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Testimony of:
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Thank you to Chairwoman Maloney, Ranking Member Comer, and members of the Oversight and Reform committee for holding this hearing and inviting me to testify on this critical topic.

I testify before you as a practicing emergency medicine doctor who is here representing my patients. The statistics I present here today have faces and names – and represent stories of the patients that I see in my emergency department. I want to bring these patients stories to you, as the decisions you make in these halls of power shape the health and well-being of everyone in the United States.

For too long, we have been more inclined to see the harms of climate change in melting ice caps and starving polar bears, than in the faces of our children, our aging parents and our neighbors. We now know that climate change matters to the health of all of us and is particularly a threat to the welfare of those least able to cope – the young, the old, the poor and many people of color.[1-4] The harms to our health represent the true – and too often hidden – human cost of climate change.

The Climate Crisis and My Patients

For example, two patients of mine – very different in many respects – were joined together by one common vulnerability, both faced death from heat stroke – the most severe form of heat illness.

The first was a vibrant, young and otherwise healthy construction worker who was working two jobs to support his growing family in record-breaking heat in Boston. By the time he arrived at my emergency department, his organs were already failing as we rapidly tried to cool him.

His story makes clear; climate change spares no one – not even a young man in excellent health.

The second was an elderly man whose wife called 911 because he was acting confused. The emergency medical technicians said that when they opened the door to their apartment, they were hit by a wave of heat that felt like the Sahara Desert. The apartment had no air conditioning and had only one window cracked open. The man's core temperature was 106°F. When I tell this

story, I often wonder about his wife who remained in the apartment that day while her husband was taken to the hospital.

His story highlights the unique vulnerability of the elderly and poor, and her story of those left behind.

Heat waves rarely make the kind of dramatic headlines that other climate-sensitive events like hurricanes can because patients often die silently in their homes, but they are the deadliest extreme weather events we face.[1,5] As global temperatures rise, heat waves are becoming more intense, longer, and more frequent.[2,4] A 2006 heat wave in California caused over 16,000 excess visits to emergency departments and nearly 1,200 excess hospitalizations.[6] Record high temperatures in Wisconsin in 2012 from mid-June to mid-July led to an estimated $251.8 million dollars in health costs.[7]

As my patients' stories illustrated, everyone is susceptible to heat-related illness, and vulnerable populations suffer most.[1-4] Outdoor workers are especially at risk for harms and many lack essential protections to keep them safe, as outlined in the extended case study in the 2019 Lancet Countdown on Health and Climate Change Policy Brief for the United States of America Appendix [see appendix].[2] In 2018, 64.7 million potential labor hours were lost, and Southern U.S. states lost 15-20% of possible daylight work hours in direct sun due to the extreme heat exposure in July 2018, which was the hottest month of the year.[2]

Another patient of mine was a 4-year old girl who presented to my emergency department on an overnight shift after multiple visits that week for asthma attacks. As she was waiting to be transported upstairs, her distraught mother shared her feelings of helplessness at being unable to protect her daughter from the high pollen levels in the Greater Boston area.

Climate change is contributing to longer and more intense pollen seasons, a known trigger for allergic conditions and respiratory diseases like asthma.[3] In 2010, the allergen oak pollen was linked to over 21,000 visits to emergency departments in the Northeast, Southeast, and Midwest with an estimated price tag of $10.4 million.[8] Climate change is expected to increase the number of these visits by 5% by 2050 and 10% by 2090.

Lastly, I treated a patient who came directly to Massachusetts General Hospital from Boston Logan Airport after leaving Puerto Rico following Hurricane Maria. She sat in the exam room with her luggage in tow and thrust a Ziploc bag at me with empty medication bottles. Her home had been destroyed, and she had not had access to her medications in weeks. Now in Boston, she had no plans on where to go and no access to health care other than the emergency department.

Oftentimes we think about climate refugees in far off lands. However, the climate crisis is also already displacing citizens within the United States as a result of the climate change-driven intensification of extreme events like hurricanes, flooding, and wildfires, which are also increasingly likely to co-occur in the same place and at the time.[3,9-11] Overall, hurricanes are getting stronger, wetter, and slower as a result of climate change leading to more destruction. Hurricane Maria was intensified by warmer ocean temperatures.[12-14] Individuals from Puerto Rico were displaced to most, if not all 50 states following Maria.[15] The U.S. Census Bureau also

found that approximately 142,000 Puerto Ricans left in 2018 with the majority moving to the mainland U.S., nearly a third more than in 2017.[16]

The Broad Health Implications of the Climate Crisis

These patient cases provide just a few examples of the broad array of ways the climate crisis harms health (e.g., vector- and waterborne diseases, decreased nutrient content in crops, harmful algal blooms, and degraded air quality through wildfire smoke and ground level ozone), affecting nearly every organ system directly or indirectly through pathways that are well described in the literature [see appendix for the 2019 *New England Journal of Medicine* interactive Perspective by Salas and Solomon].[4,17]

I often describe our understanding of climate change as an iceberg. Though we see the mass of ice above the surface of the water, there is a much larger mass underneath - the health effects that we haven't yet identified. To hint at the mass beneath the surface, we can turn to extreme heat - perhaps our best understood example of how climate change harms health. Recently, emerging evidence suggests that extreme heat may be linked to rising bacterial resistance to antibiotics, cognitive impairment, worsening mental health – and rising rates of congenital heart disease, suicide, and diabetes.[18-24] Mental health challenges from the climate crisis, which are inherently difficult to quantify, range from what has recently been termed "eco-anxiety" to new mental health concerns following exposure to extreme events to exacerbation of existing disease.[4,25]

Even broader health impacts - with significant implications for health and health care systems - stem from other societal impacts of the climate crisis. Globally, the climate crisis is linked with increasing the number of people experiencing poverty, with an additional 100 million predicted by 2030.[26] The poor, already more susceptible to the health threats of the climate crisis, can get trapped in this vicious cycle of poverty.[27] The climate crisis also leads to population movement, which interacts with poverty and creates disruptions to health care delivery. As pathways that connect climate and health grow and shift, we can expect corresponding alterations to domestic human migration patterns as a result of climate change. The U.S. Environmental Protection Agency predicts climate change will lead to population migration away from the Great Plains and Southeast Gulf states with increased gains along the coasts and Midwest.[28]

It is anticipated that health care costs will increase due to more illness and a subsequent increase in health care utilization and treatments. For example, data on ten climate-sensitive events in the United States in 2012 - ranging from hurricanes to harmful algal blooms - were estimated to cause an excess of nearly 21,000 hospitalizations and $1.5 billion in excess health care utilization.[7] Within that study, the researchers report that a West Nile Virus outbreak in Texas led to $91 million in hospital admission costs and $151.9 million in emergency department visit costs. It is estimated that the climate-attributable cases of the West Nile Virus will cost $1.1 billion in total by 2050.[28]

The Climate Crisis, Public Health, and Geographic Variation

Public health systems are critical to preventing health harms, yet as also exposed by the COVID-19 pandemic, they are underfunded and lack the nuanced evidence-based understanding required to adequately prepare for the climate and health challenges of today, let alone tomorrow. We also know that the broad geographic diversity of climate change in the United States means that different parts of the country experience difference exposures that harm health. For example, the Northeast is facing rising Lyme disease cases, Western states are suffering increased health harms of wildfire smoke, and Central states are experiencing more dramatic flooding as they did in 2019.[3,4]

Yet, even universal health threats like extreme heat vary by geographic region. For instance, the peak in hospitalizations for heat-related illnesses occurs at around 80ºF in the West and Northwest, while the peak in the South occurs at about 105ºF.[29] These variations stress the importance of having a data-driven understanding of how the climate crisis harms health locally, in addition to the national common themes. Unfortunately, heat alerts were often found to be going out after the peak of hospitalizations occurred.[29] In the Central region, this was occurring at nearly 20ºF above the peak. Exhibiting both the power of data, and the importance of public health – Northern New England and New York lowered their thresholds for heat alerts with New York City observing a reduction in heat-related illness in the elderly.[2]

The implications for public health are further explored in the 2018 and 2019 Lancet Countdown on Health and Climate Change Policy Brief for the United States of America [see appendix].[1,2]

The Climate Crisis, Clinical Practice, and Health Care Delivery

When public health systems lack the ability to prevent harm, it increases climate-related disease burdens that flow into the health care system. Climate change is making it harder for me to do my job – which is to prevent harm and improve health - and disrupting health care delivery systems [see appendix for the 2020 *New England Journal of Medicine* Perspective by Salas].[30] Nearly all of the climate exposure pathways could lead an individual to the doorsteps of my emergency department.

Often times, we try to look at historical data in medicine to get a sense for the future. For example, I always review any prior urine cultures before prescribing antibiotics for a urinary tract infection. Yet, we can no longer rely on a rear-view mirror to map out the health harms of our patients because the climate crisis is creating an unprecedented future that looks nothing like our past.

