CLIMATE EFFECTS ON HEALTH

EXTREME HEAT AND HEAT-RELATED ILLNESS

MICHIGAN 2019

How does extreme heat contribute to illness and death?

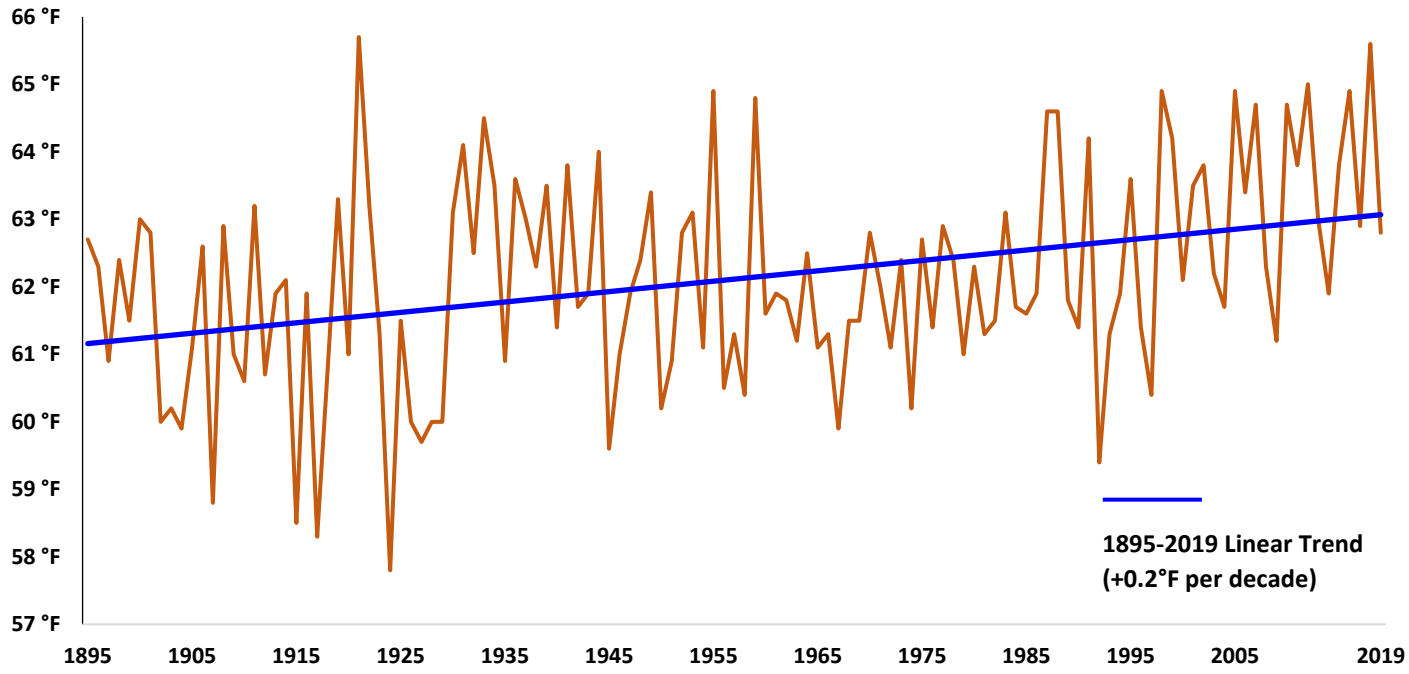
During extreme heat, the human body might not be able to cool itself by sweating, which can lead to heat-related illnesses (HRI) such as heat stroke, heat syncope (dizziness), heat cramps and heat exhaustion. Heat waves or consecutive days with extreme heat can also worsen chronic conditions including cardiovascular disease, respiratory disease, cerebrovascular disease and diabetes-related conditions.[1] Studies have found that extended exposure to high temperatures has been associated with increased hospital admissions for cardiovascular, kidney and respiratory disorders.[1] There are more than 600 deaths related to extreme heat every year in the United States.[2]

Long-term temperature trends

U.S. average temperatures have **increased by 1.3°F to 1.9°F** since record keeping began in 1895.[1] Annual average U.S. temperatures are projected to increase by 3°F to 10°F by the end of this century, depending on the level of greenhouse gas emissions and other factors.[1,3]

In Michigan, the average summer temperature (May-September) has **increased about 2.5°F since 1895**, which is about 0.2°F per decade (Figure 1). The frequency of heat waves has increased over the last six decades in the Midwest.[4] More extreme heat days and waves are expected to lead to more heat-related illnesses and deaths.[5] Heat-related deaths and illnesses are preventable.

