MINNESOTA
EXTREME HEAT TOOLKIT

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INTRODUCTION

About the toolkit

The goal of this toolkit is to help communities prepare for and respond to extreme heat and to protect the health of all Minnesotans.

The Minnesota Department of Health (MDH) published the first Minnesota Extreme Heat Toolkit in 2012. This updated 2025 version is designed for local public health professionals and emergency managers. It includes a summary of current research, actionable steps to take during an extreme heat alert, and key communication materials.

Over the past 13 years we have learned a lot about how our changing climate may impact the frequency and intensity of heat in Minnesota, how heat affects our health, important risk factors, and how to respond.

Chapter 1 explains extreme heat, explores health impacts, and identifies vulnerable populations. Chapter 2 offers guidelines for local public health departments to develop heat response actions during a heat advisory. Chapter 3 includes ready-to-use public communication materials.

How to use this toolkit

Each Minnesota community is unique, which is why this toolkit has been designed to provide flexible strategies that can be adapted to local needs. Whether you are learning about Minnesota's heat projections, looking for actionable tools to help make decisions about outdoor events, or examining specific strategies to keep your community safe during extreme heat, you can navigate directly to the sections most relevant to your work.

CHAPTER 1: OVERVIEW OF EXTREME HEAT

According to the National Weather Service, extreme heat causes more deaths annually in the United States than all other weather hazards combined (National Weather Service, 2024). A 1995 Chicago heat wave claimed over 700 lives, with 80% of victims over age 65 (Whitman et al., 1997). The same summer, two major heat waves impacted Wisconsin, making heat the number one weather-related killer in the state's history. There were 145 heat-related deaths and over 400 heat-related illnesses (NOAA, 1995).

In June 2021, an unprecedented heat dome settled over the Pacific Northwest and western North America, causing some of the highest temperatures ever recorded in the region. The heat killed more than 650 people in the United States and Canada, buckled roads, sparked wildfires, and triggered the die-off of hundreds of thousands of plants, animals, and insects (Jain et al., 2024; US Department of Agriculture, 2021). Similar to Minnesota, these northern regions, such as Washington and Oregon, are used to experiencing mild summer weather, not extreme heat. This lack of experience with heat leaves people, infrastructure, and emergency response systems less prepared.

According to the National Weather Service, extreme heat causes more deaths annually in the United States than all other weather hazards combined.

Extreme heat has harmed ecosystems, economic vitality, and humans in almost every U.S. city. According to the Atlantic Council, the United States is expected to lose $100 billion a year due to reduced worker productivity from direct effects of extreme heat (Atlantic Council of the United States, 2021). However, this number does not account for damage to food systems and agricultural production due to heat (Sixt, 2020). Factoring in physical impacts on crop yields, the annual economic impact from extreme heat could increase by an estimated additional $1 billion per state by 2050 (Atlantic Council of the United States, 2021; Sixt, 2020).

These projections are already being felt: 2024 was the hottest summer on record for the continental United States, which resulted in 136 deaths and $5.4 billion in crop losses (NOAA National Centers for Environmental Information (NCEI), 2025).

As climate change drives more frequent and intense heat waves, local public health and emergency managers play a critical role in heat education, community preparedness, and disaster response.

Measuring heat

Heat is measured differently across the United States based on regional climate patterns, historical temperature norms, and local environmental factors. Characterized by weather that is substantially hotter and/or more humid than average, the thresholds to define extreme heat vary by location and timing. For example, given the difference between average annual temperatures in St. Paul, Minnesota (45°F) and Atlanta, Georgia (61°F), what is defined as an extreme heat event in Minnesota might not register as an extreme heat event in Georgia. How hot it feels depends on location, time of year, and the interaction of multiple meteorological variables (e.g., temperature, humidity, cloud cover, wind). Hotter temperatures earlier in the spring are likely to have more detrimental health impacts than the same temperatures later in the summer because people have not had time to gradually adjust to the warmer temperatures (Kalkstein et al., 2011; Sarofim et al., 2016). Therefore, thresholds for extreme heat can shift based on location and time of year and are sensitive to the variables important for a particular location.

Tip: The National Weather Service has locations across Minnesota, Wisconsin, North Dakota, and South Dakota that issue heat alerts for Minnesota counties. Get to know the office issuing alerts for your area.

Minnesota NWS Contacts

The National Weather Service issues extreme heat watches, heat advisories, and extreme heat warnings, but the thresholds vary based on location. The National Weather Service uses heat index as a primary tool to determine a local threshold. The heat index uses air temperature and relative humidity to determine how humans perceive ambient temperature, i.e., how hot it feels. When humidity is high, the air temperature can be lower and still negatively impact human health. Cities commonly experience an urban heat island effect, whereby the design and density of a city absorbs and retains heat and hinders nighttime cooling relief (Kornhuber et al., 2024; Krehbiel & Henebry, 2016). Rural areas, especially in Midwestern agricultural and corn producing regions, have lower ambient temperatures than urban areas but can face much higher and sustained humidity levels due to moisture-producing crops (Souri et al., 2020). Therefore, the temperature threshold for issuing a heat alert varies based on regional conditions.

Table 1 offers updated Minnesota guidance—current as of March 2025, from the National Weather Service office in Duluth—on the differences among the categories of heat alerts: extreme heat watch, heat advisory, and extreme heat warning.

Thresholds for issuing a heat alert will vary across the state. For instance, a heat alert may be issued for a region of the state due to seasonal variability or in response to particular impacts, such as if a recent storm event has caused widespread power outages and thus potential loss of air conditioning. National Weather Service meteorologists in Minnesota primarily use the heat index and the wet-bulb globe temperature (WBGT) to establish formal thresholds for heat alerts, with criteria that vary slightly across the state. In addition to the heat index and WBGT, meteorologists also consult the National Weather Service HeatRisk tool, which incorporates a number of weather and health impact factors. Meteorologists may deviate from the stated criteria in consultation with local public health officials or in response to known or anticipated heat-health impacts.

Table 1: Definitions of Heat Watch, Advisory, and Warning

Heat alert	Definition	Threshold for issuing - 7-County Metro Area	Threshold for issuing - Greater Minnesota
Extreme Heat Watch	Extreme heat watches are issued when conditions are favorable for an extreme heat event in the next 24 to 72 hours. A watch is used when the risk of a heat wave has increased but its occurrence and timing is still uncertain. A watch provides enough lead time so that those who need to prepare can do so, such as city officials who have extreme heat response plans.	If any of the following are forecast: • The forecast maximum heat index will reach 100°F for one day, lasting 3 or more hours. • The forecast wet-bulb globe temperature (WBGT) will reach 87°F one day for 3 hours. • Minneapolis/St Paul (MSP) maximum heat index reaches 100°F two days in a row, along with an overnight air temperature no cooler than 73°F.	Maximum heat index reaches 105°F or greater and a minimum heat index of 75°F or greater for at least 48 hours. In Central Minnesota, either heat index of 105°F or a WBGT of 87°F lasting for 3 hours or more. In Northeast Minnesota, a heat index of 100°F or WBGT of 83°F lasting for 3 hours or more.
Heat Advisory	A heat advisory is issued when an extreme heat event is expected in the next 48 hours. These statements are issued when an extreme heat event is occurring, is imminent, or has a very high probability of occurring. An advisory is for less serious conditions that cause significant discomfort or inconvenience and, if caution is not taken, could lead to a threat to life and/or property.	If any of the following are forecast: • The forecast maximum heat index will reach 95°F for one day, for at least 3 hours. • The forecast WBGT will reach 85°F or higher for 3 hours. • The forecast maximum heat index reaches 95°F two days in a row, along with an overnight air temperature no cooler than 73°F.	Maximum heat index reaches 100°F or the maximum temperature reaches 95°F or higher, or WBGT of 85°F (Central Minnesota) for 3 hours or more. In Northeast Minnesota, a heat index of 95°F or WBGT of 83°F for 3 hours or more.
Extreme Heat Warning	An extreme heat warning is issued when an extreme heat event is expected in the next 48 hours. These statements are issued when an extreme heat event is occurring, is imminent, or has a very high probability of occurring. A warning is used for conditions posing a threat to life or property.	If any of the following are forecast: • The forecast maximum heat index will reach 100°F for one day, lasting 3 or more hours. • The forecast WBGT will reach 87°F one day for 3 hours. • MSP maximum heat index reaches 100°F two days in a row, along with an overnight air temperature no cooler than 73°F.	Maximum heat index reaches 105°F or greater and a minimum heat index of 75°F or greater for at least 48 hours. In Central Minnesota, either heat index of 105°F or a WBGT of 87°F lasting for 3 hours or more. A warning may also be issued if advisory criteria are expected for 4 days in a row.

Tip: Learn how you can use the heat index, WBGT, and HeatRisk in Chapter 2.