The medical community is increasingly engaging on the topic of how the climate crisis is impacting clinical practice, especially given the disruptions to health care delivery and the anticipated continued understanding of new health harms. This led my colleagues and I to launch the Climate Crisis and Clinical Practice Initiative in collaboration with the *New England Journal of Medicine* and Harvard where we held an inaugural symposium in Boston that brought together every major hospital system in the city in February 2020.[30-32] Through this Initiative, working with experts and hospitals around the country, we are seeking to build expert consensus and a

research agenda that outlines what we know and what we need to know in order to better understand how we in health care must adapt our clinical practice across every specialty. This, for example, can range from triage protocols, screening questions, treatments, and patient education – tailored for each climate exposure pathway, unique geographic vulnerabilities, and the local health care context.[30] For example, medications, especially those prescribed for cardiovascular or psychiatric use, may increase an individual's risk of heat-related illness.[33] In addition, certain life-saving medications, such as epinephrine or albuterol, have been found to have decreased efficacy when exposed to extreme heat.[34-36] These examples reinforce the need to add a climate lens to all we do in medicine.

Health care systems themselves are vulnerable to disruption from climate-sensitive events, leaving them at higher risk to being unable to provide high-quality care during a community's greatest need or being forced to close due to catastrophic infrastructure damage. Hospitals have closed from wildfires in the West, floods in the Central region, and hurricanes along the coast. The experience of hospitals in Florida following Hurricane Michael provides a vivid example.[37] These disruptions can result in significant revenue losses; New York University (NYU) Langone, as an example, had an estimated $1.4 billion loss in 2012 from Hurricane Sandy.[38] Damage that extends to other critical extensions of the health care system, such as outpatient pharmacies, can further amplify health care disruptions.

Power outages, more common from both heat and the intensification of extreme weather, leave physical infrastructure intact but create low resource environments in otherwise high resource hospitals.[3] Recently, 250 hospitals lost power in California due to wildfire prevention measures.[30,39,40] Typically, back-up power generation only supplies a subset of the needs, creating potentially dangerous heat exposure impacting, for example, patients, health care workers, equipment, and medications or vaccinations. A hospital near Boston lost power last year during an approximately 90°F day and was forced to evacuate patients from the upper floors and had overheated equipment that was still impaired even after power was restored.[41]

Even if a facility remains open, patients may not be able to access care due to disruptions in transportation through personal travel vehicles (e.g., loss of car) or community infrastructure (e.g., road blockages, public transportation disruption, loss of cell phone access, lack of access to EMS). Following Hurricane Maria, nearly a third of households reported disruptions including an inability to access medications (14%), utilize medical equipment that required power (10%), access health care facilities due to closures (9%) or doctors (6%), access emergency medical services by phone (9%).[42]

If patients can reach care at operable facilities, potential disruptions to care provision still exist. Health care in the United States depends on global supply chains, which have been increasingly shown to be vulnerable.[43] The national shortage of intravenous saline following Hurricane Maria exemplifies how even common medical treatments are vulnerable, let alone the personal protective equipment shortages of the COVID-19 pandemic occurring without significant additional climate stressors.[1,44,45] Following Hurricane Maria, there was an intravenous saline shortage that touched my hospital in Boston and as a result we had certain guidelines for who could receive this treatment. If my patient didn't meet the guidelines, I treated them by providing Gatorade. You can imagine a patient's surprise.

Extreme weather events can also create shortages of health professionals due to injury, displacement, or personal needs following these incidents. This occurred for over 200 Kaiser Permanente employees in the wake of the 2017 California wildfires and at NYU Langone following Hurricane Sandy in 2012.[46]

The downstream impacts to health are anticipated to be significant as health care is disrupted for patients.[47,48] Hurricane Maria led to a 62% increase in mortality compared to one year prior and about a third of these deaths are attributable to disrupted care.[42] In addition, it was recently shown that patients who had their radiation treatments for lung cancer disrupted as a result of hurricanes had decreased survival.[49]

These disruptions are now layered on top of the financial stress hospitals have faced during the COVID-19 pandemic. More than 120 rural hospitals have closed in the past decade and rates of closure are only increasing, with 18 rural hospital closures in 2019 alone.[50] Before the COVID-19 pandemic, 25% of rural hospitals were at risk of closure.[51] The pandemic will only exacerbate these risks. Through April of this year, 10 rural hospitals have already been forced to shut down due to financial challenges.[50] In the 17 days following the signing of the CARES act, two rural hospitals closed and two others announced plans for closure.[52] Not only has the COVID-19 pandemic created financial vulnerabilities for rural hospitals, it has also uniquely threatened safety-net hospitals, which primarily serve low-income communities and people of color, a population that has been disproportionately impacted by the virus itself.[53]

The Climate Crisis is a Metaproblem and Threat Multiplier: Reflections on the COVID-19 Pandemic and Health Inequities

The climate crisis is both a "metaproblem" – meaning it underlies other problems – and a "threat multiplier" – meaning it makes existing problems worse. This means that climate change touches everything and is creating barriers to successfully tackling the nation's most pressing health challenges of today, including the COVID-19 pandemic and health inequities [see appendix for the 2020 *New England Journal of Medicine* Perspective by Salas, Shultz, and Solomon]. In addition, the health harms of climate change are also intertwined with the burning of fossil fuels, which creates both dangerous air and carbon pollution.

The Climate Crisis and the COVID-19 Pandemic

The parallels between the COVID-19 pandemic and the climate crisis are clear, inaction on science that can prevent health harms will lead to illness and death, especially for the most vulnerable [see appendix for the 2020 opinion in the *British Medical Journal* by Salas].[54] But additionally, the climate crisis is making it harder for us to optimally respond to the pandemic through difficulty maintaining physical distancing, forced displacement, exacerbation of coexisting conditions, and disruption of health care services.[11]

In a recent article in the *New England Journal of Medicine* that I was first author on, my colleagues and I outline that those most at risk for sickness and death from heat – and affected by the other harms of climate change – are the very people who have been shown to be more at risk

of getting infections and dying of COVID-19 and suffering health inequities. Meanwhile, carbon and air pollution from fossil fuels are causing more of – or worsening – the very underlying medical problems that increase risk of death from COVID-19.

The climate crisis, which is intensifying extreme weather like heat waves, hurricanes and wildfires, is making power outages more likely and forcing us from our homes and to travel or congregate with others. The pandemic is sending critical ill COVID-19 patients to already overwhelmed hospitals, yet the ability of these hospitals to function and provide care is being increasingly disrupted by the climate crisis, as outlined above. If people stay quarantined in their home – to try to protect themselves from the coronavirus – they may get sick or die from heat if they don't have access to a cool environment. Even people who do have access to cooling like air conditioning may lose it during a power outage or may not be able to afford to use it. If they do leave their homes – they may find that cooling centers are not open and the usual air-conditioned public spaces are closed. Even if they find them open, they run the risk of contracting COVID-19.

These are impossible choices for people.

We outline short- and long-term strategies for local communities and state agencies to help protect people and call on the federal government to provide more coordinated policy and funding. The ones we outline are not exhaustive, but are meant to highlight the types of solutions we need.

For example, we need to ensure that cooling centers are available and open. We also need to modify usual procedures with safe practices like limiting occupancy, while also ensuring enough sites to accommodate everyone, mask wearing, ample hand sanitizer, and physical distancing. We can also provide electricity subsidies and extending moratoriums to prevent electricity and water shutoffs during extreme heat so people can remain safely at home.

In the long-term, investments in making communities cooler and more resilient to climate change, like adding greenspace and white roofs, are critical for keeping people safe within their residences during pandemics. We also need to continue to innovate our health care systems, like using community paramedicine to screen and protect people vulnerable to heat at home.

The Climate Crisis and Health Inequities

I chose emergency medicine because I have the privilege of treating whoever walks into my department – and it is a beautiful palette of humanity every shift – from the homeless to professional sports players – because every life is equally valued and provided equal care. Yet, climate change, just as the COVID-19 pandemic, is not felt equally. Minorities and low-income communities disproportionately bear the brunt of the health harms of climate change even though they contribute less to the very carbon pollution that harm them most.[2,4,55,56]

For example, Black and Latinx communities are exposed to higher levels of particulate matter air pollution, 21% and 12% more respectfully, than white communities.[55] Those who live in counties that have more low-income, less educated, and higher proportions of Black residents

have lower lifespans due to particulate matter exposure.[57] Racial minorities are also more likely to live in areas of the city that are hotter, increasing their risk for heat-related illness. Blacks are 52% more likely to reside in areas that are prone to heat-related risks, as are non-Hispanic Asians (32%), and Latinx populations (21%).[58] Evidence also suggests that historic redlining may be contributing to this disproportionate heat exposure.[59]

Example Suggestions for a Path Forward to Address the Climate Crisis to Protect Health and Advance Health Equity

The COVID-19 pandemic has made health central to decisions across nearly every sector in an unprecedented way during modern times. Similarly, health must be central to our discussions on climate change because the medical diagnosis is clear – air and carbon pollution fueling climate change are harming us. Discussion of climate policy should include the perspective of health benefits and health costs. For example, the National Oceanographic and Atmospheric Administration's calculations for the costs associated with billion-dollar weather and climate disasters should include the health costs. Thus, this hearing, and its important framing on health, is critical.

As an emergency medicine doctor, I can never take just one health problem and place it in isolation in my practice. One insult on the body creates new problems and worsens old ones, just like climate change. We have to address all of these problems together – from the climate crisis to the COVID-19 pandemic - through innovative, cohesive, multi-disciplinary solutions that recognize that they are all interconnected and mandate an integrated agenda.

