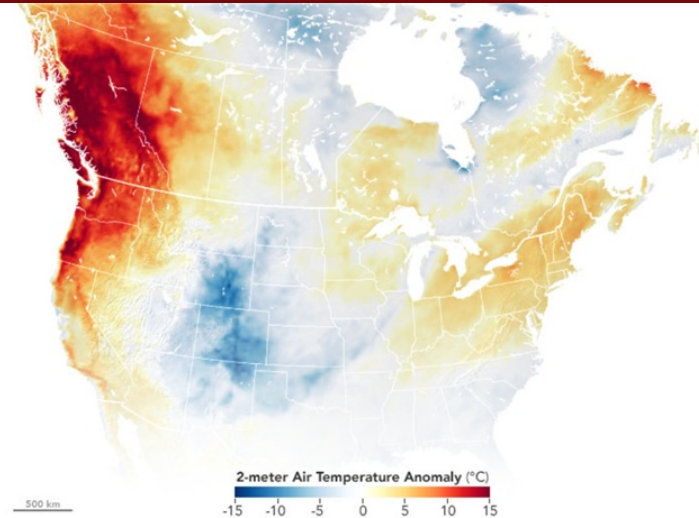


# Issue 1: The Health Impacts of Heat



Air temperature anomalies on June 27th, 2021. Image: [NASA](#)

Welcome to our first climate and health literature review! This newsletter by the [University of California Center for Climate, Health, and Equity](#) will synthesize hot topics (no pun intended) in the world of climate and health to help you stay informed on clinically relevant literature.

In this first issue, we tackle the health impacts of heat. In the aftermath of the record-breaking heatwave that swept across the American West in late June, increasing [ED visits for heat-related illness in the affected region by 69x](#) and leading to [around 600 deaths in Washington and Oregon](#), heat is on everyone's minds. In this issue, we'll be addressing the mechanisms by which heat harms the human body, how to protect yourself and your patients against its worse effects, and the equity issues at play.

So how does heat affect the body? Heat can directly lead to health effects by causing a range of heat-related illnesses described in the table below (spoiler alert: heatstroke is a medical emergency).

Severity	Heat-Related Illness	Core Temperature	Clinical Signs/ Definition
Mild	Heat stress <sup>17</sup>	Normal	Discomfort and physiologic strain
	Heat cramps <sup>7</sup>	Normal	Muscle cramps (identifiable limp or reluctance to walk) secondary to water and sodium depletion
	Heat exhaustion	Normal to slightly increased (<40° C) or decreased	Weakness, anxiety, and fainting
Severe	Heatstroke <sup>3</sup>	Increased (>40° C)	Central nervous system and cardiovascular depression

Image: [Hemmelgarn & Gannon, 2013](#)

But beyond heat-related illness, heat can lead to organ damage through a variety of mechanisms. [One systematic synthesis](#) identified five physiologic mechanisms affecting organs throughout the body: ischemia, heat cytotoxicity, inflammatory response, disseminated intravascular coagulation, and rhabdomyolysis. These mechanisms are implicated in [increased risk of myocardial infarction](#) 1-6 hours after heat exposure and a relatively new condition- [chronic kidney disease of unknown cause](#) sweeping across international agricultural communities. [One study](#) from JAMA found a statistically significant increase in hospitalizations among older adults on heat wave days for fluid and electrolyte disorders, renal failure, urinary tract infection, septicemia, and heat stroke. And some studies have shown that [air pollution is increased during heatwaves](#), leading to synergistic negative effects on [cardiovascular health in particular](#). Check out our Paper of the Week (more below) for a more detailed breakdown of the organ-system-specific changes in morbidity and mortality.