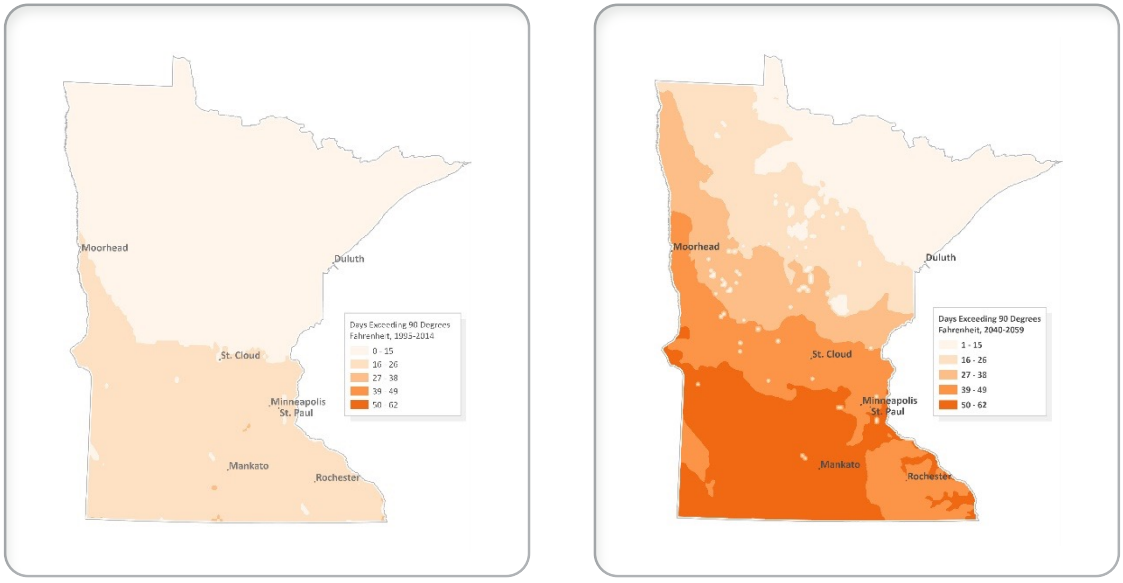
Extreme heat in Minnesota

Although Minnesota is known for being cold, extreme heat can dramatically impact our lives. Minnesota has been getting steadily warmer since 1895, with the most significant warming occurring in recent decades. According to the Minnesota Department of Natural Resources, between 1965 and 2020, the state's average annual temperature increased by 3°F (Minnesota Department of Natural Resources State Climatology Office, 2025). While a 3°F increase might not seem very dramatic, an increase in days of prolonged heat has caused a decrease in farming production and negative impacts on people's health (MDH, 2024; Minnesota Pollution Control Agency, 2025a). More days of extreme heat in areas where people are not accustomed to prolonged heat, like Minnesota, means more people are at a higher risk of heat-related illness or death.

All counties in the state had a heat index above their 95% threshold for at least five days in 2022. However, southwestern Minnesota recorded the greatest number of extreme heat days. Even northern counties had days where their daily maximum exceeded their 95% relative threshold. In 2022 there were 682 emergency department visits, 63 hospitalizations, and two deaths due to extreme heat in Minnesota (MDH, 2024).

Not only has Minnesota been steadily warming, but climate projections also indicate a continual increase in the number of days over 90°F. By the year 2040, Ramsey County may be exposed to an average of 40 days of daytime highs above 90°F, with a projected maximum of 79 days above 90°F per year (University of Minnesota Climate Adaptation Partnership, 2025). Compare this projection with Ramsey County's current average of 27 days of temperatures above 90°F in 2025 and a historical observed average of only 10 days of temperatures above 90°F.

The maps below display the difference between historical heat simulations (left) and future heat projections for 2040 (right). While we cannot be certain these projections will be exactly what Minnesota will experience, we are confident that temperatures in the future will be warmer than they were in the past. Therefore, it is essential that we prepare now for more frequent heat in the future.



The above maps show a historical simulation of the average annual number of days above 90°F from 1995 to 2014 (left) and how many days per year are projected to be above 90°F by mid-century (2040-2059) under a high climate pollution emissions scenario.

Source: University of Minnesota Climate Adaptation Partnership's MN CliMAT data.

Humidity

Minnesota is projected to get hotter and more humid in the years ahead. According to the Minnesota State Climatology Office, an increase in days of extreme heat is currently being driven by an increase in days with high humidity (Wigdahl, 2022).

Humidity is measured as the dew point, the temperature to which the air must be cooled at constant pressure for it to become saturated. The higher the dew point temperature, the greater the amount of moisture in the air. Some people may be more familiar with the term "relative humidity" to describe the amount of moisture in the air. Relative humidity is the ratio of the amount of water vapor in the air at a specific temperature to the maximum amount that the air could hold at that temperature (e.g., dew point temperature), expressed as a percentage.

The primary cooling mechanism our body utilizes is evaporation. Human bodies perspire and the perspiration evaporates into the air, cooling the body. However, when evaporation is inhibited by additional humidity, perspiration does not evaporate easily off the skin, which reduces the ability of people to cool themselves (Baldwin et al., 2023). Therefore, increased and sustained humidity makes it harder for sweat to evaporate and increases heat stress risks, especially for athletes (Clark, 2023), adults over age 65, and anyone with chronic diseases or facing a socioeconomic disadvantage (Baldwin et al., 2023).

Tip: Use the National Weather Service's heat index to easily identify what the temperature "feels like" based on current air temperature and relative humidity. What is the heat index?

People accustomed to continental climates (e.g., Minnesotans and Midwesterners generally) often begin to feel uncomfortable when the dew point temperature reaches between 65°F and 69°F (Grotjahn & Huynh, 2018; Wilkins & Horne, 2024). Dew points above 75°F are generally perceived as very uncomfortable or even oppressive by most residents in these areas (Wilkins & Horne, 2024). Higher dew point temperatures and humidity directly impact health by making it more difficult for people to cool themselves. Health impacts from heat and humidity are preventable with appropriate public health responses, such as resting in an air-conditioned space, drinking water all day, and staying informed of local heat alerts.

Poor outdoor air quality

Poor outdoor air quality is closely coupled with extreme heat and further complicates heat impacts on health. Poor air quality is caused by a mix of pollutants derived from sources such as vehicle emissions, industrial processes, wildfires, and agricultural activities (Campbell et al., 2022; Moncada & Spiteri, 2022). Stagnant weather patterns during days of prolonged heat trap pollutants close to the ground (US EPA, 2025b). Two types of pollutants that significantly contribute to poor outdoor air quality and are of high concern regarding heat and human health are ground-level ozone and fine particulate matter (World Health Organization, 2025).

Extreme heat worsens air quality by increasing the formation of ground-level ozone, which is a gas formed when volatile organic compounds (VOCs) and nitrogen oxide (NOx)—pollutants released by burning fossil fuels—react with each other in the presence of sunlight (Mertens et al., 2024). The reaction is highly sensitive to temperature, and there is a strong association between temperatures above 90°F and ground-level ozone formation (Mertens et al., 2024; Song et al., 2025). Exposure to ground-level ozone can cause harmful cardiopulmonary health effects, including lung irritation, breathing difficulties, reduced lung capacity, aggravated asthma, susceptibility to bronchitis, and increased risk of hospitalizations and death for conditions such as cardiovascular disease, respiratory diseases, and diabetes (Campbell et al., 2022).

People particularly vulnerable to adverse effects of exposure include those over age 65 and under 5 years old, outdoor workers, and anyone with preexisting respiratory or cardiac conditions (Achebak et al., 2024).

According to the U.S. Environmental Protection Agency, ground-level ozone can travel long distances by wind, so pollution levels can be high in both rural and urban areas.

Particulate matter (PM) consists of tiny airborne particles of sulfate, nitrates, ammonia, sodium chloride, black carbon, and mineral dust generated from incomplete combustion of fuels, including petroleum fuels and wood (World Health Organization, 2025). This particulate matter is dangerous, especially small particulates of 2.5 microns in diameter or smaller, known as fine particulate matter (PM2.5), because they can carry a variety of harmful substances and can penetrate the lungs and enter the bloodstream due to their small size (Curley et al., 2024; Kerr et al., 2024; World Health Organization, 2025). When PM2.5 enters the body it triggers inflammation, which has been shown to worsen chronic lung disorders, increase the risk of heart attacks and strokes, and has been linked to various mental health conditions (Kerr et al., 2024; H.-J. Kim et al., 2024; Tassanaviroj et al., 2024).

A source of PM2.5 of increasing concern is wildfire smoke. Extreme heat contributes to drought conditions, which can increase the possibility of wildfires and the subsequent release of harmful chemicals into the air (Niggli et al., 2022; Schwarz et al., 2020). Smoke generated from a wildfire thousands of miles away can affect the air quality in Minnesota. As wildfire smoke travels and ages in the atmosphere, the particles undergo chemical changes, becoming more toxic and significantly impacting health even at considerable distances from the source fire (Skyllakou et al., 2021; Yu et al., 2019). Researchers in Europe have found that smoke from wildfires is up to four times more toxic as it moves away from the source fire (Kosmopoulos et al., 2022). However, the composition of wildfire smoke can vary depending on the materials burning and the temperature of the fire (Yu et al., 2019). Ultimately, larger particles tend to fall out of the atmosphere or settle more quickly due to gravity, whereas the finer (more dangerous) particles can remain suspended in the atmosphere for extended periods (Kerr et al., 2024; Kosmopoulos et al., 2022; Skyllakou et al., 2021). For Minnesota, this means that wildfires in the western United States and Canada can cause hazy skies and hazardous air quality, even though the fires themselves are nowhere near the state.

Check the air

Keeping tabs on air quality is essential, especially during the hottest months. The U.S. Air Quality Index, or AQI, is EPA's tool to communicate about outdoor air quality and health. It helps people understand how clean or polluted the air is, and what associated health effects may be of concern. The AQI ranges from 0 to 500, with lower numbers indicating better air quality, and is divided into six color-coded categories, each of which corresponds to a different level of health concern (AirNow, 2025; Minnesota Pollution Control Agency, 2025b). Ground-level ozone and PM2.5 are two of six different pollutants taken into consideration, but ultimately the pollutant with the highest AQI value determines the overall AQI number for the indicated timeframe (AirNow, 2025; Minnesota Pollution Control Agency, 2025b).

Tip: Use AirNow.gov to view live air quality data by location.

Extreme heat and health in Minnesota

In Minnesota, summer brings hot and humid days, which can lead to extreme heat conditions that pose significant health risks, ranging from mild discomfort to life-threatening conditions (Minnesota Department of Health, 2024). Hot weather can increase core body temperature, making it difficult for our bodies to function normally, which can lead to heat-related illnesses and even death. These health risks occur when the body becomes too hot and cannot cool down, underscoring the need for heat education and adaptation.

According to the World Health Organization, deaths and hospitalizations caused by extreme heat happen quickly, often the same day or within a few days.

Heat is deadly because the average human body needs to maintain an internal temperature of approximately 98°F to function properly (Centers for Disease Control and Prevention, 2024; Matthews et al., 2025). During prolonged exposure to hot weather, it is challenging to regulate body temperature. As internal body temperature rises, the ability to perform critical functions is impaired and we become susceptible to serious adverse health effects. **Table 2** provides details on key health impacts caused by heat.

