.0180	-0.0083			-0.0083
						(0.0145)	(0.0141)			(0.0141)
Avg T >=80F						-0.0646*	-0.0415			-0.0417
						(0.0312)	(0.0300)			(0.0300)
Per capita income								-0.0016	-0.0016	-0.0017
								(0.0043)	(0.0043)	(0.0043)
N	*98,609*	*98,609*	*98,609*	*98,609*	*98,609*	*98,609*	*98,609*	*98,609*	*98,609*	*98,609*
R2	*0.28472*	*0.2835*	*0.28369*	*0.28434*	*0.2849*	*0.28395*	*0.28457*	*0.28492*	*0.28435*	*0.28459*

***** p<0.001, ** p<0.01, * p<0.05, p<0.1. Bin:60-70F as the reference Note: county fe, year by month fe, S.E clustered at the county and time*

Table 5.6 Effect of Weather on Self-Harm Mortality

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
Max Temp	-0.0025.				-0.0045**			-0.0046**		
	(0.0015)				(0.0016)			(0.0016)		
Min Temp	0.0049***				0.0076***			0.0076***		
	(0.0014)				(0.0015)			(0.0015)		
Avg Temp		0.0020.		0.0022.					0.0021.	
		(0.0011)		(0.0011)					(0.0011)	
Precipitation			-0.0017	-0.0022	-0.0058***		-0.0029.	-0.0058***	-0.0022	-0.0028.
			(0.0016)	(0.0016)	(0.0017)		(0.0016)	(0.0017)	(0.0016)	(0.0016)
Avg T< 0F						-0.3480	-0.3618			-0.3490
						(0.2924)	(0.2917)			(0.2906)
Avg T 0-10F						-0.1903*	-0.1999*			-0.1987*
						(0.0836)	(0.0837)			(0.0844)
Avg T 10-20F						-0.1069*	-0.1142**			-0.1112**
						(0.0415)	(0.0419)			(0.0426)
Avg T 20-30F						-0.0581.	-0.0635.			-0.0624.
						(0.0334)	(0.0335)			(0.0340)
Avg T 30-40F						-0.0204	-0.0229			-0.0206
						(0.0280)	(0.0280)			(0.0288)
Avg T 40-50F						-0.0139	-0.0135			-0.0114
						(0.0229)	(0.0229)			(0.0236)
Avg T 50-60F						-0.0334*	-0.0331.			-0.0314.
						(0.017)	(0.0169)			(0.0175)
Avg T 70-80F						0.0153	0.0176			0.0171
						(0.0160)	(0.0159)			(0.0162)
Avg T >=80F						0.0895***	0.0949***			0.0933***
						(0.0259)	(0.0265)			(0.0277)
Per capita income								-0.0210	-0.0210	-0.0210
								(0.0137)	(0.0137)	(0.0136)
N	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*
R2	*0.4115*	*0.41144*	*0.41141*	*0.41145*	*0.41158*	*0.41163*	*0.41165*	*0.413*	*0.41287*	*0.41307*

****** p<0.001, ** p<0.01, * p<0.05, p<0.1. Bin:60-70F as the reference Note: county fe, year by month fe, S.E clustered at the county and time*

Table5.7 Effect of Weather (Months Below 30°F) on Specific causes of death

Variables	Total mortality	Cardiovascular mortality	Respiratory mortality	Neoplasms mortality	Motor vehicle accidents	Self-harm mortality
Months Below 30°F	-0.2679 (0.3183)	0.2807 (0.1818)	-0.1731* (0.0698)	-0.0490 (0.0412)	-0.0507** (0.0187)	-0.0367. (0.0188)
Precipitation	-0.0713** (0.0237)	-0.0245* (0.0117)	0.0077 (0.0054)	-0.01* (0.0045)	-0.0126*** (0.0018)	-0.0021 (0.0016)
Observations	*1,07,423*	*1,07,424*	*1,07,424*	*1,07,424*	*98,609*	*1,07,424*
R^2	*0.89871*	*0.8628*	*0.59467*	*0.72024*	*0.2838*	*0.41145*

Note: county fe, year by month fe, S.E clustered at the county and time

Table 5.8 Effect of Weather (Months Above 80F) on Specific causes of death

Variables	Total mortality	Cardiovascular mortality	Respiratory mortality	Neoplasms mortality	Motor vehicle accidents	Self-harm mortality
Months Above 80°F	1.178*** (0.3199)	0.5590** (0.1907)	0.1352* (0.0542)	0.0006 (0.0598)	-0.0903*** (0.0259)	0.0667** (0.0234)
Precipitation	-0.0738** (0.0234)	-0.0308** (0.0118)	0.0092. (0.0055)	-0.0094* (0.0044)	-0.0115*** (0.0018)	-0.0020 (0.0016)
Observations	*1,07,423*	*1,07,424*	*1,07,424*	*1,07,424*	*98,609*	*1,07,424*
R^2	*0.89877*	*0.86284*	*0.59457*	*0.72023*	*0.28395*	*0.41149*

Note: county fe, year by month fe, S.E clustered at the county and time

Table 5.9 Extreme Weather on Total Mortality

Variable	(1)	(2)	(3)	(4)
Max Temp	0.0614*	0.0637*		
	(0.0266)	(0.0268)		
Min Temp	-0.1317***	-0.1351***		
	(0.0294)	(0.0296)		
Average Temp			-0.0558**	-0.0533**
			(0.0187)	(0.0189)
Precipitation	0.0062	0.0234	-0.0509*	-0.0403
	(0.0252)	(0.0289)	(0.023)	(0.0262)
Extreme Max T (Z>2.5)		-0.3598		
		(0.4329)		
Extreme Min T (Z>-2.0)		-0.2559		
		(0.4152)		
Extreme Average T (Z>2.5)				-0.9065.
				(0.4894)
Extreme Precipitation (Z>2.5)		-0.4669.		-0.3640
		(0.2404)		(0.2393)
Per capita income	-0.7406**	-0.7406**	-0.7408**	-0.7409**
	(0.2684)	(0.2684)	(0.2684)	(0.2684)
N	*1,07,423*	*1,07,423*	*1,07,423*	*1,07,423*
R^2	*0.90303*	*0.90304*	*0.90296*	*0.90297*

Note: county fe, year by month fe, S.E clustered at the county and time

Table 5.10 Extreme Weather on Cardiovascular Mortality

Variable	(1)	(2)	(3)	(4)
Max Temp	0.0229.	0.0234.		
	(0.0137)	(0.0139)		
Min Temp	-0.069***	-0.0708***		
	(0.0144)	(0.0146)		
Average Temp			-0.0393***	-0.039***
			(0.0096)	(0.0097)
Precipitation	0.0107	0.0215	-0.0165	-0.0086
	(0.0126)	(0.0141)	(0.0114)	(0.0125)
Extreme Max T (Z>2.5)		0.1681		
		(0.2386)		
Extreme Min T (Z>-2.0)		-0.0843		
		(0.1821)		
Extreme Average T (Z>2.5)				-0.0717
				(0.2143)
Extreme Precipitation (Z>2.5)		-0.271*		-0.2220.
		(0.1288)		(0.1269)
Per capita income	-0.2999*	-0.2999*	-0.3*	-0.3*
	(0.1432)	(0.1432)	(0.1432)	(0.1432)
N	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*
R^2	*0.86623*	*0.86624*	*0.86615*	*0.86616*

Note: county fe, year by month fe, S.E clustered at the county and time

Table 5.11 Extreme Weather on Respiratory Mortality

Variable	(1)	(2)	(3)	(4)
Max Temp	0.0025	0.0030		
	(0.0042)	(0.0042)		
Min Temp	-0.0028	-0.0026		
	(0.0050)	(0.0050)		
Average Temp			0.0001	0.0009
			(0.0029)	(0.0028)
Precipitation	0.0115**	0.0111**	0.0100**	0.0093*
	(0.0036)	(0.0038)	(0.0038)	(0.0040)
Extreme Max T (Z>2.5)		-0.2570**		
		(0.0920)		
Extreme Min T (Z>-2.0)		0.0103		
		(0.1034)		
Extreme Average T (Z>2.5)				-0.2363**
				(0.0864)
Extreme Precipitation (Z>2.5)		-0.0040		-0.0017
		(0.0491)		(0.0489)
Per capita income	-0.0598***	-0.0598***	-0.0598***	-0.0598***
	(0.0098)	(0.0098)	(0.0098)	(0.0098)
N	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*
R^2	*0.59681*	*0.59685*	*0.59681*	*0.59685*

