Heat-related Fatalities in Wisconsin During the Summer of 2012

Megan L. Christenson, MS, MPH; Sarah Dee Geiger, PhD, MS; Henry A. Anderson, MD

ABSTRACT

Background: The hottest year on record for the contiguous United States was 2012. July 2012 ranked as Wisconsin's fourth warmest July, which has profound implications for heat-related mortality.

Methods: We conducted a case series of 27 heat-related fatalities in Wisconsin during summer 2012. Data from death certificates supplemented by coroner reports were analyzed to characterize factors that increase vulnerability to heat-related fatality.

Results: The 2012 heat-related fatalities occurred in both urban and rural counties. All cases had 1 or more known risk factors: 100% lacked functioning residential air conditioning; 70% were over age 65; 75% had a cardiovascular disease; and 52% had a mental health condition. Of the 14 cases with a mental health condition, half were known to be taking psychotropic medication. None of the decedents had been in air conditioning immediately prior to death, and 8 (36%) had been using fans.

Conclusions: Air conditioning is known to be a strong protective factor in preventing heat-related deaths whereas fans have not been shown to be significantly protective across all exposure situations. Prevention efforts should stress reducing social isolation by encouraging checks by friends, neighbors, or police. Prevention messages should also warn patients on psychotropic medications that the medication could increase their risk of heat-related illness or fatality.

INTRODUCTION

The year 2012 was the hottest on record for the contiguous United States.[1] Extreme heat threatens public health by causing a variety of heat-related illnesses and injuries as well as death. Wisconsin reflected record-setting highs across the nation: July 2012 was the state's fourth warmest July and the warmest on record for Milwaukee.[2]

Previous studies of heat-related fatalities in Wisconsin focused on the heat wave of 1995,[3-6] which attributed 154 fatalities to heat,[4] 91 (59%) of which occurred in Milwaukee.[3] Subsequent public health action led to community heat response plans in Milwaukee. After implementation of a Milwaukee heat plan, an evaluation of a heat wave in 1999 found a significant decrease in fatalities.[6]

From 2000 to 2010, the annual number of heat-related deaths in Wisconsin ranged from 1 to 24. The aim of this case series is to characterize heat-related mortality by examining the demographics and risk factors of the cases of heat-related fatalities that occurred in Wisconsin during summer 2012.

METHODS

Study Design and Case Definition

We conducted a descriptive case series of heat-related fatalities in Wisconsin during summer 2012 by collecting data from 3 sources. First, we utilized a database that tracked possible and probable heat deaths reported to the Wisconsin Division of Public Health in real time during the 2012 summer season. Second, death certificates for all probable and confirmed heat-related fatalities were collected from the Wisconsin Vital Records Office (N = 33). Heat-related fatalities were identified by querying terms such as "hyperthermia," "heat," "exposure," "sun stroke," and "heat stroke" in the database of death certificates. Death records with an ICD-10 code of X30 were also extracted; this diagnosis code is assigned to cases with exposure to excessive natural heat. For the purposes of this study, deaths were considered heat-related if heat (eg, heat stroke, environmental heat stress, environmental exposure to heat, extreme heat, heat exposure), hyperthermic, or hyperthermia were listed as the primary, underlying, or contributing cause of death on the death certificate. Third, we requested full death investigation reports from coroners and medical examiners who reported one or more heat fatalities.

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Author Affiliations: Wisconsin Department of Health Services, Division of Public Health, Bureau of Environmental and Occupational Health, Madison, Wis (Christenson, Geiger, Anderson).

Corresponding Author: Henry A. Anderson, MD, 1 W Wilson St, PO Box 2659, Madison, WI, 53701-2659; phone 608.266.1253; fax 608.266.1253; e-mail henry.anderson@dhs.wisconsin.gov.

Figure 1. Timeline of Wisconsin's Heat-related Deaths in 2012.

