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Communication

Air Temperature and Death Rates in the Continental U.S., 1968–2013

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Abstract: A previous test of global warming theory, on a local level, for Texas revealed inverse correlations between air temperature and death rates. The present study expands the test field to the continental U.S. Using an ecological design, mean daily maximum air temperature ("temperature") in the 48 contiguous states plus the District of Columbia by year from 1968–2013 was compared to age-adjusted all-cause mortality ("deaths") in these same jurisdictions for the same years using Pearson correlation (n = 46 years). The comparison was made for three race categories, white, black, and all races, where each category included all ages and both genders. There was 5.0 degree F range for the years studied (62.7–67.7 degrees F). Correlations were moderate strength, inverse, and statistically significant, as follows. Whites: $r = -0.576$, $p < 0.0001$; Blacks: $r = -0.556$, $p = 0.0001$; and all races: $r = -0.577$, $p < 0.0001$. These correlations are consistent with the Texas study, both of which indicated that warmer years tended to correlate with decreased death rates. A limitation to this research is its (ecological) design, but is an initial step towards further investigation.

Keywords: global warming; death rates

1. Introduction

Global warming is characterized by the U.S. EPA as a 1.4 degree increase in the last century [1]. Adverse predictions regarding death rates have been made in regard to "climate change" [2,3]. Many of these adverse predictions are based on educated guesses, known as modeling, though some are based on actual (historical) data [2,3]. One of these studies used various statistical manipulations, revealing increased mortality for both low and high air temperatures [3]. Conversely, previous research that used a geographical design, comparing death rates and temperature by county failed to show a trend of higher

death rates in the warmer counties [4,5]. Other research on global warming theory was conducted for the state of Texas using a time-series design, comparing air temperature by year to death rates for matching years over a 46 year period [6]. That study revealed inverse relationships between temperature and death rates, where warmer years tended to correlate with lower death rates. Thus, it is not clear as to whether warmer temperatures (excluding heat waves) are associated with higher death rates. Consequently, the present study seeks to simply add to the body of knowledge on this topic by using a time-series design for the continental U.S.

2. Methods

Average age-adjusted all-cause death rates per 100,000 in the continental U.S., all ages, both genders ("death rates") by year were obtained for all available years at the CDC Wonder website, 1968–2013 [7]. Three race categories were studied: (1) all races combined; (2) blacks; and (3) whites. Average daily maximum air temperature ("temperatures") in degrees Fahrenheit for all available U.S. jurisdictions—the 48 contiguous states and District of Columbia—were obtained from National Oceanic and Atmospheric Administration (NOAA) databases for matching years (1968–2013) [8]. Alaska and Hawaii temperature data were not available at NOAA databases and therefore were not included in the study.

Using an ecological design, death rates for the three race categories by year were compared to temperatures by year using correlation analysis. Scatter plots for the three race categories *vs.* temperatures revealed reasonable linear relationships. Probability plots for all four variables (three race categories and temperature) revealed satisfactory normality of the data. Thus, Pearson correlation was considered appropriate for these data and was performed in Stata IC 12.1 (StataCorp, College Station, TX, USA). Two-tailed *p*-values less than or equal to the conventional alpha level of 0.05 were considered statistically significant.

3. Results

Descriptive statistics are provided in Table 1 and raw data is provided in Table 2. There was a 5.0 degree Fahrenheit range (62.7–67.7 degrees F) where temperatures tended to increase over the 46 year period (Figure 1). All three race categories revealed moderate strength, inverse, statistically significant correlations as follows. Whites: $r = -0.576$, $p < 0.0001$; Blacks: $r = -0.556$, $p = 0.0001$; and all races: $r = -0.577$, $p < 0.0001$ (Figures 2–4).

Table 1. Descriptive statistics. Mortality is age-adjusted per 100,000. Temperature is in degrees Fahrenheit.

