CLIMATE CHANGE

Rising injuries in a hotter climate

A statistical model based on an analysis of routinely collected data from 1980 to 2017 predicts 1,601 excess injury deaths per year in the contiguous USA if average temperatures rise by 1.5 °C.

Shanthi Ameratunga and Alistair Woodward

Over 5 million people die from injuries each year, accounting for 9% of deaths worldwide——i.e., 1.7 times the number of deaths attributed to human immunodeficiency virus and/or AIDS, tuberculosis and malaria combined[1]. The prominence of such deaths in global mortality statistics is also increasing, with road-traffic injuries, suicide and falls predicted to be the 7th, 16th and 17th leading causes of death worldwide, respectively, by 2030[1]. Deaths, however, are merely the tip of the injury pyramid. Non-fatal injuries are far more numerous, accounting for 6% of all years lived with disability[1]. With young people disproportionately more affected, injuries constitute a major public health problem with substantial societal and economic effects, globally. In this issue, Parks et al. investigate the relationship between injury deaths and anomalously warm monthly temperatures, acknowledging the increasing relevance of global climate change[2].

Seasonal variations in a variety of injuries (e.g., road crashes, drownings, suicide and falls) are well known in many countries[3–5]. The extent to which these relate to temperature variation per se is less clear, but there are plausible explanations for these potential links[6]. For example, more swimming in hot weather can lead to an increase in drowning deaths, and the risks of road crashes, suicide and assault could increase through the effects of heat and cold stress on concentration and mood. It is therefore remarkable to find only one substantial reference to injury (in relation to fires) in the last assessment report of the United Nations Intergovernmental Panel on Climate Change[7]. This can be reasonably attributed to the sparse empiric attention to the effects of climate change on injury relative to research on the effects of climate change on outcomes such as heart disease and vector-borne infections.

Parks et al. analyzed data routinely collected from 1980 to 2017 in the contiguous USA (i.e., excluding Alaska and Hawaii) to investigate if injury deaths in a state changed when the temperature in a particular month was higher than its long-term average for the state over the entire 38-year study period. They found that deaths due to drowning and transport injuries, and, to a lesser extent, assault and suicide, increased in unusually warm months, offset by a modest decrease in falls (largely in people over 85 years of age).

Credit: Ben Stansall/AFP/Getty

The 2015 Paris Climate Agreement resolved to keep global temperature rise this century below 2 °C (above pre-industrial levels) and to limit warming to 1.5 °C, if possible. Applying the risk estimates from their statistical model using routinely collected data, Parks et al. predict 1,601 additional injury deaths in 2017 if each month in each state were 1.5 °C warmer than its long-term average. The excess is predicted to be 2,135 (1% of all injury deaths in 2017) with a temperature anomaly of +2.0 °C. The authors identified variations in susceptibility by age, sex, region and mechanism. The adverse injury impacts were most pronounced among males, who accounted for 84% of excess deaths, with young and middle-aged adults most affected: approximately 92% of all excess male deaths occurred among those 15–64 year of age. An anomaly of +1.5 °C was associated with an estimated increase of 13.7% in drowning deaths among young males 15–24 year of age.

It has been argued that other health effects associated with rising temperatures may, to some extent, be balanced by gains that result from less cold weather. However, the adverse effects on injury were offset only by a relatively modest reduction in falls in warmer months, conceivably due to lower risks of slipping on icy surfaces. The study also found regional differences, with northern and mid-continent states experiencing much greater variability in temperatures than southern states. One might expect, from first principles, that boosting a month's average temperature by 1.5 °C would be far more stressful in Florida than in North Dakota.

The authors contend that their measure of exposure, an index of unusual monthly temperatures, is a better assessment of the effects of climate change than a daily or hourly temperature anomaly. A shorter time scale (an hour or a day) captures the proximal causes of ill health, but climate change acts by moving out of the familiar range of large blocks of time——that is, months or years——and the upstream mechanisms of action that cause injury may be compounding and cumulative. For instance, repeated hot nights and accumulating sleep disruption, or the deterioration of roads under prolonged heat, may magnify the influence of common injury exposures. It is possible that people's swimming habits can change when months are on average warmer, so people are more likely to swim even if the temperature on the day is no higher than usual.

