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Extreme Heat on Human Health: Heat Intensity That the Body Can Endure

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Wisdom (Philosophical) Note

Extreme Heat on Human Health: Heat Intensity That the Body Can Endure

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The World Meteorological Organization reports that July 2024 has been the hottest month ever recorded on Earth. The frequency of heat waves has been steadily increasing around the world (from an average of 2/yr in the 1960s to 6/yr in 2024 in the U.S.). More than existential environmental crisis, this pattern of increasing heat-wave frequency threatens – without exceptions – every aspect of human health. More than other weather-related disasters such as floods, tornadoes, typhoons, tsunamis, etc., extreme heat has already killed more Americans, Japanese, and Europeans with each passing year.

In 2019, ca. 470,000 people worldwide died from exposure to extreme heat, according to a paper published in 2021 by 'The lancet'. Many of these heat-inflicted mortalities are the result of heat-strokes, which occur when the surrounding temperature is excessively high and the human body loses control over internal body compensatory regulation, inciting tissue damage and follow-up organ failures within minutes.

In an example in the Phoenix suburbs, where summer temperature soared on consecutive days above 43.3℃ (110°F) for >30 days, other than 249 deaths (reasons under investigation), at least 25 people have succumbed to the heat. High ambient temperatures can also exacerbate underlying medical conditions by exerting stress on the heart, lungs and kidneys. A review published in Lancet Planetary Health found that ca. 12% increase in mortality and increased emergency care for kidney disease and chronic lung conditions were attributable to heat waves.

Apart from physical health, intense temperature increases disturb sleep, and impair brain neurotransmitter functions, and therefore impacts mental health. Recent studies have revealed that an increase in temperature of even 1℃ can exacerbate depression, anxiety, and suicide rates. Intriguingly, climate change per se is a source of mental distress, especially among

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young people.

Another concern of rising temperature is that this change expands the habitats of certain infectious diseases in warmer regions to cool-turned-warmer areas, such as illnesses from mosquito, tick, and flea bites: relevant diseases (Lyme disease, West Nile disease, malaria, etc.) incidences in the U.S. have increased by twofold between 2004 and 2018. The tick-borne Lyme disease can inflict permanent neurological damage, if untreated; and the mosquito-borne West Nile disease has caused 127 deaths in southwestern U.S. in 2021. The latest is the reemergence of malaria in the U.S. More than a habitat-driven phenomenon, this parasitic disease, which causes more than 500,000 deaths worldwide, is more likely to have been carried home among Americans who have acquired while traveling abroad in tropical areas of Africa, Asia and Latin America. It is indeed a sobering reminder that not only diseases associated with certain parts of the world may affect certain people; but they can also affect others in different and remote localities with changes in weather patterns. Indeed, at least 200 infectious diseases globally are exacerbated by climate change.

Humans can take various measures to reduce the impacts of rising environmental temperatures: 1) know the limits of groups' susceptibility to extreme heat; 2) adopt a plan based on individual heat tolerance in overcoming extreme heat; and 3) adjust factors against rising temperature within one's control.

1. Know the limits of groups' susceptibility to extreme heat: The most susceptible age groups are the elderly, the young, and those with severe underlying medical conditions, as they are likely to have more difficulties with thermoregulation. Moreover, certain psychiatric medications may lower their heat-tolerance threshold and thus their susceptibility to extreme temperatures.

2. Adopt a plan based on individual heat tolerance in overcoming extreme heat: There is an individual difference to extreme heat tolerance. It is always kind to the body to switch on air-conditioners during the onslaught of extreme heat. For the elderly or families having young children without air-conditioning facilities in their homes, they could always access community centers and communal facilities with air-conditioning. It is also handy to carry along cool-packs for cooling the body in cases where the needs arise.

3. Adjust factors against rising temperature within one's control: Attention should be paid to effects on sleep and implications for mental health. Use of substances such as alcohols, ice creams, and chili spices should be monitored, as they can affect thermoregulation. It is also advisable to wear long-sleeved shirts and pants to avoid being bitten by disease-borne insects (e.g. mosquitoes, ticks, fleas, etc.). It is helpful to discourage proliferation of said insects by removing stagnated water pools (e.g. mosquitoes) around the house, and do regular cleanup and disinfection of mattresses and carpets inside the house.

According to Ollie Jay of the Heat and Health Research Incubator at the University of Sydney: extreme heat – the silent killer – does not make dramatic television footage the way tsunamis, typhoons, tornados and floods do. It may be useful to know how much heat can the human body accommodate and endure.