Note: county fe, year by month fe, S.E clustered at the county and time

Table 5.12 Extreme Weather on Neoplasms Mortality

Variable	(1)	(2)	(3)	(4)
Max Temp	-0.0005	-0.0004		
	(0.0043)	(0.0043)		
Min Temp	-0.0004	-0.0006		
	(0.0048)	(0.0048)		
Average Temp			-0.0009	-0.0011
			(0.0024)	(0.0024)
Precipitation	-0.0090.	-0.0076	-0.0089*	-0.0075
	(0.0048)	(0.0056)	(0.0042)	(0.0052)
Extreme Max T (Z>2.5)		-0.0002		
		(0.1147)		
Extreme Min T (Z>-2.0)		-0.0106		
		(0.1023)		
Extreme Average T (Z>2.5)				0.0462
				(0.0981)
Extreme Precipitation (Z>2.5)		-0.0347		-0.0346
		(0.0638)		(0.0638)
Per capita income	-0.0944*	-0.0944*	-0.0944*	-0.0944*
	(0.0427)	(0.0427)	(0.0427)	(0.0427)
N	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*
R^2	*0.72204*	*0.72204*	*0.72204*	*0.72204*

Note: county fe, year by month fe, S.E clustered at the county and time

Table 5.13 Extreme Weather on Motor Vehicle Accidents

Variable	(1)	(2)	(3)	(4)
Max Temp	0.0131***	0.0127***		
	(0.0019)	(0.0019)		
Min Temp	-0.008***	-0.0078***		
	(0.0022)	(0.0022)		
Average Temp			0.0064***	0.0064***
			(0.0012)	(0.0012)
Precipitation	-0.007***	-0.0074***	-0.0136***	-0.0143***
	(0.0017)	(0.0021)	(0.0017)	(0.0021)
Extreme Max T (Z>2.5)		0.0994***		
		(0.0264)		
Extreme Min T (Z>-2.0)		0.0886*		
		(0.0358)		
Extreme Average T (Z>2.5)				0.0179
				(0.0267)
Extreme Precipitation (Z>2.5)		0.0101		0.0200
		(0.0268)		(0.0269)
Per capita income	-0.0016	-0.0016	-0.0016	-0.0016
	(0.0043)	(0.0043)	(0.0043)	(0.0043)
N	*98,609*	*98,609*	*98,609*	*98,609*
R^2	*0.28492*	*0.28502*	*0.28435*	*0.28436*

Note: county fe, year by month fe, S.E clustered at the county and time

Table 5.14 Extreme Weather on Self-Harm Mortality

Variable	(1)	(2)	(3)	(4)
Max Temp	-0.0046***	-0.0045**		
	(0.0012)	(0.0016)		
Min Temp	0.0076***	0.0074***		
	(0.0013)	(0.0016)		
Average Temp			0.0021.	0.0022.
			(0.0011)	(0.0011)
Precipitation	-0.0058***	-0.0056**	-0.0022	-0.0019
	(0.0016)	(0.0020)	(0.0016)	(0.0019)
Extreme Max T (Z>2.5)		-0.0231		
		(0.0407)		
Extreme Min T (Z>-2.0)		-0.0278		
		(0.0379)		
Extreme Average T (Z>2.5)				-0.0472
				(0.0375)
Extreme Precipitation (Z>2.5)		-0.0052		-0.0110
		(0.0239)		(0.0238)
Per capita income	-0.0210.	-0.0210	-0.0210	-0.0210
	(0.0126)	(0.0136)	(0.0137)	(0.0136)
N	*1,07,424*	*1,07,424*	*1,07,424*	*1,07,424*
R^2	*0.413*	*0.413*	*0.41287*	*0.41288*

Note: county fe, year by month fe, S.E clustered at the county and time

Appendix

Comparison Table 2.1 of the literature review for related papers

Aspect/Paper	Climate Change, Mortality, and Adaptation: Evidence from annual fluctuations in Weather in US	Extreme Weather Event, Mortality, and Migration.	Climate change, humidity, and mortality in the United States.	The Effect of Extreme Weather on Mortality: Evidence from the United States
Author	**Deschênes and Greenstone (2007)**	**Deschenes and Moretti (2009)**	**Alan I. Barreca (2012)**	**My thesis**
Research Question	Investigates the welfare impact of climate change on mortality in the U.S. using historical weather data and climate predictions.	How do temperature extremes affect daily mortality rates in the United States, and how does geographic mobility and air conditioning mitigate these effects?	How do temperature and humidity affect mortality rates in the United States, and what are the implications for climate change?	The effects of extreme weather conditions on mortality by specific causes across U.S. counties from 1979-2002, using various temperature and precipitation measures, including extreme deviations.
Data Used	Compressed Mortality Files (1968-2002) Energy Information Administration (1968-2002) National Climatic Data Center (weather data) Climate change predictions from Hadley Centre and NCAR models. Includes residential energy consumption as a measure of adaptation.	Mortality Data: Daily mortality rate data of whites with 9 age groups (1972–1988) from Multiple Cause of Death Files (NCHS). Weather Data: The nearest Weather station data is linked to each county. Energy consumption data	Mortality Data: Multiple Cause of Death (MCOD) files (1973–2002) from the National Center for Health Statistics (NCHS). Weather Data: National Climatic Data Center's Global Summary of the Day (GSOD) files (1973–2002).	County-level panel data from 1979-2002, covering mortality rates, temperature, and precipitation data, as well as socioeconomic data.

Weather Variables	20 temperature bins ranging from < 0°F to > 90°F, with 5°F intervals for capturing the nonlinearity.	Days with mean temperatures below 20 and 30°F and above 80 and 90°F were used as threshold variables for cold and heat exposure. And lag models upto 30 days after extreme cold temperature occures (lag ranges :1-2,3-6,7-14,15-30)	Daily mean temperature is categorized into 10°F bins. Humidity: Specific humidity is categorized into 2 grams of water vapor per kilogram of air bins.	Standard temperatures along with preciptation, Average temperature bins ranging from 0°Fto >80°F for capturing the non-linearity, Temperature thresholds: months above 80°F as extreme heat and months below 30°F are as the extreme cold. And also includes the standardized z-scores to see the impact of extreme deviations on the mortality.
Empirical Model/Methods	A semi-parametric model with 20 temperature bins. Models include minimum, maximum, and average temperatures and precipitation. Two-panel datasets: Panel A: Bins average temperature. Panel B: 2 separate bins by Maximum and minimum temperatures. County fixed effects, state-by-year fixed effects.	Panel fixed-effects regression with county, year, and month fixed effects. Controls for up to 30 days of lagged weather effects. Interaction of temperature with county-level air conditioning coverage to measure adaptation. Interaction of temperature with county-level air conditioning coverage to measure adaptation	Panel fixed-effects model with county-by-calendar-month fixed effects and county-by-calendar-month quadratic time trends. Includes interaction terms between temperature and humidity. Uses a two-month moving average of weather variables	Panel fixed effects models with county and year-by-month fixed effects. Comprehensive analysis of the existing literature(standard temperature and precipitation variables, Average temperature bins, extreme temperature thresholds) specifically includes the new methodological approach to see the impact of extreme deviations by using the Z-scores.

