Heat-Related Deaths

1 Describe the physical, chemical, or biological measurements upon which this indicator is based. Are these measurements widely accepted as scientifically and technically valid? Explain.

This indicator is based on causes of death as reported on death certificates. A death certificate typically provides space to designate an immediate cause of death along with up to 20 contributing causes, one of which will be identified as the underlying cause of death. This indicator focuses on deaths for which heat-related factors were listed as the underlying cause. The World Health Organization (WHO) defines the underlying cause of death 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."

Causes of death are certified by a physician, medical examiner, or coroner, and are classified according to a standard set of codes called the International Classification of Diseases (ICD). Deaths for 1979 through 1998 are classified using the Ninth Revision of ICD (ICD-9). Deaths for 1999 and beyond are classified using the Tenth Revision (ICD-10). This indicator reports the number of deaths per year for which the underlying cause had one of the following ICD codes:

- ICD-9 codes E900: "excessive heat—hyperthermia" and E900.0: "due to weather conditions."
- ICD-10 code X30: "exposure to excessive natural heat—hyperthermia."

Although causes of death rely to some degree on the judgment of the physician, medical examiner, or coroner, the "measurements" for this indicator are expected to be generally reliable based on the medical knowledge required of the "measurer" and the use of a standard classification scheme based on widely accepted scientific definitions. When more than one cause or condition is entered, the underlying cause is determined by the sequence of conditions on the certificate, provisions of the ICD, and associated selection rules and modifications.

2 Describe the sampling design and/or monitoring plan used to collect the data over time and space. Is it based on sound scientific principles? Explain.

Mortality data are collected for the entire population and, therefore, are not subject to sampling design error. For virtually every death that occurs in the United States, a physician, medical examiner, or coroner certifies the causes of death on an official death certificate. State registries collect these death certificates and report causes of death to the National Vital Statistics System (NVSS). NVSS's shared relationships, standards, and procedures form the mechanism by which the U.S. Centers for Disease Control and Prevention (CDC) collects and disseminates the nation's official vital statistics. The NVSS registers virtually all deaths and births nationwide and is the most comprehensive source of mortality data for the U.S. population.

Standard forms for the collection of data and model procedures for the uniform registration of death events have been developed and recommended for state use through cooperative activities of the states and CDC's National Center for Health Statistics (NCHS). For example, CDC has published a U.S. standard death certificate (see: www.cdc.gov/nchs/data/dvs/DEATH11-03final-ACC.pdf), and most state certificates conform closely to this standard in content and arrangement. All states collect a minimum data set specified by NCHS, including underlying causes of death. CDC has published procedures for collecting vital statistics data (CDC, 1995).

This indicator excludes deaths to foreign residents and deaths to U.S. residents who died abroad.

3 Describe the conceptual model used to transform these measurements into an indicator. Is this model widely accepted as a scientifically sound representation of the phenomenon it indicates? Explain.

This indicator simply reports the total number of deaths per year that have been classified with heat-related illness as the underlying cause of death. No additional transformations were required. When plotting the data, EPA inserted a break in the line between 1998 and 1999 to reflect the transition from ICD-9 codes to ICD-10 codes. The change in codes makes it difficult to accurately compare pre-1999 data with data from 1999 and later.

4 What documentation clearly and completely describes the underlying sampling and analytical procedures used?

General information regarding data collection procedures can be found in the Model State Vital Statistics Act and Regulations (CDC, 1995). For additional documentation on the CDC WONDER database (EPA's data source for this indicator) and its underlying sources, see: http://wonder.cdc.gov/wonder/help/cmf.html.

Data are collected on death certificates. CDC has posted a recommended standard certificate of death online at: www.cdc.gov/nchs/data/dvs/DEATH11-03final-ACC.pdf. For a complete list and description of the ICD codes used to classify causes of death, see: www.who.int/classifications/icd/en.

5 To what extent is the complete data set accessible, including metadata, data-dictionaries, and embedded definitions? Are there confidentiality issues that may limit accessibility to the complete data set?

Data for this indicator were obtained from CDC's Compressed Mortality File, which can be accessed through the CDC WONDER online database at: http://wonder.cdc.gov/mortSQL.html (CDC, 2009). CDC WONDER provides free public access to mortality statistics, allowing users to query data for the nation as a whole or data broken down by state or region, demographic group (age, sex, race), or ICD code. Users can obtain the data for this indicator by accessing CDC WONDER and querying the following ICD codes for the entire U.S. population:

- ICD-9 codes E900: “excessive heat—hyperthermia” and E900.0: “due to weather conditions.”
- ICD-10 code X30: “exposure to excessive natural heat—hyperthermia.”