Tip: An urgent public health response is needed when a heat alert is issued. Refer to Chapter 2 for how to respond.

Table 2: Health impacts of extreme heat

Medical condition	Symptom(s)	Causes	Safety tips
Heat cramps	Muscle spasms. Muscles usually affected include the abdomen, calf, thighs, and shoulder muscles. Body temperature normal or elevated core temperature up to 104°F.	Drinking liquid without electrolytes, dehydration, electrolyte deficiency.	Stop all activities, relocate to a cool location, rest and drink electrolyte-containing fluids. Seek medical attention if symptoms persist.
Heat edema	Swelling in the ankles, feet, and hands. Body temperature normal or elevated core temperature up to 104°F.	Occurs in people who are not acclimatized to heat. Increased blood flow to the skin in limbs.	Remove the affected person from the heat. Elevate and apply compressive stockings to the affected limbs.

Medical condition	Symptom(s)	Causes	Safety tips
Heat exhaustion	Profuse sweating, weakness, rapid breathing, dizziness, nausea/vomiting, muscle cramps, normal mentation. Body temperature normal or elevated core temperature up to 104°F.	Drinking liquid without electrolytes, dehydration, electrolyte deficiency.	Stop all activities, relocate to a cool location, rest, and drink electrolyte-containing fluids. It can be difficult to determine if someone has heat stroke and not exhaustion. If symptoms do not quickly improve, or if the person is unable to orally rehydrate, seek medical attention.
Heat rash	Red cluster of pimples, blisters, itching, red rash on the skin that usually occurs on the neck, chest, breast, and/or groin.	Blockage of sweat ducts.	Remove the affected person from heat. Minimize exposure of skin to sun. Keep the affected area dry. Seek medical attention if rash does not improve.
Heat stroke This is a life threatening, adverse effect of exposure to extreme heat.	Oral body temperature of 104°F and above. Often sudden onset of symptoms; confusion or loss of consciousness, rapid and strong pulse, hot, red, and dry skin headache, dizziness, nausea/vomiting.	Body is unable to maintain heat diffusion through the skin. Normal regulation of body temperature is no longer intact. Mortality can be as high as 50%.	Call 911 immediately if you see anyone with these symptoms and have a body temperature of 104°F and above. While waiting for first responders, the affected person should be taken to a cool shady area. Cool the person with immersion in cool water, spraying the person with cool water while fanning the person vigorously, or placing ice packs on neck, axilla, and groin. The person is unlikely to be able to tolerate oral fluids.
Heat syncope	Dizziness, fainting. Body temperature normal or elevated core temperature up to 104°F.	Increased blood flow to the skin resulting in decreased blood flow to the central nervous system.	Lay the affected person gently on the floor and provide lots of fluid. Seek medical attention.
Heat tetany	Respiratory problems, such as breathing difficulty, muscular problems, including spasms or numbness or tingling of muscles. Body temperature normal or elevated core temperature up to 104°F.	Hyperventilation. Respiratory alkalosis.	Remove the affected person from the heat and advise the person to breathe slowly.

Adapted from the following sources:

Bernhardt, J. M., Quinn, L., & Cox, R. (2024). The Heat-Related Illness Screening Tool: A Case Study for Populations at Risk. *Nursing Economic$*, 42(2), 59–98. https://doi.org/10.62116/NEC.2024.42.2.59

Centers for Disease Control and Prevention. (2024, September 23). *Heat-related Illnesses*. Heat Stress. https://www.cdc.gov/niosh/heat-stress/about/illnesses.html

Matthews, T., Raymond, C., Foster, J., Baldwin, J. W., Ivanovich, C., Kong, Q., Kinney, P., & Horton, R. M. (2025). Mortality impacts of the most extreme heat events. *Nature Reviews Earth & Environment*, 1–18. https://doi.org/10.1038/s43017-024-00635-w

Danzig, R. M., Raunig, J. M., & Acholonu, C. J. (2024). Exertional Heat Illness—From Identifying Heat Rash to Treating Heat Stroke. *Pediatric Annals*, 53(1), e17–e21. https://doi.org/10.3928/19382359-20231113-04

Tripp, B. L., Winkelmann, Z. K., Eberman, L. E., & Smith, M. S. (2021). Factors Affecting Incidence Rate of Exertional Heat Illnesses: Analysis of 6 Years of High School Football Practices in North Central Florida. *Orthopaedic Journal of Sports Medicine*, 9(9), 23259671211026627. https://doi.org/10.1177/23259671211026627

It is difficult to know the full scope of population health impacts from heat. Heat illnesses and heat-related deaths are underestimated because many medical visits and death certificates are not documented as being heat-related, especially if heat is a secondary cause exacerbating a chronic disease (Bernhardt et al., 2024). Similarly, each county in the United States is tasked with creating its own criteria for what is considered to be a heat-related death, and many deaths are only counted as heat-related if heat is explicitly recorded as an underlying or contributing cause of death (Roush, 2024). However, this method does not capture the full extent of heat-related deaths across the country, and it is estimated that heat-related deaths are vastly undercounted (Roush, 2024; Wittenberg et al., 2024). Therefore, it is important to be aware that heat-related illnesses can cause various symptoms and exacerbate a wide variety of existing medical conditions; this makes the cause of death difficult to establish if not witnessed by a medical professional (Roush, 2024).

Heat exhaustion and heat stroke are two serious heat-related health impacts that need to be the focus of broad educational awareness efforts. Heat exhaustion occurs when the body becomes overheated and cannot cool itself effectively (Bernhardt et al., 2024; Centers for Disease Control and Prevention, 2024). If left untreated, heat exhaustion can quickly progress to heat stroke, a life-threatening condition where the body loses its ability to regulate its temperature. Unlike heat exhaustion, heat stroke requires immediate medical attention, as it can lead to organ failure and death (Bernhardt et al., 2024; Centers for Disease Control and Prevention, 2024). Recognizing these conditions early and taking prompt action—such as moving to a cool place, hydrating, and seeking medical help for heat stroke—can prevent serious health impacts.

Tip: For a downloadable infographic on the signs and symptoms of heat exhaustion & heat stroke, go to mn.gov/heat.

Importantly, extreme heat can worsen chronic health conditions. Being exposed to extreme heat places additional stress on the body, making it harder for individuals with preexisting conditions to regulate internal body temperature (Ebi, Capon, et al., 2021). In the following section we will explore who is at greatest risk from extreme heat.

Vulnerable groups

Everyone is susceptible to illnesses due to extreme heat, but certain characteristics can increase a person's risk. Demographic characteristics, social and behavioral factors, and geographical and environmental factors may affect a person's exposure and ability to maintain a stable body temperature. Some populations may have more than one characteristic or risk factor that could put them at an even higher risk of illness or death when exposed to extreme heat. According to data from MDH, males over age 65 have the highest rates of heat-related illness emergency department visits and hospitalization in the state (Minnesota Department of Health, 2024). Males between the ages of 15 and 34 have the second highest rate of heat-related emergency department visits. Identifying populations more vulnerable to extreme heat is necessary in order to direct resources toward people who need additional aid during extreme heat events.

Characteristics contributing to higher health risk from extreme heat

PREEXISTING CONDITIONS

Heat can exacerbate many health conditions, putting certain people at increased risk for heat-related illnesses and death (Ebi, Capon, et al., 2021). Any condition that affects the body's ability to cool itself or puts additional stress on already compromised systems will make a person more susceptible to negative health effects from heat (Bell et al., 2024). However, the impact of extreme heat on preexisting conditions is understudied. While more research is still needed, the following preexisting conditions are known to increase a person's health risk when exposed to extreme heat:

Cardiovascular disease conditions

Extreme heat puts extra strain on the heart to increase blood flow to the skin to dissipate heat and cool the body (Ebi, Capon, et al., 2021). People living with cardiovascular conditions, such as arrhythmia, congestive heart failure, acute coronary syndrome with or without myocardial infarction, myocardial infarction, or a history of stroke can have an impaired response to this strain and experience serious health consequences (Liu et al., 2022; Sorensen & Hess, 2022; Vaidyanathan, 2020). All-cause cardiovascular illness is the primary cause of death during heatwaves (Ebi, Capon, et al., 2021), and people with preexisting cardiovascular disease have 4 to 7 times greater risk of cardiovascular mortality during extreme heat events (Chaseling et al., 2021).

Endocrine disorders

Exposure to extreme heat is known to worsen preexisting endocrine disorders, since the endocrine system is our body's primary control center to enact internal adaptations to changes in external temperature (Hannan et al., 2024). While this list is not comprehensive, people living with the following endocrine disorders face higher risk of illness and death when exposed to extreme heat: diabetes mellitus, thyroid dysfunction, and adrenal insufficiency (Hannan et al., 2024; Pingitore et al., 2024).

Higher proportion of body fat

Heat is transferred out of the body through a thermal exchange with the surrounding air, which is why we sweat. People with a higher proportion of body fat face an increased risk of negative health outcomes with short-term exposure to extreme heat, especially in humid environments, because thicker layers of adipose tissue act as an insulating barrier, thereby preventing rapid heat loss (Achebak et al., 2024; Koch, 2023).

Intellectual disabilities
Living with intellectual disabilities, such as Down syndrome or certain types of autism, may impair a person's ability to recognize signs of heat distress, communicate discomfort, or take steps to cool down effectively (Cardiello et al., 2024; Park et al., 2024).

Kidney diseases
People living with kidney diseases are at a significantly heightened risk of illness and death during days of prolonged heat. Kidney diseases that increase the risk of deadly dehydration and hyperthermia include acute renal failure, electrolyte abnormalities, nephrolithiasis, rhabdomyolysis with renal insufficiency or failure, and urinary tract infections (Liu, Varghese, Hansen, Borg, et al., 2021; Sorensen & Hess, 2022). Additionally, healthy kidney functioning can be compromised during days of extreme heat due to dehydration, thereby placing added stress on the kidneys (Liu, Varghese, Hansen, Borg, et al., 2021).

