Heat: How much can the human body stand?

July 6 2023, by Dennis Thompson

Record-breaking heat waves are pummeling the United States and the world, causing many to wonder how much of this a body can take and still survive.

The limit is somewhere between 104 and 122 degrees Fahrenheit if you're sitting perfectly still, according to a small study conducted in the United Kingdom.

Researchers say they are starting to hone in on the high temperatures that begin to overwhelm the human body's defenses against heat, or what they call the upper critical temperature.

"We find that some individuals, but not others, exhibit an increase in metabolic rate at rest when ambient temperature gets high," said senior researcher Lewis Halsey, a professor at the University of Roehampton School of Life and Health Sciences in London.

"An increase in metabolic rate will increase heat generated by the body," Halsey said. "Those people exhibiting a substantial increase in metabolic rate are going to be less well-adapted to being in the heat, because when things get hot outside their bodies produce even more heat."

The study also found that humidity makes things worse, because it causes your sweat to be less effective in cooling off the body, Halsey added.

"When it's hot and humid, if there are increases in metabolic rate, those increases tend to be bigger," he said.

Halsey planned to present his latest findings this week at the Society for Experimental Biology's annual meeting, in Edinburgh, Scotland.

This upper critical temperature for humans will be critical to understand as climate change causes searing heat domes to settle over different parts of the world, said Dr. Christopher Lemon, an assistant professor of emergency medicine with Johns Hopkins University School of Medicine.

"We're going to be operating in extreme heat, and understanding a little bit more about the effects on the body and at what point we push too far sounds like that would be extremely important for us moving forward," Lemon said.

The new study came out as the world baked under its hottest day on record. On Monday the globe experienced an average global temperature of 62 degrees F, *CNN* reported.

A heat dome killed 13 people in Texas and one in Louisiana last week, and many U.S. cities are expected to reach record high temperatures during early July, the *Associated Press* said.

Much is already known about the lower critical temperature for humans, which is around 82 degrees F, researchers said in background notes.

Below that temperature, the human body needs to expend more energy to maintain the necessary core temperature of 98.6, researchers said. When it's colder, the body will resort to reactions such as shivering as a means of producing more body heat.

Given that, it would make sense that there is an upper critical temperature as well, where the body isn't able to cool itself without expending more energy, researchers said.

The human body responds to heat by producing sweat, which cools the skin as it evaporates, Halsey said. The body also shunts more blood out to the skin, to give the blood a better chance to cool off thanks to sweating.

To track these and other responses to heat, Halsey and his team recruited 13 healthy people to spend an hour on three separate occasions in an environment chamber.

In the chamber, participants were exposed to temperatures between 104 and 122 degrees and humidity between 25% and 50%. They were asked to remain at rest, and wore a light vest and shorts.

Researchers observed a particularly large increase in metabolic rate between the baseline of 82 degrees and the higher heat of 104 degrees.

There also was another large increase in metabolic rate at 122 degrees when humidity jumped from 25% to 50%, the study says.

"In humidity, sweating doesn't work very well because sweating involves evaporation of water from the body and evaporation is scuppered by humidity in the air, because there's already a high-water-vapor pressure in the air that stops evaporation working," Halsey said.

As would be expected, participants struggled most at 122 degrees and 50% humidity, results showed.

Researchers also observed increases in heart rate as heat and humidity rose, demonstrating that the body was working hard to get blood out to the skin for cooling.

Compared to the baseline of 82 degrees, participants experienced a 16% increase in heart rate at 104 degrees and a 64% increase at 122 degrees with 50% humidity.

"That increase in heart rate is greater in women than in men," Halsey added.

How heat can harm the body

Extreme heat can damage the body in a number of ways, experts said.

For starters, increases in heart rate and blood pressure puts an enormous strain on the heart, said Dr. Howard Weintraub, clinical director of the Center for the Prevention of Cardiovascular Disease at NYU Langone Health in New York City.

The body's attempts to cool off also can affect the performance of organs, said Dr. Barrak Alahmad, a research fellow at the Harvard T.H. Chan School of Public Health's Department of Environmental Health.

"When the body is heated, the blood shifts away from the organs to under the skin in an attempt to cool it down, so you get all this blood moving away from your organs, so it affects the kidneys, for example," Alahmad said.

Dehydration caused by sweating further destabilizes the body, as do changes in enzyme function that can occur with high body temperatures, Weintraub added.

"When you get dehydrated, your heart is going to have to work a whole lot harder and your heart rate goes up. Your blood pressure may suffer. So there's numerous biologic processes that are adversely influenced under adverse thermal environments," Weintraub said.

At some point, the body will fail, Lemon said.

"You get this cascade of physiologic changes and, unfortunately, they can only go so far before there's a system shutdown, until they can't compensate anymore," Lemon said.

What about bodies in motion?

While this study is a good start, experts said more needs to be done to understand the body's response to high temperatures.

For example, this experiment was conducted with people who were lying still, Weintraub said. Studies need to be done in people who are working or exercising in high temperatures.

"What you're really worried about is not what happens to you when you sit still, but when you're doing things," Weintraub said. "What happens to the guy who has to be outdoors when it's over 100 degrees Fahrenheit? That would have more impact."

Future studies also should take into account different coping mechanisms, such as working in shade or using a fan to help perspiration evaporate and cool the body, Alahmad said.

In their study, Halsey and his team recommended that researchers first focus on air temperatures between 90 and 104 degrees F, to pinpoint the average temperature at which the body starts expending more energy in its efforts to cool off.

They also call for research into which types of people are more vulnerable to higher temperatures.

"Some respond to increases in ambient temperature by increasing metabolic rate and some don't," Halsey said. "We don't know which individuals are doing that, or we can't characterize it."

According to the U.S. Centers for Disease Control and Prevention, people 65 years and older are at higher risk from extreme heat, as are kids 2 years and under and folks with chronic diseases and mental illness.

Results from Halsey's work also have appeared previously in the journal Physiological Reports.

More information: The U.S. Centers for Disease Control and Prevention has more about coping with hot weather.