Main Findings	Predicts a modest increase in mortality rates due to climate change, with significant increases in residential energy consumption. Highlights the importance of adaptation strategies like air conditioning.	Heat-related mortality is associated with short-term displacement of deaths (harvesting). Cold-related mortality is more persistent, affecting mortality rates for up to 30 days after the event. Geographic mobility and air conditioning have contributed to increased longevity in the U.S.	Both temperature and humidity have a U-shaped relationship with mortality. Temperature above 90°F and below 50F and humidity above 16 g/kg significantly increase mortality rates. Increased humidity levels are more dangerous with high tempratures. Mortality rates are projected to decrease slightly on aggregate but increase in hot and humid areas by the end of the 21st century	standard maximum temperatures are significantly associated with total, cardiovascular, and respiratory mortalities. Minimum and average temperatures are harmful to motor vehicles and self-harm mortalities. The use of average temperature bins from <0°F to 80°F uncovered the non-linear nature of temperature effects on mortality. Specifically, bins ranging from <0°F to 60°F are highly correlated with the total and cardiovascular mortalities. Months with average temperatures above 80°F are significantly associated with increased mortality rates, particularly for total mortality, cardiovascular, respiratory, and self-harm causes. Extreme maximum temperatures are significantly correlated with the motor vechicle accidents, likely due to tire blowouts and a slight increase in cardiovascular mortalities but statistically insignificant. Conversely, extreme minimum temperatures were also significantly associated with motor vehicle accidents, particularly in conditions involving wet ice.

Results of Counties with a Below 100,000 Population

County and year-by-month fixed effects; clustered standard errors at county code and year-by-month (with < 100,000 population counties)

Table A1 Effect of Weather on Total Mortality

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Max Temp	0.2214				0.3000			0.2918		
	(0.2203)				(0.3084)			(0.2995)		
Min Temp	-0.3999				-0.5060			-0.5012		
	(0.3288)				(0.4466)			(0.4408)		
Avg Temp		-0.1461.		-0.1455.					-0.1500.	
		(0.0773)		(0.0792)					(0.0816)	
Precipitation			-0.047*	-0.0076	0.2306		-0.0125	0.2333	-0.0011	-0.0085
			(0.024)	(0.0333)	(0.2575)		(0.0487)	(0.2569)	(0.0293)	(0.0468)
Avg T< 0F						-0.4820	-0.5417			0.8307
						(0.9102)	(0.5580)			(1.565)
Avg T 0-10F						-12.74	-12.79			-12.57
						(14.12)	(13.96)			(13.74)
Avg T 10-20F						-1.038	-1.070			-0.7569
						(3.353)	(3.237)			(2.925)
Avg T 20-30F						3.822*	3.799*			3.921*
						(1.592)	(1.677)			(1.724)
Avg T 30-40F						-1.818	-1.828			-1.567
						(3.454)	(3.412)			(3.184)
Avg T 40-50F						-1.269	-1.268			-1.037
						(2.273)	(2.280)			(2.094)
Avg T 50-60F						-2.508	-2.507			-2.331
						(2.742)	(2.748)			(2.603)
Avg T 70-80F						1.248	1.258			1.202
						(0.9810)	(0.9347)			(0.8930)
Avg T >=80F						3.453	3.477			3.302
						(2.421)	(2.320)			(2.303)
Per capita income								-2.335	-2.336	-2.329
								(2.011)	(2.012)	(2.006)
N	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*
R2	*0.94880*	*0.94880*	*0.94880*	*0.94880*	*0.94880*	*0.94881*	*0.94881*	*0.94897*	*0.94896*	*0.94897*
Adj. R2	*0.94849*	*0.94848*	*0.94848*	*0.94848*	*0.94849*	*0.94849*	*0.94849*	*0.948653*	*0.94864*	*0.94864*

**** p<0.001, ** p<0.01, * p<0.05, p<0.1. Bin:60-70F as the reference*

Note: county fe, year by month fe, S.E clustered at the county and time

Table A2 Effect of Weather on Cardiovascular Mortality

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Max Temp	-0.0367				-0.0248			-0.0259		
	(0.0392)				(0.0336)			(0.0333)		
Min Temp	-0.0512				-0.0673			-0.0666		
	(0.0315)				(0.0450)			(0.0440)		
Avg Temp		-0.087*		-0.0890.					-0.0896.	
		(0.0441)		(0.0466)					(0.0470)	
Precipitation			-0.0018	0.0225	0.0350		0.0234	0.0354	0.0234	0.0239
			(0.0284)	(0.0383)	(0.0431)		(0.0446)	(0.0428)	(0.0384)	(0.0446)
Avg T< 0F						1.318	1.430			1.625
						(1.044)	(1.174)			(1.392)
Avg T 0-10F						-0.0669	0.0114			0.0418
						(1.903)	(1.705)			(1.685)
Avg T 10-20F						3.689.	3.749.			3.793.
						(2.166)	(2.264)			(2.291)
Avg T 20-30F						2.116*	2.160*			2.177*
						(0.9456)	(1.015)			(1.023)
Avg T 30-40F						-0.3451	-0.3250			-0.2879
						(1.073)	(1.037)			(1.015)
Avg T 40-50F						-0.1757	-0.1789			-0.1462
						(0.5729)	(0.5789)			(0.5657)
Avg T 50-60F						-0.5700	-0.5726			-0.5476
						(0.6740)	(0.6787)			(0.6686)
Avg T 70-80F						0.9903	0.9714			0.9635
						(0.8884)	(0.8544)			(0.8497)
Avg T >=80F						2.016	1.972			1.948
						(1.533)	(1.454)			(1.441)
Per capita								-0.3331	-0.3331	-0.3306
income								(0.3252)	(0.3253)	(0.3244)
N	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*
R2	*0.93653*	*0.93653*	*0.93652*	*0.93653*	*0.93653*	*0.93655*	*0.93655*	*0.93656*	*0.93656*	*0.93658*
Adj. R2	*0.93613*	*0.93613*	*0.93613*	*0.93613*	*0.93613*	*0.93615*	*0.93615*	*0.93616*	*0.93616*	*0.93618*

**** p<0.001, ** p<0.01, * p<0.05, p<0.1. Bin:60-70F as the reference*

Note: county fe, year by month fe, S.E clustered at the county and time

Table A3 Effect of Weather on Respiratory Mortality

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
Max Temp	0.0064				0.0171			0.0164		
	(0.0188)				(0.0270)			(0.0264)		
Min Temp	-0.0103				-0.0248			-0.0244		
	(0.0227)				(0.0339)			(0.0335)		
Avg Temp		-0.0031		-0.0046					-0.0050	
		(0.0044)		(0.0046)					(0.0046)	
Precipitation			0.0178.	0.0191.	0.0314		0.0215	0.0316	0.0196.	0.0218
			(0.0104)	(0.0107)	(0.0264)		(0.0160)	(0.0264)	(0.0109)	(0.0161)
Avg T< 0F						0.0746	0.1776			0.2927
						(0.6092)	(0.5395)			(0.4987)
Avg T 0-10F						-1.859	-1.787			-1.770
						(1.744)	(1.691)			(1.674)
Avg T 10-20F						-0.8388	-0.7839			-0.7577
						(0.9001)	(0.8638)			(0.8456)
Avg T 20-30F						0.4359	0.4762			0.4865
						(0.4130)	(0.4349)			(0.4391)
Avg T 30-40F						-0.5064	-0.4879			-0.4660
						(0.6884)	(0.6761)			(0.6601)
Avg T 40-50F						-0.3920	-0.3950			-0.3756
						(0.5071)	(0.5091)			(0.4957)
Avg T 50-60F						-0.5103	-0.5127			-0.4979
						(0.5132)	(0.5150)			(0.5047)
Avg T 70-80F						0.5894	0.5720			0.5673
						(0.4047)	(0.3928)			(0.3899)
Avg T >=80F						1.019	0.9783			0.9636
						(0.6821)	(0.6543)			(0.6486)
Per capita								-0.1964	-0.1965	-0.1952
income								(0.1476)	(0.1477)	(0.1465)
N	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*
R2	*0.77441*	*0.77441*	*0.77441*	*0.77441*	*0.77441*	*0.77451*	*0.77451*	*0.77465*	*0.77464*	*0.77474*
Adj. R2	*0.77302*	*0.77302*	*0.77302*	*0.77302*	*0.77302*	*0.77311*	*0.77311*	*0.77325*	*0.77325*	*0.77333*