Liver diseases
At a molecular level, exposure to extreme heat stresses our vital organs and is known to severely damage an otherwise healthy liver (Ebi, Capon, et al., 2021; Roy et al., 2024). For people living with preexisting liver diseases—such as acute liver failure, alcoholic liver disease, or cirrhosis—exposure to extreme heat may lead to rapid liver decline and increased mental confusion (Davis et al., 2017; Ribeiro et al., 2020).

Mental illness
Exposures to even slight increases in extreme heat for people not acclimatized is associated with a dramatic increase in mental illnesses, such as anxiety, aggressive behavior, bipolar disorder, depression, mental fatigue, suicide attempts, and suicide complications (Y. Kim et al., 2019; Liu, Varghese, Hansen, Xiang, et al., 2021). Admissions to psychiatric hospitals increase significantly during heat waves, as does mortality of those diagnosed with mental illness (Thompson et al., 2018).

Neurological diseases
While more inquiry is needed on this topic (Tewari et al., 2023), heat impacts have been investigated in people living with Alzheimer's disease and related dementias (Delaney et al., 2025) and spinal cord injuries (Bass et al., 2024). These studies found the likelihood of hospitalization for people with neurological diseases increases rapidly after one day of exposure and then again after four days of exposure to extreme heat due in part to thermoregulation impairments and insufficient transportation to access health care (Bass et al., 2024; Delaney et al., 2025). Additionally, increased agitation and disruptiveness have been observed in nursing home patients with dementia during days of extreme heat (Thompson et al., 2018).

Pregnancy
Exposure to extreme heat during pregnancy puts increased strain on the pregnant person's cardiovascular and respiratory systems (Rogne et al., 2024). This may lead to illness and even death for the adult and/or harm to the infant, such as preterm birth, low birth weight, congenital heart defects, traumatic brain injuries, and stillbirth (Chersich et al., 2020; Konkel, 2019). Pregnant people from low-income and historically marginalized groups are at increased risk for heat-related maternal mortality and stillbirth (Baharav et al., 2023).

Respiratory disease conditions
Extreme heat is often coupled with poor air quality, which can make breathing more difficult for people with respiratory diseases (Kotcher et al., 2024). Breathing hot humid air is particularly challenging and is known to exacerbate the following conditions: asthma, acute respiratory distress, bronchitis, chronic obstructive pulmonary disease (COPD), and pulmonary hypertension (Bell et al., 2024; H. M. Choi et al., 2022). Additionally, extreme heat coupled with poor air quality places people with preexisting respiratory diseases at an increased risk of respiratory infections and pulmonary edema (Bell et al., 2024). Respiratory conditions are the second leading cause of heat-related mortality, after cardiovascular conditions (Ebi, Capon, et al., 2021).

MEDICATIONS AND DRUGS

People taking certain medications are at greater risk for heat-related illness and death. The most concerning medications are those that control for or interfere with water imbalance (Bell et al., 2024). This class of medications can impact a person's heat sensitivity by interfering with the body's cooling functions or water/salt retention, which can cause rapid onset of dizziness, excessive sweating, and confusion (Khan & Mubeen, 2025; Wylie et al., 2025). While more research is needed on this topic, **Table 3** lists some of the categories of medications and drugs that may increase the risk of heat-related illnesses.

Table 3 is not an exhaustive list and is for reference purposes only. People are encouraged to speak with their health care provider about potential health risks of exposure to extreme heat while taking medications. Health care providers are encouraged to utilize their expertise to assess an individual patient's risk.

Table 3: Categories of medications and drugs that may increase risk of heat-related illnesses

Category	Potential heat risk
ACE inhibitors	May increase risk of fainting. May reduce sensation of thirst.
Alcohol	May increase dehydration, decrease the body's ability to thermoregulate, and impair the person's perception of heat.
Amphetamines	May increase body temperature through metabolic heat production.
Antibiotics	Most antibiotics are temperature-sensitive and may become unstable and ineffective when exposed to heat before being taken as prescribed. Also, may increase skin sensitivity to the sun and risk of sunburn-like symptoms.
Anticholinergenics (cough and cold medications)	May interfere with sweating, preventing the body from cooling.
Antihistamines	May limit radiative cooling due to vasoconstriction.
Antihypertensives	May interfere with the body's cooling functions, thereby decreasing the body's ability to thermoregulate.
Antipsychotics, Neuroleptics, Psychotropics	May interfere with the body's ability to regulate internal temperature and/or water and salt retention, which may increase risk of hyperthermia or heat stroke.
Benzodiazepines	May affect judgment, reduce alertness, and decrease perception of heat.
Beta blockers	May profoundly impact thermoregulation by decreasing the body's ability to shunt large volumes of hyperthermic blood away from the core and to the skin.
Calcium channel blockers	May compromise vascular compensatory mechanisms, which may lead to reduced ability for vasodilation.

Category	Potential heat risk
Diuretics	May cause dehydration and may decrease the body's ability to thermoregulate.
Dopaminergics (for Parkinson's disease)	May increase internal heat production in the body.
Illicit drugs	May reduce alertness; may increase body's internal heat production.
Laxatives	May increase risk of dehydration.
Lithium (mood stabilizer)	May affect judgment and may lead to dehydration and kidney injury.
SSRIs (selective serotonin-reuptake inhibitors)	May interfere with the body's cooling functions and decrease the body's ability to thermoregulate.
Thyroid agonists	May increase internal heat production in the body.
Tricyclic antidepressants	May result in cold hands and feet with internal heat centered at the core of the body, limiting radiative cooling.
Vasoconstrictors	May profoundly impact thermoregulation by decreasing the body's ability to shunt large volumes of hyperthermic blood away from the core and to the skin.

Adapted from the following sources:

Bell, M. L., Gasparrini, A., & Benjamin, G. C. (2024). Climate Change, Extreme Heat, and Health. *New England Journal of Medicine*, 390(19), 1793–1801. https://doi.org/10.1056/NEJMra2210769

Sorensen, C., & Hess, J. (2022). Treatment and Prevention of Heat-Related Illness. *New England Journal of Medicine*, 387(15), 1404–1413. https://doi.org/10.1056/NEJMcp2210623

Wong, A. Y. S., Iwagami, M., Taniguchi, Y., Kawamura, C., Suzuki, A., Douglas, I. J., Bhaskaran, K., Sugiyama, T., Kuroda, N., Nitsch, D., & Tamiya, N. (2024). The role of psychotropics on the associations between extreme temperature and heat-related outcomes among people with mental health conditions: Population-based study. *Psychological Medicine*, 54(16), 4658–4664. https://doi.org/10.1017/S0033291724002824

Wylie, K., Foong, L. H., Loo, K., & Hamrosi, M. (2025). Heat health in general practice: An evidence-based approach to the prevention of heat-related illness. *Australian Journal of General Practice*, 54(1/2), 25–33. https://www.proquest.com/docview/3165454535/abstract/CE7D77E72BFA4EA8PQ/1

Tip: More information on the connection between heat and medications can be found at CDC Heat and Medications Guidance for Clinicians.

AGE

Older

Extreme heat disproportionately affects older adults (Khatana et al., 2022; Shin et al., 2024). While people over age 65 are not a homogeneous group, certain physiological changes associated with aging, especially the body's decreased ability to thermoregulate, increase older adults' risk of experiencing heat-related illnesses (Millyard et al., 2020). Additionally, chronic disease conditions, the use of certain medications, insufficient transportation, and social isolation contribute to older adults facing a higher risk of adverse health outcomes from heat (Khatana et al., 2022; Thiamwong et al., 2024). Recent studies have demonstrated that exposure to even one episode of extreme heat is linked to both cognitive decline (E. Y. Choi et al., 2023) and rapid cellular aging for those over age 65 (E. Y. Choi & Ailshire, 2025).

Older adults are a steadily growing segment of the population. Using 2020 U.S. Census data and estimates from the Minnesota State Demographic Center, as of 2022 the number of adults over age 65 eclipsed the K-12 population for the first time in history. The population of older adults is projected to double between 2010 and 2030, such that more than 1 in 5 Minnesotans will be an older adult (Minnesota State Demographic Center, 2024). When it comes to heat and health, there are four main factors that predict poor health outcomes for older adults: people with disabilities, social isolation, individuals with low income, and those for whom English is not their preferred language (Rhoades et al., 2018). Given the large population of older Minnesotans and the increased heat risk faced as we age, local public health and emergency planners must better identify and provide outreach to this especially vulnerable group of community members.

Younger

Research identifies children, especially children ages 5 years and younger (including infants), as having greater risk for mortality during hot weather (Azan et al., 2025; Zheng et al., 2023). Children may be at increased risk due to dependency on other people for their care and physiological differences, including a smaller body mass to surface area ratio than adults, blunted thirst response, production of more metabolic heat per pound of body weight, and lower cardiac output (Azan et al., 2025; Rogne et al., 2024). Older children and adolescents may be at risk of heat illness from participating in outdoor sports or spending time in school buildings with insufficient cooling (Clark, 2023; Danzig et al., 2024).

Children are also more likely to die from heat exposure inside a vehicle. In the United States between 1998 and 2023, an average of 37 children (5 days old to 14 years old) died per year from being left in a motor vehicle during warm weather (Null, 2025). More than half of the deaths were in children under 2 years of age. Temperatures in parked cars can increase quickly even on relatively mild days (i.e., approximately 70°F), especially if the car is parked in the sun (US EPA, 2023).

SOCIAL AND BEHAVIORAL FACTORS

Economic Constraints and Lack of Resources

Some people cannot afford to access resources that are necessary to protect health, such as weatherized homes and air conditioning (see information on insufficient built environments below) (da Silva & Requia, 2025; Rhoades et al., 2018). Additionally, historically or structurally marginalized communities may face higher levels of crime. If someone is concerned for their safety, they may be less likely to use window-mounted air conditioners, open windows to increase air circulation, or leave the home to visit cooling centers.

