doi:10.1111/j.0361-3666.2008.01041.x

Overview of deaths associated with natural events, United States, 1979–2004

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Analysis of the National Center for Health Statistics' Compressed Mortality File showed that between 1979 and 2004, natural events caused 21,491 deaths in the United States. During this 26-year period, there were 10,827 cold-related deaths and 5,279 heat-related deaths. Extreme cold or heat accounted for 75 per cent of the total number of deaths attributed to natural events—more than all of deaths resulting from lightning, storms and floods, and earth movements, such as earthquakes and landslides. Cold-related death rates were highest in the states of Alaska, Montana, New Mexico, and South Dakota, while heat-related deaths were highest in the states of Arizona, Missouri, and Arkansas. These deaths occurred more often among the elderly and black men. Other deaths were attributed to lightning (1,906), storms and floods (2,741), and earth movements (738). Most deaths associated with natural events are preventable and society can take action to decrease the morbidity and mortality connected with them.

Keywords: cold, death rate, flood, heat, lightning, mortality, storms

Introduction

Natural events such as extreme cold or hot weather, earth movements, floods, hurricanes, and lightning are responsible for hundreds of deaths each year in the United States. Each type of weather-related event causes devastation and loss of life in a unique manner. The geography and climate behind these events result in certain regions of the US being more likely to be affected by particular types of events than others are. Cold weather-related events include periods of exceptionally low temperatures. The most severe low temperatures tend to occur in the northeast and midwest regions of the country. Heat-related events, such as heatwaves, are periods of unusually high temperatures. Heatwaves tend to occur during the late summer months. Although other regions of the US may experience heatwaves, the southwestern quadrants of the country tend to be more severely affected. Lightning most often strikes in the summer when thunderstorm clouds form. In the US, the highest frequency of cloud-to-ground lightning is in Florida due to the presence of high moisture content in the atmosphere at levels below 5,000 feet and high surface temperatures that produce strong sea breezes along the Florida coast. The US western mountains, the coastal land off the Gulf of Mexico and inland from Florida to Texas, and the Atlantic coast in the southeast are regions where conditions are favourable for the development of lightning. Storms include blizzards, hurricanes, tornadoes, and torrential rains. Blizzards are dangerous winter storms with high winds and heavy snow. The winter months of January through March are when blizzards typically happen.

Published by Blackwell Publishing, 9600 Garsington Road, Oxford, OX4 2DQ, UK and 350 Main Street, Malden, MA 02148, USA

Hurricanes and tornadoes generally arise in the spring and summer months. The official hurricane season runs from early June to late November. Hurricanes are tropical storms comprising high-velocity winds accompanied by heavy rainfall and tidal surge, which can cause flooding. Earthquakes are associated with plate tectonics and occur most frequently in Hawaii and along the western coastline of the US.

Numerous reports discuss the economic devastation or human health effects associated with a specific type of natural event. However, there are no current reports that investigate which of these various types of natural events cause the most loss of life in the US. In this paper, we draw attention to the fact that extreme temperatures cause more deaths than avalanches, earthquakes, floods, landslides, lightning, hurricanes, tornadoes, or volcanic eruptions and identify the demographic characteristics of the groups most affected by these events.

Methods

The data used in this report are from the National Center for Health Statistics (NCHS)'s Compressed Mortality File (CMF) (CDC, 2004a). This file is publicly available via the Centers for Disease Control and Prevention (CDC)'s Compressed Mortality File. The CMF contains the underlying cause of death as recorded on a death certificate for US residents who died in the United States and the District of Columbia along with the state and county of residence, year of death, race, sex, and age group of the decedent at death. Table 1 lists the International Classification of Diseases (ICD) codes, ICD-9 and ICD-10, for mortalities due to natural events. These two classification codes were grouped by natural event to allow for the combining of the 1979–98 data and the 1999–2004 data grouped by the ICD-9 and ICD-10 systems of classification, respectively. The total number of deaths for each group of years was added to show the total number of deaths from 1979 through 2004. Deaths classified as 'weather not specified' were not included in this analysis as the type of natural event could not be determined. The ICD-9 classification allowed deaths due to specific natural events to be coded as 'other specified origin' and 'of unspecified origin'. While these deaths are not included in the analysis, 'other specified' and 'of unspecified origin' account for the large portion of deaths due to extreme temperature. Between 1979 and 1998, 6,782 deaths due to cold were classified as 'unspecified origin' and 3,809 deaths due to heat were classified as 'unspecific origin'. Under the ICD-10 classification system, deaths due to natural events are not coded as 'unspecified origin'. Consequently, the increase in the number of deaths due to temperature extremes may be the result of the new classification.