*** p<0.001, ** p<0.01, * p<0.05, p<0.1. For average temp bins took 60-70F as the reference

Note: county fe, year by month fe, S.E clustered at the county and time

Table A4 Effect of Weather on Neoplasm Mortality

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Max Temp	0.0266				0.0399			0.0392		
	(0.0383)				(0.0553)			(0.0546)		
Min Temp	-0.0501				-0.0680			-0.0677		
	(0.0612)				(0.0844)			(0.0839)		
Avg Temp		-0.0195		-0.0200					-0.0204	
		(0.0183)		(0.0191)					(0.0193)	
Precipitation			0.0017	0.0071	0.0390		0.0041	0.0392	0.0077	0.0044
			(0.0094)	(0.0131)	(0.0515)		(0.0147)	(0.0515)	(0.0132)	(0.0143)
Avg T< 0F						1.251	1.270			1.379
						(0.8383)	(0.8837)			(0.9792)
Avg T 0-10F						-2.759	-2.745			-2.728
						(2.919)	(2.889)			(2.871)
Avg T 10-20F						1.217	1.228			1.253
						(1.056)	(1.079)			(1.101)
Avg T 20-30F						-0.0587	-0.0510			-0.0414
						(0.1984)	(0.1840)			(0.1783)
Avg T 30-40F						0.2961.	0.2996.			0.3203.
						(0.1639)	(0.1741)			(0.1924)
Avg T 40-50F						0.2046***	0.2041**			0.2223**
						(0.0605)	(0.0665)			(0.0696)
Avg T 50-60F						-0.1692	-0.1696			-0.1557
						(0.2108)	(0.2115)			(0.1972)
Avg T 70-80F						-0.3225	-0.3259			-0.3303
						(0.3233)	(0.3301)			(0.3303)
Avg T >=80F						-0.5061	-0.5138			-0.5276
						(0.4401)	(0.4576)			(0.4670)
Per capita								-0.1836	-0.1838	-0.1841
income								(0.1783)	(0.1785)	(0.2198)
N	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*
R2	*0.84043*	*0.84042*	*0.84042*	*0.84042*	*0.84043*	*0.84044*	*0.84044*	*0.84048*	*0.84048*	*0.84049*
Adj. R2	*0.83944*	*0.83944*	*0.83944*	*0.83944*	*0.83944*	*0.83944*	*0.83944*	*0.83949*	*0.83949*	*0.83949*

*** p<0.001, ** p<0.01, * p<0.05, p<0.1. Bin:60-70F as the reference

Note: county fe, year by month fe, S.E clustered at the county and time

Table A5 Effect of Weather on Motor vehicle accidents

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Max Temp	0.0418				0.0485			0.0486		
	(0.0299)				(0.0398)			(0.0398)		
Min Temp	-0.0294				-0.0384			-0.0385		
	(0.0214)				(0.0344)			(0.0344)		
Avg Temp		0.0163		0.0168					0.0168	
		(0.0117)		(0.0113)					(0.0113)	
Precipitation			-0.0022	-0.0065	0.0194		-0.0078	0.0193	-0.0066	-0.0079
			(0.0095)	(0.0068)	(0.0285)		(0.0051)	(0.0286)	(0.0068)	(0.0052)
Avg T< 0F						-0.3437	-0.3819			-0.3904
						(0.3109)	(0.2973)			(0.2976)
Avg T 0-10F						0.0743	0.0487			0.0457
						(0.2590)	(0.2710)			(0.2710)
Avg T 10-20F						-0.6468	-0.6661			-0.6701
						(0.5209)	(0.5108)			(0.5108)
Avg T 20-30F						-0.7764	-0.7905			-0.7923
						(0.6550)	(0.6475)			(0.6474)
Avg T 30-40F						-0.2133	-0.2194			-0.2234
						(0.2309)	(0.2277)			(0.2255)
Avg T 40-50F						0.0900	0.0914			0.0879
						(0.1471)	(0.1465)			(0.1431)
Avg T 50-60F						-0.0836	-0.0826			-0.0854
						(0.1100)	(0.1105)			(0.1090)
Avg T 70-80F						-0.4862	-0.4799			-0.4791
						(0.3689)	(0.3720)			(0.3716)
Avg T >=80F						-0.7188	-0.7039			-0.7014
						(0.4841)	(0.4909)			(0.4899)
Per capita								0.0334	0.0333	0.0326
income								(0.0357)	(0.0357)	(0.0358)
N	*100,729*	*100,729*	*100,729*	*100,729*	*100,729*	*100,729*	*100,729*	*100,729*	*100,729*	*100,729*
R2	*0.76123*	*0.76120*	*0.76119*	*0.76120*	*0.76123*	*0.76135*	*0.76135*	*0.76126*	*0.76123*	*0.76138*
Adj. R2	*0.75962*	*0.75960*	*0.75960*	*0.75959*	*0.75962*	*0.75973*	*0.75972*	*0.75964*	*0.75962*	*0.75974*

**** p<0.001, ** p<0.01, * p<0.05, p<0.1. Bin:60-70F as the reference*

Note: county fe, year by month fe, S.E clustered at the county and time

Table A6 Effect of Weather on Self-Harm Mortality

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Max Temp	-0.0081				-0.0088			-0.0090		
	(0.0072)				(0.0076)			(0.0075)		
Min Temp	0.0119.				0.0129.			0.0130.		
	(0.0072)				(0.0076)			(0.0076)		
Avg Temp		0.0030***		0.0027**					0.0025**	
		(0.0008)		(0.0010)					(0.000)	
Precipitation			0.0050	0.0043	-0.0021		0.0073	-0.0020	0.0045	0.0074
			(0.0047)	(0.0049)	(0.0040)		(0.0074)	(0.0039)	(0.0049)	(0.0075)
Avg T< 0F						-0.6362.	-0.6015.			-0.5664
						(0.3701)	(0.3564)			(0.3521)
Avg T 0-10F						-1.122	-1.098			-1.093.
						(0.6903)	(0.6661)			(0.6590)
Avg T 10-20F						-0.3467*	-0.328*			-0.320*
						(0.1497)	(0.1331)			(0.1254)
Avg T 20-30F						-0.2085*	-0.194*			-0.191*
						(0.1055)	(0.0945)			(0.0948)
Avg T 30-40F						-0.3554	-0.3491			-0.3425
						(0.2880)	(0.2825)			(0.2764)
Avg T 40-50F						-0.3487	-0.3497			-0.3438
						(0.2932)	(0.2942)			(0.2888)
Avg T 50-60F						-0.2858	-0.2866			-0.2821
						(0.1968)	(0.1976)			(0.1942)
Avg T 70-80F						0.0930	0.0871			0.0857
						(0.1179)	(0.1148)			(0.1135)
Avg T >=80F						0.2783	0.2646			0.2602
						(0.2312)	(0.2222)			(0.2180)
Per capita								-0.0599	-0.0599	-0.0595
income								(0.0634)	(0.0634)	(0.0631)
N	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*
R2	*0.66945*	*0.66945*	*0.66945*	*0.66945*	*0.66945*	*0.66948*	*0.66948*	*0.66954*	*0.66953*	*0.66956*
Adj. R2	*0.66742*	*0.66742*	*0.66742*	*0.66742*	*0.66742*	*0.66742*	*0.66742*	*0.66749*	*0.66749*	*0.66749*