When a patient is critically ill and crashing in front of me, I give that patient every treatment that may save their life. The same is true for this crisis - we need to boldly and urgently implement solutions together. With critically ill patients, there is also often a narrow window when treatment works. If we don't act quickly, the patient may still die even though the treatment would have saved their life earlier. We are in that narrow window for the climate crisis. Climate scientists have clearly outlined that those of us alive today have the profound responsibility of being the ones that have to swiftly act and reduce our greenhouse gas emissions over the next decade.[60]

Reducing our greenhouse gas emissions by reducing our reliance on fossil fuels – also called mitigation – will improve health immediately. As an example for how quickly air pollution can improve – thus exhibiting the immediate benefits – we experienced a 17% reduction in greenhouse gas emissions worldwide with the slowed activity caused by the pandemic, with marked decreases in air pollution.[61,62] While it will benefit everyone, it will disproportionately benefit vulnerable populations.

Even if I could snap my fingers today and stop all greenhouse gas emissions, the carbon pollution already in the atmosphere locks us into continued warming. Thus, to prepare our public health and health care systems, the federal government must ensure they have the financial resources and the evidence-base to adapt and be resilient for what lies ahead, especially as compounding challenges arise. Our current investment for these types of integrated responses is far from adequate. Only 5% of all climate adaptation investments in the United States went to the

health care sector in 2016.[1,63] Financial investments at all levels – local, state, and federal - are required, but future federal stimulus packages can be an immediate platform.

In addition, there is a paucity of funding to support work in this space without promotion and facilitation of the multidisciplinary approach that is required. Unprecedented challenges require unprecedented solutions. We must recognize the complexity and encourage and facilitate multidisciplinary research and collaboration, especially between federal agencies. For example, the National Science Foundation could put forth funding for trans-disciplinary efforts to comprehensively understand the nexus of climate change and health. Generating further evidence will build upon our existing base to allow us to better understand these issues and optimally guide our preparation.

Please see the 2018 and 2019 Lancet Countdown on Health and Climate Change Policy Briefs for the United States of America for more detailed recommendations [see appendix].

Closing

As members of Congress, you have the power to create real, upstream solutions that can address the root causes of climate change and help build the health systems that could prevent illnesses or death in my patients.

The COVID-19 pandemic has placed health central in our society unlike ever before in modern times, and it has exposed our underfunded public health infrastructure and fragile health care systems.

More importantly, it has shown us that when we ignore the science and delay action, people die.

I am here to urge you to make health the driver of climate action, to set aside your differences and agree that health is common ground that we can all stand on, and to collectively vow to learn from the suffering and loss of our current moment to avoid the same mistake with the climate crisis.

Thank you for your time.

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Appendix

Document 1
Salas RN *et al*, The Climate Crisis and Covid-19 —A Major Threat to the Pandemic Response, The *New England Journal of Medicine*, 2020

Document 2
Salas RN, Lessons from the Covid-19 Pandemic Provide a Blueprint for the Climate Emergency, The *British Medical Journal*, 2020

Document 3
Salas RN, The Climate Crisis and Clinical Practice,
The *New England Journal of Medicine*, 2020

Document 4
Salas RN *et al*, The Climate Crisis — Health and Care Delivery,
The *New England Journal of Medicine*, 2019

Document 5
2019 Lancet Countdown on Health and Climate Change: Policy Brief
for the United States of America

Document 6
2019 Lancet Countdown on Health and Climate Change Policy Brief
for the United States of America: Appendix

Document 7
2018 Lancet Countdown on Health and Climate Change Brief
for the United States of America

The NEW ENGLAND JOURNAL of MEDICINE

Perspective

The Climate Crisis and Covid-19 — A Major Threat to the Pandemic Response

Renee N. Salas, M.D., M.P.H, James M. Shultz, Ph.D., and Caren G. Solomon, M.D., M.P.H.

Just as an active 2020 Atlantic hurricane season is getting under way, the entire U.S. hurricane coast, from Texas to the Carolinas, is witnessing explosive outbreaks of Covid-19 cases in communities where physical distancing restrictions have been eased. As an early wake-up call, Tropical Storm Cristobal made landfall in Louisiana on June 7, triggering coastal evacuation orders and a federal emergency declaration. Concurrently, temperatures continue to set records throughout the southern United States, while Arizona has been battling multiple historic wildfires that are also requiring communities to evacuate their homes. All this as summer had just begun.

These events suggest that the United States will increasingly face complex, challenging scenarios, given the confluence of our two most pressing global health threats — the rapid emergence of the Covid-19 pandemic and the insidiously evolving climate crisis. Both these crises disproportionately harm the health of vulnerable and economically disadvantaged people, including those affected by structural racism. Understanding the challenges posed by this conjunction is essential if we are to devise effective and equitable strategies to protect and improve health. Attention must be directed toward key pathways through which the climate crisis threatens efforts to contain SARS-CoV-2 transmission and improve Covid-19 outcomes, which include difficulty maintaining physical distancing, exacerbation of coexisting conditions, and disruption of health care services.

The intensity, frequency, and duration of climate-related extreme events — including hurricanes, wildfires, floods, heat waves, and droughts — are increasing, and these events often overlap temporally and geographically,[1] jeopardizing SARS-CoV-2 infection control. Both the Atlantic hurricane and western wildfire seasons are predicted to be worse than average in 2020. But proven standard disaster mitigation strategies — mass sheltering and population evacuation — increase the risk of viral transmission by moving large groups of people and gathering them close together. For example, evacuation orders were issued for more than 1 million people during Hurricane Florence in 2018. Covid-19 health risks are even greater when weather events are more intense, since widespread catastrophic damage results in mass displacement, which risks introducing the virus into new locales and clustering vulnerable survivors together in temporary accommodations.

No other year in recorded history has been as hot as the years between 2014 and 2019, and 2020 has a high likelihood of being the hottest year ever. Despite the hypothesis that higher temperatures and humidity might reduce SARS-CoV-2 transmission, Covid-19 cases are increasing rapidly throughout warm southern states, confirming expert predictions.[2] Extreme heat poses additional challenges to Covid-19 mitigation efforts. For example, wearing a face mask, especially an N95, is uncomfortable in high heat and humidity and may exacerbate risks for heat-related illnesses[3]; conversely, not wearing a mask increases the likelihood of spreading Covid-19. During heat waves, cooler indoor venues, including designated cooling centers, may become crowded with residents from households lacking air conditioning or facing heat-related electrical blackouts.

Cardiovascular and chronic pulmonary disease — recognized risk factors for severe Covid-19 — are closely linked to climate change, through effects including extreme heat, ground-level ozone, wildfire smoke, and increased pollen counts over longer seasons.[4] Moreover, fine particulate matter air pollution — linked to combustion of fossil fuels — increases the prevalence of both conditions. Marginalized groups are at higher risk than others for exposure to high levels of air pollution and associated chronic illnesses, as well as for Covid-19–related illness and death. Recent unpublished data have suggested direct associations between long-term exposure to particulate air pollution and risk of Covid-19–associated death.[5]

Climate change also complicates the ability of patients with Covid-19 to gain access to and receive the best available health care services. Heat waves and climate-related disasters may generate a surge of "climate casualties" seeking care in facilities already filled with Covid-19 patients.[4] Conversely, health care access for these patients may be acutely compromised in the aftermath of climate-driven extreme events, owing to physical damage to facilities, power outages, supply-chain disruptions, and depletion of staff — leading to cascading disruptions of services.

Our responses in the United States to climate change over recent years and to the Covid-19 pandemic over recent months have been inadequate and dangerous, disproportionately harming the most vulnerable communities. Both responses have been characterized by delayed and disjointed government action, denigration of scientific evidence, distortion of truth, withdrawal from critical global alliances, and reliance on antiquated public health infrastructure and fragile health care systems. To effectively manage both crises, we need an integrated response, firmly grounded in science, that values health as a fundamental right for all. As we collectively reimagine an equitable, all-hazards-responsive health infrastructure, we will need to take concrete actions focused on the key intersections between climate change and the Covid-19 pandemic.

In the short term, to minimize the transmission of SARS-CoV-2 during climate-intensified extreme weather events, standard sheltering, evacuation, and related strategies will have to be modified (see box). Long-term actions, with implications for future resiliency, include prioritizing federal and state funding for mitigation plans to prepare for a future of climate-driven intensification of extreme weather and superimposed events, using an approach that takes all hazards into account.

During extreme-heat events, interventions are needed to ensure that the people who are most susceptible to both heat-related illness and severe Covid-19 disease can either remain at home safely or have safe cooling options. More sustained approaches include alterations in the built environment (e.g., expanding green space, making more roofs white) and community outreach programs for the most vulnerable.

Ongoing adaptations and transformations in health care delivery, prompted by the Covid-19 pandemic, can also be effectively applied to climate-driven extreme events. In particular, the expansion of telemedicine — in areas where computer or phone service is intact — and the use of community paramedicine services can improve our ability to address medical and psychological needs, and minimize SARS-CoV-2 exposure, for people who cannot readily obtain care. Investments in strengthening our health care infrastructure and delivery systems, such as supply chains, are also essential to ensuring resiliency during pandemic or climate shocks.

Though evidence-based guidance from federal agencies is important and would be welcome, implementation of strategies at the state and local levels requires capacity, coordination, and attention to subnational needs. Given that states were forced to reprioritize budget allocations because of the pandemic, facing the chal-

Short-Term Strategies for Managing Climate-Related Extreme Events during the Covid-19 Pandemic.