Cause of death on the CMF is the underlying cause of death, which the World Health Organization (WHO) defines as 'the disease or injury which initiated the train of events leading directly to death, or the circumstances of the accident or violence which produced the fatal injury' (WHO, 1992). Underlying cause of death is selected from the conditions entered by the physician on the cause of death section of the death certificate. When the physician enters more than one cause or condition,

Table 1 ICD-9 and ICD-10 codes for deaths associated with natural events

Natural event	ICD-9 code	ICD-10 code
Cold	901.0 excessive cold due to weather conditions 901.8 other specified origin 901.9 of unspecified origin	X31 exposure to excessive natural cold
Heat	900.0 excessive heat due to weather conditions 900.9 of unspecified origin	X30 exposure to excessive natural heat
Weather not specified	904.3 exposure to weather conditions not elsewhere classifiable	X32 exposure to sunlight X39 exposure to other and unspecified forces of nature
Lightning	907 lightning	X33 victim of lightning
Storms and floods	908 cataclysmic storms and floods resulting from storms	X37 victim of cataclysmic storms, (includes blizzards, tornadoes, and hurricanes) X38 victim of flood
Earth movements	909 cataclysmic earth surface movements and eruptions	X34 victim of earthquake X35 victim of volcanic eruptions X36 victim of avalanche, landslide and other earth movements

the underlying cause is determined by the sequence of conditions on the certificate, provisions of the ICD, and associated selection rules and modifications. Underlying cause of death is classified in accordance with the International Classification of Diseases. Deaths for 1979–98 are classified using the Ninth Revision (ICD-9), while deaths for 1999 and beyond are classified using the Tenth Revision (ICD-10) (US Department of Health and Human Services, 2005).

Deaths due to natural events were classified as caused by cold, heat, lightning, storms or floods, and earth movements. Crude death rates were calculated by dividing the number of condition-specific deaths by the 2000 US census population and converting the rate to per million people. To identify demographic characteristics of the groups most affected, crude death rates are described by age group, race and gender, geographic location, and year of death. The CMF categorises race into one of three groups: white; black; and other. The other racial group includes persons of American Indian, Alaskan Native, and Asian or Pacific Islander decent. Geographic location is defined as the place of death and is recorded for deaths in each of the 50 US states and the District of Columbia.

Results

Cold

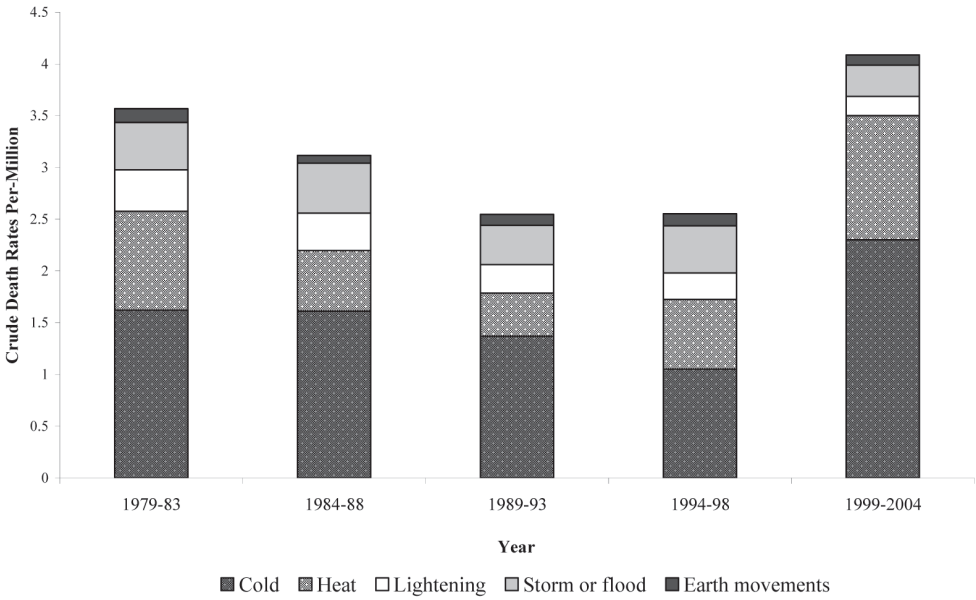
Cold weather is the major cause of death due to natural events (Table 2). Fifty per cent of the 21,491 deaths (10,827) between 1979 and 2004 were related to extreme cold. The number of cold-related deaths averaged approximately 416 per year, with

