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Heat-Related Mortality — Arizona, 1993–2002, and United States, 1979–2002

Hyperthermia is the elevation of body temperature resulting from the body's inability to dissipate heat (1). Continued exposure to ambient heat close to body temperature (98.6°F [37.0°C]) contributes to a substantial number of deaths from hyperthermia, especially among elderly persons (2). To assess the health risk from hyperthermia, Arizona health practitioners and CDC researched cases of heat-related death and illness in Arizona, used U.S. death certificate data to summarize trends in heat-related deaths, and compared age-specific, heat-related death rates in Arizona with those in the United States overall. Findings indicated that, during 1979–2002, a total of 4,780 heat-related deaths in the United States were attributable to weather conditions and that, during 1993–2002, the incidence of such deaths was three to seven times greater in Arizona than in the United States overall. Public health agencies in communities affected by periods of extreme heat should educate populations at risk (e.g., persons aged ≥65 years) and consider designing and implementing location-specific heat response plans (HRPs).

Case Reports — Arizona

Case 1. In July 2001, a boy aged 14 years was participating in a youth boot camp west of Phoenix when he began hallucinating and eating dirt. He had been in direct sunlight for 1–5 hours in an outside temperature of 111°F (44°C). When the boy became unresponsive, camp supervisors placed him in a bathtub with a running shower. The tub drain reportedly

became blocked with dirt and other material. The camp supervisors returned to find the boy with his face in the water. The supervisors telephoned 911, but the boy never regained consciousness and was pronounced dead later that night. The office of the medical examiner (ME) attributed the boy's death to complications of near-drowning and dehydration from heat exposure. The ME did not document a core body temperature.

Case 2. In August 2004, at 5:50 p.m., two sisters aged 2 and 4 years were found unresponsive in the locked family car by their mother in a Phoenix suburb. The children had been locked in the car for more than 15 minutes. Temperatures inside and outside the automobile were not recorded; however, high temperatures in the area on that day and at that time ranged from the mid-90s (–32°C) to 101°F (38°C). When emergency medical services (EMS) personnel arrived, both children were asystolic. During helicopter transport to the hospital, EMS personnel administered multiple doses of intraosseous epinephrine and atropine. At the emergency department (ED), rectal temperatures were 106.4°F (41.3°C) for the younger girl and 105.0°F (40.6°C) for the older girl. Both children were pronounced dead within 10 minutes of arrival at the ED. The ME found severe cerebral edema in both children and declared hyperthermia as the cause of death.

Case 3. In May 2004, at approximately 4 p.m. in Phoenix, a man aged 35 years with a history of schizophrenia suddenly collapsed after working in a garden for 1 hour in 98°F (37°C) heat. EMS personnel found him unresponsive, with a heart rate of 170 beats per minute (bpm). At the ED, his rectal temperature was 105.4°F (40.8°C). Primary diagnosis was heat stroke with nonepileptic convulsions, with a secondary diagnosis of burn blisters with epidermal loss on limbs and trunk. The patient was intubated, rapidly cooled with fans and ice baths, and started on ceftriaxone and vancomycin; however, subsequent cultures and imaging studies were within normal limits. The man's hospital course was complicated by rhabdomyolysis, but he recovered and was discharged on the third day.

Case 4. In September 2004, at approximately 11 a.m. in a Phoenix suburb, a woman aged 59 years who had been riding her bicycle was found lying on the ground with altered mental status. The ambient temperature was 95°F (35°C). EMS personnel recorded a blood pressure of 130/72 mm/Hg, a heart rate of 174 bpm, and a respiratory rate of 28 breaths per minute. Serial examinations, multiple radiographs, and computerized tomography scans did not locate any trauma. The patient had an oral temperature of 101.4°F (38.8°C) 1 hour after arriving at the ED. Primary diagnosis was heat stroke; schizophrenia (not otherwise specified), gastric hemorrhage, and acute renal failure were secondary diagnoses. The woman's mental status returned to baseline when she was externally

cooled with water misters and fans. She was observed overnight and discharged the next day after improvement of her clinical status.

