Heat Illness: Emergency Department Visits for Heat Illness

Type of EPHT Indicator	Health outcome
Measures	1. Annual age-adjusted rate of emergency department visits for heat stress per 100,000 population 2. Annual crude rate of emergency department visits for heat stress per 100,000 population 3. Annual number of emergency department visits for heat stress
Derivation of Measure(s)	*Numerator*: • Patients treated in an Emergency Department (ED) having any ICD-9 code in the range of 992.0-992.9, or cause of injury code E900.0 or E900.9. • Cases with a code of E900.1 (man-made source or heat) anywhere in the record are excluded. *Denominator*: Midyear resident population, by gender, for state and by county *Adjustment*: • Age-adjustment by the direct method to the Year 2000 US Standard population • U.S. 2000 standard population by age categories from Surveillance Epidemiology and End Results (SEER), National Cancer Institute
Unit	1. Age-adjusted rate per 100,000 population 2. Rate per 100,000 population 3. Number
Geographic Scope	EPHT grantee states with hospitalization data
Geographic Scale	State, County
Time Period	Ed visits between May 1 to September 30, inclusive, for each year, 2003 to most recent year available
Time Scale	May–September of each data year
Rationale	The Intergovernmental Panel on Climate Change (IPCC) projects with "virtual certainty" suggest that climate change will cause more frequent, more intense, and longer heat waves (1). Any individual, regardless of age, sex or health status can develop heat stress if engaged in intense physical activity and/or exposed to environmental heat (and humidity). Physiologic mechanisms maintain the core body temperature (i.e., the operating temperature of vital organs in the head or trunk) in a narrow optimum range around 37 °C (98.6 °F). When core body temperature rises, the physiologic response is to sweat and circulate blood closer to the skin's surface to increase cooling. If heat exposure exceeds the physiologic capacity to cool, and core body temperature rises, then a range of heat-related symptoms and conditions can develop. Heat stress or Heat-related illness ranges from mild heat edema and rash, heat syncope, heat cramps, to the most common type, heat exhaustion (2). Heat-related cramps, rash,

	and edema are relatively minor readily treatable conditions; however, they should be used as important warning signs to immediately remove the affected individual from the exposure situation. *Heat cramps* are brief, intermittent, and often severe muscular cramps occurring typically in muscles that are fatigued by heavy work (2). Individuals with heat cramp can also exhibit hyponatremia and hypochloremia (which are low serum sodium and chloride levels). *Heat syncope* is a temporary loss of consciousness as a result of prolonged heat exposure (2). Individuals adapt to hot, humid environment by dilation of cutaneous vessels in the skin to radiate heat. Peripheral vasodilation along with blood volume loss, results in lowering the blood pressure which can result in inadequate central venous return and cerebral perfusion, causing light-headedness and fainting. *Heat exhaustion* is a consequence of extreme depletion of blood plasma volume, which may be coincident with hyponatremia and/or peripheral blood pooling (2). Heat exhaustion often does not present with definitive symptoms and may be misdiagnosed, often as an acute viral illness. Symptoms include mild disorientation, generalized malaise, weakness, nausea, vomiting, headache, tachycardia (rapid beating of the heart), and hypotension. Because untreated heat exhaustion can progress to heat stroke, the most serious form of heat-related illness, treatment should begin at the first signs of heat exhaustion (3). *Heat stroke* is an extreme medical emergency that if untreated can result in death or permanent neurological impairment (2). Heat stroke occurs when a person's core body temperature rises above 40 °C (104 °F) as a result of impaired thermoregulation. High core body temperature and disseminated intravascular coagulation results in cell damage in vital organs, such as the brain, liver, and kidneys, which can lead to serious illness and death (3). Death may occur rapidly due to cardiac failure or hypoxia, or it can occur days later as a result of renal failure due to dehydration and/or rhabdomyolysis (i.e., the breakdown of muscle fibers with release into the circulation of muscle fiber contents, some of which are toxic to the kidney and can cause kidney damage) (4). Heat stroke is typically divided into two types. The two types are in general clinically the same, except that the individuals/population groups affected require medical interventions specific to their unique physiology and medical status (3). "Exertional Heat Stroke," as the name implies, involves strenuous physical activity under high temperature conditions to which the heat stroke victim was not acclimatized, and usually affects healthy young adults, such as athletes, outdoor laborers and soldiers. "Classic" heat stroke, by definition does not involve exertion, and usually affects susceptible individuals, such as infants and young children, the elderly, or people with chronic illness. Because heat stroke, even if treated, can have a death rate as high as 33%, and up to 17% of heat stroke survivors suffer permanent damage, measures should be taken to prevent heat-related illness, especially among vulnerable populations. The relationship between extreme heat and increased daily morbidity and mortality is well established. This indicator captures hospital

	admissions directly attributed to heat stress (e.g., heat illness, heat stroke, and hyperthermia). It is a measure that can be tracked easily and consistently across geography and time, and acts as a sentinel for the broader range of heat-related illness that is not recognized and/or coded as such.
Use of the Measure	Heat stress can manifest in a number of clinical outcomes, and people with chronic health problems (e.g., cardiovascular disease, diabetes, obesity) are more susceptible to the effects of heat than healthy individuals. For these reasons, heat stress may not be listed as the primary diagnosis. This indicator therefore includes all cases where heat stress is explicitly listed as the primary diagnosis or any other diagnosis. Increases in the rates of ED visits for heat stress are one potential impact of rising global temperatures. Tracking these data can help document changes over place and time, monitor vulnerable areas, and evaluate the results of local climate-adaptation strategies.
Limitations of the Measure	Periods of extreme heat are frequently associated with increases in hospital visits and admissions for many causes. This measure does not capture the full spectrum of heat-stress, where exposure to excess heat is not explicitly documented.
Data Sources	*Numerator*: State emergency department data *Denominator*: US Census Bureau population data
Limitations of Data Sources	*Emergency Department data*: • Data are not available for all states. • Number of diagnostic fields in hospital records varies from state to state. Utilization of EDs varies geographically. *Census data*: • Only available every 10 years, thus postcensal estimates are needed when calculating rates for years following the census year.
Related Indicators	• Heat vulnerability • Heat-related mortality • Temperature distribution • Heat stress hospitalizations
References	1. Confalonieri U, Menne B, Akhtar R, Ebi KL, Hauengue M, Kovats RS, et al. 2007. Human health In: Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE. , editors. Climate Change 2007: Impacts, Adaptation and Vulnerability Contribution of Working Group II to: Fourth Assessment Report of the Intergovernmental Panel on Climate Change. New York: Cambridge University Press. pp. 391–431. 2. Rosen's Emergency Medicine: Concepts and Clinical Practice. 2010. Chapter 139: Heat illness. In JA Marx Editor-in-Chief; RS Hockberger & RM Walls Senior Editors; JG Adams … [et al] Editors (7th ed). Philadelphia: Mosby Elsevier. 3. American Medical Association. Heat-related Illness During

Extreme Weather Emergencies (Report 10 of the Council on Scientific Affairs (A97), 1997; www.ama-assn.org/ama/pub/category/13637.html).

4. Centers for Disease Control and Prevention. Heat-related deaths--Los Angeles County, California, 1999-2000, and United States, 1979-1998. MMWR 2001; 50(29):623-6.