Heat in the Heartland
60 Years of Warming in the Midwest

The summer of 2011 was a scorcher. All but eight states reported above-average summer temperatures, and four states broke records for extreme heat. Such sticky, steamy, uncomfortable weather is poised to become even more common as our climate warms. But hot, humid days are not just uncomfortable. Extreme heat kills. Heat is actually the biggest weather-related killer in the United States, claiming, on average, more lives each year than floods, lightning, tornadoes, and hurricanes combined. From 1999 to 2003, exposure to excessive heat killed an estimated 3,442 U.S. residents.

High temperatures can lead to dehydration, heat exhaustion, and deadly heatstroke. Very hot weather can also aggravate existing medical conditions, such as diabetes, respiratory disease, kidney disease, and heart disease. Urban residents, the elderly, children, agricultural workers, and people with impaired health are particularly susceptible to heat-related illness and death.

Dangerous heat is not just a future concern. Through original research, we found that hot summer weather and heat waves have indeed become more common, on average, in the nation’s heartland over the last six decades.

Some 65 million Americans call the Midwest home. To represent this vast and varied region, we selected five major metropolitan areas and five nearby smaller cities.

Our research focuses on weather systems called air masses: vast bodies of air that define the weather around us. We explored whether the number of days with dangerously hot summer air masses, which are linked to human health risks, as well as cool, dry summer air masses has changed over the last 60 years. We also examined how average daytime and nighttime temperatures and humidity levels within these weather systems have changed over time. We did so because high temperature, lack of cooling relief at night, and high humidity all contribute to heat-related illness.

Our Results
One type of summer air mass that can harm people’s health has become more common in Cincinnati over the past 63 years. The city now sees two more days of the hottest and most humid weather, on average, per summer than in the mid-1940s. In nearby Lexington, KY—the smaller city paired with Cincinnati in our research—the number of these very hot, muggy days has more than doubled, from about two during a typical summer early in the study period to about five each summer in the most recent decade. Meanwhile both cities now get less relief from the heat, having two fewer cool, dry days per summer, on average.

Nighttime cooling is critical for reducing heat stress from higher daytime temperatures. In Cincinnati, nighttime temperatures of both hot, humid air masses and hot, dry air masses have risen slightly. However, dew point temperatures of both those air masses have fallen slightly, reducing risk associated with humidity. In Lexington, overnight temperatures have also climbed for both types of hot air masses, as well as for cooler, dry air masses. A 2009 study projected that Cincinnati could face almost a month (29 days) with temperatures of 100°F or above each year by the end of this century, under a scenario with higher global warming emissions. The number of such days would rise by only eight each year under a lower-emissions scenario.

We also examined summer weather trends in Toledo, OH—a smaller city about 200 miles north of Cincinnati. Both Toledo and Cincinnati have seen an increase in hot, humid weather and a drop in cool, dry weather. In particular, Toledo has seen a substantial drop in the number of cool, dry days—from about 12 per typical summer in the 1940s and 1950s to an average of three in recent summers. In other ways, however, Toledo’s heat trends more closely resemble Detroit. Overnight temperatures in Toledo during hot, dry weather, for example, rose by about 3.5°F over a roughly 60-year period, while overnight dew point temperatures rose by about 5°F, on average. That means overnight relative humidity for these typically dry air masses rose by 3.5 percent.

Overall, there is not a clear explanation why Cincinnati’s record runs counter to trends in other cities in the region in some important categories. Those findings may reflect a physical phenomenon or a statistical artifact. However, the results from Toledo are in line with those from most other Midwest cities in our study. Furthermore, future projections show increasing summer heat in both cities, so heat response plans are essential.
Building a More Resilient Ohio

How Communities Can Protect Health during Extreme Heat

The Environmental Protection Agency’s *Excessive Heat Events Guidebook* outlines several steps that officials can take to protect public health and save lives during extreme heat events:

- Communicating the danger of extreme heat by ensuring real-time public access to information on the risks and appropriate responses,
- Establishing and facilitating access to air-conditioned public shelters,
- Directly assessing and, if needed, intervening on behalf of those at greatest risk, including homeless individuals, older people, those in public housing, and those with known medical conditions,
- Establishing systems to alert public health officials about high-risk individuals or those in distress during an extreme heat event, such as lists of these residents and telephone hotlines they can call.

While all communities can benefit from these tools and planning initiatives, urban neighborhoods are uniquely susceptible to extreme heat. Officials, urban planners, and architects should make special efforts to mitigate rising temperatures in these neighborhoods, such as by expanding the amount of vegetation in public spaces, adopting standards for reflective roofing and paving materials, and lowering global warming emissions.

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### 63 Years of Weather Trends: Cincinnati, OH (1948–2011)

#### Daily Summer Weather Trends

<table>
<thead>
<tr>
<th>Very Hot, Humid Days</th>
<th>Hot, Dry Days</th>
<th>Cool, Dry Days</th>
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<tbody>
<tr>
<td>Increased 🚀208% 2 Days</td>
<td>Decreased 45% 2 Days</td>
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<thead>
<tr>
<th>Temperature and Humidity Changes in Very Hot, Humid Nights</th>
<th>Temperature and Humidity Changes in Hot, Dry Nights</th>
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<tr>
<td>Temperature</td>
<td>Dew Point</td>
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<td>Increased 0.2°F</td>
<td>Decreased 0.7°F</td>
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#### Nighttime Summer Weather Trends

High nighttime temperatures and high relative humidity bring no relief from the heat, putting people at risk for heat-related illness and death.

#### Three-Day Heat Wave Trends

Three consecutive days of high heat and humidity can increase heat-related illness and death.