Figure 1: Michigan's annual average temperature and linear trendline from May-September, 1895-2019†



†Adapted from NOAA National Centers for Environmental Information, Climate at a Glance: Statewide Time Series, 1900-2019, published June 2020, retrieved on June 10, 2020 from https://www.ncdc.noaa.gov/cag/

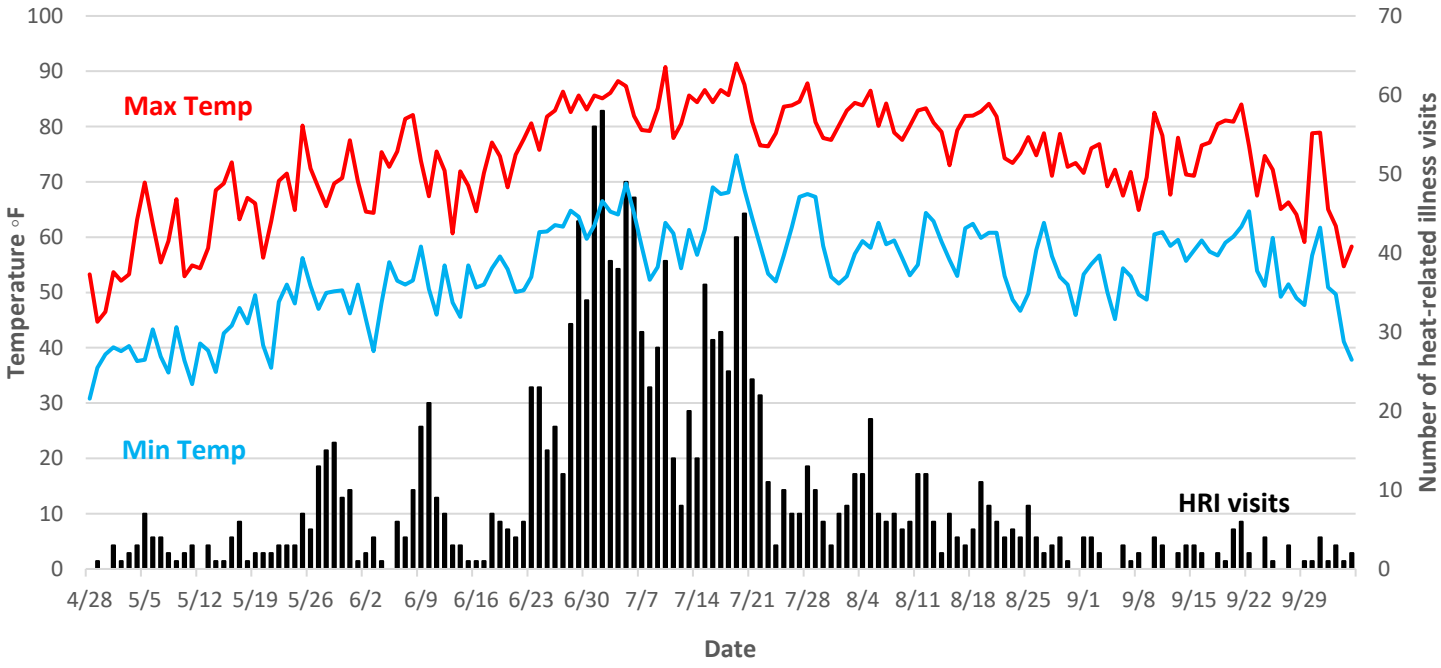
Trends in emergency department HRI visits by daily temperature

Observed relationships between temperature, death and illness differ across regions and seasons and are based on average temperatures in those locations and the timing of the heat event.[1] For example, a 95°F day in Michigan will have different health impacts than a 95°F day in Texas, and similarly, a 95°F day in May will have different health impacts than in August.[1,6]

Looking at maximum and minimum daily temperatures can help us understand the relationship between emergency department (ED) HRI visits and temperature in Michigan throughout the summer. Individuals without access to air conditioning might not be able to recover from high daily maximum temperatures when there are also high minimum temperatures.

In 2019, HRI visits to EDs in Michigan started to increase after maximum temperatures consistently rose above 80°F in late June and minimum temperatures were above 60°F (Figure 2). Even though temperatures were still high in September, there were fewer ED HRI visits by the end of summer. This is probably because of acclimatization, which happens when the human body adapts to repeated exposure to a hot environment. However, children and older adults can't adapt as well to extreme heat throughout the summer.[1,7] The number of daily ED HRI visits came from the Michigan Syndromic Surveillance System (MSSS), while daily maximum and minimum temperatures for Michigan were obtained from the National Syndromic Surveillance System (NSSP) (See *Data Sources and Methods* for details).