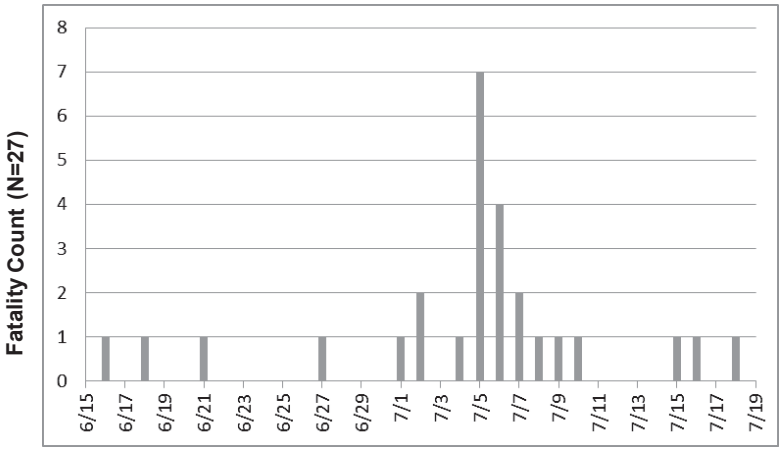
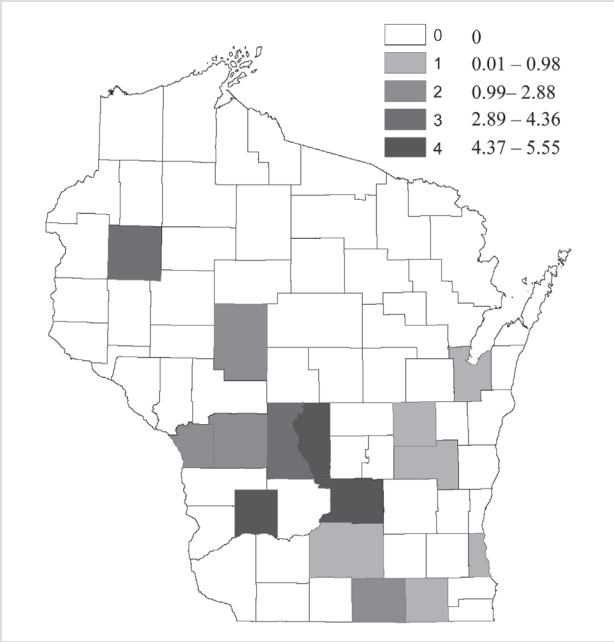


Figure 2. 2012 Heat-related Death Rate by County (per 100,000 population).



Rate calculated using 2011 Department of Health Services population estimates.

Key Variables

Demographic variables from the death certificates were entered into a Microsoft Access (Microsoft Corporation, Redmond, Washington) database, including gender, age, race, and education level. Relevant health conditions were coded into 3 categories: cardiovascular diseases (eg, coronary heart disease, heart failure, myocardial infarction, and hypertension), mental health (eg, schizophrenia, depression, hoarding), and substance abuse (current or historical drug and/or alcohol use). These variables were chosen based on the existing body of literature (including academic studies as well as public health practice reports) and feasibility of extracting and coding data from our sources. Death certificate data were supplemented by information extracted from the coroner reports, including fan/air conditioning use (not present, unknown, present but not functioning, functioning and used, and functioning but not used), comorbidities (cardiovascular diseases, mental health, and substance abuse), and other circumstances at time of death. If the coroner report indicated that the residence temperature was greater than 80°F but did not specify air conditioning use, it was coded as not present. Though poverty has been linked to heat-related fatalities,[7] unfortunately, neither data source included information on income level or poverty status.

RESULTS

Investigation of 6 of the originally reported fatalities did not confirm the death as a "case." Excluding these 6 resulted in a study sample size of 27. We achieved a 94% coroner response rate for supplemental coroner reports. Figure 1 shows that heat fatalities occurred between June 16 and July 18 with a peak of 7 deaths on July 5. Figure 2 displays fatality rates by county in a state map of Wisconsin, with darker shading indicating increasing fatality rate.

Table 1 presents characteristics of the study population along with comparison statistics for the Wisconsin general population. "The breakdown of heat as a primary or underlying cause versus contributing cause of death was 70% and 30%, respectively. The split between genders was almost equal and the majority of decedents (81.5%) were white, which is not significantly different from the proportion of whites in Wisconsin's general population. Approximately 74.1% of the sample had cardiovascular disease and 51.9% experienced 1 or more mental health conditions (22.2% were schizophrenic, and hoarding was mentioned in 18.5% of the cases). About 56% of the sample was aged 65-84, highly significantly different from the 11.6% in the general population ($P < 0.001$). Table 2 shows the availability and use of cooling techniques among the decedents. None of the decedents had been using air conditioning at the time of death, and 8 (36.4%) had been using a fan.

Case Reports

We are highlighting 4 of the 27 total cases due to noteworthy characteristics, including risk factors particularly consistent with existing literature, situations which highlight an opportunity for improving public health prevention efforts, and/or extenuating

circumstances. Along with each case profile, we also offer key messages for future prevention efforts.

Case 1. On July 2, 2012, a 75-year-old woman died in the car where she had been primarily living, in the driveway of her home. She was reported to be a hoarder on the medical examiner's investigation report. Police performed 2 welfare checks (at 1:30 AM and 2 PM) on the date of death before a neighbor found her deceased at 10:30 PM. The heat index indicated on the death certificate was 115°F (at 10:30 PM). The decedent's adult daughter was away on her honeymoon at the time of death.

Comment: Welfare checks, commonly recommended by state and local public health, were ineffective in preventing this death though we do not know if the decedent was offered help. A welfare check is when a community member requests that the police check on the safety of someone. Local health departments and law enforcement should consider joint efforts to provide recommendations for those living in unsafe environmental conditions, including affordable cooling methods if air conditioning is not an option.