Individual-level data (i.e., individual death certificates) are not publicly available due to confidentiality issues.

6 Are the descriptions of the study or survey design clear, complete, and sufficient to enable the study or survey to be reproduced? Explain.

Yes. The documentation available from CDC explains how data were collected and aggregated. The response to Question 5 explains how users can obtain the data that were used to construct this indicator.

7 To what extent are the procedures for quality assurance and quality control of the data documented and accessible?

Vital statistics regulations have been developed to serve as a detailed guide to state and local registration officials who administer the NVSS. These regulations provide specific instructions to protect the integrity and quality of the data collected. This quality assurance information can be found in CDC (1995).

8 What statistical methods, if any, have been used to generalize or portray data beyond the time or spatial locations where measurements were made (e.g., statistical survey inference, no generalization is possible)? Are these methods scientifically appropriate?

The NVSS collects data on virtually all deaths that occur in the United States, meaning the data collection mechanism already covers the entire target population. Thus, it was not necessary to extrapolate the results on a spatial or population basis. No attempt has been made to reconstruct trends prior to the onset of comprehensive data collection 1979, and no attempt has been made to project data forward into the future.

9 What uncertainty measurements or estimates are available for the indicator and/or the underlying data set?

Uncertainty estimates are not available for this indicator. Because statistics have been gathered from virtually the entire target population (i.e., all deaths in a given year), these data are not subject to the same kinds of errors and uncertainties that would be inherent in a probabilistic survey or other type of representative sampling program.

10 To what extent do uncertainty and variability impact the conclusions that can be inferred from the data and the utility of the indicator?

As described in the response to Question 9, there is very little uncertainty associated with the sample size. However, some uncertainty could be introduced as a result of the professional judgment required of the medical professionals filling out the death certificates, which could potentially result in misclassification or underreporting in some number of cases—probably a small number of cases, but still worth noting. There is also substantial variability within the data, due in part to the influence of a few large events. Many of the spikes apparent in Figure 1 can be attributed to specific severe heat waves occurring in large urban areas.

11 Describe any limitations or gaps in the data that may mislead a user about fundamental trends in the indicator over space or over the time period for which data are available.

Limitations to this indicator include the following:

1. This indicator is based on the underlying cause of death as entered on a death certificate by a medical professional. Some individuals might have had competing causes of death, potentially leading to misclassification and/or underreporting of heat-related mortality.
2. ICD-9 codes were used to specify underlying cause of death for the years 1979 to 1998. Beginning in 1999, cause of death was specified with ICD-10 codes. The two revisions differ substantially, so data from before 1999 cannot easily be compared with data from 1999 and later.
3. In addition to the underlying cause of death, a death certificate will also document other contributing causes of death as well as other contributing factors. This indicator does not include deaths for which heat was listed as a contributing cause of death but not the underlying cause of death. Including deaths for which heat was a contributing cause would increase the number of deaths shown in Figure 1.
4. The fact that a death is classified as “heat-related” does not mean that high temperatures were the only factor that caused the death. Pre-existing medical conditions can greatly increase an individual’s vulnerability to heat.
5. Heat waves are not the only factor that can affect trends in “heat-related” deaths. Other factors include the vulnerability of the population, the extent to which people have adapted to higher temperatures, the local climate and topography, and the steps people have taken to manage heat emergencies effectively.
6. Heat response measures can make a big difference in death rates. Response measures can include early warning and surveillance systems, air conditioning, health care, public education, infrastructure standards, and air quality management. For example, after a 1995 heat wave, the City of Milwaukee developed a plan for responding to extreme heat conditions in the future. During the 1999 heat wave, this plan cut heat-related deaths nearly in half compared with what was expected (Weisskopf et al., 2002).

12 References

CDC (Centers for Disease Control and Prevention). 1995. Model State Vital Statistics Act and Regulations (revised April 1995). DHHS publication no. (PHS) 95-1115. <www.cdc.gov/nchs/data/misc/mvsact92aacc.pdf>

CDC (Centers for Disease Control and Prevention). 2009. CDC Wide-ranging Online Data for Epidemiologic Research (WONDER). Compressed mortality file, underlying cause of death. 1999–2005 (with ICD-10 codes) and 1979-1998 (with ICD-9 codes). Accessed August 2009. <http://wonder.cdc.gov/mortSQL.html>

Weisskopf, M.G., H.A. Anderson, S. Foldy, L.P. Hanrahan, K. Blair, T.J. Torok, and P.D. Rumm. 2002. Heat wave morbidity and mortality, Milwaukee, Wis, 1999 vs. 1995: An improved response? Amer. J. Public Health 92:830–833.