Variable	*n*	Mean	SD	Minimum	Maximum
All race mortality	46	954.5	151.5	732.6	1304.0
Black mortality	46	1206.0	187.2	861.1	1612.5
White mortality	46	932.5	144.9	731.3	1271.0
Temperature	46	64.4	1.1	62.7	67.7

Table 2. Raw averages for the four variables in the study. Temp = average daily maximum air temperature [8]. Whites, blacks, and all races refer to race categories for the age-adjusted death rates.

Year	Temp	Whites	Blacks	All Races
1968	63.21	1271.00	1612.50	1304.00
1969	63.19	1239.60	1561.70	1270.80
1970	63.55	1207.10	1536.50	1238.80
1971	63.53	1186.50	1487.60	1216.00
1972	63.08	1183.80	1492.00	1213.60
1973	63.82	1166.30	1479.20	1196.00
1974	64.32	1118.50	1398.60	1144.90
1975	63.23	1067.80	1342.20	1093.30
1976	64.07	1065.40	1340.70	1090.60
1977	64.58	1030.10	1312.70	1055.50
1978	62.77	1023.40	1291.60	1047.80
1979	62.71	990.60	1255.60	1014.40
1980	64.44	1012.70	1311.60	1039.30
1981	65.07	984.10	1256.60	1007.70
1982	62.83	963.60	1220.20	985.50
1983	63.07	967.50	1239.90	990.60
1984	63.59	959.60	1234.70	982.80
1985	63.05	963.60	1259.20	988.50
1986	64.90	953.00	1264.90	979.20
1987	65.34	943.40	1261.10	970.30
1988	65.18	947.40	1282.20	976.10
1989	63.97	920.00	1273.80	950.70
1990	65.63	909.40	1248.90	938.70
1991	64.80	893.20	1234.00	922.70
1992	64.13	877.70	1205.70	906.10
1993	62.68	897.00	1240.60	926.70
1994	64.80	885.50	1216.60	914.10
1995	64.34	882.20	1213.90	910.30
1996	63.71	868.90	1178.00	894.50
1997	63.72	855.60	1139.60	878.50
1998	65.63	849.10	1127.50	870.90
1999	66.20	854.90	1136.00	876.50
2000	65.31	850.00	1123.10	870.20
2001	65.64	840.90	1106.50	859.70
2002	65.19	839.30	1097.60	856.80
2003	65.11	827.40	1080.90	844.30
2004	64.61	798.80	1044.10	814.50
2005	65.49	801.30	1035.40	815.90

Table 2. *Cont.*

Year	Temp	Whites	Blacks	All Races
2006	66.41	779.50	998.20	792.50
2007	65.64	764.40	972.20	775.90
2008	64.45	767.40	947.80	775.70
2009	64.17	742.90	913.00	750.20
2010	64.66	742.00	898.40	747.70
2011	65.16	740.40	875.50	743.10
2012	67.69	731.60	864.40	733.80
2013	64.15	731.30	861.10	732.60

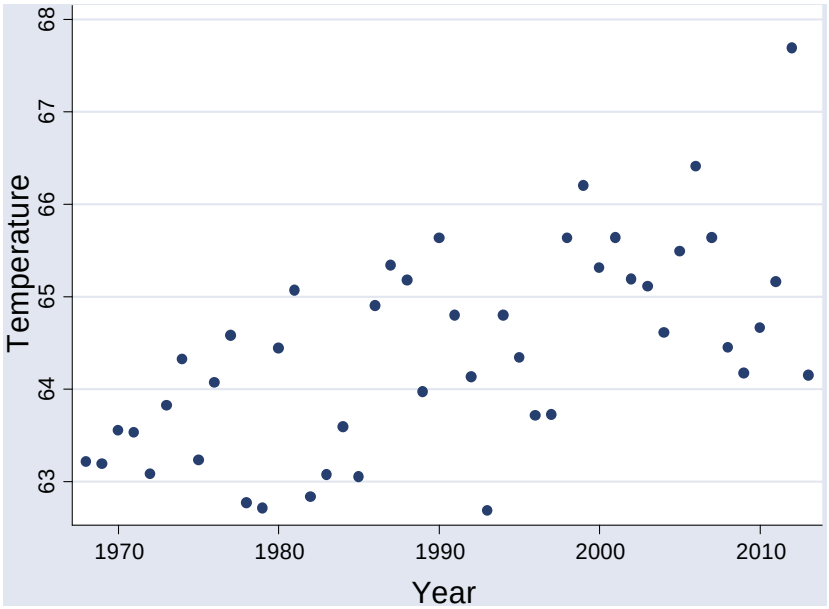

Figure 1. Temperatures by year for continental U.S., 1968–2013.