**** p<0.001, ** p<0.01, * p<0.05, p<0.1. Bin:60-70F as the reference*

Note: county fe, year by month fe, S.E clustered at the county and time

Table A7 Effect of Weather (Months Below 30°F) on Specific causes of death

Variables	Total mortality	Cardiovascular mortality	Respiratory mortality	Neoplasms mortality	Motor vehicle accidents	Self-harm mortality
Months Below 30°F	5.401 (4.712)	3.015 (2.264)	0.9642 (0.9736)	-0.2318 (0.1812)	-0.7775 (0.6027)	0.1996 (0.3009)
Precipitation	0.0206 (0.0746)	0.0361 (0.0549)	0.0299 (0.0213)	-0.0012 (0.0076)	-0.0115** (0.0036)	0.0075 (0.0071)
Observations	*110,016*	*110,016*	*110,016*	*110,016*	*100,729*	*110,016*
R^2	*0.94881*	*0.93654*	*0.77445*	*0.84042*	*0.76127*	*0.66946*
Adj. R2	*0.94849*	*0.93615*	*0.77306*	*0.83944*	*0.75966*	*0.66743*

Note: county fe, year by month fe, S.E clustered at the county and time

Table A8 Effect of Weather (Months Above 80F) on Specific causes of death

Variables	Total mortality	Cardiovascular mortality	Respiratory mortality	Neoplasms mortality	Motor vehicle accidents	Self-harm mortality
Months Above 80°F	2.353** (0.7916)	1.393* (0.6531)	0.3838* (0.1813)	-0.1184 (0.1089)	-0.3962 (0.2396)	0.0699 (0.0536)
Precipitation	-0.0585** (0.0219)	-0.0084 (0.0259)	0.0160 (0.0098)	0.0022 (0.0098)	-0.0001 (0.0107)	0.0047 (0.0048)
Observations	*110,016*	*110,016*	*110,016*	*110,016*	*100,729*	*110,016*
R^2	*0.94880*	*0.93652*	*0.77441*	*0.84042*	*0.76120*	*0.66945*
Adj. R2	*0.94848*	*0.93613*	*0.77303*	*0.83944*	*0.75960*	*0.66742*

Note: county fe, year by month fe, S.E clustered at the county and time

Table A9 Extreme Weather on Total Mortality

Variable	(1)	(2)	(3)	(4)
Max Temp	0.2918	0.3291		
	(0.2995)	(0.3257)		
Min Temp	-0.5012	-0.6278		
	(0.4408)	(0.5295)		
Average Temp			-0.1500	-0.1465
			(0.0816)	(0.0801)
Precipitation	0.2333	0.2985	-0.0011	0.0341
	(0.2569)	(0.3032)	(0.0293)	(0.0484)
Extreme Max T (Z>2.5)		-0.4228		
		(0.6554)		
Extreme Min T (Z>-2.0)		-17.94		
		(11.10)		
Extreme Average T (Z>2.5)				-1.473
				(0.7983)
Extreme Precipitation (Z>2.5)		-1.732		-1.086
		(1.220)		(0.6688)
Per capita income	-2.335	-2.335	-2.336	-2.336
	(2.011)	(2.011)	(2.012)	(2.012)
N	*110,016*	*110,016*	*110,016*	*110,016*
R^2	*0.94895*	*0.94895*	*0.94894*	*0.94894*
Adj. R2	*0.94863*	*0.94863*	*0.94862*	*0.94862*

Note: county fe, year by month fe, S.E clustered at the county and time

Table A10 Extreme Weather on Cardiovascular Mortality

Variable	(1)	(2)	(3)	(4)
Max Temp	-0.0259	-0.0115		
	(0.0333)	(0.0266)		
Min Temp	-0.0666	-0.1216		
	(0.0440)	(0.0639)		
Average Temp			-0.0896	-0.0904
			(0.0470)	(0.0478)
Precipitation	0.0354	0.0657	0.0234	0.0464
	(0.0428)	(0.0619)	(0.0384)	(0.0540)
Extreme Max T (Z>2.5)		0.7345		
		(0.4958)		
Extreme Min T (Z>-2.0)		-7.734		
		(4.849)		
Extreme Average T (Z>2.5)				0.1659
				(0.8446)
Extreme Precipitation (Z>2.5)		-0.7539		-0.6272
		(0.5104)		(0.4489)
Per capita income	-0.3331	-0.3331	-0.3331	-0.3331
	(0.3252)	(0.3252)	(0.3253)	(0.3253)
N	*110,016*	*110,016*	*110,016*	*110,016*
R^2	*0.93656*	*0.93656*	*0.93656*	*0.93656*
Adj. R2	*0.93616*	*0.93616*	*0.93616*	*0.93616*

Note: county fe, year by month fe, S.E clustered at the county and time

Table A11 Extreme Weather on Respiratory Mortality

Variable	(1)	(2)	(3)	(4)
Max Temp	0.0164	0.0309		
	(0.0264)	(0.0370)		
Min Temp	-0.0244	-0.0762		
	(0.0335)	(0.0738)		
Average Temp			-0.0050	-0.0041
			(0.0046)	(0.0044)
Precipitation	0.0316	0.0416	0.0196	0.0240
	(0.0264)	(0.0364)	(0.0109)	(0.0158)
Extreme Max T (Z>2.5)		-0.0987		
		(0.1550)		
Extreme Min T (Z>-2.0)		-7.595		
		(6.129)		
Extreme Average T (Z>2.5)				0.0202
				(0.2549)
Extreme Precipitation (Z>2.5)		-0.2685		-0.1460
		(0.2587)		(0.1592)
Per capita income	-0.1964	-0.1966	-0.1965	-0.1965
	(0.1476)	(0.1476)	(0.1477)	(0.1477)
N	*110,016*	*110,016*	*110,016*	*110,016*
R^2	*0.7746*	*0.77461*	*0.77461*	*0.77461*
Adj. R2	*0.77321*	*0.77322*	*0.77321*	*0.77321*

Note: county fe, year by month fe, S.E clustered at the county and time

Table A12 Extreme Weather on Neoplasms Mortality

Variable	(1)	(2)	(3)	(4)
Max Temp	0.0392	0.0248		
	(0.0546)	(0.0389)		
Min Temp	-0.0677	-0.0117		
	(0.0839)	(0.0234)		
Average Temp			-0.0204	-0.0207
			(0.0193)	(0.0194)
Precipitation	0.0392	0.0434	0.0077	0.0143
	(0.0515)	(0.0533)	(0.0132)	(0.0179)
Extreme Max T (Z>2.5)		-0.2931		
		(0.3695)		
Extreme Min T (Z>-2.0)		8.422		
		(9.008)		
Extreme Average T (Z>2.5)				0.0410
				(0.1028)
Extreme Precipitation (Z>2.5)		-0.1199		-0.1778
		(0.1304)		(0.1464)
Per capita income	-0.1836	-0.1835	-0.1838	-0.1838
	(0.1783)	(0.1783)	(0.1785)	(0.1785)
N	*110,016*	*110,016*	*110,016*	*110,016*
R^2	*0.84048*	*0.8405*	*0.84048*	*0.84048*
Adj. R2	*0.8395*	*0.83951*	*0.83949*	*0.83950*

Note: county fe, year by month fe, S.E clustered at the county and time

Table A13 Extreme Weather on Motor Vehicle Accidents

Variable	(1)	(2)	(3)	(4)
Max Temp	0.0486	0.0458		
	(0.0398)	(0.0399)		
Min Temp	-0.0385	-0.0288		
	(0.0344)	(0.0347)		
Average Temp			0.0168	0.0166
			(0.0113)	(0.0112)
Precipitation	0.0193	0.0216	-0.0066	-0.0056
	(0.0286)	(0.0322)	(0.0068)	(0.0089)
Extreme Max T (Z>2.5)		0.0662		
		(0.0479)		
Extreme Min T (Z>-2.0)		1.524		
		(1.108)		
Extreme Average T (Z>2.5)				0.0453
				(0.0474)
Extreme Precipitation (Z>2.5)		-0.0486		-0.0241
		(0.1036)		(0.0645)
Per capita income	0.0334	0.0335	0.0333	0.0333
	(0.0357)	(0.0357)	(0.0357)	(0.0357)
N	*100,729*	*100,729*	*100,729*	*100,729*
R^2	*0.76125*	*0.76125*	*0.76122*	*0.76122*
Adj. R2	*0.75964*	*0.75963*	*0.75961*	*0.75961*