Table 2 Deaths due to natural events in the US, 1979–2004

Natural event	Number of deaths
Excessive cold due to weather conditions	10,827
Excessive heat due to weather conditions	5,279
Lightning	1,906
Storms and floods, including blizzards, tornadoes, and hurricanes	2,741
Earth movements, including earthquakes, volcanic eruptions, avalanches, landslides, and other events	738
Total	**21,491**

crude death rates ranging from 0.7–2.6 per million (Figure 1). The region of the US with the most deaths due to cold weather was the mountain region, with a crude death rate of 3.7 per million. While the mountain region overall had the highest crude death rate, there were other states with substantial crude death rates. Alaska at 14.5 had the highest crude death rate for cold-related deaths, followed by Montana at 9.4, New Mexico at 8.9, and South Dakota at 7.2 (Table 3). The crude death rates were higher for black men (5.0 per million) and men of other race (5.9 per million) compared

Figure 1 Crude death rates by year for each type of natural event, US, 1979–2004*



* The Ninth Revision of the International Classification of Diseases (ICD-9) was used to report mortality data from 1979–98, while data from 1999–2002 is classified by the Tenth Revision (ICD-10). A dotted line is used to differentiate between the two different classification systems. The last column includes six years of data compared to five. The addition of the sixth year increases the cold death rate by 0.1 and decreases the heat death rate by 0.1.

Table 3 Crude death rate for deaths due to natural events by geographical division and areas, US, 1979–2004

	Crude death rate[1]					
	Total population	**Cold**	**Heat**	**Lightning**	**Storms and floods**	**Earth movements**
United States region	**6,680,742,340**	**1.6**	**0.8**	**0.3**	**0.4**	**0.1**
New England	**344,926,905**	**1.3**	**0.2**	**0.1**	**0.1**	**0.1**
Connecticut	85,640,853	1.0	0.1[2]	0.1[2]	0.1[2]	0.0[2]
Maine	31,709,579	1.5	0.4[2]	0.3[2]	0.1[2]	0.2[2]
Massachusetts	157,794,772	1.3	0.2	0.1[2]	0.0[2]	0.1[2]
New Hampshire	28,841,270	1.4	0.2[2]	0.2[2]	0.0[2]	0.1[2]
Rhode Island	26,193,662	1.5	0.2[2]	0.1[2]	0.0[2]	0.0[2]
Vermont	14,746,769	2.6	0.3[2]	0.3[2]	0.1[2]	0.1[2]
Middle Atlantic	**995,435,705**	**1.4**	**0.3**	**0.1**	**0.2**	**0.0**
New Jersey	206,278,720	1.2	0.3	0.1	0.1[2]	0.0[2]
New York	475,864,056	1.1	0.2	0.1	0.1	0.0[2]
Pennsylvania	313,292,929	1.9	0.6	0.2	0.4	0.0[2]
East North Central	**1,122,328,291**	**1.8**	**0.5**	**0.2**	**0.3**	**0.0[2]**
Illinois	307,931,020	2.1	0.9	0.2	0.3	0.0[2]
Indiana	149,163,119	1.7	0.5	0.3	0.3	0.0[2]
Michigan	247,329,261	1.9	0.3	0.2	0.2	0.0[2]
Ohio	287,011,223	1.1	0.3	0.2	0.3	0.0[2]
Wisconsin	130,893,668	2.5	0.7	0.3	0.3	0.0[2]
West North Central	**472,736,179**	**2.4**	**1.7**	**0.3**	**0.6**	**0.0[2]**
Iowa	74,513,287	2.7	1.3	0.2[2]	0.5	0.0[2]
Kansas	65,999,339	2.2	2.2	0.4	0.9	0.0[2]
Minnesota	117,331,627	1.7	0.3	0.2	0.2	0.0[2]
Missouri	136,770,559	2.0	3.5	0.3	0.8	0.0[2]
Nebraska	42,461,204	1.7	0.6	0.4[2]	0.5	0.0[2]
North Dakota	16,923,191	6.4	0.3[2]	0.2[2]	0.4[2]	0.1[2]
South Dakota	18,736,972	7.2	0.8[2]	0.7[2]	0.8[2]	0.1[2]
South Atlantic	**1,178,656,495**	**1.5**	**0.7**	**0.4**	**0.5**	**0.0[2]**
Delaware	18,065,180	2.4	0.7[2]	0.2[2]	0.1[2]	0.0[2]
District of Columbia	15,702,930	5.3	1.8	0.3[2]	0.1[2]	0.0[2]