How do these organ effects and hospitalizations pan out? According to a [recent study in Lancet Planetary Health](#), 0.91% of global excess deaths are heat-related, a number that has increased by 0.21 percentage

points in the last 16 years. And [a recent paper in Nature Climate Change](#) estimates that, across the world, 37% of warm-season heat-related mortality is attributable to human-induced climate change. Without aggressive emissions reductions, the future looks bleak:

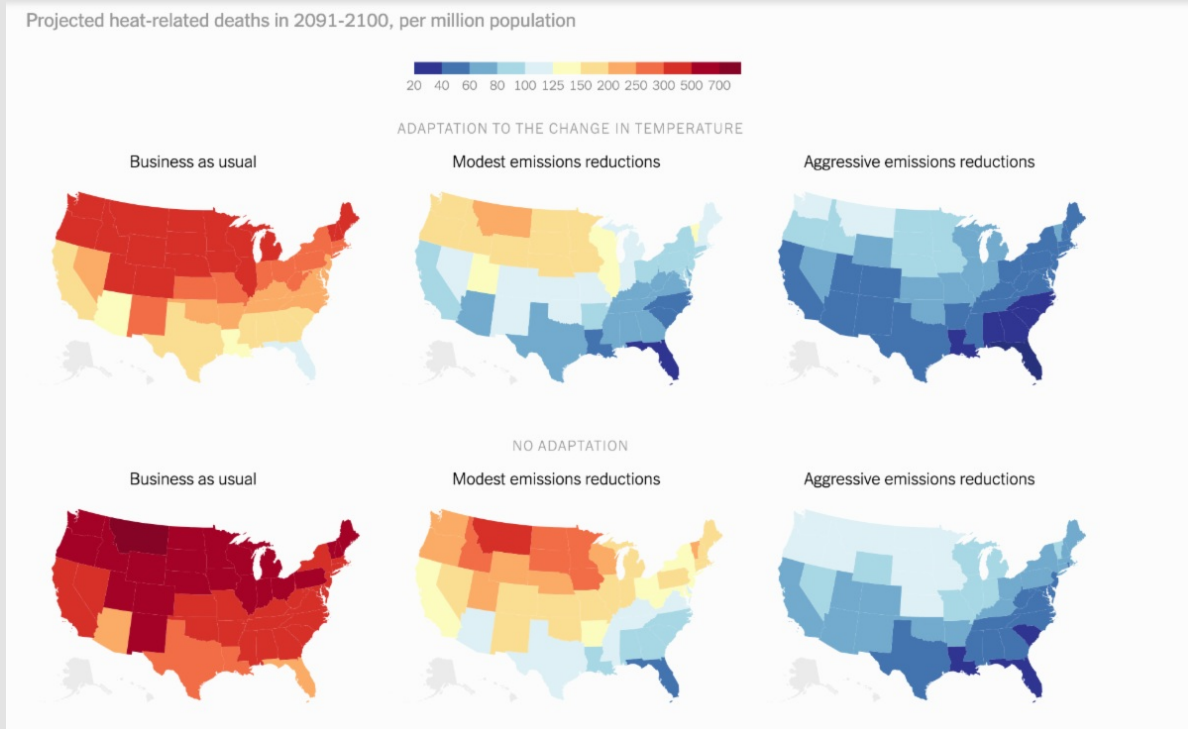


Image: NYTimes

But as the image depicts, adaptation can mitigate deaths. So while it doesn't seem like we will be escaping these heat waves anytime soon, read on to hear about how we can adapt as individuals, clinicians, and health systems.

## Turning up the Heat: Paper of the Week

Our [paper of the week](#), a systematic review and meta-analysis, analyzes the effects of air temperature on mortality and morbidity outcomes among older adults.

Highlighted Paper of the Week

### Effects of Air Temperature on Climate-Sensitive Mortality and Morbidity Outcomes in the Elderly

A Systematic Review and Meta-analysis of Epidemiological Evidence

Bunker A, Wildenhain J, Vandenberg A, et al. EBioMedicine. (2016)



### Main Findings

A 1°C increase in temperature increases:

**Cerebrovascular mortality by 1.40%**  
(95% CI 0.06%-2.75%)

**Cardiovascular mortality by 3.44%**  
(3.18%-4.02%)



A 1°C decrease in temperature increases:

**Cardiovascular mortality by 1.66%**  
(1.19%-2.14%)

**Respiratory mortality by 2.90%**  
(1.84%-3.97%)

 **Respiratory mortality by 3.60%**  
(3.18%-4.02%)



 **Respiratory morbidity by 4.93%**  
(1.54%-8.44%)

## Study Type: Systematic Review and Meta-Analysis

### Inclusion Criteria

Studies focusing on **quantitative effects of temperature on elderly (65+ y.o.)**

**18**

papers on mortality

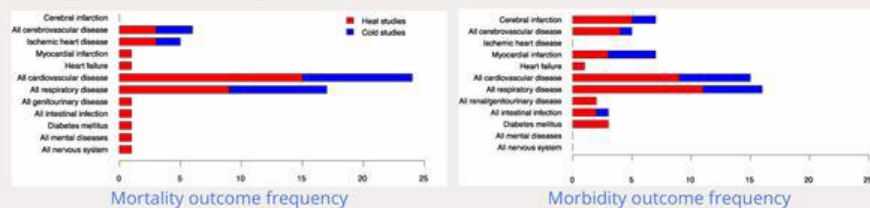
**38**

papers on morbidity

### Potential Study Limitations

- Authors used funnel plots and noted that **the meta-analysis results could be skewed by possible publication bias**
- **Most studies drawn from the "temperate climate zone,"** and may not be representative of populations living in more extreme climates
- Although some mechanisms are proposed, **study cannot definitively pinpoint etiological mechanisms**

### Highlighted Figures



**Figure 3 of the paper** shows the number of studies that demonstrated mortality or morbidity related outcomes for specific causes. Of note are the **high frequency of adverse cardiovascular and respiratory disease outcomes** reported by studies in the meta-analysis.



## Clinician Takeaways

- Widening global temperature ranges increase elderly morbidity and mortality especially through adverse cerebrovascular, cardiovascular, respiratory outcomes (Section 4: Discussion)
- Social determinants of health such as "living alone, multiple comorbidities and high medication use, slow physiological adaptation and behavioural response to thermal stress, limited access to medical care and housing with heating or cooling" are especially relevant to the elderly population (Section 1: Introduction)
- Exposure to extreme temperatures may need to occur over "three or more years/seasons" before correlations with such adverse outcomes are observed (Section 4: Discussion)

Read the full paper [here](#)

## Cold Hands, Warm Heart: Clinician's Corner

**Which patients are at highest risk of heat related morbidity and mortality?** In [one meta-analysis](#), prognostic factors significantly associated with highest risk of death during a heat wave were confinement to bed (OR 6.4), not leaving home daily (OR 3.4), being unable to care for oneself (OR 3.0), as well as preexisting psychiatric (OR 3.6), cardiovascular (OR 2.5), or pulmonary (OR 1.6) illness. Having working home AC, visiting cool environments, and increasing social contact were associated with better outcomes.

**What evidence-based advice should we be giving patients?** A [Lancet review](#) reported that the following commonly offered advice has a strong evidence base:

1. Increase fluid intake during hot weather: In particular, older adults should drink water without waiting for thirst due to a less strong thirst drive.
2. Stay in a cool or air-conditioned place: AC has been associated with a strong protective effect.
3. Wear light garments and shower/bathe frequently: Both activities had a clear exposure-response



association in the 2003 Paris heatwave.

4. Restrict physical activity: Even a 3 degree C increase in core body temperature is dangerous.

5. Medication monitoring: Patients on drugs that can impede heat loss (see below) should be given recommendations on monitoring (e.g. bodyweight measurements).

In contrast, the following frequently touted advice is not well supported by evidence:

1. Use fans to stay cool: In fact, fans have not been associated with improvements in morbidity, likely because they increase the rate of dehydration.

2. Avoid alcohol and coffee: While alcohol does have a diuretic effect and can cause some degree of decreased heart contractility and peripheral vasodilation, low-moderate consumption of low-alcohol beverages (e.g. beer) and coffee/tea is probably okay. Spirits should be avoided.