Social Isolation
Social isolation is one of the greatest risk factors for heat stroke death (Williams & Marmot, 2023). At least one-quarter of community-dwelling Americans aged 65 and older are considered socially isolated (National Academies of Sciences, Engineering, and Medicine, 2020). Socially isolated people may be less likely to recognize the symptoms of excessive heat exposure, less likely to leave their homes if hot, and/or less willing or able to reach out for help from others (Dolph, 2021; Greenberg, 2014).

Use of Alcohol or Drugs
The consumption of alcoholic beverages or recreational drugs during extreme heat events increases the risk of heat-related illnesses. Alcoholic beverages can cause dehydration and depress the thermoregulatory system. In addition, alcohol and drug use impairs judgment, influencing a person's ability to recognize symptoms of extreme heat and make decisions to limit exposure (Cronley et al., 2024; Ryus & Bernstein, 2022).

Low Risk Perception
An individual's perception of the risk significantly influences their behaviors and decisions connected to extreme heat (Heidenreich & Thieken, 2024). Risk perception is influenced by many factors, including life experiences, emotional attachments to a place, gender, and socio-economic status (Heidenreich & Thieken, 2024; Paton, 2019; Tierney, 2019). If people do not perceive extreme heat as a risk, people are less likely to heed public health warnings (Hotalling et al., 2024; Tierney, 2019).

Language Barriers
Community members, especially older adults, whose preferred language is not the primary language of the city in which they live could potentially face life-threatening challenges to receiving and understanding public health warnings if communication is not translated to languages spoken in their community (Blackburn et al., 2025; Rhoades et al., 2018).

OUTSIDE EXERTION

Outdoor Workers
People who work in outdoor occupations, such as farming, landscaping, roofing, and construction, are at an increased risk for heat-related illnesses. Studies have shown that construction workers in the United States are 13 times more likely to die from a heat-related illness compared to workers in other industries, and within the industry, roofers and road construction workers face a particularly high risk (Ferrari et al., 2025). People with outdoor occupations may be exposed to extreme heat for longer periods of time and need to take extra precautions to stay cool and hydrated (Venugopal, 2023). The productivity of outdoor workers begins to decline at around 68°F. Heat exposure impairs cognitive function and skilled motor function, which increases the risk of accident and injury (Ebi, Capon, et al., 2021).

Sporting Events
People who are involved in sporting activities or are generally physically active outside are at an increased risk for heat-related illnesses (Clark & Konrad, 2024). Athletes and spectators may be exposed to the sun and extreme heat for longer periods of time and need to take extra precautions to stay cool and hydrated.

Outdoor Recreation
Activities such as gardening, hiking, or playing outside can cause the body to generate extra heat, which becomes difficult to regulate when combined with high temperature, high humidity, and limited shade (Ebi, Capon, et al., 2021).

INSUFFICIENT BUILT ENVIRONMENTS

Electricity Dependency at Home
People who are dependent upon electricity to power durable medical equipment, such as oxygen machines, are at increased risk during heat-induced power outages (Washam, 2024).

Institutional Care Settings
People living in long-term care facilities (e.g., skilled nursing facilities, assisted living facilities, group homes, prisons) and/or are bedridden at home are at increased risk of heat-related illnesses (Greenberg, 2014; Skarha et al., 2023). These groups may be at increased risk due to underlying medical conditions, dependency on others for care, lack of air conditioning or control over air conditioning use, and use of medications that affect their body's ability to internally regulate temperature.

Lack of Accessible Housing
Housing that does not meet the accessibility needs of inhabitants makes it harder for people to evacuate to shelter, thereby compounding a person's heat risks. A systematic review found that people who use mobility aids, such as a wheelchair or walker, and live in housing not well-suited to their aids were at a higher risk of death during a heat wave (Vu et al., 2019).

Lack of Air Conditioning
Lack of air conditioning during days of extreme heat places individuals at a higher risk of heat-related illnesses, especially older adults and people with preexisting health conditions. Lack of air conditioning includes households that do not have an air conditioning unit and households that do have a cooling unit but choose not to use it due to cost or other reasons.

Air conditioners regulate and cool indoor air temperatures, putting less strain on the body's thermoregulatory system, giving our bodies a break from trying to cool itself.

Fans are NOT effective in temperatures over 90°F, because fans simply disperse the same hot air (US EPA, 2006). In hot weather, the death rate for people who use residential air conditioning is consistently lower than the rate for people who did not use air conditioning (Eisenman et al., 2016; Sera et al., 2020). Long periods of heat exposure without access to proper cooling can be life-threatening, which is an especially high risk factor for hot overnight sleeping conditions.

Living on the Top Floor
People living in top floor apartments or with bedrooms located in converted attics are at increased risk of heat-related illnesses when sleeping (Ebi, Vanos, et al., 2021; Zhang et al., 2025). Hot air rises and is trapped by the roof, so that people who live on the top floors of a building are exposed to higher temperatures (Kumar et al., 2024). Indoor temperatures can be 10 to 20 degrees higher than outdoor air temperatures.

Minimal Insulation
Inadequate residential insulation puts people at an increased risk of exposure to extreme temperatures. Cool air inside is quickly lost through poor insulation, which can quickly lead to extreme heat in the home (Gibberd, 2020; Kumar et al., 2024).

School Buildings
Children, educators, and staff in public schools in many northern states are at risk for heat-related illness due to aging infrastructure, lack of air conditioning, and shifts in warming patterns (Danzig et al., 2024; Laouadi et al., 2024). Many school buildings were designed for a cooler climate and to be unused during the summer. As temperatures remain high in the fall at the start of the school year and rise in the spring, classrooms can become and remain dangerously hot.

Unhoused
People experiencing homelessness face significant risks during days of extreme heat (Cronley et al., 2024). Without stable housing, people are especially vulnerable to heat-related illnesses and death (Sampedro et al., 2024; Schwarz et al., 2022). During the annual point-in-time count, the U.S. Department of Housing and Urban Development (HUD) found 9,201 people in Minnesota were homeless in 2024, a 9.6% increase from 2023 (Minnesota Homeless Management Information System (MN HMIS), 2024).

GEOGRAPHIC AND ENVIRONMENTAL CONSIDERATIONS

Rural Areas
Rural areas, especially in Midwestern agricultural regions, have lower ambient temperatures than urban areas but can face much higher and sustained humidity levels due to moisture-producing crops, such as corn (Souri et al., 2020). Increased and sustained humidity makes it harder for humans to sweat and thus leads to higher heat stress risk, especially for those who have additional heat-related risk factors (Baldwin et al., 2023). Trends in emergency department visits for heat-related illnesses show that Greater Minnesota (the area of Minnesota not including the seven-county metro area) populations have higher rates of heat-related emergency department visits compared to the metro population, and males over age 65 have the highest rate of visits (Minnesota Department of Health, 2024).

Urban Areas
More than 80% of Minnesota's population lives in urban areas, according to the 2020 Census (Minnesota State Demographic Center, 2024). People living in cities and highly built-up areas often experience the "urban heat island" or "heat island" effect, whereby dense infrastructure and limited green space contribute to higher temperatures (Dare, 2021; U.S. EPA, 2024; US EPA, 2025c). The urban heat island effect is a measurable increase in ambient air temperature and results primarily from the replacement of vegetated land with buildings, roads, brownfields, and other heat-absorbing and reflecting infrastructure.

Cities or highly built-up areas are usually hotter during the day and hotter at night than rural areas. A review of research studies and data found that in the United States, the heat island effect increases daytime temperatures by about 1–7°F compared to temperatures in outlying areas, and nighttime temperatures about 2–5°F higher (Shandas et al., 2019; Voelkel et al., 2018). The urban heat island effect increases with city size, but impacts all cities, regardless of size. It is important to note that someone may not perceive their community as urban, but where they live could still experience the urban heat island effect. Heat islands can increase health risks from extreme heat by increasing the potential maximum temperatures residents are exposed to and the length of time that they are exposed to elevated temperatures (US EPA, 2025a; Voelkel et al., 2018).

In addition to direct health impacts, prolonged heat has cascading local impacts because it stresses a community's essential services. Extreme heat can result in increased energy use, lead to power outages, damage highways and roads, and increase strain on the provision of available essential services like emergency hospital services, ambulance services, and security (World Health Organization, 2024). To combat the health impacts of heat, public health and emergency managers will benefit from developing response plans, which focus on those most at risk for heat illness. **See Chapter 2 for resources and strategies communities can use to respond to the health and economic impacts of extreme heat.**

CHAPTER 2: IMMEDIATE HEAT RESPONSE RESOURCES

The National Weather Service's "Weather Related Fatality and Injury Statistics" data show that, over the past 30 years, average annual deaths from extreme heat were higher than those from all other types of hazardous weather (National Weather Service, 2024; NOAA National Centers for Environmental Information (NCEI), 2025).

Chapter 2 includes resources and guidance for local leaders to develop effective heat response plans for Minnesota communities. The chapter begins with a review of heat-related tools to support informed decision-making and concludes with recommendations for fast, community-wide responses to heat alerts. Developing a community-wide heat response is an evolving process and can be improved based on lessons learned from previous responses; this chapter provides recommendations to guide local action.

Tools for informed decision-making

To effectively prepare for and respond to extreme heat in Minnesota, local leaders need to access accurate data using real-time information. This section provides short summaries and links to key tools and resources that can support informed decision-making, while also offering suggestions on how to use each resource.

Heat index

The heat index uses air temperature and relative humidity in the shade to determine how humans perceive ambient temperature, i.e., how hot it feels. When humidity is high, the air temperature can be lower and still negatively impact human health. As an example, if the air temperature is 94°F and the relative humidity is 65%, the temperature feels like 114°F and can be even hotter in the sun. Certain ranges of temperatures in the heat index are more likely to cause harmful health effects. To find out how hot it feels for a given temperature and relative humidity, review the following heat index chart.

How to use the heat index: The heat index is a useful tool to share with the public to understand when it is dangerously hot and when extra precautions should be taken, such as increasing hydration, taking breaks in the shade, and avoiding outdoor activities during the hottest part of the day. Consider sharing the heat index in public health heat messaging.