Florida	349,213,803	0.5	0.6	0.7	0.3	0.0[2]
Georgia	180,083,750	1.6	1.2	0.4	0.6	0.0[2]
Maryland	126,139,719	1.3	0.5	0.2	0.2	0.0[2]
North Carolina	182,332,444	1.4	0.4	0.4	0.6	0.0[2]
South Carolina	93,903,075	2.7	1.6	0.4	0.5	0.0[2]
Virginia	165,104,422	2.7	0.5	0.3	0.4	0.0[2]
West Virginia	48,111,172	2.5	0.1	0.3	1.3	0.0[2]
East South Central	**411,110,686**	**2.1**	**0.9**	**0.5**	**1.0**	**0.0[2]**
Alabama	108,594,028	2.1	0.9	0.5	1.5	0.0[2]
Kentucky	99,539,963	2.2	0.8	0.5	0.6	0.0[2]
Mississippi	69,594,370	2.4	1.0	0.7	1.2	0.0[2]
Tennessee	133,382,325	1.8	0.9	0.4	0.9	0.0[2]
West South Central	**732,281,346**	**1.0**	**1.3**	**0.4**	**1.0**	**0.0[2]**
Arkansas	64,114,112	2.0	3.1	0.7	2.0	0.0[2]
Louisiana	113,484,616	0.7	1.0	0.6	0.5	0.0[2]
Oklahoma	85,323,103	2.3	1.6	0.4	1.3	0.0[2]
Texas	469,359,515	0.7	1.1	0.3	0.9	0.0[2]
Mountain	**390,048,309**	**3.7**	**1.7**	**0.6**	**0.4**	**0.7**
Arizona	104,800,355	3.2	4.8	0.6	0.4	0.1[2]
Colorado	94,372,997	2.2	0.2[2]	0.8	0.3	1.1
Idaho	28,966,919	3.1	0.8	0.4[2]	0.3[2]	0.9
Montana	21,999,052	9.4	0.5[2]	0.5[2]	0.2[2]	2.1
Nevada	36,703,606	1.7	2.2	0.1[2]	0.5[2]	0.1[2]
New Mexico	41,612,805	8.9	0.4[2]	0.8	0.3[2]	0.1[2]
Utah	48,988,698	1.9	0.4[2]	0.7	0.2[2]	1.0
Wyoming	12,603,877	6.1	0.3[2]	0.4[2]	1.4[2]	1.7
Pacific	**1,033,218,424**	**1.0**	**0.6**	**0.1**	**0.1**	**0.3**
Alaska	14,583,400	14.5	0.1[2]	0.1[2]	0.3[2]	3.6
California	778,441,756	0.6	0.7	0.0	0.1	0.2
Hawaii	29,272,593	0.1[2]	0.1[2]	0.0[2]	0.3[2]	0.1[2]
Oregon	78,466,604	2.3	0.5	0.1[2]	0.2[2]	0.4
Washington	132,454,071	1.3	0.2	0.1[2]	0.2	0.7

Notes:

[1] Crude death rate calculated using 2000 US census population and multiplying rate by 1,000,000.

[2] Death rates based on counts of 20 or less have a relative standard error of 23 per cent or more and therefore may be statistically unreliable.