Case 2. On July 6, 2012, a 48-year-old male correctional institute inmate was found dead in his 95°F cell. The decedent had been treated the previous day for heat-related issues. Hyperthermia was the immediate cause of death while significant conditions contributing to the death included chronic psychotic illness and hepatitis C with cirrhosis. The decedent was taking 3 psychotropic medications that can create an increased risk for hyperthermia.

Comment: Institutions that do not have air conditioning should consider implementing special protections such as additional cool showers, fluids, electrolytes, and cold packs for inmates on drugs that could predispose them to heat injury or death.

Case 3. On July 18, 2012, a 62-year-old Hispanic woman was found deceased in her 90°F apartment. She was unclothed and appeared to have fallen from her recliner chair with her asthma inhaler nearby. She had last been seen by her son 2 days prior. The window air conditioning unit in her apartment was inoperable. The immediate cause of death was acute exacerbation of asthma. She had a history of hypertension and mesothelioma, as well as other comorbid conditions. With only a primary education level, the decedent was illiterate.

Comment: Written public health messaging (at least in English) would have been ineffective in preventing this heat-related death. Vulnerable individuals with health conditions such as asthma and other pulmonary conditions that can be exacerbated by heat could benefit from a personalized heat-readiness plan.

Case 4. On July 22, 2012, an 86-year-old man was found deceased in his recliner at home, wearing only socks and a t-shirt. Neighbors had not seen him for 2 weeks, so date of death was estimated to be between July 15-18. The man had no immediate family and lived alone without air conditioning or fans. The many observed signs of neglect included mice, envelopes with checks waiting to be cashed, and a kitchen sink filled with rancid water. The only food in the residence was 1 slice of cheese, cheese spread, and coleslaw which had been expired for almost a year.

Comment: Social isolation played a key role in this heat fatality. Social services, local public health, and police could work

Table 1. Demographic Characteristics

	Study Sample	Wisconsin General Population, 2010	*P*-value[a]
	N (%)	N (%)	—
Total	**27 (100)**	**5,686,986 (100)**	—
Women	**14 (51.9)**	**2,864,586 (50.4)**	**0.88**
Age, years			
<20	0 (0)	1,502,196 (26.4)	<0.001
20-44	1 (3.7)	1,833,912 (32.2)	<0.001
45-64	7 (25.9)	1,573,564 (27.7)	0.84
65-84	15 (55.6)	658,809 (11.6)	<0.001
85+	4 (14.8)	118,505 (.02)	0.068
Race/ethnicity			
White	22 (81.5)	4,902,067 (86.2)	0.54
Black/African American	2 (7.4)	359,148 (6.3)	0.83
American Indian	1 (3.7)	54,526 (1.0)	0.46
Hispanic	2 (7.4)	336,056 (5.9)	0.77
Education level[b]			
Primary (0-8 years)	4 (14.8)	133,010 (3.5)	0.10
Secondary (9-12 years)	16 (59.3)	1,508,717 (39.7)	0.042
College (>12 years)	7 (26.0)	2,158,568 (56.8)	<0.001
Lived alone	**15 (55.6)**		-
Comorbidities			
Cardiovascular disease	20 (74.1)		-
Mental health	14 (51.9)		-
Substance abuse	3 (11.1)		-
Autopsy performed	**10 (37.0)**		-
Role of heat in cause of death			
Primary or underlying	19 (70.4)		-
Contributing	8 (29.6)		-

[a]Statistical significance tested using a 2-sample z-test for the difference in proportions
[b]Total for Wisconsin general population is age 25 and older: N=3,800,295
Note: blank cells indicate that information unavailable for comparison.

Table 2. Availability and Use of Cooling Techniques (N=22)[a]

	A/C (%)	Fan (%)
Not present	15 (68.2)	1 (4.5)
Unknown	3 (13.6)	11 (50.0)
Present		
Not functional	2 (9.1)	0 (0)
Functional		
Used	0 (0)	8 (36.4)
Not used	2 (9.1)	2 (9.1)

[a]N=5 excluded (for Table 2 only), due to outdoor heat exposure.

together to identify socially isolated individuals with a goal of checking on their safety and providing education on heat risk factors.

DISCUSSION

Risk and protective factors

Though a relatively low number of deaths are attributable to heat compared to other causes of death such as those associated with prevalent chronic diseases, heat-related fatalities are almost always preventable. Therefore, identifying effective interventions targeting vulnerable populations is crucial.

