

Too hot to handle: The human health consequences of extreme heat

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Climate change is making parts of the world too hot and humid for human survival. Globally, extreme heat, which increased by 200% between 1983 and 2016, affected more than 1.7 billion people in 13,115 cities. According to the World Health Organization, extreme heat killed more than 166,000 people between 1998 and 2017. In 2021, a “heat dome” in the U.S. Pacific North-west and Canadian west coast, killed hundreds of people as well as more than a billion sea creatures. There are few countries around the world that have not experienced record-breaking temperatures, and for many people, extreme heat, which disproportionately affects the poor and those with chronic heart or kidney disease, is becoming the new normal.

Extreme heat and humidity impede physiological responses to heat

The human body has evolved mechanisms for dissipating excess heat. Maintaining the body’s optimal core temperature is critical because overheating can denature enzymes and proteins, resulting in multiple organ failure and death. In response to increased body temperature, temperature-sensing nerves signal the brain to initiate multiple thermoregulatory processes to shed heat, including sweating and shifting blood from central organs to the periphery of the body by vasodilation (widening) of blood vessels in the skin. Evaporation of sweat cools down the skin’s surface, while increased blood flow to the periphery transfers heat generated by muscles to the skin where it more readily dissipates into the environment.

However, heat and high humidity make it harder to cool down. Extreme heat decreases heat dissipation from the body’s surface, while high humidity slows down evaporation of sweat. At a certain threshold of heat and humidity, it is not possible to sweat fast enough to prevent overheating. Researchers modelling current trends of increasing heat and humidity predict that Central America and Mexico, India, Pakistan, the Persian Gulf and Southeast Asia will reach this threshold before the end of the century. People living in coastal regions will also be at risk because warming ocean temperatures coupled with extreme heatwaves promote water evaporation, adding humidity to the air.

Adverse health outcomes associated with extreme heat and high humidity

While physiological responses to heat are effective in healthy individuals experiencing moderate humidity and hot weather, even under these conditions, the effort to cool down strains the heart and kidneys. In response to extreme heat and high humidity, this strain can result in organ failure, also known as heat stroke, an outcome more likely to occur in individuals with pre-existing cardiovascular or kidney disease.

Extreme heat exacerbates dehydration, which reduces blood volume. Without sufficient rehydration, reduced blood volume causes blood pressure to drop rapidly, resulting in loss of consciousness. Reduced blood volume and blood pressure also cause the heart to work harder, which can lead to heart failure, and severe dehydration can lead to acute kidney damage.

Even healthy adults exposed to extreme heat can experience heat cramps, heat exhaustion or heat stroke. Without medical intervention, heat stroke can kill. In about 20% of people who survive heat stroke, the brain may never fully recover, resulting in personality changes or poor coordination. Extreme heat also has negative health effects on children and young adolescents, and recent studies conducted in the United States, Australia and China revealed a strong association between extreme heat and preterm birth, which is a major cause of infant mortality and life-long health complications. How extreme heat causes preterm birth is not clear but reduced uterine blood flow and increased levels of oxytocin (the hormone that induces uterine contraction) due to dehydration have been proposed as potential mechanisms.

The risks of these heat-related complications are significantly reduced by staying in air-conditioned rooms, maintaining hydration to lessen the load on the heart and kidney, and reducing physical activity to decrease heat generated by muscles. However, socioeconomic status strongly influences the feasibility of deploying these protective strategies: surviving extreme heat and high humidity depends on access to air conditioning, insulated homes, jobs that don't require extreme physical labor in the outdoor environment and effective policies to protect the most vulnerable populations.

Factors contributing to extreme heat and high humidity

Climate change is the most significant factor driving extreme heat and high humidity. Human use of fossil fuels has increased emissions of greenhouse gases, which absorb and trap solar heat in the atmosphere. The resulting increase in air and ocean water temperatures directly contributes to more frequent and longer periods of extreme heat and high humidity. Another factor underlying the increased frequency and duration of extreme humid heat events is urbanization. According to the United Nations (UN), 55% of the global population resides in urban areas, a number predicted to reach 68% by 2050. Cities are, on average, generally warmer than rural areas due to physical components of the urban built environment. Conventional construction materials such as pavement, buildings, and infrastructure create an "urban heat island" phenomenon by trapping solar heat during the day and emitting it at night. Reduced vegetation in cities intensifies extreme heat because vegetation reflects solar radiation, reduces CO₂ levels, and provides shade and moisture.

In summary, we have built a civilization in a world that does not exist anymore. The more the planet heats up, the less comfortably liveable it is for humans. At an average temperature increase of 1.5°C, the limit agreed to by nearly 200 countries during the 2015 Paris climate agreement, about 14% of the world's population will experience severe heatwaves once every five years. This number jumps to more than a third of the global population at an average temperature increase of 2°C, which is the current predicted trajectory. Governments, industries, and individuals need to take immediate action to support the development of resources for curbing the factors that are driving the increasing temperatures and humidity and for protecting against extreme heat. Failure to do so will ensure that deadly heatwaves will continue to increase in frequency and duration, resulting in increased human illness and death, particularly amongst economically disadvantaged communities and individuals with chronic cardiovascular or kidney disease.

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