Average Increase in Heat Waves Harmful to Human Health

No Change

In this box, we identified statistically significant values at *p<0.05* and ^p<0.10.

### What The Future Might Look Like

Assuming current carbon emissions trends continue (equivalent to the higher-emissions scenario), the Midwest will likely face scorching summer days with temperatures that soar above 90°F—and even 100°F—late in this century. If carbon emissions are significantly curtailed (lower-emissions scenario), far fewer summer days will be extremely hot. The data for this section were compiled from other sources. This report’s original research does not include projections of potential future climate changes.
Climate change affects each city and state in unique ways, and policymakers must be aware of local patterns. Successful heat response plans require collaboration among many agencies and organizations, city-specific criteria on the risks of extreme heat and methods to reach residents most at risk, and a communication plan. Developing such comprehensive plans will require effort and funding, but they are vital to preparing for the extreme temperatures to come.

**Action Plans and Resources**

Although Cincinnati does not have an official heat action plan, it does have a Heat Wave Monitoring Program, managed by the Cincinnati Health Department (CHD). The CHD monitors daily weather forecasts, issues heat alerts, and designates heat emergencies based on information from the National Weather Service. The Cincinnati Drug and Poison Information Center also issues special health alerts during extreme heat events.

Once an extreme heat warning is in place, substantial coordination must occur between various city and county agencies, as well as local media and other private stakeholders—all of whom manage different parts of the response plan. A Heat Wave Monitoring team notifies health officials, including the medical director, the director of public health nursing, the CHD’s public information officer, health commissioners with jurisdiction within the region, and the Hamilton County Coroner’s Office. Other personnel notified include the mayor, the city manager, and the deputy city manager; designees for the police and fire departments; officials at the Recreation Department; and staff of local utilities, such as Water Works and Duke Energy.

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**How Heat Affects Health**

- **Head**
  - Symptoms of heat exhaustion can include headache, dizziness, irritability, fatigue, and loss of coordination. Hallmarks of heatstroke—a medical emergency—include marked changes in mental status, such as confusion, delirium, irritability, loss of consciousness, and seizures.

- **Mouth**
  - Increased thirst, dry mouth, and other symptoms such as weakness and nausea often signal dehydration—a loss of water or salts because of heavy sweating or inadequate fluid intake. If left untreated, dehydration can lead to serious health effects.

- **Heart**
  - Your heart has to work harder to keep your body from overheating when outside temperatures rise. Tachycardia (rapid heartbeat) can occur with heat exhaustion, and cardiac arrhythmias (abnormal or irregular heart rhythms) can occur with heatstroke. Patients with a history of cardiovascular disease and high blood pressure are at greater risk of hospitalization during heat waves.

- **Lungs**
  - Asthma, chronic obstructive pulmonary disease, and other respiratory diseases can worsen when temperatures spike. People with pneumonia and influenza are also at greater risk of hospitalization during a heat wave.

- **Liver**
  - Heatstroke can injure the liver.

- **Kidneys**
  - Heatstroke can lead to kidney failure.

- **Skin**
  - Heat rash—also called prickly heat, or miliaria—occurs when sweat ducts become blocked. It is most common in babies, and in hot, humid environments. Flushed, pale, or clammy skin and profuse sweating can be signs of heat exhaustion.

- **Arms and Legs**
  - Heat cramps can cause painful muscle spasms and cramping in the arms, shoulders, and legs.

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The weather types that have become more common in Ohio—very hot, humid air masses, and hot, dry air masses—are associated with heat-related illness and death. Very hot, humid air masses increase the risk of hyperthermia—elevated body temperature—while hot, dry air masses raise the risk of dehydration. Rising overnight temperatures are also problematic, because a lack of nighttime relief increases the risk of heat-related complications.
The city has taken specific steps to deal with extreme heat and its health-related risks, including:

• Opening recreation centers to serve as cooling centers during periods of excessive daytime heat
• Communicating basic information on heat safety to residents using the city’s website, press releases sent to local media, and social media such as Facebook and Twitter
• Asking local utility companies to discontinue power shutoffs during heat alerts
• Monitoring heat-related ambulance runs and ensuring that all ambulances have the proper medical supplies to respond to heat-related health emergencies
• Protecting an iconic Cincinnati tourist attraction by declaring that horse-drawn carriages will not operate during heat alerts

One interesting note: CHD researchers studying risk factors for heat-related deaths found that people taking medications and people with mental illness are especially vulnerable to extreme heat. The CHD has targeted these groups for special outreach during heat waves.

Other Initiatives
Ohio does not prohibit public utilities from turning off gas or electricity when they are the sole power source for cooling during periods of extreme heat. However, the state does require a 30-day delay in a utility disconnection, if a medical professional certifies that that step would endanger an individual’s health.

Conclusion
In addition to investing in preventive measures to protect public health and save lives during extreme heat events, we must also take aggressive action to reduce heat-trapping emissions from the burning of fossil fuels. If we do not, temperatures will likely continue to rise, and we will have to cope with the effects of extreme heat on our daily lives, our health, and our economy for decades to come. We need strategies to both build climate-resilient communities and reduce the global warming emissions that are driving climate change. Our health and well-being—and those of our children—depend on it.

Heat-response plans that include communicating with residents and setting up cooling centers are important in Cincinnati and Toledo. Residents themselves must also take protective steps, such as drinking plenty of water, spending a few hours a day in air conditioning, and avoiding strenuous activity. These precautions are often difficult for the elderly, athletes, and outdoor workers, like this traffic director near Toledo, who may ignore warnings or have less access to cooled spaces.