Note: county fe, year by month fe, S.E clustered at the county and time

Table A14 Extreme Weather on Self-Harm Mortality

Variable	(1)	(2)	(3)	(4)
Max Temp	-0.0090	-0.0102		
	(0.0075)	(0.0076)		
Min Temp	0.0130.	0.0186*		
	(0.0076)	(0.0086)		
Average Temp			0.0025***	0.0029**
			(0.0007)	(0.0010)
Precipitation	-0.0020	0.0007	0.0045	0.0077
	(0.0039)	(0.0055)	(0.0049)	(0.0069)
Extreme Max T (Z>2.5)		-0.1135		
		(0.1207)		
Extreme Min T (Z>-2.0)		0.8768		
		(0.5406)		
Extreme Average T (Z>2.5)				-0.1321
				(0.1214)
Extreme Precipitation (Z>2.5)		-0.0958		-0.1112
		(0.0828)		(0.0854)
Per capita income	-0.0599	-0.0599	-0.0599	-0.0599
	(0.0634)	(0.0634)	(0.0634)	(0.0635)
N	*110,016*	*110,016*	*110,016*	*110,016*
R^2	*0.66951*	*0.66951*	*0.66951*	*0.66951*
Adj. R2	*0.66747*	*0.66747*	*0.66748*	*0.66747*

Note: county fe, year by month fe, S.E clustered at the county and tim

Robustness checks

county and year-by-month fixed effects; clustered standard errors at county code

Table R1 Effect of Weather on Total Mortality

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Max Temp	0.2214				0.3000			0.2918		
	(0.2284)				(0.3150)			(0.3071)		
Min Temp	-0.3999				-0.5060			-0.5012		
	(0.3342)				(0.4517)			(0.4464)		
Avg Temp		-0.1461.		-0.1455.					-0.1500.	
		(0.0810)		(0.0834)					(0.0870)	
Precipitation			-0.0473	-0.0076	0.2306		-0.0125	0.2333	-0.0011	-0.0085
			(0.0335)	(0.0442)	(0.2580)		(0.0586)	(0.2595)	(0.0481)	(0.0608)
Avg T< 0F						-0.4820	-0.5417			0.8307
						(1.976)	(1.840)			(2.141)
Avg T 0-10F						-12.74	-12.79			-12.57
						(15.39)	(15.23)			(15.02)
Avg T 10-20F						-1.038	-1.070			-0.7569
						(3.631)	(3.523)			(3.255)
Avg T 20-30F						3.822*	3.799*			3.921*
						(1.769)	(1.850)			(1.940)
Avg T 30-40F						-1.818	-1.828			-1.567
						(3.646)	(3.605)			(3.392)
Avg T 40-50F						-1.269	-1.268			-1.037
						(2.504)	(2.511)			(2.324)
Avg T 50-60F						-2.508	-2.507			-2.331
						(2.825)	(2.830)			(2.693)
Avg T 70-80F						1.248	1.258			1.202
						(1.126)	(1.083)			(1.046)
Avg T >= 80						3.453	3.477			3.302
						(2.613)	(2.515)			(2.386)
Per capita income								-2.335	-2.336	-2.329
								(2.019)	(2.020)	(2.014)
N	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*
R2	*0.94880*	*0.94880*	*0.94880*	*0.94880*	*0.94880*	*0.94881*	*0.94881*	*0.94897*	*0.94896*	*0.94897*

**** p<0.001, ** p<0.01, * p<0.05, p<0.1. Bin:60-70F as the reference*

Note: county fe, year by month fe, S.E clustered at the county

Table R2 Effect of Weather on Cardiovascular Mortality

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
Max Temp	-0.0367				-0.0248			-0.0259		
	(0.0402)				(0.0345)			(0.0345)		
Min Temp	-0.0512				-0.0673			-0.0666		
	(0.0324)				(0.0457)			(0.0450)		
Avg Temp		-0.872*		-0.0890.					-0.0896.	
		(0.044)		(0.0469)					(0.0473)	
Precipitation			-0.0018	0.0225	0.0350		0.0234	0.0354	0.0234	0.0239
			(0.0283)	(0.0386)	(0.0429)		(0.0445)	(0.0431)	(0.0390)	(0.0447)
Avg T< 0F						1.318	1.430			1.625
						(1.292)	(1.399)			(1.562)
Avg T 0-10F						-0.0669	0.0114			0.0418
						(2.610)	(2.477)			(2.462)
Avg T 10-20F						3.689.	3.749			3.793
						(2.187)	(2.287)			(2.317)
Avg T 20-30F						2.116*	2.160*			2.177*
						(0.9213)	(0.9933)			(1.003)
Avg T 30-40F						-0.3451	-0.3250			-0.2879
						(1.089)	(1.054)			(1.035)
Avg T 40-50F						-0.1757	-0.1789			-0.1462
						(0.5942)	(0.6002)			(0.5899)
Avg T 50-60F						-0.5700	-0.5726			-0.5476
						(0.6849)	(0.6896)			(0.6808)
Avg T 70-80F						0.9903	0.9714			0.9635
						(0.8883)	(0.8540)			(0.8508)
Avg T >= 80						2.016	1.972			1.948
						(1.540)	(1.461)			(1.450)
Per capita income								-0.3331	-0.3331	-0.3306
								(0.3264)	(0.3265)	(0.3256)
N	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*
R2	*0.93653*	*0.93653*	*0.93652*	*0.93653*	*0.93653*	*0.93655*	*0.93655*	*0.93656*	*0.93656*	*0.93658*

*** p<0.001, ** p<0.01, * p<0.05, p<0.1. Bin:60-70F as the reference

Note: county fe, year by month fe, S.E clustered at the county

Table R3 Effect of Weather on Respiratory Mortality

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Max Temp	0.0064				0.0171			0.0164		
	(0.0183)				(0.0265)			(0.0260)		
Min Temp	-0.0103				-0.0248			-0.0244		
	(0.0219)				(0.0332)			(0.0328)		
Avg Temp		-0.0031		-0.0046					-0.0050	
		(0.0045)		(0.0047)					(0.0049)	
Precipitation			0.0178.	0.0191.	0.0314		0.0215	0.0316	0.0196.	0.0218
			(0.0100)	(0.0105)	(0.0261)		(0.0158)	(0.0262)	(0.0108)	(0.0160)
Avg T< 0F						0.0746	0.1776			0.2927
						(0.6646)	(0.5977)			(0.5382)
Avg T 0-10F						-1.859	-1.787			-1.770
						(1.792)	(1.743)			(1.727)
Avg T 10-20F						-0.8388	-0.7839			-0.7577
						(0.9002)	(0.8632)			(0.8433)
Avg T 20-30F						0.4359	0.4762			0.4865
						(0.3768)	(0.4016)			(0.4083)
Avg T 30-40F						-0.5064	-0.4879			-0.4660
						(0.6829)	(0.6703)			(0.6544)
Avg T 40-50F						-0.3920	-0.3950			-0.3756
						(0.5021)	(0.5041)			(0.4902)
Avg T 50-60F						-0.5103	-0.5127			-0.4979
						(0.5115)	(0.5131)			(0.5027)
Avg T 70-80F						0.5894	0.5720			0.5673
						(0.4039)	(0.3919)			(0.3889)
Avg T >= 80						1.019	0.9783			0.9636
						(0.6798)	(0.6518)			(0.6421)
Per capita								-0.1964	-0.1965	-0.1952
income								(0.1478)	(0.1479)	(0.1467)
N	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*
R2	*0.77441*	*0.77441*	*0.77441*	*0.77441*	*0.77441*	*0.77451*	*0.77451*	*0.77465*	*0.77464*	*0.77474*