## "Hot as a Hare, Mad as a Hatter" - Pharmaceuticals and Heat

There are limited studies specifically investigating drug use and heat-related morbidity, though there are some drug classes that are hypothesized to put patients at greater risk of poor outcomes after extreme heat exposure. Be cautious when prescribing the following drug classes during heat waves:

- Diuretics and ACEi (risk of hypovolemia and orthostatic hypotension)
- Antianginal drugs and B-blockers (reduce HR and contractility)
- Laxatives (e.g. lactulose) or drugs that cause vomiting/diarrhea (e.g. colchicine)
- Drugs with anticholinergic effects (e.g. antipsychotics, antihistamines)
- Dopamine antagonists, neuroleptics, and serotonin antagonists (interfere with thermoregulation)
- NSAIDs (decrease renal perfusion)
- Sympathomimetics and thyroxine (increase metabolic heat production)

It's also important to counsel patients that the risks of certain recreational drugs may be higher during heat waves due to impaired alertness and perception of heat (e.g. opioids) and increased heat production (e.g. MDMA).

**What can healthcare workers do?** Talk to patients early (preferably spring and early summer) about common symptoms of heat-related illness and encourage them to seek out cooling facilities or public facilities like libraries if they do not have access to home AC. On a clinic/health system level, consider developing a system to check in with vulnerable patients during heat waves, or adopting a process for emergency recognition and management of heatstroke like the [evidence-based heat alert pathway proposed by this study](#).

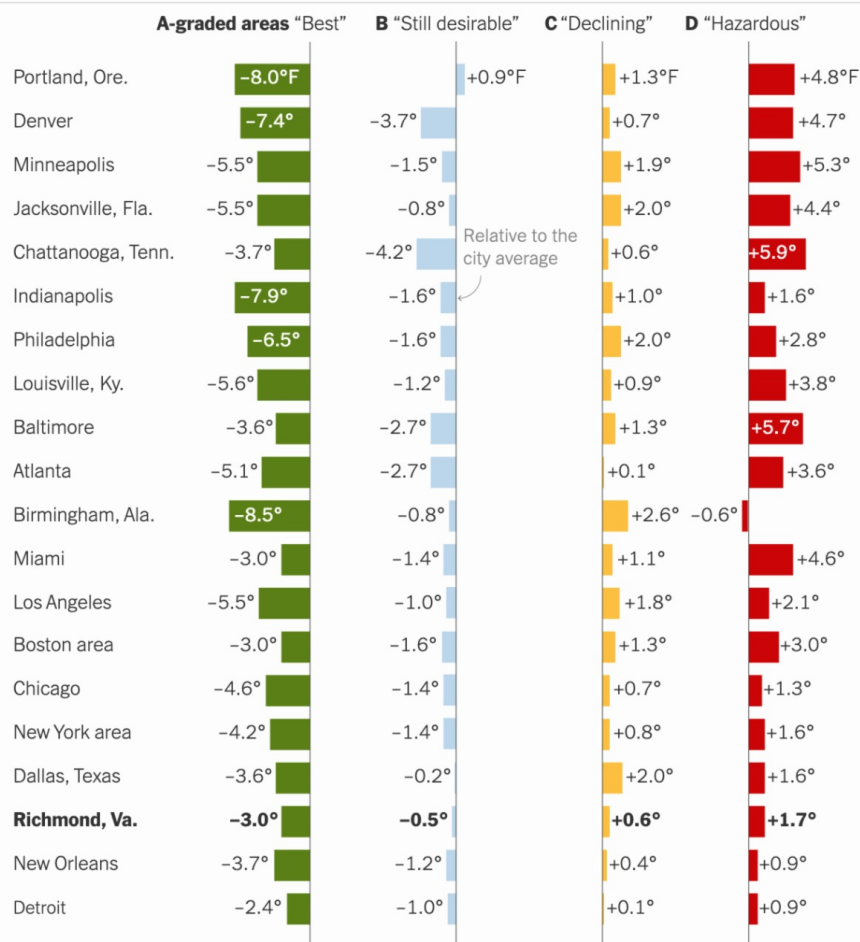
For more information, check out these [excellent toolkits for patients, providers, and caregivers](#) created by the Climate Psychiatry Alliance (available in multiple languages!).