Figure 1: National Weather Service heat index

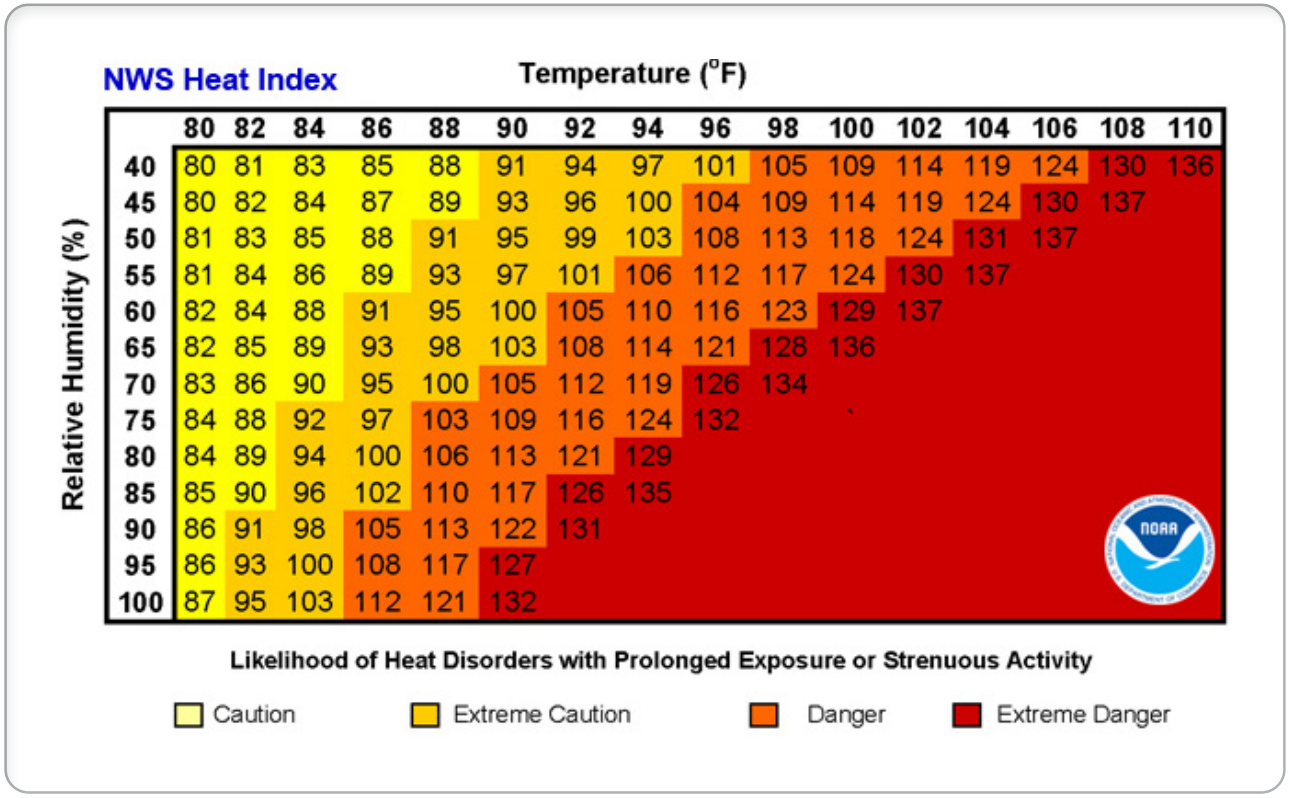


Table 4: National Weather Service description of heat index levels

Warning	Heat index	Effect on the body
Caution	80°F - 90°F	Fatigue possible with prolonged exposure and/or physical activity.
Extreme caution	90°F - 103°F	Heat stroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity.
Danger	103°F - 124°F	Heat cramps or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity.
Extreme danger	125°F - and above	Heat stroke highly likely.

Source: NOAA

What the heat index levels mean: The heat index is a measure that combines air temperature and humidity to provide a clearer picture of the health risks from exposure.

HeatRisk

The National Weather Service in Minnesota is experimenting with a new tool called HeatRisk, which uses a single daily number or category ranging from zero to four to predict heat health impacts. Co-developed by the National Oceanic and Atmospheric Administration (NOAA), the National Weather Service, and the Centers for Disease Control and Prevention (CDC), the HeatRisk tool has potential to provide a more nuanced assessment of heat-related health risks for each community. HeatRisk considers how unusually warm the high and low temperatures are, the duration of heat, and adjusts its calculations based on known historical heat impacts from CDC peer-reviewed research on heat-attributable deaths.

How to use HeatRisk: This color-coded forecast tool accounts for temperature, humidity, duration of heat, and population vulnerability. Use it to better understand localized heat-related health impacts in the next 24 hours.

Table 5: Explanation of HeatRisk categories

Category	Risk of heat-related impacts
Green 0	Little to no risk from expected heat.
Yellow 1	Minor - This level of heat affects primarily those individuals extremely sensitive to heat, especially when outdoors without effective cooling and/or adequate hydration.
Orange 2	Moderate - This level of heat affects most individuals sensitive to heat, especially those without effective cooling and/or adequate hydration. Impacts possible in some health systems and in heat-sensitive industries.
Red 3	Major - This level of heat affects anyone without effective cooling and/or adequate hydration. Impacts likely in some health systems, heat-sensitive industries and infrastructure.
Magenta 4	Extreme - This level of rare and/or long-duration extreme heat with little to no overnight relief affects anyone without effective cooling and/or adequate hydration. Impacts likely in most health systems, heat-sensitive industries and infrastructure.

Retrieved from NWS HeatRisk https://www.wpc.ncep.noaa.gov/heatrisk/

Wet-bulb globe temperature

The wet-bulb globe temperature (WBGT) is a way to measure how heat affects the human body by combining temperature, humidity, sunlight, wind speed, and solar radiation into one number (Clark & Konrad, 2024). Unlike regular temperature readings, the WBGT gives us a better picture of how hot it feels and how hard it is for the body to cool itself. National Weather Service meteorologists in Minnesota use the heat index and WBGT as the primary tools for forecasting heat and health risks.

How to use WBGT to modify sports activities: To effectively communicate heat risk, wet-bulb globe temperature is often represented using color. The following location-specific suggestions were created by the Minnesota State High School League and are based on guidance from the National Weather Service.

Table 6: Minnesota-specific outdoor sport heat modifications

WBGT Range (°F)	Practice recommendation	All sports changes	Additional football changes
South less than 77.1 **North** less than 73.5	Normal activities	Provide at least three separate rest breaks each hour with a minimum duration of three minutes each during the workout.	
South 77.1-82 **North** 73.5-78.4	Caution for intense or prolonged exercise	Watch at-risk players carefully. Provide at least three separate rest breaks each per hour with a minimum duration of four minutes each.	
South 82.1-85 **North** 78.5-81.4	Maximum practice time is 2 hours	Provide at least four separate rest breaks each hour with a minimum duration of four minutes each.	Players are restricted to helmet, shoulder pads, and shorts during practice. If the WBGT rises to this level during practice, players may continue to work out wearing football pants without changing to shorts.
South 85.1-87.1 **North** 81.5-83.5	Maximum practice time is 1 hour	20 minutes of rest breaks distributed throughout the hour of practice.	No protective equipment may be worn during practice, and there may be no conditioning activities.
South Greater than 87.1 **North** Greater than 83.5	No outdoor workouts or non-air conditions indoor workouts	Delay practice until cooler WBGT level is reached.	

Wet-bulb globe temperature has been widely used to guide heat safety decisions for high school sports (Clark, 2023; Casa et al., 2013). The most accurate way to measure WBGT is with handheld meters at the location of activity, because wind and humidity can fluctuate over short distances (Clark & Konrad, 2024). These meters are relatively affordable and available to purchase from many stores. However, if a handheld meter is not available, contact your local National Weather Service station by phone or email for help in estimating the current WBGT in your precise area.

The Minnesota State High School League provides additional guidance on competitions and practice during severe weather, including heat: Board Policy for Weather Conditions and Competition or Practice

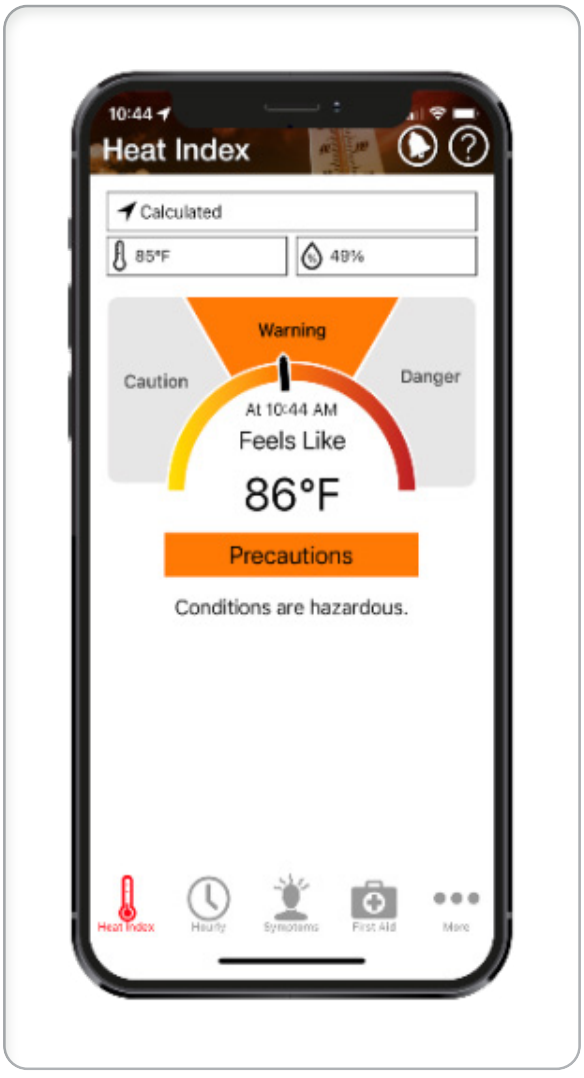
Phone app for location-specific outdoor heat exposure

The OSHA-NIOSH Heat Safety Tool app was developed by the Occupational Safety and Health Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH), the U.S. Department of Labor (DOL), and the Centers for Disease Control and Prevention (CDC).