Extreme events (e.g., hurricanes, wildfires): evacuation and sheltering

- Communicate clearly to the public that the Covid-19 pandemic does not change the imperative to evacuate, given the substantial risks of remaining in place during extreme climate-driven hazards.
- Use existing community pandemic-communication channels to disseminate critical information.
- Increase the number of available shelter sites, with lower occupancy per site, more separated spaces within sites, and more space per shelter resident (e.g., using smaller "noncongregate shelters," hotels).
- Use standard shelter-registration information (name, contact phone number) for all persons entering, to facilitate contact tracing in case Covid-19 is diagnosed in persons who used the shelter.
- Implement shelter protocols for infection control, including daily symptom checks, isolation of symptomatic persons, mandatory wearing of face masks, ample supplies of hand sanitizer, hand-washing stations, and meals provided in disposable containers.
- Adapt guidance for minimizing Covid-19 viral transmission in mass care settings for use with in-home sheltering — because many evacuees shelter with family and friends.

Extreme heat: remaining at home and cooling locations

- Provide electricity subsidies and extend moratoriums to prevent electricity and water shutoffs for people with pandemic-related unemployment and economic hardships to allow them to remain in their homes.
- Ensure effective alternatives to minimize heat exposure if designated cooling centers or popular indoor, air-conditioned venues are closed.
- Ensure that cooling centers follow guidelines similar to best-practice guidelines noted above.
- Minimize transmission risks by limiting occupancy and providing or requiring masks and hand sanitizer in air-conditioned venues open to the public, such as malls or movie theaters.
- Use phone text messages, as used for pandemic communication, for heat-health notifications.

lenges ahead will require coordinated federal policy and dedicated funding.

In recent months, the increasing worldwide attention to the urgency of addressing climate change has been sidelined by the pandemic and the critically needed reckoning on racial inequity. Yet the interconnectedness of these challenges underscores the need for integrated policy initiatives. As emphasized in a letter from 40 million health professionals to G20 leaders, governments must prioritize investments in health, clean air and water, and a stable climate in stimulus packages for recovering from the Covid-19 pandemic.

Reductions in greenhouse-gas emissions and air pollution that were observed while globally applied lockdown measures were in force to slow the spread of Covid-19 are proving to be temporary. Interventions to create sustained reductions in the use of fossil fuels can reduce the risks for multiple medical conditions — especially in vulnerable communities — by improving air quality and limiting the downstream health harms of the climate crisis.

Until the development and mass deployment of a safe and effective vaccine enables the United States to move past the Covid-19 pandemic, the climate crisis will challenge our pandemic responses; beyond the pandemic, the climate crisis will continue to pose existential risks. It is past time to implement robust and equitable responses to both.

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thebmjopinion

Renee N. Salas: Lessons from the covid-19 pandemic provide a blueprint for the climate emergency

April 23, 2020

Two essential clinical principles have guided my practice as an emergency medicine doctor. First, I must use whatever information is available to predict and prepare for my patient's next potential crisis, such as identifying my back-up intubation plan from the start. The second is that treatments often must be implemented in a certain window for optimal efficacy; timely intervention is critical.

For the covid-19 pandemic, these two principles were ignored as the United States federal government dismissed early evidence that coronavirus was a global threat and failed to prepare the country—thus missing the optimal window to intervene. As a result, the U.S. currently has the highest death toll in the world.

Unfortunately, the U.S. has also not pursued meaningful federal action on the climate crisis despite overwhelming evidence and harms to health through a frighteningly broad array of pathways—such as heat waves, intensification of extreme weather, and vector-borne diseases. Indirectly, it also disrupts the delivery of healthcare and impacts clinical practice. While this already contributes to significant morbidity and mortality, we are still within a window of action to minimize harm and save lives.

Three lessons have emerged from the pandemic that can serve as a blueprint for the medical community's response to the climate crisis: health professionals must use their voices as trusted sources; prevention must be prioritized; and a rapid, coordinated global response is essential.

Health professionals must use their voices as trusted sources

We are in an era where science is often disregarded, even when it can guide timely, life-saving decisions. In the case of covid-19, misinformation smothered the alarms—feeling eerily reminiscent of the backlash climate scientists have been facing for decades. The repercussions are human suffering and lives lost.

Health professionals are serving as trusted voices in this pandemic, adding crucial narratives to the numbing statistics and neutralizing dangerous misinformation. The same is needed for the climate crisis. Physicians have been shown to be the most trusted source of information for climate change and health, while nurses are consistently the most trusted professionals. Our voices prioritize the health benefits of climate action, and our patient stories add the necessary context.

Prevention must be prioritized

The covid-19 pandemic, just like the climate crisis, reinforces the essential need for resilient public health systems by exposing the limitations of medical treatments and the fragility of our healthcare systems. When covid-19 is ravaging the lungs of my patient, all I can offer is supportive care. Treatments for diseases exacerbated by the climate crisis can also be limited; treating an asthma exacerbation from rising pollen doesn't remove the cause.

Even further challenges arise if care delivery is compromised. For covid-19, this includes capacity concerns and the lack of vital resources like personal protective equipment, testing, and ventilators; for the climate crisis, unprecedented heatwaves and extreme weather jeopardize infrastructure, power grids, and supply chains. This places prevention as the utmost priority.

Preventive efforts in the pandemic to "flatten the curve", such as social distancing, have been critical as we optimize other public health resources and increase hospital resiliency. For the climate crisis, prevention means reducing carbon emissions and air pollution from the burning of fossil fuels. This intervention improves health, saves lives, and reduces burdens on the healthcare system. If this isn't enough motivation, in contrast to social distancing, reducing greenhouse gas (GHG) emission can create jobs and be cost–effective. Thus, the medical community must advocate for prevention here just as it has in the pandemic.

A rapid, coordinated global response is essential

This pandemic serves as a poignant reminder of just how interconnected our world is. We are united in a shared vulnerability to this invisible pathogen, just as we are for the unseen GHGs. Both crises are exacerbating underlying inequalities as vulnerable communities—from particular sub-populations to entire countries—bear the brunt of harm. Mismanagement of the pandemic in one country threatens lives in another, just as GHGs can exert their deadly effect halfway around the globe.

Synchronized global and national action is significantly more effective than uncoordinated subnational responses, whether for ventilator procurement or reducing reliance on fossil fuels. Urgent, coordinated responses provide the optimal path out of both the global pandemic and the climate crisis, utilizing a multi-disciplinary approach that includes health professionals.

The importance of the medical community, and our inherent responsibilities as public servants, is perhaps the clearest it has been in modern day. Yet even as I battle the covid-19 pandemic on the frontlines, my guiding principles compel me to continue to strive for preventive action on climate. Although the U.S. failed to act in January on the pandemic, we are still in the "January" equivalent for the climate crisis. These lessons can serve as a poignant blueprint to mobilize health professionals to save lives before it is too late.

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The NEW ENGLAND JOURNAL of MEDICINE

Perspective

FEBRUARY 13, 2020

The Climate Crisis and Clinical Practice

Renee N. Salas, M.D., M.P.H.

"A wave of heat hit us as we opened the door, like we were in the Sahara Desert!"

Sweat was beading on the forehead of the emergency medical technician as he wheeled in an elderly man with a reported fever, whose apparent confusion had led his wife to call 911. In the midst of a record-breaking heat wave, the pair was found in a top-floor apartment with no air conditioning and only one partially open window. The man was transferred to a bed, where a rectal thermometer registered nearly 106°F. We diagnosed heatstroke and rushed him to our highest-urgency area to begin cooling him.

Increasingly, such patients are becoming the human face of the climate crisis, as recognition of its health harms grows.[1] This knowledge has led to fledgling efforts to develop public health solutions to help populations prepare and adapt, and plenty of fundamental work remains to be done. But clinicians spend our days working with individual patients, and we've heard little discussion of the implications of the climate crisis for our daily practice.

Effects that climate scientists have been warning us about for decades are now clearly visible in the headlines — the Australian wildfires are only the latest catastrophe. The climate crisis is a quintessential metaproblem and threat multiplier, with frighteningly broad health implications, ranging from climate-sensitive waterborne and foodborne illness to worsening mental health. It is making it more difficult for all of us in medicine to do our job of preventing harm and improving health, one patient at a time. There is thus a profound and urgent need to implement clinical practice improvements that will safeguard the health of our patients and the resilience of our care delivery system in the face of growing climate-related challenges.

Record-breaking heat waves and extreme weather events may fill our news feeds,[1] but less visible types of exposure to climate change also have health implications — such as rising pollen levels and decreasing nutritional value of food. And combined insults can compound harms. Such exposures suggest that there are vast opportunities to identify necessary improvements in clinical practice. These improvements may vary by geographic area, medical specialty, and local practice characteristics.