Table 4 Crude death rate for deaths due to natural events by race, gender, and age group, US, 1979–2004

	Crude death rate[1]					
	Total population	**Cold**	**Heat**	**Lightning**	**Storms and floods**	**Earth movements**
Race/gender						
White male	2,734,069,074	1.8	0.6	0.5	0.5	0.2
White female	2,838,896,769	0.8	0.3	0.1	0.4	0.0
Black male	395,583,373	5.0	1.3	0.4	0.5	0.0[2]
Black female	438,540,039	1.5	0.8	0.1	0.3	0.0[2]
Other male	133,795,437	6.0	0.3	0.4	0.4	0.1[2]
Other female	139,897,752	5.9	0.2	0.1[2]	0.1[2]	0.1[2]
Age						
<1	100,651,815	0.3	1.0	0.0[2]	0.4	0.0[2]
1–4	386,963,665	0.1[2]	0.5	0.0[2]	0.3	0.0[2]
5–19	1,464,262,965	0.2	0.1	0.3	0.3	0.0
20–34	1,582,372,298	0.6	0.3	0.4	0.3	0.2
35–54	1,738,190,427	1.7	0.7	0.3	0.4	0.1
55–74	1,050,639,262	3.1	1.5	0.2	0.6	0.1
75–84	270,394,385	7.1	3.5	0.1[2]	0.9	0.0[2]
85+	87,307,627	15.2	5.2	0.0[2]	0.7	0.0[2]

Notes:

[1] Crude death rate calculated using 2000 US census population and multiplying rate by 1,000,000.

[2] Death rates based on counts of 20 or less have a relative standard error of 23 per cent or more and therefore may be statistically unreliable.

to other race and gender classifications (Table 4). The age group most affected by the cold was the elderly, particularly persons of 85 years or more. Among the 85 and older age group there were 1,330 deaths, with a crude death rate of 15.2 per million.

Heat

Excessive heat is the second largest contributor to deaths by natural events in the US. Heat as an underlying cause of death is associated with 25 per cent of deaths (5,279) caused by natural events between 1979 and 2004 (see Table 2). In years without heatwaves the number of heat-related deaths associated with weather conditions averages about 144 per year, with crude deaths rates of between 0.2 and 1.2 per million (Figure 1). There have been multiple major heatwaves in the US since 1979, including in Missouri in 1980, Illinois and Wisconsin in 1995, Illinois and Ohio in 1999, and most recently in Missouri, New Mexico, Oklahoma, and Texas in 2001 (Jones

et al., 1982; CDC, 1995, 2002; Knobeloch et al., 1997; Kaiser et al., 2001; Naughton et al., 2002). In those years, the crude death rate stood at 2.9 per million in 1980, 1.4 per million in 1995, 2.1 per million in 1999, and 1.1 per million in 2001. Heat-related deaths have occurred in all states, including Alaska, where one was reported in 1999. The geographical areas with the highest heat-related crude death rates were the West, North, Central, and Mountain regions. The states with the highest heat-related crude death rates were Arizona, Missouri, and Arkansas, with 4.8, 3.5, and 3.1, respectively (Table 3). Among the racial and gender classifications, black men and women have a higher mortality from heat-related deaths than do men and women from white and other racial backgrounds. Black men and women had crude death rates of 1.3 and 0.8 per million, respectively. The crude death rates for all other classifications were less than one per million. Similar to cold-related deaths, extreme heat is more likely to affect the elderly. The crude death rate peaks at 5.2 per million for those of 85 years and more (Table 4).

Lightning

Nine per cent or 1,906 deaths in 1979–2004 resulted from lightning. During that period, the crude death rate for lightning did not undergo significant changes. There is some variability in the crude death rates by state; however all state or geographical areas had a crude death rate of less than one per million (Table 3). Similarly the crude death rates for all racial and gender classifications and for age are less than one per million (Table 4). For racial and gender classifications men had higher crude deaths rates than women. When considering age, persons between the ages of 20 and 34 have the highest crude death rate. Due to the small number of lightning-related deaths, though, the estimated crude death rates may not adequately describe the relationship between age and lightning-related mortality.

Storms and floods

Storms and floods made up 13 per cent of the 21,491 deaths (2,741) due to natural events. The crude rate for deaths due to storms and floods ranges between 0.2 and 0.8 during the 26-year time span investigated (Figure 1). Arkansas had the highest crude death rate: 2.0 per million people (Table 3). Crude death rates did not vary between race and gender classification. Although all age categories had a death rate of less than one per million the highest death rates were among those aged 55 years or more (Table 4).