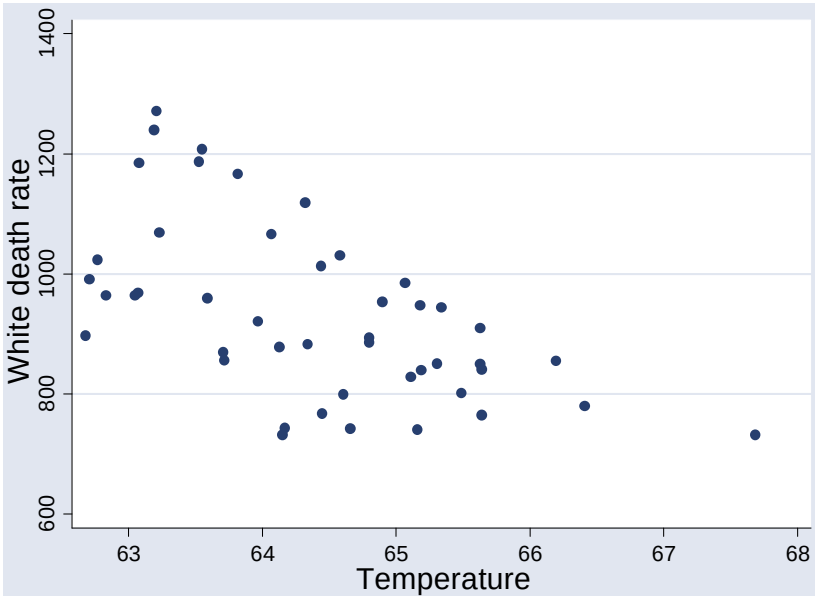

Figure 2. Yearly temperatures *vs.* yearly white age-adjusted death rates in the continental U.S., 1968–2013.

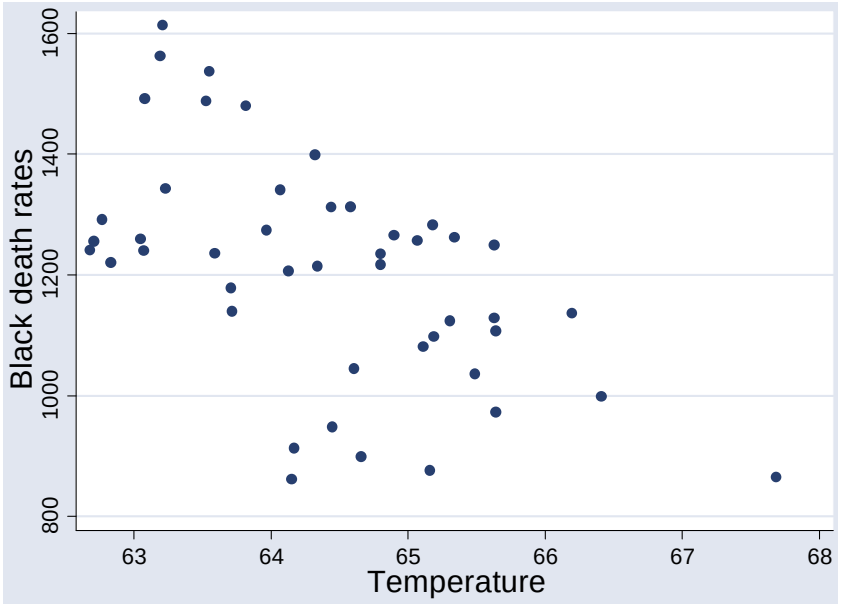

Figure 3. Yearly temperature *vs.* yearly black age-adjusted death rates in the continental U.S., 1968–2013.