It is a free mobile app for both iOS and Android devices that provides real-time heat index calculations, hourly forecasts, and outdoor safety recommendations based on location-specific conditions.

Heat safety app for all: Although designed for workers and supervisors to calculate the heat index at their worksite and determine their risk level, the OSHA-NIOSH Heat Safety Tool app can help anyone working or recreating outdoors make informed heat safety decisions.

Figure 2: Image of OSHA-NIOSH Heat Safety Tool app



How to initiate a community-wide heat response

Immediate action is required when the National Weather Service issues an extreme heat alert. There are three types of National Weather Service alerts:

Extreme Heat Watches are issued when conditions are favorable for an extreme heat event in the next 24 to 72 hours. A watch is used when the risk of a heat wave has increased but its occurrence and timing is still uncertain. A watch provides enough lead time so that those who need to prepare can do so, such as city officials who have extreme heat response plans.

Heat Advisories are issued when an extreme heat event is expected in the next 48 hours. These statements are issued when an extreme heat event is occurring, is imminent, or has a very high probability of occurring. An advisory is for less serious conditions that cause significant discomfort or inconvenience and, if caution is not taken, could lead to a threat to life and/or property.

Extreme Heat Warnings are issued when an extreme heat event is expected in the next 48 hours. These statements are issued when an extreme heat event is occurring, is imminent, or has a very high probability of occurring. A warning is used for conditions posing a threat to life and/or property.

The following steps are offered as a starting point for local leaders to respond quickly to incoming heat.

1. Issue immediate public warnings.
2. Set up cooling centers or offer places people can go to stay cool.
3. Prepare for power outages.
4. Plan for a hotter Minnesota.

Not all the following steps or strategies will be feasible or appropriate for every location. The best strategies for any given jurisdiction use local resources and are tailored to reach priority populations within the community. Therefore, the guidance below can be modified to best meet a community's pressing needs during a heat advisory.

Issue Immediate Public Warnings

Effective community outreach during disasters requires clear public communication and collaboration with trusted partners. Local public health and local emergency managers should work closely to ensure consistent messaging. Share heat alerts from the National Weather Service with the public through social media, local radio, newspapers, and community bulletin boards. These alerts should provide details like the forecasted duration of the heat, basic safety tips, and a website or phone number that people can access or call to find local cooling resources.

Tip: Chapter 3 contains communication materials like social media messages.

Illnesses and deaths from heat can and do occur at temperatures below the alert levels. The National Weather Service heat alerts are a critical tool for notifying the public of incoming extreme heat; however, these alerts are not fully based on human health risk. Consider using the National Weather Service heat alerts as a guide in combination with an understanding of risk profiles in your community to choose timing of community-specific heat responses.

Tip: Chapter 1 contains a comprehensive list of conditions contributing to increased vulnerability to extreme heat.

Existing disaster response registries, such as Everbridge or OnSolve CodeRED, can be critical resources to reach vulnerable populations. Local public health, emergency management, and the regional Minnesota Department of Health (MDH) Public Health Preparedness Consultants could coordinate outreach to people listed in the disaster registries.

Set up cooling centers

Setting up cooling centers or offering options for cool places people can go is an essential step during heat emergencies. Cool places provide a crucial refuge, particularly for those most vulnerable to heat-related health risks. A cooling center can be any existing physical location that is utilized during a community-wide emergency to centralize essential resources and improve heat response.

Key considerations when choosing locations for cooling centers:

- Consult your county's approved sheltering list compiled by the Red Cross or local emergency management to gain an initial understanding of previously vetted facilities.
- Prioritize locations with both air conditioning and a backup generator.
- Ensure all locations are ADA-compliant.
- Indicate which locations will allow pets, how many per person, and what types of animals.
- Decide if the cooling center will be open 24 hours or only during the hottest portion of the day.
- Contact facility managers early to confirm they can accommodate people seeking relief, have space to store cooling supplies, and will allow local public health to set up an information station at the location for an agreed upon time.
- Arrange for supplies to be delivered to the cooling centers and for public health staff, emergency managers, health care providers, and/or volunteers to be stationed at each location.
- Ensure prominent placement of large signs to indicate where cooling centers are and how to enter the buildings.
- Add entertainment, and practical services to attract visitors who may not perceive a need to avoid heat exposure. Entertainment/services could include TVs, bingo, knitting circles, a farmers' market, or computer support.

Ideally, cooling centers should be located in popular community areas where people are familiar with the location and visit frequently during non-extreme heat days. A recent National Institutes of Health study examined the effectiveness of 1,402 cooling centers across 81 U.S. cities. Researchers found significant disparities in access (Adams et al., 2023). Of particular concern, adults over age 65 were less likely to live within access areas as compared to people under age 65 (Adams et al., 2023). Given the increasing severity and frequency of extreme heat, expanding access—particularly to older adults—will be critical. Cooling centers could be located in public spaces, such as a libraries or community centers, or in underutilized summer spaces such as school buildings. When setting up a cooling center in commonly used public spaces, consider:

Religious Organizations

- Buildings owned by religious organizations may prioritize their members during emergencies, which could restrict their capacity to function as public cooling centers.

Malls

- An indoor mall can be a place of cooling refuge; evaluate adding this location to a list of recommended places people can go to find relief anytime the mall is open.
- Coordinate with local police to inform them of the mall's designation as a place of cooling refuge.

Libraries and Community Centers

- Establish hours when cooling supplies and public health staff or volunteers will be available.
- These hours could be set for the duration of the building's open hours or only during the hottest part of the day.

Transportation

- Ensure transportation—either public transportation or shuttles—is available to and from cooling centers. Explore working with other agencies and organizations to provide this transportation for free.
- School buses are often used to shuttle people to cooling centers. However, they cannot provide relief on their own because many school buses lack air conditioning.

Clear communication about cooling resources is essential. Even the most well-planned cooling center network is only effective if people know how to access it. Public messaging should make it easy for community members to find and use cooling centers. Information should be included in all heat-related communications, using a variety of methods to ensure broad reach.

- Provide a **central phone number** where residents can receive real-time information about heat safety and cooling locations.
- Develop and promote an up-to-date **webpage** to identify the locations of cooling centers. Confirm that cooling centers will be in operation prior to every event. If not, mark or remove them from the webpage.
- Use the **communication methods** your community members are most receptive to, such as local TV or radio news, social media, text alerts, or community organizations.
- Add **large, colorful signage** to the outside of buildings so that people can see from the street where cooling centers are located, where to park, and how to enter the building.

Prepare for power outages

Extreme heat can disrupt the power supply, and vulnerable populations that use electricity and battery dependent assistive technology and medical devices (e.g., oxygen, electric wheelchairs), elevators for mobility assistance, or refrigerated medications (e.g., insulin, some nebulizers) are at increased risk during power outages (Greenberg, 2014; Washam, 2024). Additional strain on the power grid due to demand for cooling during the hottest parts of the day may lead to brownouts or a complete community-wide power outage.

Below are factors to consider when planning for the possibility of a community-wide power outage that lasts at least two days during a heatwave:

- Coordinate with your regional MDH Public Health Preparedness Consultant to develop a plan.
  - The local public health and emergency manager relationship is critical during a community-wide power outage.
  - Locate your regional Public Health Preparedness Consultants (PHPCs).
- When choosing cooling centers, find out if the facility has a backup generator for use in case of power outages.
  - As soon as possible, let the power company know which locations have been designated as cooling centers. This designation as a critical facility may allow for priority power restoration.

- Partner with the local utility provider to identify households who face a health risk if the power is shut off; coordinate to provide outreach and/or transportation to a cooling center.
- Utility providers should not require a doctor's note when people are self-reporting use of electricity and battery dependent assistive technology and medical devices. This extra step inhibits participation in what could be a lifesaving program.
- Prevent heat-related power shutoffs by coordinating with the utility company to perform rolling brownouts or electricity metering; make sure the public is aware of any disruptions to their electricity.
- Prevent heat-related power shutoffs by encouraging all people to conserve energy. It is important that businesses and those who are low risk during extreme heat participate in energy conservation to protect those who are vulnerable. Energy conservation tips include:
    - Turn off lights and air conditioning in businesses that are not in use.
    - Set air conditioner to low or 78°F; while this may not be the ideal level of coolness for some people, it is cool enough to keep the body safe and reduces strain on the electrical grid.
    - Close curtains and blinds.
    - Avoid using unnecessary kitchen appliances that are energy intensive or generate heat.
    - Close doors so that air conditioning is limited to one room or part of the home.

Plan for a hotter Minnesota

Addressing the growing threat of extreme heat in Minnesota requires a proactive and coordinated approach. Immediately after a crisis is an excellent time to plan future responses. Here are some key steps to create and/or modify a community-wide Heat Action Plan once the immediate threat of heat is over.

To begin, document the challenges faced during the recent heat emergency. Use these insights to develop the outline of a Heat Action Plan that clearly defines:

- Lead agency/organization responsible for overseeing the plan.
- Criteria for activating the plan.
- Roles and responsibilities of key agencies and organizations.
- A communication strategy to keep the public informed.
- Methods to identify and support high-risk and vulnerable populations.
- Strategies to prevent heat-related illnesses and deaths.
- A process to evaluate and improve the plan over time.
- Identify and respond to people who need assistance accessing shade or air-conditioned spaces.

The details and timing of a Heat Action Plan will vary based on local conditions, resources, and needs. By working together to address the growing risk of extreme heat, we can ensure all Minnesotans—especially those most vulnerable to heat-related impacts—are supported and protected. In Chapter 3 we will review communication strategies and materials that can be used to increase awareness of heat risks before and during a heatwave.

Tip: The United Nations has online resources to help communities create a long-term plan for heat resilience.

CHAPTER 3: PUBLIC COMMUNICATION MATERIALS

Effective communication requires a multimedia approach. This section contains customizable communication tools for local leaders to use to inform Minnesota communities of the health risks of heat and how to stay safe.