Prevalent cardiovascular disease in our sample (74.1%) is consistent with existing literature.[8,9] This is especially true among elderly populations who have a limited ability to thermoregulate their body temperature compared to younger populations.[10]

About 52% of our sample had at least 1 mental illness; half of the 14 mental health cases were taking psychotropic medication while the other half were either not taking medication or it was unknown. Two case-control studies of heat-related fatalities found that mental illness is a significant risk factor for heat-related mortality.[9,11] The literature suggests that antipsychotic drugs can predispose users to heat-related illness by interfering with thirst and ability to thermoregulate.[12,13] Furthermore, vulnerability to heat can be exacerbated by deficits in self-care, characteristic of individuals with depression and schizophrenia.[13] Such barriers can lower the likelihood of pursuing preventive measures such as showers and cooling shelters. In addition, patients with schizophrenia can be disproportionately affected by heat-related fatalities; 22% of the fatalities in our sample were schizophrenic compared to worldwide prevalence of schizophrenia of around 0.5%.[14] Of the 6 schizophrenic cases in our sample, 5 (83%) were under the age of 65. A case-control study by Kaiser et al found a similarly high percentage of heat fatality cases with schizophrenia: 4 (24%) of the 17 cases were schizophrenics,[11] while another study found that deaths due to schizophrenia increased by more than 2-fold during heat waves.[15]

Our study of fatalities underscores the importance of social support networks, specifically for social isolates and shut-ins. Fifty-six percent of the study sample lived alone. Studies show that living alone, a potential indicator of social isolation, is a risk factor for heat-related fatalities.[9,16] Our case series suggested that it is not only important to check on isolated individuals to make sure they are not in heat distress but also to ensure that current living conditions are safe.

Complete lack of air conditioning across our sample also was striking. Many other studies have found that air conditioning is a strongly protective factor against heat-related death.[9,11,16] Efficacy of fans, on the other hand, is situation dependent and some studies have shown them to be not significantly protective.[9,11,17]

Strengths

In addition to collecting death certificate data on the heat-related fatalities, we completed a thorough follow-up of each case to obtain the coroner/medical examiner death investigation report. These reports provided valuable contextual information about the circumstances of the deaths (94% response rate). To our knowledge, this is the first study to note hoarding as a potential mental health risk factor for heat-related fatality. Small sample size and lack of baseline comparison rates prevent us from attributing significance to this observation, but future analytical studies should consider the topic for further investigation.

Limitations

One limitation of our study is variability in the case definition used for heat-related death by coroners and medical examiners across the state. A uniform definition for heat-related death that has been posited by the National Association of Medical Examiners is one "…in which exposure to high ambient temperature either caused the death or significantly contributed to it."[18] It also recommends determining the diagnosis from "… circumstances surrounding the death, investigative reports concerning environmental temperature, and/or measured antemortem body temperature at the time of collapse." Despite efforts to standardize the definition, varying criteria are used in the determination of heat-related death in Wisconsin. For example, 37% of our study's cases involved an autopsy. Also, some collected a rectal temperature of the decedent while others noted the ambient temperature or conducted a toxicology analysis. Because of this inconsistent determination, we cannot rule out the possibility of selection bias, potentially resulting in an underestimate of heat-related fatalities.

CONCLUSION

The case studies and descriptive statistics from our study help inform state- and local-level preparation for future heat waves. Local agencies should partner in community heat response planning to broaden awareness and involvement. Given that three-fourths of the sample had cardiovascular disease outcomes and half suffered from mental health conditions, intervention strategies should target these high-risk groups. Providers should be encouraged to provide verbal warnings to mental health patients taking psychotropic medications that are known to affect the body's ability to cool itself, as well as to educate cardiovascular patients about their elevated risk to heat-related mortality. Other heat planning strategies could include targeted and individualized heat response plans from social services for socially isolated and vulnerable individuals.

Short-term prevention efforts should emphasize the importance of air conditioning and other cooling strategies. Although visiting an air conditioned place has been associated with lower heat-related mortality,[16] results are mixed.[9] Further research is

needed to assess cooling center effectiveness among those most vulnerable to extreme heat. Fans should not be emphasized as the main preventive strategy since they are not significantly protective across all heat exposure situations.[16,17] However, since fans may be the only option for some individuals and can be effective in certain situations, messaging should include instructions for correct fan usage, including use when temperatures are below the high 90s. Other simple cooling techniques should also be recommended, such as loose and light-colored clothing, plenty of cool liquids, cool baths, and limited caffeine and alcohol consumption.[19] Long-term prevention strategies such as green infrastructure and increased tree canopy cover should also be considered for their sustainable cooling effects.[20]

In addition, the current study reinforces need for a consistently used case definition for heat-related fatalities by coroners and medical examiners. Standardization would ensure that heat-caused fatalities are correctly identified and characterized in order to improve future public health prevention efforts.

Temperatures are rising globally, making prevention of heat-related fatalities a continuing challenge. The public health workforce should consider allocating resources to crafting and enacting effective intervention strategies to minimize preventable heat-related fatalities.

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