Although these were not directly investigated in this study, the authors propose several plausible mechanisms that could explain the excess injury deaths in anomalously warm months, ranging from changes in behavior, such as more swimming in natural water, deterioration in driving performance, increased alcohol consumption and more time outdoors; to greater levels of interpersonal interactions, resulting in confrontations and conflicts; and to higher levels of emotional distress among young people. It is important to note, however, that other weather variables relevant to injury, such as rainfall, humidity, sunshine and wind, may act in their own right while also interacting with temperature, although not necessarily in consistent or predictable fashions[4,5]. There is a need to develop more-sensitive indicators that could elucidate climate-sensitive injury patterns.

We also argue for finer-grained information that characterizes localities and populations most affected. Previous research has identified that people who are poor or African-American, live in coastal and low-lying areas or are outdoor workers are at increased risk of climate-change health effects due to intersecting vulnerabilities[8–10]. A multi-country multi-city study of suicide and temperature that identified nonlinear associations in northeast Asia and more linear associations in several Western countries (including the USA)[11] also indicates the need to explore the possibility of varying patterns of injury–temperature associations in different settings.

Climate-change policy presents unprecedented opportunities for implementing equity-focused public-health plans that address the synergistic and intergenerational effects of multiple risk factors and social determinants that influence injuries[6,12]. The need to address this is particularly urgent in low- and middle-income countries that experience over 80% of the global injury burden and are generally more vulnerable to the effects of extreme weather. ❐

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Competing interests

The authors declare no competing interests.

PUBLIC HEALTH

Implications of legacy lead for children's brain development

Children at a higher risk of lead exposure develop smaller brain cortical surface area and volume, but only if they are from low-income families.

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Although lead has largely been banned from gasoline, pipes, paint, and other consumer products in most countries, legacy lead in the environment remains an ongoing hazard for children around the world[1]. Exposure to lead, a neurotoxicant, is associated with disrupted cognitive and behavioral development[2]. Despite decades of study, not enough is known about the structural changes in the brain that underlie these disruptions, or to what extent they are lasting, modifiable, or likely to worsen over time. In this issue, Marshall et al. report that US children living in neighborhoods with higher risks of lead exposure develop smaller cortical volumes and surface areas if they are from low-income families but not if they are from middle- or high-income families[3]. The authors interpret these brain morphology differences, which were accompanied by deficits in cognitive test performance, as suggesting that the children from low-income families are possibly more vulnerable to lead's neurotoxic effects than are their more affluent peers.

No level of lead exposure has been deemed safe for children. While humans have been interacting with lead for millennia[4], not enough is known about how its harms are mediated. Animal studies have shown that lead mimics calcium at the cellular level[5]. It is absorbed through the gastrointestinal and respiratory tracts, binds to erythrocyte proteins in the blood, and may pass through the blood–brain barrier via calcium ATPase pumps[5]. Once in the brain, lead enters glia and neurons through voltage-sensitive calcium channels and, there, perturbs calcium homeostasis, disrupts mitochondrial function, and suppresses neurotransmitter storage and release[5]. Lead's half-life in the brain is 2 years, and its presence at even low levels during development may disrupt neuronal proliferation, differentiation, and synapse formation[5]. However, it is not clear how to generalize such findings to humans, whose toxicodynamics of lead metabolism, removal and vulnerability vary by age, sex, and genetics. Owing to its known toxicity and persistent use in metalworking, food preparation, building materials, and fuel, lead——as well as its removal——has been invoked to explain a number of historical events and trends, from the fall of the Roman Empire[6], to the rise in IQ across the second half of the 20th century[7], to the drop in urban crime rates in the 1990s[8]. Such arguments have been controversial because, among other issues, lead exposure is typically entwined with adversities related to socio-economic deprivation, including lack of access to high-quality housing, nutrition, education, and healthcare[9]. This has led to an at times acrimonious area of research, sometimes fueled by opinionated financial interest from lead-related industries[10].