Download communication materials at mn.gov/heat.

Social media messages

General messages

- **Stay Cool, Stay Safe!** Find air-conditioned spaces, drink plenty of water, and check on loved ones.
- **Hot Cars Kill!** Never leave kids or pets in a parked car—temperatures rise dangerously fast.
- **Hydrate!** Beat the heat by drinking water often—don't wait until you're thirsty.
- **Know the Signs!** Dizziness, nausea, and confusion could mean heatstroke. Call 911 and cool down fast!
- **Pets Overheat Too!** If it's too hot for your bare feet, it's too hot for their paws! Walk early or late.
- **Fans Alone Won't Cut It!** When it's 90+, fans blow hot air—find a cooling center or use AC if possible.
- **Be a Heat Hero!** Check on neighbors, especially older adults and those without air conditioning.
- **Know Where to Go!** Find cooling centers near you before the heat wave hits. Your life could depend on it!
- Extreme heat can be deadly if your body gets too hot. Be sure to drink water, stay cool, and check on friends, family, and neighbors.
- Heat-related illness can happen to anyone; but older adults, young children, outdoor workers, and people with chronic conditions are more at risk.
- Your pets need help staying cool, too! Provide fresh water, shade, and never leave them in a parked car.
- Drinking alcohol or caffeine can make dehydration worse.
- Extreme heat isn't just uncomfortable, it's deadly!
- Stay hydrated, even if you're not thirsty. Dehydration can sneak up on you!
- Avoid outdoor activities during peak heat. Try to stay in air-conditioned areas between 10am and 4pm when temperatures are highest.
- Never leave children or pets alone in a parked car when it is hot!
- Know the signs and symptoms of heat-related illnesses and learn how you can keep yourself and your loved ones safe.
- During hot weather, watch for signs of heat exhaustion. If someone is experiencing heavy sweating, nausea, or fainting, you can help: Move them to a cool place, give them water, and put cool, wet cloths on their body. If their symptoms get worse or don't resolve quickly, call 911 and get medical help immediately!

Targeted messages

Adults age 65+

Stay safe in the heat! As temperatures rise, adults over age 65 are at a higher risk for heat-related illnesses. Drink water often, stay cool, and know the signs and symptoms of heat-related illness.

Young children

Planning outdoor activities with the kids this week? Be sure they take frequent breaks, drink plenty of water, and that you know the signs of heat-related illness.

People with certain health conditions

Your health matters—don't ignore the heat! People with cardiovascular and respiratory diseases may be more sensitive to extreme heat. Stay cool, stay hydrated, and stay informed!

People who work or exercise outdoors

When you must be outdoors in hot weather, take steps to stay cool and healthy. Cut down on exercise and other hard tasks during the hottest part of the day, drink plenty of water, rest often in shady areas, wear light, loose clothing, wear sunscreen, and know the signs and symptoms of heat illness!

People with disabilities

Extreme heat can be dangerous, especially for people with physical disabilities who may have trouble moving to a cooler location. Tips: Stay hydrated, have an emergency plan, and check on your loved ones and neighbors!

Stay cool and stay safe! Extreme heat can be especially risky for people with intellectual disabilities, who may have trouble recognizing or communicating heat illness. Learn to identify the signs and symptoms in yourself and in others.

People without access to effective cooling

Heat can be dangerous! If your home is too hot, cool off at a local community center, library, shopping mall, or church.

Power is out

Keep fridges and freezer doors closed.

Use a generator if you have one, but keep it outdoors and away from doors, windows, and vents. Carbon monoxide can be deadly.

If you rely on electric medical devices, let your utility know that you have medically necessary equipment and submit required paperwork to certify it.

Pregnant people

Pregnant and facing the heat? Stay safe! Extreme heat can harm both you and your baby. Stay hydrated, rest in air-conditioned spaces, learn the symptoms of heat-related illness, and know when to get help.

Radio public service announcement (PSA) examples

1. "Temperatures are rising, and extreme heat can be dangerous. Stay safe by drinking plenty of water, avoid outdoor activity during the hottest part of the day, and find a cool place to rest. If you feel dizzy, nauseous, or weak, it could be heat exhaustion—get to a cooler place and hydrate right away. Remember to check on older neighbors, people living alone, and those without air conditioning. Stay cool, stay hydrated, and stay informed, Minnesota!"
2. "This is [Your Name] with [Local Public Health Department], bringing you an important message about extreme heat. Temperatures are rising, and a heat advisory has been issued for [County/Region] starting [Date]. This is not about being uncomfortable—it's about protecting yourself, your family, and your community from serious health risks. Visit mn.gov/heat to learn how to stay cool and stay safe."
3. "An excessive heat watch/warning/advisory for [area covered] runs through [date & time]. [Provide heat indices from NWS]. Excessive heat is dangerous, and conditions can be life-threatening. Be sure that you and your family members stay cool and hydrated by drinking plenty of water. If you have air conditioning, use it. If you do not, seek air-conditioned buildings during the heat of the day, such as public libraries and community centers, malls, and movie theaters. [Other identified location] also provides an air-conditioned place where residents may go between the hours of [list hours of availability] to cool off and get out of the heat. [Insert address of place and if free transportation is available, list info.]"

Sample news release

For Immediate Release

Extreme Heat is Forecasted—Stay Safe

Hot temperatures [combined with high humidities] are forecasted to occur in [Jurisdiction] over the next [insert period, e.g., 3 days]. Stay safe by following the steps below:

Stay Cool

- Rest in a shaded area, an air-conditioned space, or another cool place like a community center, library, or mall.
- Wear loose-fitting, lightweight, light-colored clothing and use sunscreen.
- Limit your time outdoors as much as possible and take frequent breaks if you must be outside.

Stay Hydrated

- Drink plenty of water, don't wait until you are thirsty.
- Limit alcoholic or caffeinated beverages because they contribute to dehydration.
- Choose water and beverages with electrolytes.

Stay Informed

- Follow local weather and news reports.
- Know the signs and symptoms of heat-related illnesses, such as heatstroke and heat exhaustion and learn how to respond.

More Tips

- Never leave children or pets alone inside a vehicle.
- Check on loved ones and neighbors.
- Heat-related illness can happen to anyone; but older adults, young children, pregnant people, outdoor workers, and people with chronic health conditions are more at risk.

For more information, go to mn.gov/heat.

CONCLUSION

Heat is a silent killer that is often overlooked. In 2023, extreme heat killed more people in the United States than all other weather-related deaths combined (Adams-Fuller, 2023; NOAA National Centers for Environmental Information (NCEI), 2025).

This toolkit provides information to help local public health staff and emergency managers respond quickly to heat emergencies. By increasing awareness of heat risks, providing strategies to identify and protect vulnerable groups, and offering practical tools and guidance to make informed decisions, we can work toward improving health outcomes during days of extreme heat.

As Minnesota gets hotter and more humid, investments in heat preparedness and response strategies can save lives.

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APPENDIX: ADDITIONAL RESOURCES

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Examples from Minnesota communities

Source	Website	Description
Twin Cities Heat Watch 2024	https://www.ramseycounty.us/climate-action/urban-heat-island-study	Collaborative community science heat mapping project data for Ramsey and Hennepin counties.
Cooling options in Hennepin County	https://www.hennepin.us/cool	Local heat preparedness resources and interactive map of cooling center locations.
Olmsted Hazard Mitigation Plan	https://olmsted-county-hmp-umn.hub.arcgis.com/	Details heat risks and vulnerable populations (pg. 46).
Met Council Extreme Heat Map	https://metrocouncil.org/Communities/Planning/Local-Planning-Assistance/CVA/Extreme-Heat.aspx	Interactive map visualizing Twin Cities extreme heat data.

Forecasting extreme heat sources

Source	Website	Description
Minnesota – CliMAT	https://climate.umn.edu/MN-CliMAT	Interactive online tool from UMN providing community-level climate projections for Minnesota.
National Integrated Heat Health Information System	HEAT.gov	Provides resources to identify current and upcoming heat risks, find energy assistance, and use the HeatRisk Tool.
Minnesota Department of Natural Resources – Climate Trends	https://arcgis.dnr.state.mn.us/ewr/climatetrends/	Interactive map showing Minnesota climate trends including extreme heat.
Climate Explorer	https://crt-climate-explorer.nemac.org/	Visualize projected changes in climate, including heat, for any U.S. city or county.

Health guidance

Source	Website	Description
Clinical Guidance for Heat Health (CDC)	https://www.cdc.gov/heat-health/hcp/clinical-guidance/index.html	Clinical tools and resources for addressing heat impacts on health.
Heat and Medications (CDC)	https://www.cdc.gov/heat-health/hcp/clinical-guidance/heat-and-medications-guidance-for-clinicians.html	Guidance for clinicians on the interaction of medications and heat.
SAMHSA Disaster Distress Helpline	https://www.samhsa.gov/find-help/helplines/disaster-distress-helpline	Immediate crisis counseling for people affected by heat-related disasters.
SCORCH Heat and Medications Taskforce	https://scorch.arizona.edu/heat-and-medications-taskforce	Information on how common medications may impact heat sensitivity.
American Psychological Association — Heat and Mental Health	https://www.apa.org/monitor/2024/06/heat-affects-mental-health	Effects of extreme heat on mental health.
Yale Climate Connections — Heat Guide	https://yaleclimateconnections.org/heat-guide/	News stories on heat-related topics and resources for communicating about climate change and heat risks.
Heat-Resilience Data Portal (MDH)	https://data.web.health.state.mn.us/heat	Data on heat-related illnesses and health access for Minnesota.

Identifying vulnerable community members

Source	Website	Description
Assessing Heat Risks in Health Care (WHO)	https://www.who.int/publications/i/item/9789240022904	A guide for assessing heat risks in health care settings.
Climate Change & Social Vulnerability (EPA)	https://www.epa.gov/cira/social-vulnerability-report	Overview of how climate change disproportionately affects socially vulnerable populations.
Mapping Vulnerable Populations (EPA)	https://assessments.epa.gov/risk/document/&deid=341861	Tool for mapping heat-vulnerable community members.