Figure 2: Daily emergency department visits for heat-related illnesses (HRI)† by temperature‡, Michigan, April 28-October 5, 2019



† 2019 Michigan Syndromic Surveillance System. Heat Related Illness (HRI) is defined as having one or more specific keywords listed as the chief complaint for the ED visit. The keywords are listed in the Data Sources and Methods section.

‡ 2019 NSSP Biosense Platform, ESSENCE.

Demographic patterns in HRI visits

Everyone, regardless of age, sex or health status, is at risk for HRI, but some people are more at risk. People who are most at risk include adults aged 65 years and older, infants and children, those with chronic health conditions, low-income individuals and families, athletes and outdoor workers. A national study concluded that most HRI hospitalizations involved males and adults aged 65 years and older using data from 20 states from 2001-2010.[8] Other studies have found that sex is a risk factor for HRI, since men are more likely than women to work outdoors and seek medical attention for HRI.[8,9,10]

In 2019, 54 percent of ED HRI visits were male in Michigan, which is consistent with other studies finding higher HRI counts in males compared to females (Figure 3). Most ED HRI visits were adults aged 18-34 (38%), with adults aged 35-49 years old (19%) and children aged 5-17 years old (16%) following respectively (Figure 4).

Figure 3: Percent of heat-related illness visits by sex, Michigan, April 28-October 5, 2019†

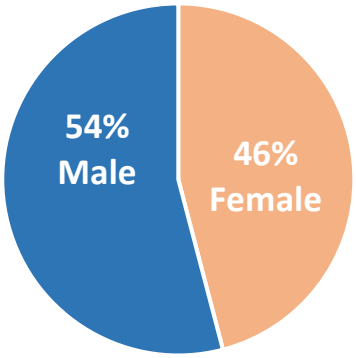
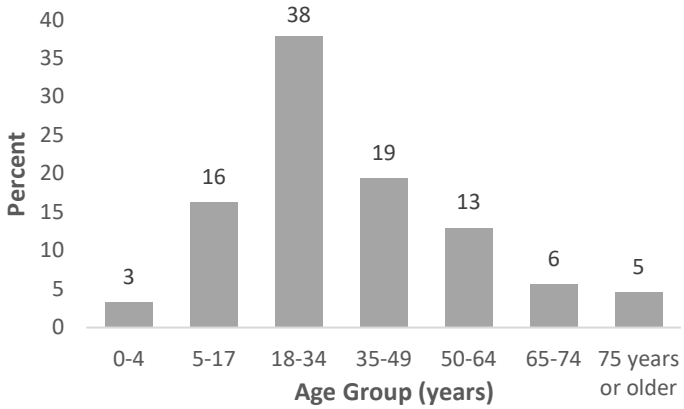


Figure 4: Percent of heat-related illness visits by age group, April 28-October 5, 2019†



†2019 Michigan Syndromic Surveillance System. Heat Related Illness (HRI) is defined as having one or more specific keywords listed as the chief complaint for the ED visit. The keywords are listed in the Data Sources and Methods section. (Figures 3 and 4).

How to be protected from HRI

General tips on how to stay cool during the summer:

- Find somewhere with air-conditioning.
- Take cool showers or baths.
- Wear lightweight, light-colored clothing.
- Do not rely on a fan as your primary cooling device.
- Avoid direct sunlight.
- Drink more water than usual.
- Don't wait until you're thirsty to drink more fluids.
- Avoid alcohol or liquids containing high amounts of sugar.
- Remind others to drink enough water.

Check out the Michigan Heat Awareness and Safety Fact Sheet for more tips and information!

Data Sources and Methods

The National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information headquarters developed *Climate at a Glance* for near real-time analysis of monthly temperature and precipitation data across the contiguous United States. The data can be used for the study of climate variability and change. Statewide data come from the U.S. Climate Divisional Database, which has data from January 1895 to February 2020. For Figure 1, the trendline is a linear regression line using the least squares method.

The Michigan Syndromic Surveillance System (MSSS) is a real-time surveillance system that uses electronic patient encounter data reported by emergency departments and urgent care centers to track illness syndromes and detect unusual levels of illnesses based on patients' chief complaints, which are recorded at intake. It is run by the Michigan Department of Health and Human Services.