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## Hot Spots: Let's Talk Equity

As with everything in the climate change arena, there are some major equity issues at play when it comes to heat. It is well documented that low-wealth and communities of color are disproportionately affected by extreme heat. For example, [according to one paper](#), those in low-wealth neighborhoods have significantly higher heat exposure compared to those in wealthier neighborhoods in the same city, and in 97% of American cities, the average person of color lives in an area with higher urban heat than non-Hispanic whites. This is due to the urban heat island effect, a phenomenon in which areas in cities with fewer trees and more paved surfaces that absorb and radiate heat (think asphalt) have warmer than average temperatures, sometimes by as much as 7 degrees C. And these variations are rooted in structural racism- in a study of over 100 American cities, [one study](#) shows that on a national scale, land surface temperatures in formerly redlined areas are about 2.6 °C hotter during the summer than in non-redlined areas, with significantly less tree cover.

Here's an image from an incredible [NYTimes article](#) summarizing the paper that shows the lingering effects of historical redlining in America's cities today:



## Hot off the Press: What We're Reading

- [This perspective piece](#) highlights the increasing number of deaths due to chronic kidney disease of unknown origin (CKDu) in regions that have undergone significant climatic changes over the past years. It mostly affects agricultural workers, who are involved in physical labor outdoors under high temperatures, often above 40 degrees C. This exposure can cause daily subclinical kidney injury due to ischemia, temperature-induced oxidative stress, and decreasing intracellular energy stores, eventually leading to impaired kidney function and CKD.
- Rising temperatures impact not only our physical health, but our mental health as well. [This review](#) published in Nature Climate Change found an almost linear relationship between temperature and suicide rates – between 1968-2004 in the US, when the average monthly temperature of a given location increased by 1 degree C, the monthly suicide rate increased 0.68% (95% CI 0.53%-0.83%), with depressive disorders playing a role in almost half of all suicides.
- Heat-related illness management can be especially complicated during the COVID-19 pandemic and may overburden already strained emergency healthcare systems. [This commentary](#) discusses similarities between heat illness and COVID-19 symptoms, including but not limited to hyperthermia, fatigue, headache, myalgia, and dyspnea, which may make it difficult to differentiate between the two conditions. The lack of specific biomarkers to ascertain a diagnosis for either condition further complicates their management. Since COVID-19 cannot be completely ruled out due to the possibility of asymptomatic infection, authors suggest patients presenting with heat illness may needlessly be admitted to negative-pressure isolation rooms, leaving fewer of this vital resource for those with confirmed COVID-19.

## Hot on the Trail: Learn More

- [This recording](#) of last Friday's webinar by the UCSF Climate Change and Mental Health Task Force- "Sizzling Hot: Practical and Advocacy Implications for Health Care Providers".
- [This video](#) from the Royal Society of Medicine reviews hazardous temperatures and cardiac health.
- These podcasts and podcast episodes talk extreme heat in our warming world:
  - The episode "[Casting Shade](#)" about shade inequity, health, and spatial justice from the

podcast "Not Built for Us", produced by a medical student at Brown.

- Climate Centre Today's new podcast "[Can't Take the Heat](#)" by Roop Singh, provides a detailed look at heatwaves and how people are adapting to a warming world.
- The episode "[Extreme Heat in the News, Naming Heat Waves, Thermal Equity, and more with Dr. Ladd Keith](#)" from "America Adapts: The Climate Change Podcast" about the choices we face due to climate change and the people who make them.

[Access our Zotero literature repository here](#)

[Learn more at the UC Center for Climate, Health, and Equity website](#)

*This newsletter was created by Karly Hampshire, Sigal Maya, Lawrence Huang, and Sophie Genigeorgis on behalf of the UC Center for Climate, Health, and Equity.*