

- Temperature

A touch of sun: the impact of heat events on children

Effects on the very young can be significant, including low birth weight and prematurity, learning loss during the school years, and heat-related illness and death. Excessive heat can impact young children's development and health both in the moment and a

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There is sufficient evidence to show global warming is causing temperatures across the globe to rise significantly enough to cause disruptions. Heat waves are occurring with greater frequency and are lasting longer than ever before, with the World Meteorological Organisation declaring that 2023 was the hottest year on record. While humans have adapted and acclimatised themselves to several variations in climate, there is believed to be a limit beyond which our bodies cannot process this change. The correlation between health outcomes and environmental conditions is something that has been broadly hinted at, but not studied in detail. It is about time to do that.



The first of a series, this working paper from the Early Childhood Scientific Council on Equity and the Environment, Harvard University, (Extreme Heat Affects Early Childhood Development and Health: Working Paper No. 1., 2023) explores how extreme heat can affect young children's biological systems and disrupt development, as well as the many ways it can amplify the effects of systemic inequities.

The authors also indicate the powerful effects that extreme temperatures can have during pregnancy and early childhood, including impacts on learning, sleep quality, and mental and behavioural health. It also explains how heat amplifies systemic inequities, including air quality, access to nutritious foods, and structural disadvantages. In addition, it provides some practical solutions to mitigate climate change, slow the heating of our environment, and provide new ways of cooling our communities. This includes tips on how to mitigate the impact of extreme temperatures, finding new ways of cooling the communities where children live, and grow, along with some community initiatives that have reportedly started to bear fruit.

While the dangers of excessive heat for older people and those with heart and lung conditions are well known, the effects of heat during pregnancy, infancy, and childhood get less attention, and this is what the paper tries to set right. Effects on these groups can be significant, including low birth weight and prematurity, learning loss during the school years, and heat-related illness and death. Excessive heat can impact young children's development and health both in the moment and across the lifespan, the paper underlines.

It stands to reason that extreme heat affects infants and young children more than most adults because their smaller bodies heat up more quickly, and their capacity for body temperature modulation is still under development and therefore, far less efficient. Infants and young children also can't seek out cooler environments or get water to drink without relying on adults. The paper adds that children and adolescents with chronic health conditions, such as asthma, obesity, or diabetes, are even more susceptible to heat-related illnesses.

How does heat impact humans?

In an attempt to further explain the science, the authors of the paper provide a blowbyblow account of how excessive heat works on every part of the human body. The human body responds to excessive heat primarily by redistributing blood flow toward the skin so heat can transfer out of the body and into the environment through sweat which evaporates on the skin, bringing body temperature down. The blood flow cooling method is especially important for young children. As long as the air temperature is cooler than the body's temperature, heat dissipates through the skin to the outside environment. When temperatures rise, the brain regulates these physiological responses, with additional input from temperaturesensitive nerve cells in the skin and throughout the body.

Cells also produce heat shock proteins, which act as "chaperones" that stabilise the structure of other proteins that high temperatures could damage. Every cell in the body contains heat shock proteins, protecting a variety of other proteins that are critical to life, including hemoglobin, which carries oxygen to our cells. Over short periods of time, heat shock proteins are effective and helpful in regulating body temperature, but when temperatures stay too high for too long, they lose their ability to function, and the proteins they protect start to break down.

This could mean a higher susceptibility to infections and a decreased response to vaccines, only a couple of the cascade of reactions that can occur as a result of the breaking down of proteins.

How does this affect various organs, then?

— The hypothalamus acts as a thermostat for the entire body, sensing temperatures and reacting to keep core temperatures within a healthy range. Continuous, high temperatures prevent the hypothalamus from shutting off these cooling responses. Also, when the heat shock proteins break down, the body identifies them as invaders and sends out immune cells to fight them, thus keeping them from their main task of fighting infections.

Brain Skin and Gut

— In response to heat, pores in the skin open to allow more sweat to pass through and evaporate, increasing the body's ability to cool itself. The lining of the gut can become leaky allowing bacteria to pass through to other parts of the body. Over a period of time, this can increase the likelihood that harmful bacteria and toxins will reach the body's vital organs via the circulatory system.

Heart and Other Muscles

— In response to excess heat, the heart rate increases to send more blood to the skin, releasing the body's core heat into the environment. Consequently, less blood is sent to the muscles, which can constrain muscle growth, cause muscle fibres to break down, and contribute to kidney dysfunction, the authors write.

— Is the most commonly understood symptom of heat strokes, but what does it actually do to the body? Not having enough water in the system thickens the blood, which can lead to increased blood clotting and heart failure from blockages in the arteries.

When sustained over time, all these responses can lead to what is known as "heat stress." When this happens, the body begins to break down and critical functions shut down, increasing the likelihood of damage to the heart, lungs, and kidneys as well as the risk of heatrelated death.

Dehydration Pregnant women and children

In pregnant women, high temperatures may result in reduced blood flow in the placenta, dehydration, and inflammation, which can trigger preterm birth. There is evidence that during

times of high temperatures, there are increased rates of stillbirth, as well as more premature and lower birth weight babies, again, linked to a greater risk of a range of poor outcomes later in life, including impaired cognition, reduced growth, and chronic health issues such as cardiovascular disease and diabetes in adulthood.

Given children's fledgling ability to achieve homeostasis, apart from the immediate physical effects on a child, the authors argue that heat can disrupt development through three distinct pathways: — heat is linked to slower cognitive function and reduced concentration ability.

Learning loss may

Learning loss

occur because heat's effects on the brain can produce slower reaction times and an inability to focus and can have lasting effects on learning outcomes. Hotter school days two, three, and even four years prior to a test correlate to lower scores. — getting enough good-quality sleep is essential for healthy growth and development. A growing body of evidence shows associations between less sleep in infancy and childhood obesity, and sleep habits in childhood may impact weight well into adulthood. The third crucial factor is

— because children's brains and bodies are developing rapidly and are highly sensitive to their experiences, early childhood is a period where threats to wellbeing can have long-lasting effects on mental health. Because of this, treatment and prevention efforts in the early years can have much larger effects on children's long-term psychological health and wellbeing than efforts that begin later, the paper advises. The brain detects extreme heat as a threat to wellbeing, which activates the stress response system. While heat affects everyone, the paper highlights how it also amplifies the effects of systemic inequities in housing, neighbourhood density, community infrastructure, and economic opportunity, contributing to an unequal burden of dangerous conditions for families from marginalised groups and with lower incomes.

Heat amplifies systemic inequities, including air quality, access to nutritious foods, and structural disadvantages

Sleep quality behavioural health Tackling extreme heat Mental and

Because the effects of climate change are so interrelated, all efforts to address the root causes — and inequality more broadly — will boost the impact of efforts to mitigate the effects of extreme heat on children. The paper recommends policies that target emissions, immediate action to reduce harm from heat events, and adapting infrastructure to be better placed to handle the increase in heat. This would include improving structural cooling options in buildings, including greening campaigns, installing air conditioning and other cooling mechanisms; providing accessible links to the power grid; and developing proper heat plans. The experts have advised highlighting some models that work in all these segments.

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