*** p<0.001, ** p<0.01, * p<0.05, p<0.1. Bin:60-70F as the reference

Note: county fe, year by month fe, S.E clustered at the county

Table R4 Effect of Weather on Neoplasm Mortality

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Max Temp	0.0266				0.0399			0.0392		
	(0.0388)				(0.0558)			(0.0551)		
Min Temp	-0.0501				-0.0680			-0.0677		
	(0.0616)				(0.0848)			(0.0844)		
Avg Temp		-0.0195		-0.0200					-0.0204	
		(0.0184)		(0.0192)					(0.0195)	
Precipitation			0.0017	0.0071	0.0390		0.0041	0.0392	0.0077	0.0044
			(0.0085)	(0.0126)	(0.0514)		(0.0110)	(0.0515)	(0.0129)	(0.0111)
Avg T< 0F						1.251	1.270			1.379
						(0.9185)	(0.9581)			(1.054)
Avg T 0-10F						-2.759	-2.745			-2.728
						(3.263)	(3.239)			(3.220)
Avg T 10-20F						1.217	1.228			1.253
						(1.069)	(1.093)			(1.110)
Avg T 20-30F						-0.0587	-0.0510			-0.0414
						(0.1829)	(0.1710)			(0.1641)
Avg T 30-40F						0.2961.	0.2996			0.3203
						(0.1760)	(0.1833)			(0.1989)
Avg T 40-50F						0.2046*	0.2041*			0.2223*
						(0.0913)	(0.0902)			(0.0957)
Avg T 50-60F						-0.1692	-0.1696			-0.1557
						(0.1873)	(0.1883)			(0.1773)
Avg T 70-80F						-0.3225	-0.3259			-0.3303
						(0.2992)	(0.3059)			(0.3095)
Avg T >= 80						-0.5061	-0.5138			-0.5276
						(0.4229)	(0.4388)			(0.4500)
Per capita income								-0.1836	-0.1838	-0.1841
								(0.1776)	(0.1778)	(0.1779)
N	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*
R2	*0.84043*	*0.84042*	*0.84042*	*0.84042*	*0.84043*	*0.84044*	*0.84044*	*0.84048*	*0.84048*	*0.84049*

*** p<0.001, ** p<0.01, * p<0.05, p<0.1. Bin:60-70F as the reference

Note: county fe, year by month fe, S.E clustered at the county

Table R5 Effect of Weather on Motor vehicle accidents

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
Max Temp	0.0418				0.0485			0.0486		
	(0.0300)				(0.0398)			(0.0398)		
Min Temp	-0.0294				-0.0384			-0.0385		
	(0.0213)				(0.0343)			(0.0343)		
Avg Temp		0.0163		0.0168					0.0168	
		(0.0118)		(0.0113)					(0.0113)	
Precipitation			-0.0022	-0.0065	0.0194		-0.0078	0.0193	-0.0066	-0.0079.
			(0.0094)	(0.0066)	(0.0285)		(0.0047)	(0.0285)	(0.0066)	(0.0048)
Avg T< 0F						-0.3437	-0.3819			-0.3904
						(0.2750)	(0.2558)			(0.2589)
Avg T 0-10F						0.0743	0.0487			0.0457
						(0.3016)	(0.3138)			(0.3126)
Avg T 10-20F						-0.6468	-0.6661			-0.6701
						(0.5077)	(0.4971)			(0.4967)
Avg T 20-30F						-0.7764	-0.7905			-0.7923
						(0.6496)	(0.6419)			(0.6418)
Avg T 30-40F						-0.2133	-0.2194			-0.2234
						(0.2233)	(0.2202)			(0.2181)
Avg T 40-50F						0.0900	0.0914			0.0879
						(0.1435)	(0.1431)			(0.1402)
Avg T 50-60F						-0.0836	-0.0826			-0.0854
						(0.1037)	(0.1043)			(0.1029)
Avg T 70-80F						-0.4862	-0.4799			-0.4791
						(0.3663)	(0.3694)			(0.3692)
Avg T >= 80						-0.7188	-0.7039			-0.7014
						(0.4815)	(0.4882)			(0.4872)
Per capita income								0.0334	0.0333	0.0326
								(0.0356)	(0.0356)	(0.0354)
N	*100,729*	*100,729*	*100,729*	*100,729*	*100,729*	*100,729*	*100,729*	*100,729*	*100,729*	*100,729*
R2	*0.76123*	*0.76120*	*0.76119*	*0.76120*	*0.76123*	*0.76135*	*0.76135*	*0.76126*	*0.76123*	*0.76138*

*** p<0.001, ** p<0.01, * p<0.05, p<0.1. Bin:60-70F as the reference

Note: county fe, year by month fe, S.E clustered at the county

Table R6 Effect of Weather on Self-Harm Mortality

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Max Temp	-0.0081				-0.0088			-0.0090		
	(0.0078)				(0.0083)			(0.0082)		
Min Temp	0.0119				0.0129			0.0130		
	(0.0079)				(0.0084)			(0.0084)		
Avg Temp		0.0030*		0.0027.					0.0025.	
		(0.0015)		(0.0016)					(0.0015)	
Precipitation			0.0050	0.0043	-0.0021		0.0073	-0.0020	0.0045	0.0074
			(0.0051)	(0.0052)	(0.0045)		(0.0076)	(0.0046)	(0.0052)	(0.0077)
Avg T< 0F						-0.6362	-0.6015			-0.5664
						(0.4242)	(0.4111)			(0.4062)
Avg T 0-10F						-1.122	-1.098			-1.093
						(0.7625)	(0.7413)			(0.7347)
Avg T 10-20F						-0.3466*	-0.328*			-0.320*
						(0.162)	(0.145)			(0.138)
Avg T 20-30F						-0.208.	-0.194*			0.191*
						(0.108)	(0.096)			(0.096)
Avg T 30-40F						-0.3554	-0.3491			-0.3425
						(0.2915)	(0.2859)			(0.2796)
Avg T 40-50F						-0.3487	-0.3497			-0.3438
						(0.2986)	(0.2995)			(0.2939)
Avg T 50-60F						-0.2858	-0.2866			-0.2821
						(0.1967)	(0.1974)			(0.1937)
Avg T 70-80F						0.0930	0.0871			0.0857
						(0.1215)	(0.1184)			(0.1170)
Avg T >= 80						0.2783	0.2646			0.2602
						(0.2375)	(0.2287)			(0.2241)
Per capita								-0.0599	-0.0599	-0.0595
income								(0.0635)	(0.0635)	(0.0632)
N	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*	*110,016*
R2	*0.66945*	*0.66945*	*0.66945*	*0.66945*	*0.66945*	*0.66948*	*0.66948*	*0.66954*	*0.66953*	*0.66956*

*** p<0.001, ** p<0.01, * p<0.05, p<0.1. Bin:60-70F as the reference Note: county fe, year by month fe, S.E clustered at the county

Table R7 Effect of Weather (Months Below 30°F) on Specific causes of death

Variables	Total mortality	Cardiovascular mortality	Respiratory mortality	Neoplasm mortality	Motor vehicle accidents	Self-harm mortality
Months Below 30°F	5.401 (4.817)	3.015 (2.284)	0.9642 (0.9727)	-0.2318 (0.2044)	-0.7775 (0.6043)	0.1996 (0.3000)
Precipitation	0.0206 (0.0799)	0.0361 (0.0548)	0.0299 (0.0212)	-0.0012 (0.0075)	-0.0115*** (0.0032)	0.0075 (0.0073)
Observations	*110,016*	*110,016*	*110,016*	*110,016*	*100,729*	*110,016*
R^2	*0.94881*	*0.93654*	*0.77445*	*0.84042*	*0.76127*	*0.66946*
Adj. R2	*0.94849*	*0.93615*	*0.77306*	*0.83944*	*0.75966*	*0.66743*

Note: county fe, year by month fe, S.E clustered at the county

Table R8 Effect of Weather (Months Above 80F) on Specific causes of death

Variables	Total mortality	Cardiovascular mortality	Respiratory mortality	Neoplasms mortality	Motor vehicle accidents	Self-harm mortality
Months Above 80°F	2.353** (0.8811)	1.393* (0.6536)	0.3838* (0.1800)	-0.1184 (0.1180)	-0.3962 (0.2412)	0.0699 (0.0564)
Precipitation	-0.0585. (0.0321)	-0.0084 (0.0258)	0.0160. (0.0094)	0.0022 (0.0088)	-0.0001 (0.0106)	0.0047 (0.0051)
Observations	*110,016*	*110,016*	*110,016*	*110,016*	*100,729*	*110,016*
R^2	*0.94880*	*0.93652*	*0.77441*	*0.84042*	*0.76120*	*0.66945*
Adj. R2	*0.94848*	*0.93613*	*0.77303*	*0.83944*	*0.75960*	*0.66742*