The pathways by which people are exposed to the effects of climate change vary dramatically by region — such as vibrio species in the coastal northeastern United States and wildfires in the West. The situation is dynamic, however, with old threats popping up in new locations or seasons, as exemplified by the spread of vectorborne diseases. And even universal threats, such as heat stress, may vary by region: different regions, for instance, have distinct temperature thresholds at which the rate of heat-related hospital-

Suggested Clinical Practice Improvements for Heat Stress in Emergency Medicine.*

Domain	Possible Improvements
Emergency medical services	Measurement of rectal temperature and initiation of cooling in the prehospital setting Provision of patient education on avoiding heat-related illness for patients who choose not to be transported to the hospital
Triage protocols	Daily alert to clinical teams regarding extreme heat capable of resulting in peak burden of heat-related illness (e.g., approximately 86°F for the Northeast[2]) Implementation of heatstroke pathway for quick identification and treatment (e.g., obtain heat exposure and exertion history and rectal temperature for patients with fever)
Patient screening	Flagging in electronic medical record for patients with high-risk medical conditions (e.g., cardiovascular or renal disease) and heat-sensitive medications Screening for access to cool home environment (e.g., air conditioning units and financial means to operate them) or participation in high-risk occupation (e.g., outdoor work)
Interventions	Ensuring easy access to cooling equipment (e.g., immersion chambers, fans, and water-dispersion devices) in the emergency department Considering changes to high-risk medications (e.g., antihypertensives, SSRIs), weighing benefit against theoretical risk
Patient education and discharge	Follow-up calls or home visits after discharge for patients at high risk for heat-related illness Provision of heat-index education and direction of patients to real-time updates to inform behavior Instruction on risk factors for heat-related illness and on care of heat-sensitive medication (e.g., albuterol) Development of backup plan for cooling and electricity-dependent medical supplies at home or work in case of power outage
Health care delivery	Implementation of team drills for clinicians and staff that simulate the limited-resource environment created by a backup generator or complete loss of power with generator failure Analysis to identify future supply-chain vulnerabilities to proactively prepare treatment alternatives

* Improvements will vary according to the climate-change exposure pathway and by geographic area, medical specialty or health discipline, and local practice characteristics. SSRI denotes selective serotonin-reuptake inhibitor.

izations peaks.[2] Historically hot Arizona hits a hospitalization spike beginning around 101°F, whereas cooler Oregon starts seeing a spike at 81°F — well below temperatures that trigger heat alerts.[2]

Though the implications for certain specialties — and other health disciplines, such as social work — are clearer than others, every specialty will see practice consequences. Even radiation oncologists may see more patients die if treatment is disrupted by climate-sensitive hurricanes.[3] Improving clinical practice requires consideration of factors such as local patient demographics, social determinants of health, and health care infrastructure.

All climate pathways have implications for the practice of emergency medicine and thus need to be considered when we're identifying improvements. My encounter with the elderly man with heatstroke prompted me to think through one set of possible systemic and patient-level improvements — just one example of such a step, focused on heat stress and key care delivery disruptions in the Northeast (see table).

These suggested practice and care delivery improvements highlight certain fundamental principles for emergency medicine, such as serving as a health safety net for vulnerable people who are disproportionately harmed by the climate crisis. Screening for access to cool environments or high-risk occupations should occur in the primary care physician's office. But emergency departments play an important role during periods of extreme heat: by the time patients see their primary care provider, if they have one, the harm may already have been done.

In the case of heat stress, clinicians also need to determine whether patients are taking medications that may affect the risk of, or may be affected by, heat-related illness. Certain medications, such as diuretics and selective serotonin-reuptake inhibitors, can put patients at higher risk for heat-related illness, though data are relatively sparse.[1] In addition, medications (including lifesaving medications) frequently have optimal storage temperatures for maximal efficacy. Albuterol inhalers have been shown to have decreased efficacy when exposed to temperatures of 140°F — a temperature that may be reached inside a car during periods of extreme heat.[4] The data on epinephrine also give cause for concern for degradation in extreme heat. There are thus critical research and education gaps to be filled.

Improvement of health care delivery to minimize disruptions is another important area that requires more research.[1] Power outages during extreme heat can create dangerous situations in which patients may lose access to cooling equipment or electricity-dependent medical supplies at home. Hospitals must rely on backup generators that may power only certain aspects of operation, resulting in technological complications and turning normally high-tech hospitals into limited-resource environments. Recently, nearly 250 hospitals were affected by the intentional power outages in California, undertaken to reduce the risk of wildfires. Many of the events that expose us to the effects of climate change can also result in supply-chain disruptions like those that have caused shortages of intravenous saline.[1] Such disruptions further hinder clinicians' ability to provide care, and they present a significant opportunity to proactively prepare instead of reflexively reacting to each individual crisis.

Despite the irony, I often describe our current knowledge of the health effects of climate crisis as an iceberg. Though we see a peak above the water's surface, there is much more to fear from the larger mass beneath — the effects that we haven't yet identified. For example, rising temperatures were recently linked to increasing bacterial resistance to antibiotics.[5] The full health implications of the climate crisis may be far more immense and insidious than we have so far imagined. Although dedicated climate and health research is needed, this gap can be addressed more rapidly by adding a climate-change lens to existing lines of research.

Transitioning from theoretical discussions to practical applications will require multidisciplinary collaboration and sharing of best practices. We will need to learn from health professionals and systems that have already been facing dynamic climate threats that will increasingly affect other regions. Collaboration is the driving force behind the Climate Crisis and Clinical Practice initiative that is being launched in Boston on February 13, 2020, with the first of what we, the organizers, hope will be numerous symposia held throughout the United States and elsewhere. The initiative aims to highlight this critical need and provide an online forum to promote conversation. Although ultimately the best medicine for the climate crisis is preventive — the urgent reduction of greenhouse gases — we cannot ignore the myriad ways in which our patients' health is already being harmed and our responsibility to improve our practice.

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Modernizing Scope-of-Practice Regulations — Time to Prioritize Patients

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Ongoing payment reforms are pressing health systems to reorganize delivery of care to achieve greater value, improve access, integrate patient care among settings, advance population health, and address social determinants of health. Many organizations are experimenting with new ways of unleashing their workforce's potential by using telehealth and various forms of digital technology and developing team- and community-based delivery models. Such approaches require reconfiguring of provider roles, but states and health care organizations often place restrictions on health professionals' scope of practice that limit their flexibility.[1]

These restrictions are inefficient, increase costs, and reduce access to care. As leaders of public and private research centers

transform climate change from a politicized problem for polar bears into an opportunity to improve human health — and act to create a healthier, more just, and sustainable world.

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Interactive Perspective: The Climate Crisis — Health and Care Delivery

An interactive graphic and an audio interview with Dr. Salas are available at NEJM.org

The consequences of climate change directly affect human health, the practice of medicine, and the stability of health care systems. An Interactive Perspective by Salas and Solomon, now available at NEJM.org, elucidates these effects and some approaches to mitigating them. In this new feature, clinicians will find the climate-related information most relevant to their medical specialty, as well as a broader exploration of this major public health emergency.

INCREASING GREENHOUSE GASES

CLIMATE DRIVERS

Increasing Temperatures

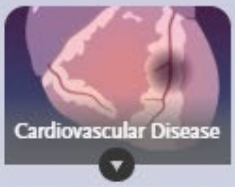
Extreme Weather Events

Rising Sea Levels

EXPOSURE PATHWAYS

HUMAN HEALTH

HEALTH CARE DELIVERY



MULTIDISCIPLINARY INTERSECTIONS

OPPORTUNITIES FOR HEALTH PROFESSIONALS

The Lancet Countdown on Health and Climate Change

Policy brief for the United States of America

NOVEMBER 2019

LANCET COUNTDOWN: TRACKING PROGRESS ON HEALTH AND CLIMATE CHANGE

APHA
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Introduction

This third annual Policy Brief focuses on the connections between climate change and health in the United States (U.S.) in 2018. It draws out some of the most nationally relevant findings of the 2019 global Lancet Countdown report with **U.S.-specific data and supplemental sources to highlight the key threats and opportunities climate change poses for the health of everyone in the U.S.**

Executive Summary

Worker productivity is decreasing due to extreme heat.

Heat limits worker productivity, and reduced labor capacity is often the first sign of health harms from heat. U.S. workers, especially in agriculture and industry, lost nearly 1.1 billion potential labor hours between 2000-2018 and 64.7 million potential hours in 2018 alone from extreme heat.

Exposure of older adults to heatwaves is increasing.

Heatwaves are increasingly frequent and severe, and adults aged 65 years or older are especially susceptible to sickness and death during these events. Since older adults are also a growing population in the U.S., the number of heatwave exposure events for older adults has been increasing in recent years relative to a 1986-2005 baseline.

People are dying from air pollution.

In 2016, fine particulate air pollution ($PM_{2.5}$) caused over 64,000 premature deaths in the U.S. Compared to the general population, Indigenous peoples, Blacks, Latinx, people living in poverty, or less educated individuals are more likely to experience and sometimes die earlier from unhealthy air. Burning fossil fuels like coal or oil is the largest driver of harmful air and carbon pollution.

FURTHER INFORMATION

This Brief draws on indicators 1.1.3, 1.1.4, 2.1.3, 3.1.1, 3.3.2 from the 2019 global Lancet Countdown report. Further information on the methodology and data used can be found in the full report and its appendix, available at www.lancetcountdown.org/2019-report. Please see appendix for case studies and supplemental materials as referenced in this Brief, available at www.lancetcountdownus.org.