Earth movements

In the US, earth movement-related deaths represent the smallest proportion of deaths due to natural events. During the 26-year period, 738 earth movement-related deaths were reported. By year, the crude death rate did not exceed 0.3 per million (Figure 1). Crude death rates by state ranged from none reported to 3.6 per million people in Alaska. Most states had few to no deaths related to earth movements. The crude death

rate was less than one per million persons in all but five states: 3.6 for Alaska, 2.1 for Montana, 1.7 for Wyoming, 1.1 for Colorado, and 1.0 for Utah. Given the small number of deaths attributed to earth movements, all crude death rates by race and gender classification and by age group were less than one death per million (Table 4). The number of deaths within each of these categories is small, and the rates are subject to statistical error.

Discussion

The NCHS' CMF data show that there were more deaths due to extreme cold and heat than lightning, storms and floods, and earth movements during the years 1979–2004. When considering age, severe cold and heat are most likely to affect the elderly. Black men and men of other race appear to be disproportionately affected by cold weather-related events, while black men and women are more affected by heat-related events than other racial and gender classifications.

The number of deaths attributed to temperature extremes seems disproportionately high when examining the amount of media attention and disaster relief resources directed at these types of cases compared to cataclysmic events such as hurricanes, floods, and tornadoes. Temperature-related events such as the Chicago heatwave of 1995 caused an estimated 700 deaths and relatively little structural damage. Despite the large number of fatalities in a short period, the Chicago heatwave was mostly reported in the local news media and disaster assistance was primarily provided by the City of Chicago or local organisations. In contrast, the local and national media dedicate significant airtime and newspaper space to destructive natural phenomena such as earthquakes, floods, hurricanes, landslides, and tornados. Hurricane Andrew, which caused USD 26 billion of damage and resulted in 26 directly related deaths (Rappaport, 1993), received months of national media coverage, including front-page stories about the devastation and federal and state assistance.

Catastrophic events like floods, hurricanes, and tornadoes cause significant structural damage to buildings, homes, and roadways. Structural damage due to a single event can run into billions of dollars. The Federal Emergency Management Agency (FEMA) reported that between 1990 and 1999 hurricanes and typhoons were the most costly weather-related events. A total of USD 7.78 billion was given for hurricane- and typhoon-related disaster assistance. Areas affected by Hurricane Floyd in 1999, which resulted in 52 deaths, received USD 725.7 million (FEMA, 2004a; CDC, 2000). More recently, in 2004, FEMA approved more than USD 120 million for disaster assistance associated with Hurricane Charley (FEMA, 2004b). Thirty-one Floridians died because of Hurricane Charley (CDC, 2004b). Similarly, the midwest floods of summer 1993 caused approximately USD 21 billion of damage and 48 deaths (Ross and Lott, 2003). In contrast, winter storms between 1990 and 1999 attracted only USD 1 billion of disaster assistance (FEMA, 2004a).

Some limitations to this report must be highlighted. For example, crude death rates were calculated using the death certificate data reported to the NCHS' CMF.

Although this database is the primary source for mortality statistics in the US, various studies have reported crude death rates that differ from those calculated from CMF data. For instance, a study by Semenza et al. (1996) reported close to 700 deaths due to the Chicago heatwave, while the CMF reported only 364 heat-related deaths for the entire US in 1995, and only 50 heat-related deaths for the state of Illinois. Thus, the CMF underreports the actual number of deaths due to severe heat and perhaps other natural events. The underestimation of actual deaths due to severe cold and heat may be greater between 1979 and 1998 than 1999 and 2004 because a large proportion of deaths coded as 'unspecified origin' between 1979 and 1998 were not included in this analysis since they could not be attributed to a natural phenomenon. The differences in the two classification systems may explain the increase in cold- and heat-related deaths from 1979–98 as compared to 1999–2004. Despite the changes in the classification of cause of death and potential underestimates, the CMF is a useful resource as it provides a conservative estimate and qualitatively examines the number of deaths attributed to natural events, especially if underreporting is consistent for all deaths due to natural events.