Heat-Related Mortality — United States, 1979–2002

During 1979–2002, the most recent years for which national data are available, 4,780 deaths were classified as heat related because of weather conditions.* Of the 4,686 (98%) heat-related deaths attributed to weather for which age of the decedent was reported, 260 (6%) occurred among children aged <15 years, 2,356 (50%) among persons aged 15–64 years, and 2,070 (44%) among persons aged ≥65 years (3). During 1979–2002, heat waves with high mortality occurred in 1980 (St. Louis and Kansas City, Missouri), 1995 (Chicago, Illinois), and 1999 (Cincinnati, Ohio, and Chicago). During that period, the annual rate of heat-related deaths from weather conditions was highest among persons aged ≥65 years (Figure 1).

Heat-Related Mortality — Arizona, 1993–2002

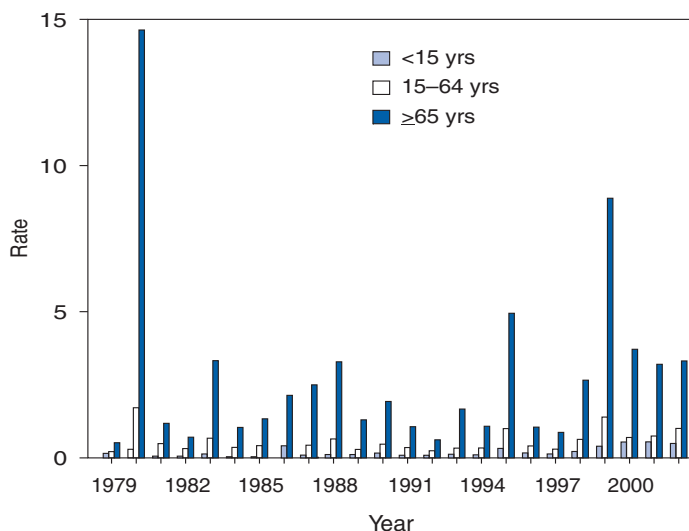
Arizona experiences intense and prolonged summer heat. Normal daily maximum temperature reaches ≥100°F (≥38°C) in early June and can remain at that level until mid-September (4). During 1993–2002, a total of 253 deaths in Arizona were attributable to heat exposure. During this period, Arizona had the highest average annual age-adjusted† rate of death from heat exposure (five deaths per million) among U.S. states. Within the state, the highest average annual age-adjusted death rates (>10 per million population) occurred in the western counties of Mohave, La Paz, and Yuma. Combining data from the period 1993–2002, the rate of death from heat exposure in Arizona for persons aged ≥25 years was three to seven times higher than that for the United States overall and ranged from two deaths per million persons aged 25–34 years to 42 deaths per million persons aged ≥85 years (Figure 2).

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* For the period 1979–1998, deaths were classified according to *International Classification of Diseases, Ninth Revision (ICD-9)*, code E900.0, “due to weather conditions.” For the period 1999–2002, deaths were classified according to *ICD-10*, code X30, “exposure to excessive natural heat.”

† Rates age-adjusted to the 2000 U.S. standard population.

FIGURE 1. Annual rate* of heat-related deaths attributed to weather conditions† or exposure to excessive natural heat,‡ by age group and year — United States, 1979–2002

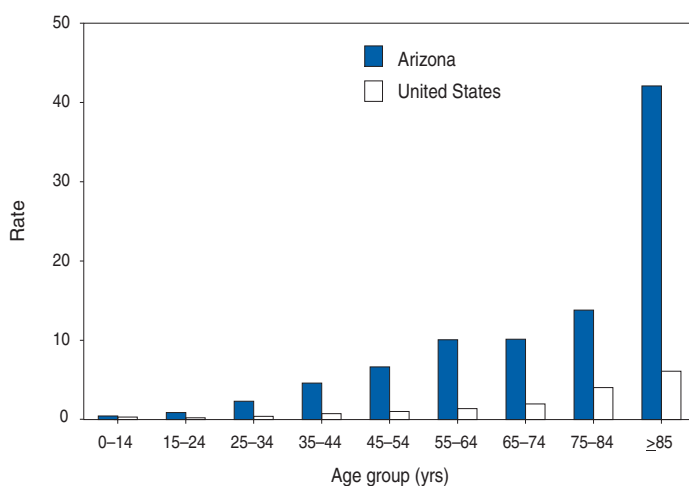


* Per 1,000,000 population.