SPECIAL U.S. FOCUS: CLIMATE CHANGE AND HEALTH EQUITY

Unequal Vulnerabilities and Health Burdens - Now and in the Future

Human-caused climate change continues to cause widespread harm to the health of people living in the U.S. While no one is immune from the threat climate change poses, these health harms are disproportionately borne by vulnerable and marginalized populations, a theme explored in this Brief. In addition, as today's children become adults, they are likely to face far greater health impacts from climate change than those occurring in recent years.

Decreasing carbon intensity but rising carbon emissions in the energy system.

While data from the 2019 global Lancet Countdown report indicates that the U.S. energy system had a record low carbon intensity in 2016, the most recent year available, U.S. energy-related carbon emissions rose by 2.8% in 2018, the largest increase since 2010. While renewable energy technology is increasingly cost-effective, the technology needs to be dramatically scaled up to lower the country's carbon emissions.

City-level climate assessments and local solutions to protect health.

Much of the U.S. recognizes the challenges that climate change brings. Nearly two-thirds of 136 cities surveyed in 2018 have completed climate risk assessments or are in the process of doing so. Health impacts vary by region and locality, underscoring the importance of identifying the communities most impacted, and the need for individual and local community action plans to protect health, especially for the most vulnerable.

Key Messages and Policy Recommendations

U.S. political leaders are faced with a critical choice: to either sow change now and reap the health benefits, or continue to delay and suffer health harms as a result. According to the Intergovernmental Panel on Climate Change (IPCC), global greenhouse gas (GHG) emissions must be reduced by at least 45% from 2010 levels by 2030 and reach net zero by 2050 to meet the goal of the Paris Agreement to limit warming to 1.5°C.[1]

The policy recommendations put forth in this Brief offer **tremendous health benefits attainable with rapid and substantial actions to combat climate change**. U.S. policymakers should **integrate health considerations into proposed climate policies**, recognizing that **the goal of responding to climate goes beyond reducing carbon emissions, and seize opportunities to improve health, save lives, and protect the most vulnerable**.[2,3]

For additional policy recommendations, please refer to the *U.S. Call to Action on Climate, Health and Equity: A Policy Action Agenda*, that was released in 2019.[4]

Mitigation of climate change: Improving health now and in the future through rapid reduction of GHGs and a just transition to clean, renewable energy

1. **Rapidly reduce GHG emissions:** Policymakers at all levels of government and across all sectors must ensure reductions in GHG emissions that far surpass the existing Paris Agreement commitments and align with IPCC recommendations.

2. **Commit to decarbonization:** Policymakers should adopt legislation and regulatory action that supports rapid transition of electricity generation away from fossil fuels and reduces emissions from the transportation sector. This would follow the precedent set by the ten states and the District of Columbia that have announced a 100% clean or renewable electricity goal, and the fourteen states and the District of Columbia that have enacted low-emission vehicle standards (as of October 2019).

3. **Enable healthier lifestyles to reduce carbon emissions:** Policymakers should invest in infrastructure that supports active travel like biking and walking. Interventions to facilitate active travel simultaneously decrease emissions of GHGs and air pollution, while also promoting physical activity and offering multiple benefits for health.

Adaptation to climate change: Protecting health and making healthcare systems resilient

4. **Invest in evidence-based adaptation and improved surveillance:** Federal, state, and local governments should invest further in evidence and monitoring to guide health protection strategies, including surveillance of the health impacts of climate change and efforts to improve understanding of how future climate trends are likely to impact health.

5. **Increase resilience by strengthening health systems:** Federal and state agencies should minimize climate-related disruptions to public health and healthcare systems through improvements such as resilient infrastructure, emergency preparedness, and supply chain resilience.

Climate Change is Harming the Health of Everyone

People in the United States are living in a changed world that is about 1.98°F (1.1°C) warmer than pre-industrial times;[1,5] 18 of the 19 hottest years ever recorded have been since 2000.[6] In addition to the direct health impacts of increasing heat,[7–9] these warmer temperatures expand the areas where mosquitoes that transmit diseases like Zika can live, and contribute to longer active mosquito seasons.[9,10] In addition, there were 14 climate- and weather-related disasters in the U.S. in 2018, each of which had associated health harms and exceeded a billion dollars in economic loss, with a record fourth-highest total of 91 billion U.S. dollars (USD).[11] Wildfires in California were the largest, deadliest, and costliest to date with significant health tolls (see appendix for case study - 2018 Camp Fire: California's Deadliest Wildfire).[12] At least five 'one-in-1,000 year' rainfall events took place in the U.S. in 2018, causing devastating flooding across the country,[13] with associated health risks including water contamination and diarrheal illness.[9,14] These are just a few examples of the widespread health consequences of climate change beyond the areas of focus in this Brief.

Rising Carbon Emissions in the U.S.

To minimize health harms, there is a need to address the main driver of climate change and reduce emissions of greenhouse gases (GHGs) such as carbon dioxide (CO_2). The *Intergovernmental Panel on Climate Change (IPCC) Special Report: Global Warming of 1.5°C*, published in 2018, stated that global CO_2 emissions must be almost halved by 2030 and reach net zero around 2050 to limit the planet's warming to below 2.7°F (1.5°C) by 2100.[1] It has also been estimated that global emission reductions of at least 3% per year are needed in order to keep warming below 3.6°F (2°C),[15] a temperature that would result in far more health dangers than 2.7°F (1.5°C).[16] Instead, U.S. CO_2 emissions rose by an estimated 3.1% in 2018.[17]

Climate Change and Health Equity

Oil, gas, and coal operations produce air pollution and drive climate change, which is causing extensive harm to the health of people in the U.S.[14] Some people are more vulnerable, either because of increased susceptibility to harm (e.g., a person's age, pregnancy status, or existing health problems), increased exposure (e.g., a person's job, race, socioeconomic status, or location), limited ability to adapt to impacts (e.g., a person's disabilities or access to healthcare) - or a combination of these factors, which compound over time (Figure 1).[18] Just as climate change exacerbates existing health inequities by worsening harms and increasing costs for the most vulnerable, interventions to reduce GHG emissions can lessen health inequities and increase opportunities for everyone to enjoy a healthy life.[9,18]

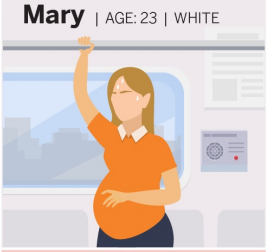
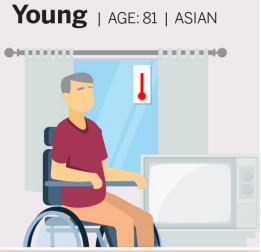
Unequal Health Vulnerability in a Heatwave

Certain populations are more vulnerable to the impacts of climate change, and disproportionately experience health harms from it, widening existing health disparities. This graphic shows how four people in an urban area are impacted by a heatwave, which are becoming more frequent and severe due to climate change, to highlight examples of vulnerability and adaptation.

LANCET COUNTDOWN: TRACKING PROGRESS ON HEALTH AND CLIMATE CHANGE

RISK FACTOR
PROTECTIVE FACTOR

A/C = air conditioning

		Sasha | AGE: 6 | BLACK 	**Mary** | AGE: 23 | WHITE 	**Cesar** | AGE: 42 | LATINX 	**Young** | AGE: 81 | ASIAN 
KEY HEALTH RISK		Asthma attack from air pollution	Birth complications	Death from heatstroke	Heat-related heart failure
VULNERABILITY CATEGORY	SUSCEPTIBILITY	■ Child ■ Asthma ■ Otherwise healthy	■ Young adult ■ Pregnant ■ Healthy	■ Middle age ■ High blood pressure ■ Medication increases heat sensitivity	■ Older age ■ Heart condition ■ Medication increases heat sensitivity
	EXPOSURE	■ Person of color* ■ Lives by sources of air pollution ■ Air pollution worsened by heat	■ Apartment with poor insulation ■ Subway to work doesn't have A/C ■ A/C at work	■ Person of color* ■ Works outside in the sun ■ No A/C at home	■ Person of color* ■ Room on top floor ■ Poor A/C in nursing home
	ABILITY TO ADAPT	■ Inadequate health insurance ■ Middle class ■ Good family support	■ Health insurance ■ Poor ■ Lack of social support	■ No health insurance ■ Undocumented immigrant ■ Good social support	■ Health insurance ■ Middle class ■ Limited mobility
HEALTH OUTCOME		 Visits emergency department for an asthma attack	 Struggles to protect herself from heat but delivers a healthy baby	 Develops heatstroke and nearly dies	 Long hospitalization for heart failure
ADAPTATION ACTION		Real-time air-quality surveillance program sends warnings to vulnerable residents when pollution levels are high	Doctor is further educated on how heat impacts clinical practice and proactively counsels on heat risk throughout pregnancy	State health officials institute new heat-safety regulations to protect outdoor workers	Nursing home implements a heat emergency protocol to protect patients and invests in A/C improvements

***Statistically, people of color are exposed to environmental harms at disproportionately higher rates. Therefore, we are including it here as a risk factor for exposure.**
Disclaimer: These fictional characters were created for illustrative purposes to highlight vulnerability, and certain vulnerabilities can exist in more than one category.