Another concern is misclassification of death certificate data. There are multiple ways in which misclassification of cause of death can occur. However, when multiple conditions are listed as the cause of death it is possible that one of these conditions could be the true underlying cause of death. Similarly there is little consensus on the standard definitions of weather-related morbidity and mortality. For example, there are several definitions of a heat-related death. The definition most often used is one of exclusion and requires that the core body temperature at the time of death be greater than or equal to 105 degrees Fahrenheit (40.6 degrees Celsius). If the core body temperature is not taken at the time of death, the medical examiner or coroner will probably not specify excessive heat as the underlying cause of death on the victim's death certificate. While the National Association of Medical Examiners has established criteria for a heat-related death, the definition needs to be adopted by medical examiners and coroners in the US to ensure uniformity in classifying a death due to hyperthermia (Donoghue et al., 1977). Although the CMF is subject to misclassification, this occurs with all databases of mortality records and one hopes that the bias is similar for the same underlying cause of death. In addition, there is some overlap in natural event definitions, making it difficult, therefore, to label correctly the cause of death. For instance, a blizzard-related death could be classified as death due to excessive cold or a cataclysmic storm.

Vital records contain essential data regarding cause and time of death but they have their limitations. To obtain a better understanding of the impact of natural disasters, investigators have used hospital admissions or mortality records obtained at the local level to complement vital records data. Although it is difficult to classify and attribute injury and deaths accurately (Peek-Asa et al., 1998; Semenza et al., 1999; Shoaf et al., 1998), there is a growing body of literature with which to address this problem. CDC has proposed a framework to create a standard for ascertaining and classifying disaster-attributed mortality. The proposed system is flexible enough to include

all potentially preventable deaths related to disasters by enhancing current data systems and uses a flow chart and classification matrix to minimise errors in classifying deaths not related to a disaster (Combs et al., 1999).

Lastly, although extreme temperatures tend to result in more loss of life in the US than other weather-related events that damage structures, there is always an exception to the rule. The devastation caused by the 2005 Hurricanes Katrina and Rita was catastrophic by all accounts. Hurricane Katrina was the most costly and one of the most deadly hurricanes ever to strike the US (Knabb, Rhome and Brown, 2005), affecting Alabama, Florida, Georgia, Louisiana, and Mississippi (CDC, 2006a). Not only did this hurricane cause an estimated USD 75 billion of structural damage in five states, but the estimated death toll was greater than 1,300 (Knabb, Rhome and Brown, 2005). The hurricane and subsequent flooding resulted in the displacement of an estimated 200,000 persons in at least 18 states (CDC, 2006a). Twenty-six days after Hurricane Katrina, on 29 August 2005, Hurricane Rita hit the Louisiana–Texas border, adding to the devastation in the region (CDC, 2006b).

Conclusion

In the US, disastrous weather-related events can occur at any time. Although technology cannot prevent a hurricane or heatwave, accurate detection and forecasting, warning impacted populations, successful evacuation, and engineering structures to protect their occupants can reduce potential loss of life due to these events. Knowing what types of weather-related events are likely to occur in a particular area as well as who is at greater risk can steer federal, state, and local governments in designing effective disaster preparedness and mitigation programmes. In addition, knowing which groups of people are at greater risk can provide a guide as to whom prevention strategies target. These groups include the poor, the elderly, and people with limited mobility, a mental or chronic illness, and living in long-term care facilities (Jones et al., 1982; Kilbourne et al., 1982; Semenza, 1996; Weisskopf et al., 2002). The poor may be reluctant to spend money or may not have sufficient funds to evacuate the area; the elderly may be less able or willing to leave their homes; people with a chronic illness may need to bring medical equipment to assist them with basic life functions; and people on medication may be more susceptible to the hazards of extreme cold or heat.

Much attention is given to natural events that cause the most economic damage, but deaths from high or low temperatures account for most weather-related deaths and most importantly, these deaths may be more preventable than those caused by earth movements, floods, and storms. Public education programmes should be in place before summer or winter to alert people of the dangers and the need to take precautions to avoid the dangers of extreme heat or cold. In addition, programmes such as the Chicago Extreme Weather Operations Plan can serve as a model for state and local governments on how to activate and coordinate a response to hazardous weather conditions.

Acknowledgments

The authors would like to thank Dr. Stephen B. Thacker, M.D., M.Sc., Director of the Office of Workforce and Career Development, Centers for Disease Control and Prevention, for his critical review of the manuscript.

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