† *International Classification of Diseases, Ninth Revision (ICD-9)*, code E900.0.

‡ *ICD-10*, code X30.

FIGURE 2. Average annual rate* of heat-related deaths attributed to weather conditions† or exposure to excessive natural heat,‡ by age group — United States, 1993–2002



* Per 1,000,000 population.

† *International Classification of Diseases, Ninth Revision (ICD-9)*, code E900.0.

‡ *ICD-10*, code X30.

Editorial Note: The Arizona cases described in this report highlight the spectrum of disease caused by exposure to excessive heat. Exposure to prolonged periods of high temperature can cause heat-related illnesses, including heat cramps, heat

syncope, heat exhaustion, heat stroke, and death (5). Heat exhaustion is the most common heat-related illness (6). Signs and symptoms include intense thirst, heavy sweating, weakness, paleness, discomfort, anxiety, dizziness, fatigue, fainting, nausea or vomiting, and headache. Core body temperature can be normal, below normal, or slightly elevated, and the skin can be cool and moist (5,7,8). If unrecognized and untreated, these mild to moderate signs and symptoms can progress to heat stroke (6), a severe illness clinically defined as core body temperature $\geq 105.0^{\circ}\text{F}$ ($\geq 40.6^{\circ}\text{C}$), accompanied by hot, dry skin and central nervous system abnormalities, such as delirium, convulsions, or coma (5,7,8).

To prevent heat-related illness and death, public health agencies should identify susceptible populations and risk behaviors. Children, elderly persons, and persons without access to air conditioning are at increased risk for heat-related illness and death. In addition, persons with chronic mental disorders or cardiopulmonary disease and those receiving medications that interfere with salt and water balance, such as diuretics, anticholinergic agents, and tranquilizers that impair sweating, are at greater risk for heat-related illness and death. Drinking alcoholic beverages, ingesting illicit drugs (e.g., cocaine or amphetamines), and participating in strenuous outdoor physical activities (e.g., sports or manual labor) in hot weather also are risk behaviors associated with heat-related illness (7,9,10).

Periodic heat waves highlight the need for public health interventions to prevent excess morbidity and mortality; written HRP are central to those interventions. HRP detail actions that local government agencies and nongovernment organizations can take in the event of a forecast of extremely hot weather to reduce heat-related mortality (Box).

All heat-related deaths and illnesses are preventable. In hot weather, persons can take precautions, including rescheduling strenuous outdoor activities to cooler times of the day, reducing the level of physical activity, drinking additional water, wearing lightweight and light-colored clothing, and increasing the amount of time spent in air-conditioned environments (7). Indoors, persons can prevent sunlight from coming through windows and minimize cooking; sprinkling water on clothing also can reduce heat stress. Parents should never leave young children in parked cars and should keep cars locked when not in use. Relatives, neighbors, and caretakers of persons at risk for heat-related illness and death (e.g., elderly, disabled, and homebound persons) should frequently check on these persons, recognize symptoms of heat-related morbidity, and take appropriate action (5).

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BOX. Criteria for development of an effective heat response plan (HRP)

- Identify a lead agency and other participating agencies and nongovernment organizations, describing roles and responsibilities in detail.
- Review plans annually, before onset of warm weather, to review response protocols and confirm participation of lead personnel.
- Identify activation and deactivation thresholds for the HRP by using community-specific factors affecting mortality (e.g., extremes in daytime high and nighttime low temperatures and deviation from local norms).
- Before a heat emergency, use preexisting communication plans and public education tools to define a clear communications strategy and pathway from the lead agency to first responders, the public, and the media.
- Define risk factors, populations at high risk, and methods to reach them (e.g., daily checks on the elderly by social service agency personnel and provision for transportation to air-conditioned public centers).
- Establish a method to evaluate and revise the HRP, including post-emergency meetings with participating agencies to review response activities, activation and deactivation thresholds, communication plans, outreach activities, and the association between weather data and heat-related morbidity and mortality.

SOURCE: Bernard SM, McGeehin MA. Municipal heat wave response plans. *Am J Public Health* 2004;94:1520–2.

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