Figure 1: Unequal health vulnerability in a heatwave.[9,14,18,20,21]

If our current trajectory continues, children, in particular children of color, in the U.S. today will face compounded health harms and billions of dollars in health-related costs over the course of their lives (Figure 2).[9,18,19] In fact, "without significant intervention, this new era will come to define the health of an entire generation."[22]

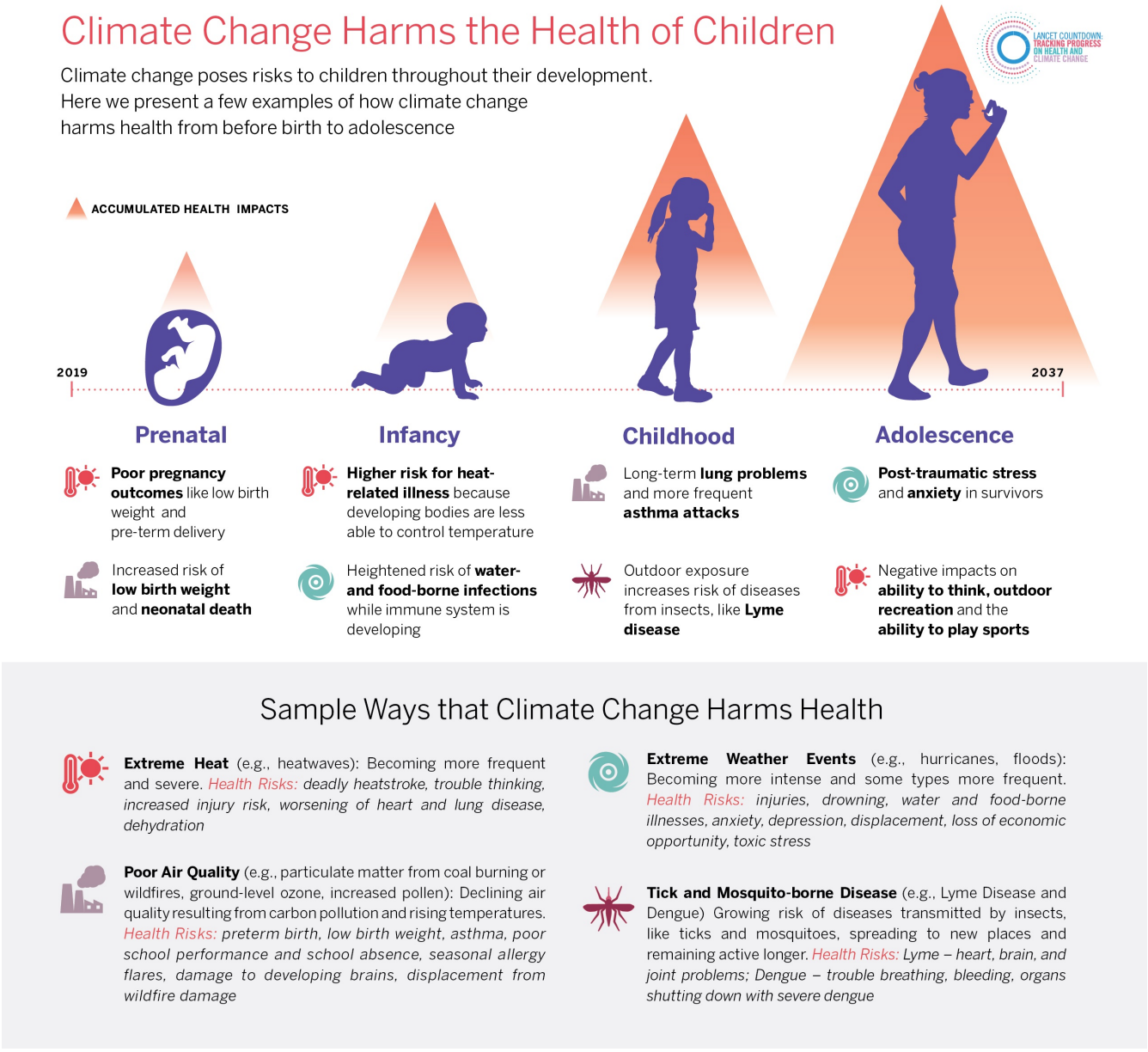


Figure 2: Climate change harms the health of children.[9,18,21–27]

Impacts of Heat on Health and Productivity

U.S. Data: Heat and Health - Change in Labor Capacity

Between 2000-2018, it is estimated that U.S. labor productivity declined by nearly 1.1 billion potential labor hours due to extreme heat, with particular losses in the industrial and agricultural sectors. In 2018 alone, 64.7 million potential work hours were lost (industry – 36.1 million; agriculture – 27.7 million; service - 910,000).* Southern U.S. states (defined as those below 34°N latitude) lost 15-20% of possible daylight work hours for heavy labor (e.g., agriculture and construction) in direct sun due to heat exposure during the hottest month in 2018 (July). Texas, Louisiana, Mississippi, Alabama, Georgia, and Florida were particularly impacted (Figure 3).[22]

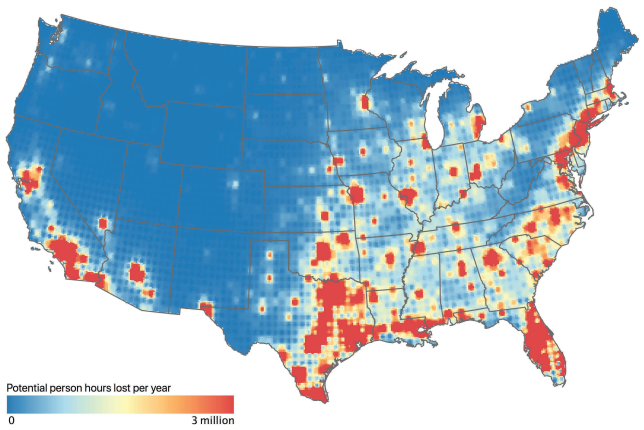


Figure 3: Potential full-time equivalent work (12 hours per day, 365 days per year) lost.[22]

Map of annual million potential person hours lost per cell based on % service sector working at 200W, % of industry sector working at 300W and % agricultural sector working at 400W with 3 million hours per cell-year, assuming all work in direct sun.

Rising temperatures have negative health impacts such as deadly heat stroke, adverse birth outcomes, and worsening heart, lung, and mental health conditions.[8] Heatwaves in the U.S. are becoming more frequent and intense, and the number of extreme heat days is increasing (Figure 4).[28,29]

Reduced labor productivity due to extreme heat illustrates the far-reaching impacts of climate change on human health (see appendix for extended case study - Heat-related Illness and Vulnerability in the Workplace).[12] Lost wages from potentially forfeited labor hours can further exacerbate financial burdens on already struggling families as well as impact the U.S. economy. Of these most impacted states, Mississippi, Alabama, and Louisiana have some of the highest poverty rates in the country.[32]

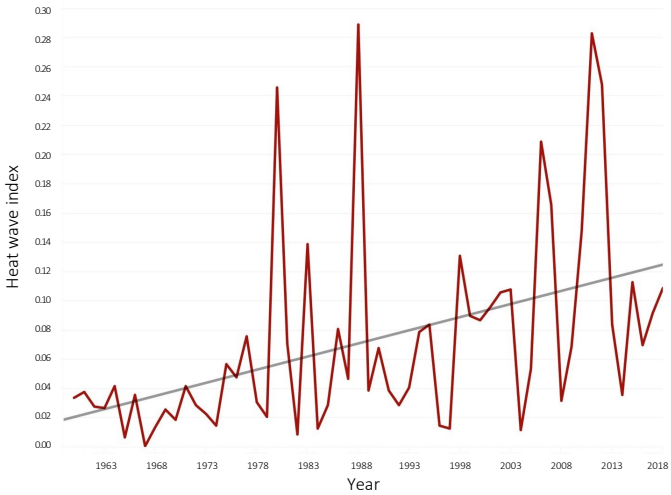


Figure 4: U.S. annual heat wave index from 1960 - 2018.[30,31]

This index highlights abnormally hot or cold days over the contiguous 48 states. As an example, a heat wave index of 0.2 could mean that 20% of the country had one heatwave, 10% experienced two heatwaves, etc.

U.S. Data: Heat and Health - Exposure of Vulnerable Populations to Heatwaves

Older adults age 65 and above are especially vulnerable to extreme heat. In 2011, 22.3 million additional heatwave exposure events for older adults occurred (with one exposure event being one heatwave experienced by one person 65 years and older) above the 1986-2005 average. In 2016, 11.6 million more exposure events occurred compared to baseline, followed by 3.7 million in 2017 and 3.1 million in 2018.[22]

By 2030, all "baby boomers" will be over the age of 65 and are projected to outnumber children under the age of 18 in the U.S. by 2034.[33] Thus, the observed trend of more heatwave exposure events in older adults above the 1986-2005 baseline is likely a reflection of both a larger number of older adults and the increased frequency and length of heatwaves.[28,34] As this population grows, the number of older adults at risk of illness, hospitalization, or death from extreme heat is also anticipated to increase.

Some of the reasons older adults are more vulnerable to the health impacts of extreme heat include the natural aging process, pre-existing illnesses (e.g., heart or lung problems), and medications that cause adverse reactions in extreme heat situations.[18] Older adults' ability to adapt to extreme heat can be limited by factors such as reliance on caregivers, decreased mobility, being homebound, social isolation, and lacking access to air conditioning - all of which increase their vulnerability as extreme heat exposure intensifies.[18,35,36]

*Updated methodology from the 2018 Lancet Countdown Global Report.