Whether a given temperature can kill depends on factors such as humidity, wind velocity, direct exposure to sunlight, clothing being worn, exertion level, and individual difference (body size, body condition, genetic makeup etc.). A man and his young son died hiking when surrounding temperatures reportedly reached 48.3℃ (119°F) in Texas, while a young couple , their baby daughter, and the family dog all died at just 41.7℃ (107°F) while hiking in California in 2021 (chronicled in a book entitled The Heat Will Kill You First by Jeff Goodell) speak of the factors influencing body susceptibility to surrounding temperatures.

Heat can kill because our bodies are made of cells, survived by being contained with a membrane to prevent dehydration. However, the cell membrane degrades and disintegrates when the body temperature becomes excessively hot, whereas homeothermic animals, humans need to maintain a body core temperature (BCT) within 36.7-36.9℃ (98.0 – 98.4°F) to stay comfortably alive. According to Cheuvront (a heat physiologist who previously worked at the U.S. Army Research Institute of Environmental Medicine, Exertion and External Temperature), human BCT can increase to 40.0℃ (104°F) for a transient

interval without permanent damage. Exertion and external temperature – just like fevers – can factor into human BCT.

Human bodies cool off by sending blood containing heat to the skin to dissipate heat into the air; however this mechanism only works until the air temperature is ca. 35℃ (95°F), or the peak temperature that can be tolerated by the human skin. As a means for survival, like any organism, the human body evolved to develop sweat glands for secreting sweat. It is sweat that helps with further heat dissipation via evaporation at the critical point when the skin can no longer handle heat dissipation from the body; however, if the humidity increases to excessively high, the vapor pressure around the body prevents evaporation, and secretions from sweat pores pool and drips as sweat. In other words, humans will start to 'cook' in their own body heat at a temperature equivalent to 35℃ (95°F) with 100% humidity. More vulnerable people can suffer heatstroke at lower temperatures. Other factors contributing to individual difference include human bodies standing under the direct sun or in the shade of trees: the former situation leads to higher BCT even under the same temperature. Airflow can facilitate sweat evaporation, allowing body heat to dissipate to the surroundings (this is how the fan works to cool BCT). Jay (2021) pointed out that the majority of heat-related deaths are not due to heatstroke, the elderly and those with pre-existing clinical conditions, many of whom are at a greater risk of heart attack or heart failure, because the body's cooling mechanisms induce cardiovascular stress when the stress-load exerted on body is beyond body accommodation limits. Others may die of renal failure from combined unfavorable effects of blood deprivation for the kidney and dehydration.

Once the BCT increases above 40.0℃ (104°F), high-risk physiological events rapidly occur, and fatal heat stroke follows when the temperature reaches 41.1℃ (106°F). Humans can acclimatize to heat over a few days in a high-temperature environment: they will start sweating more quickly and easily, decrease their BCT with increased intake of fluid volume and frequency. These are evolutionary changes of organisms - or adaptation - for survival.

A 5-level 'heat stress' warning scale has been devised by Jay (2021) to alert people if the risk is low, moderate, high, very high, or extreme. These levels incorporate a combination of heat-related environmental factors such as temperature, wind, sun exposure and humidity to warn people when those factors line up in a deadly combination. Alerts could be relayed to the public via mass media. Along similar line of thoughts, Japan has been disseminating alert warnings in summers recently: although signs and symptoms, preventive measures, dietary adjustments, physical activities, etc. related with heat-strokes have been circulated via the mass media; however, actual procedures in formulating workout of categorizing the alerts remain unknown.

A science-based heat-risk scale is useful to alert the public, workers and employers as well as relevant parties to possible health and death risks. This way, workers, especially those dwelling in outdoor workplaces, can take breaks to avoid unnecessary hospitalizations and death. Employers will also get to justify their moral and ethical grounds on health consciousness using this alert system. It is just unfair to outdoor workers by the passing of a law in Texas that would allow employers to deny workers breaks for water and shade even under intense heat at 46.1℃ (115°F).

Extreme heat has been killing people for decades, especially heat-island cities. As our Earth gets hotter, more pressure will put on city officials to embrace heat-warming systems, and to fabricate and transform more buildings to public cooling centers. Additionally, a science-based alert system could be formulated so as to prevent heat from killing humans.

It is beyond doubt that climate change is now a public heat crisis. The unfavorable health impacts we are experiencing will multiply, complicate and intensify for future generations if we ignore the currently progressing climate change.