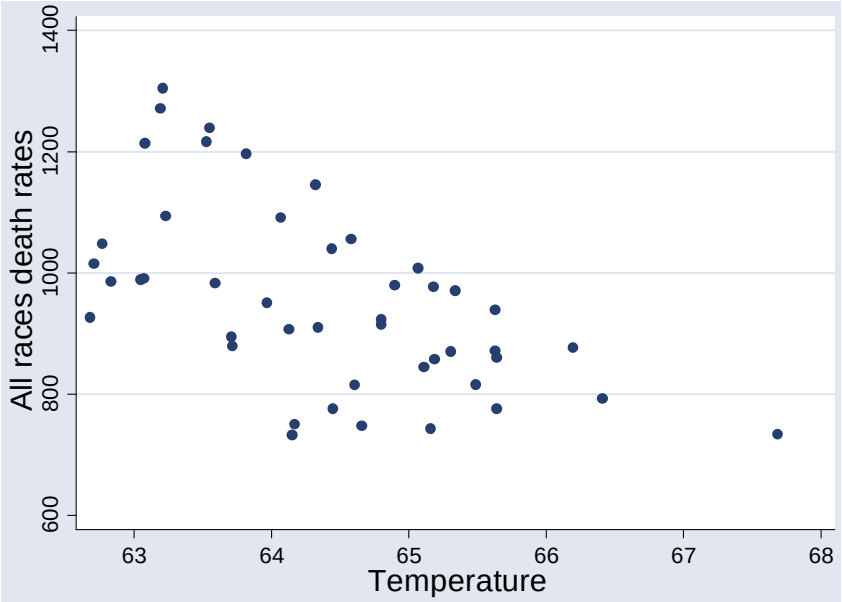

Figure 4. Yearly temperature *vs.* yearly all races age-adjusted death rates in the continental U.S., 1968–2013.

4. Discussion

These findings indicated that warmer years were correlated with lower death rates, which is a similar result to that revealed in the Texas study [6]. However, the study is at odds with other research on this topic that revealed adverse associations between warmer temperatures and death rates [2,3]. One reason for the difference may be in the different designs. The aforementioned studies that revealed adverse associations between warmer temperatures and death rates, looked at cities for the U.S [2,3], whereas the present study looked at nearly the entire U.S. as a whole (48 states + District of Columbia). There is likely more mobility outside of a jurisdiction at the city level *vs.* at the country level, which would seem

to suggest greater reliability with the latter (present) design. Another difference is in the number of years studied: 13 in one study [3] *vs.* 46 in the present study. The author was unable to determine the number of years analyzed in the other aforementioned paper [2].

Limitations to the study are: (a) its (ecological) design, where individual exposures and outcomes are unknown, as is a limitation to other studies showing different results; and (b) no other factors related to death rates were included. The exclusion of other factors is consistent with predictions for global warming, where warmer temperatures alone (*vs.* global warming and, for example, smoking) are thought to be predictive (of future adverse events). A factor not included in this study is the general advancement that mankind makes over time that may prolong lifespan. However, it can be argued that these advances may somehow be related to warmer temperatures, just as warmer temperatures may be related to a plethora of future adverse events, as global warming advocates might speculate. Strengths of the study include: (a) the entire continental U.S. population was included; and (b) age and race were accounted for.

5. Conclusions

In this study, warmer years tended to be related to lower death rates, which is consistent with a previous similar study for Texas, but the opposite was claimed in other studies that looked at locations at the city level in the U.S. Thus, the science is not settled on the topic of global warming and death rates. Further research is indicated to verify these findings, using this (ecological) or other research designs.

Author Contributions

The author performed all the tasks involved in this study, including data collection, data analysis, and writing the manuscript.

Conflicts of Interest

The author declares no conflict of interest.

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