Note: county fe, year by month fe, S.E clustered at the county

Table R9 Extreme Weather on Total Mortality

Variable	(1)	(2)	(3)	(4)
Max Temp	0.2918	0.3291		
	(0.3071)	(0.3326)		
Min Temp	0.2918	0.3291		
	(0.3071)	(0.3326)		
Average Temp			-0.1500.	-0.1465.
			(0.0870)	(0.0860)
Precipitation	0.2333	0.2985	-0.0011	0.0341
	(0.2595)	(0.3060)	(0.0481)	(0.0721)
Extreme Max T (Z>2.5)		-0.4228		
		(0.6195)		
Extreme Min T (Z>-2.0)		-17.94		
		(12.90)		
Extreme Average T (Z>2.5)				-1.473.
				(0.8125)
Extreme Precipitation (Z>2.5)		-1.732		-1.086
		(1.268)		(0.7705)
Per capita income	-2.335	-2.335	-2.336	-2.336
	(2.019)	(2.019)	(2.020)	(2.020)
N	*110,016*	*110,016*	*110,016*	*110,016*
R^2	*0.94895*	*0.94895*	*0.94894*	*0.94894*

Note: county fe, year by month fe, S.E clustered at the county

Table R10 Extreme Weather on Cardiovascular Mortality

Variable	(1)	(2)	(3)	(4)
Max Temp	-0.0259	-0.0115		
	(0.0345)	(0.0281)		
Min Temp	-0.0666	-0.1216.		
	(0.0450)	(0.0658)		
Average Temp			-0.0896.	-0.0904.
			(0.0473)	(0.0481)
Precipitation	0.0354	0.0657	0.0234	0.0464
	(0.0431)	(0.0621)	(0.0390)	(0.0548)
Extreme Max T (Z>2.5)		0.7345		
		(0.4847)		
Extreme Min T (Z>-2.0)		-7.734		
		(5.019)		
Extreme Average T (Z>2.5)				0.0202
				(0.2376)
Extreme Precipitation (Z>2.5)		-0.7539		-0.6272
		(0.5124)		(0.4520)
Per capita income	-0.3331	-0.3331	-0.3331	-0.3331
	(0.3264)	(0.3264)	(0.3265)	(0.3264)
N	*1,10,016*	*1,10,016*	*1,10,016*	*1,10,016*
R^2	*0.93656*	*0.93656*	*0.93656*	*0.93656*

Note: county fe, year by month fe, S.E clustered at the county

Table R11 Extreme Weather on Respiratory Mortality

Variable	(1)	(2)	(3)	(4)
Max Temp	0.0164	0.0309		
	(0.0260)	(0.0368)		
Min Temp	-0.0244	-0.0762		
	(0.0328)	(0.0737)		
Average Temp			-0.0050	-0.0041
			(0.0049)	(0.0047)
Precipitation	0.0316	0.0416	0.0196.	0.0240
	(0.0262)	(0.0360)	(0.0108)	(0.0157)
Extreme Max T (Z>2.5)		-0.0987		
		(0.1481)		
Extreme Min T (Z>-2.0)		-7.595		
		(6.101)		
Extreme Average T (Z>2.5)				-0.3271*
				(0.141)
Extreme Precipitation (Z>2.5)		-0.2685		-0.1460
		(0.2547)		(0.1550)
Per capita income	-0.1964	-0.1966	-0.1965	-0.1965
	(0.1478)	(0.1478)	(0.1479)	(0.1479)
N	*1,10,016*	*1,10,016*	*1,10,016*	*1,10,016*
R^2	*0.7746*	*0.77461*	*0.77461*	*0.77461*

Note: county fe, year by month fe, S.E clustered at the county

Table R12 Extreme Weather on Neoplasms Mortality

Variable	(1)	(2)	(3)	(4)
Max Temp	0.0392	0.0248		
	(0.0551)	(0.0396)		
Min Temp	-0.0677	-0.0117		
	(0.0844)	(0.0241)		
Average Temp			-0.0204	-0.0207
			(0.0195)	(0.0196)
Precipitation	0.0392	0.0434	0.0077	0.0143
	(0.0515)	(0.0530)	(0.0129)	(0.0173)
Extreme Max T (Z>2.5)		-0.2931		
		(0.3793)		
Extreme Min T (Z>-2.0)		8.422		
		(8.996)		
Extreme Average T (Z>2.5)				0.0410
				(0.1028)
Extreme Precipitation (Z>2.5)		-0.1199		-0.1778
		(0.1296)		(0.1431)
Per capita income	-0.1836	-0.1835	-0.1838	-0.1838
	(0.1776)	(0.1775)	(0.1778)	(0.1778)
N	*1,10,016*	*1,10,016*	*1,10,016*	*1,10,016*
R^2	*0.84048*	*0.8405*	*0.84048*	*0.84048*

Note: county fe, year by month fe, S.E clustered at the county

Table R13 Extreme Weather on Motor Vehicle Accidents

Variable	(1)	(2)	(3)	(4)
Max Temp	0.0486	0.0458		
	(0.0398)	(0.0400)		
Min Temp	-0.0385	-0.0288		
	(0.0343)	(0.0348)		
Average Temp			0.0168	0.0166
			(0.0113)	(0.0113)
Precipitation	0.0193	0.0216	-0.0066	-0.0056
	(0.0285)	(0.0321)	(0.0066)	(0.0087)
Extreme Max T (Z>2.5)		0.0662		
		(0.0563)		
Extreme Min T (Z>-2.0)		1.524		
		(1.090)		
Extreme Average T (Z>2.5)				0.0453
				(0.0488)
Extreme Precipitation (Z>2.5)		-0.0486		-0.0241
		(0.1037)		(0.0647)
Per capita income	0.0334	0.0335	0.0333	0.0333
	(0.0356)	(0.0356)	(0.0356)	(0.0356)
R^2	*0.76125*	*0.76125*	*0.76122*	*0.76122*

Note: county fe, year by month fe, S.E clustered at the county

Table R14 Extreme Weather on Self-Harm Mortality

Variable	(1)	(2)	(3)	(4)
Max Temp	-0.0090	-0.0102		
	(0.0082)	(0.0082)		
Min Temp	0.0130	0.0186*		
	(0.0084)	(0.0090)		
Average Temp			0.0025.	0.0029
			(0.0015)	(0.0018)
Precipitation	-0.0020	0.0007	0.0045	0.0077
	(0.0046)	(0.0062)	(0.0052)	(0.0074)
Extreme Max T (Z>2.5)		-0.1135		
		(0.1278)		
Extreme Min T (Z>-2.0)		0.8768		
		(0.6571)		
Extreme Average T (Z>2.5)				-0.1321
				(0.1257)
Extreme Precipitation (Z>2.5)		-0.0772		-0.0997
		(0.0625)		(0.0708)
Per capita income	-0.0599	-0.0599	-0.0599	-0.0599
	(0.0635)	(0.0635)	(0.0635)	(0.0635)
N	*1,10,016*	*1,10,016*	*1,10,016*	*1,10,016*
R^2	*0.66951*	*0.66951*	*0.66951*	*0.66951*

Note: county fe, year by month fe, S.E clustered at the count

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Data sources:

1. Global Historical Climatology Network (GHCN) is from the National Oceanic and Atmospheric Administration https://www.noaa.gov/
2. National Center for Health Statistics, Multiple Causes of Death Files: 1968-2002. https://www2.nber.org/data/vital-statistics-mortality-data-multiple-cause-of-death.html
3. Per capita income and employment data is from the Bureau of Economic Analysis https://www.bea.gov/data/gdp
4. Population estimates is from the US Census Bureau https://www.census.gov/