The heat-related illness (HRI) visits summarized in this report were identified by searching text from chief complaints for specific keywords that, when combined and weighted, meet the definition of the Heat Syndrome. The MSSS Heat Syndrome's 36 keyword terms included: *dehydration, dehydrated, dehydrate, dehydrat, dehydraton, heat, heatstroke, overheating, overheated, heating, heated, sun, sunburn, sunburnt, sunburned, hyperthermia, sunstroke, heat rash, heat exhaustion, heat stroke, over heated, heat exposure, heat related, heat exhaust, over heating, heat cramps, heat illness, heat issues, heat bumps, sun burn, sun poisoning, sun burned, sun blisters, sun reaction, heat syncope* and *heat fatigue*. Terms excluded were *attack, flash, palpitations, rate, racing, flashes, pad, pack* and *vent*. These terms were excluded to reduce the number of wrongly classified keywords in the Heat syndrome. MSSS Heat Syndrome visits can be subdivided into heat, sun and dehydration related. Only heat and sun-related visits were used in this report.
This definition may not have captured all visits for HRI and may have included some non-heat-related illness visits due to the nature of syndromic surveillance data which is based on the patient's description at intake and not illness diagnosis.

For Figure 2, daily maximum and minimum temperatures were calculated as the average maximum and minimum temperatures for all available weather service stations in Michigan reporting to the National Syndromic Surveillance Program (NSSP) BioSense Platform using the ESSENCE tool. The weather service stations included Alpena, Battle Creek, Benton Harbor, Detroit, Flint, Gaylord, Gaylord WFO, Grand Rapids, Holland, Houghton Lake, Jackson, Kalamazoo, Lansing, Marquette, Muskegon, Pellston, Traverse City and Tri Cities (Saginaw, Bay City, and Midland) in Michigan.

References

1. Sarofim, M.C., S. Saha, M.D. Hawkins, D.M. Mills, J. Hess, R. Horton, P. Kinney, J. Schwartz, and A. St. Juliana, 2016: Ch. 2: Temperature-Related Death and Illness. *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment*. U.S. Global Change Research Program, Washington, DC, 43–68. http://dx.doi.org/10.7930/J0MG7MDX
2. Centers for Disease Control and Prevention (CDC), National Center for Environmental Health (NCEH), Agency for Toxic Substances and Disease Registry (ATSDR). (2019). *Natural Disasters and Severe Weather: Extreme Heat*. Retrieved June 29, 2020, from https://www.cdc.gov/disasters/extremeheat/index.html
3. Walsh, J., D. Wuebbles, K. Hayhoe, J. Kossin, K. Kunkel, G. Stephens, P. Thorne, R. Vose, M. Wehner, J. Willis, D. Anderson, S. Doney, R. Feely, P. Hennon, V. Kharin, T. Knutson, F. Landerer, T. Lenton, J. Kennedy, and R. Somerville, 2014: Ch. 2: Our Changing Climate. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 19-67. doi:10.7930/J0KW5CXT. Luber, G., and M. McGeehin, 2008: Climate change and extreme heat events. American Journal of Preventive Medicine, 35, 429-435, doi:10.1016/j.amepre.2008.08.021.
4. Balbus, J., A. Crimmins, J.L. Gamble, D.R. Easterling, K.E. Kunkel, S. Saha, and M.C. Sarofim, 2016: Ch. 1: Introduction: Climate Change and Human Health. *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment*. U.S. Global Change Research Program, Washington, DC, 25–42. http://dx.doi.org/10.7930/J0VX0DFW
5. Anderson, G. B., and M. L. Bell, 2011: Heat waves in the United States: Mortality risk during heat waves and effect modification by heat wave characteristics in 43 U.S. communities. Environmental Health Perspectives, **119**, 210-218. doi:10.1289/ehp.1002313
6. Hanna, E. G., and P. W. Tait, 2015: Limitations to thermoregulation and acclimatization challenge human adaptation to global warming. *International Journal of Environmental Research and Public Health*, **12**, 8034-8074. doi:10.3390/ijerph120708034
7. Choudhary, E., A. Vaidyanathan, 2014: Heat Stress Illness Hospitalizations- Environmental Public Health Tracking Program, 20 States, 2001-2010. *Morbidity and Mortality Weekly Report (MWWR*). Retrieved June 10, 2020, from https://www.cdc.gov/mmwr/preview/mmwrhtml/ss6313a1.htm?s_cid=ss6313a1_w
8. Noe RS, Choudhary E, Cheng-Dobson LJ, Wolkin AF, Newman SB. Exertional heat-related illnesses at the Grand Canyon National Park, 2004–2009. Wilderness Environ Med 2013;24:422–8.
9. Pillai S, Noe R, Murphy M, et al. Heat illness: predictors of hospital admissions among emergency department visits—Georgia, 2002–2008. J Community Health 2013;2013:1–9.

This report was prepared by the Michigan Climate and Health Adaptation Program, Michigan Department of Health and Human Services, June 2020.