People in the U.S. are Dying from Air Pollution

U.S. Data: Air Pollution, Energy, and Transport - Premature Mortality from Ambient Air Pollution by Sector

In addition to causing climate change, fossil fuel combustion emits harmful air pollution, notably fine particulate matter known as $PM_{2.5}$ (particles 2.5 micrometers and smaller).[37] In 2016, there were 64,200 premature deaths in the U.S. due to ambient $PM_{2.5}$ air pollution, of which 8,600 were due to coal combustion in the power, industry, and household sectors.[22]

Air pollution is known to have a wide range of negative health impacts, and the health damages of air pollution are experienced unequally.[38,39] For example, Blacks and Latinx are exposed to higher levels of $PM_{2.5}$ air pollution (21% and 12% higher, respectively) when compared to the overall population.[40] Indigenous people have also been found to be more exposed to air pollution.[41] Despite higher exposure, these populations contribute least to the problem. Blacks and Latinx bear an excess "pollution burden," meaning they experience 56% and 63% more air pollution exposure, respectively, than they cause from their own consumption of goods and services.[40] This inequality contributes to a shorter lifespan due to $PM_{2.5}$ exposure for people who live in counties that are poorer, less educated, or have a higher proportion of Black residents.[42]

Mitigation of Climate Change: Carbon Emissions in the U.S. Energy System

Understanding the sources of GHG emissions can inform where to focus efforts (Figure 5).[43] The transportation and electricity generation sectors were the largest sources of emissions. U.S. carbon emissions per capita in 2016 remained one of the highest in the world at approximately 14.6 tons of CO_2 per person compared to 6.7 in China, 5.4 in the United Kingdom, and 1.6 in India.[44]

U.S. Data: Energy System and Health - Carbon Intensity of the Energy System

Since 1971, the carbon intensity of the total primary energy supply (TPES) in the U.S. has declined. In 2016 (the most recent year for which data available), the carbon intensity of TPES reached a record low of 53.3 metric tons of CO_2 emitted for each terajoule (TJ) of primary energy (Figure 6).[22]

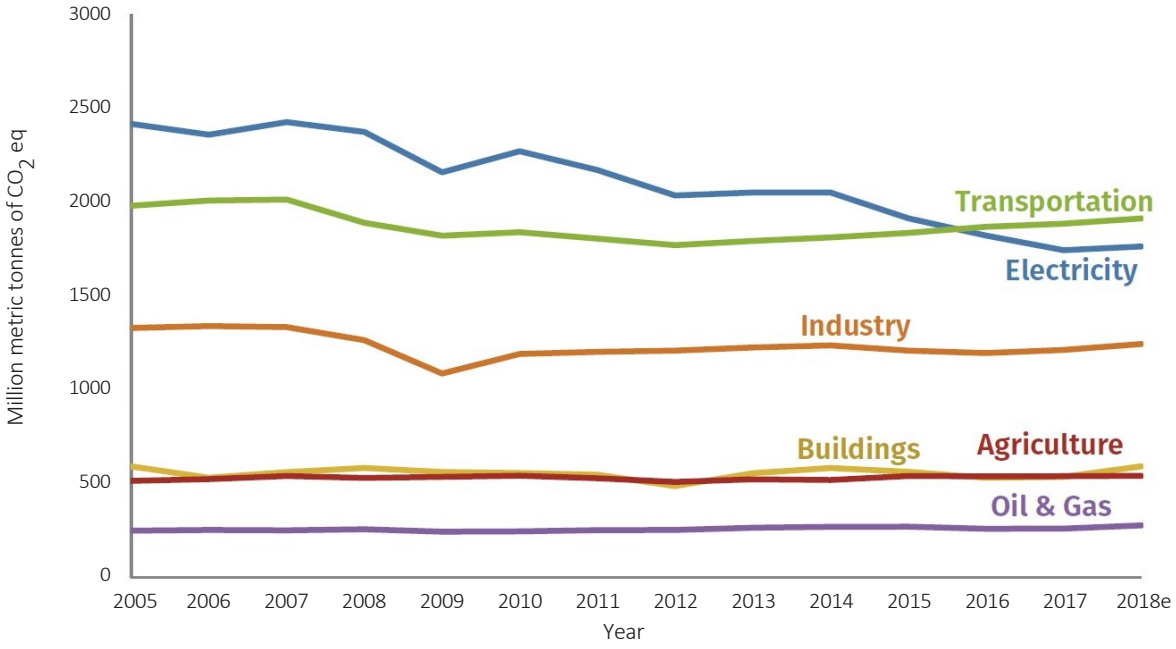


Figure 5: Greenhouse gas (GHG) emissions by sector in the U.S. from 2005 - 2018e.[45]

2018e is an estimated 2018 value. Energy CO_2 estimates included in these economy-wide GHG numbers are calculated using EIA, rather then EPA methodology, and thus include transportation fuels for interntational travel and a number of other minor differences.

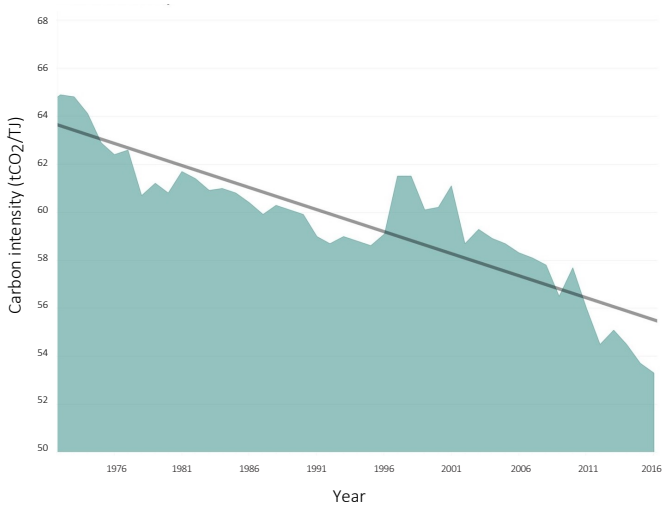


Figure 6: Carbon intensity of the U.S. energy system by tons of CO_2 (tCO_2) emitted for each per TJ of primary energy supplied.[22]

The U.S. Energy and Information Administration reports that U.S. energy-related CO_2 emissions rose by 2.8% in 2018, which was the largest increase since 2010.[46] There was also a 4% rise in U.S. energy consumption in 2018 (see appendix - Rising Energy Consumption in the U.S. and Need for Indoor Climate Control).[12,47] Meanwhile, prices for electricity from renewable sources have dropped substantially, making wind and solar increasingly competitive.[48]

Policies that reduce carbon emissions in the energy sector, such as increasing the use of renewable energy and optimizing energy efficiency, will improve health by reducing climate-related health harms and air pollution from the burning of fossil fuels. The U.S. EPA has developed estimates of the health benefits of improved air quality per kilowatt hour of increased renewable energy and energy efficiency investments.[49] Transitioning rapidly to renewable sources makes economic sense, with costs outweighed by the billions of USD saved from health benefits alone.[50,51] One study found that the health savings from state and local renewable energy policy in the "Rust Belt" region exceeded the policy cost by 34%.[50] These benefits will vary by location, and the transition should be managed in a fair and just way.

Adaptation to Climate Change: Local Solutions to Protect Health

U.S. Data: Adaptation Planning and Assessment - City-level Climate Change Risk Assessments

City level governments are especially well placed to implement adaptation measures. Of 136 U.S. city governments surveyed in 2018, two-thirds were in the process of or had completed a climate risk assessment, 11% intended to complete one in the future, and 23% responded "No."[22]

Unfortunately, even with a rapid and urgent reduction of GHG emissions, harms to health and disruptions to healthcare systems will persist since GHGs can remain in the atmosphere for hundreds of years.[52] Thus, it is critical for the U.S. to build on work like the Centers for Disease Control and Prevention's Building Resilience Against Climate Effects (BRACE) framework to determine the best ways to protect health through proactive adaptation in parallel with GHG mitigation.[53] There is also growing recognition in the medical community of the threat climate change poses to health and the delivery of care (see appendix - The Consequences of Climate Change on Clinical Practice and Healthcare Delivery: Opportunities for the Healthcare Sector).[12]

Since climate change impacts each region of the U.S. differently, a national understanding of how to best protect and improve health must be tailored at city and regional levels. A recent study showed that there are substantial regional differences in the heat conditions during which individuals are hospitalized, demonstrating how population responses to a given climate impact can vary by location.[54] For instance, the peak in hospitalizations for heat-related illnesses occurs at around 80°F in the West and Northwest, while the peak in the South occurs at about 105°F. In many regions, officials issue heat alerts at points hotter than at which individuals are being affected. In recognition of this disconnect, Northern New England and New York lowered their thresholds for heat alerts,[55] with reductions in heat-related illnesses in older adults already observed in New York City.[56]

Within cities, certain populations are at greater risk of harm from temperature rises because of existing inequities, "urban heat islands" (warmer area in cities due to human-made structures which can be up to 22°F hotter than surrounding areas at night),[57] a lack of greenspace, inadequate housing, or not having air conditioning or the money to keep it running.[35,58–61] To aid effective allocation of limited resources, states like Florida and Minnesota are mapping populations that are especially at risk of exposure to heat, flooding, and air pollution to protect residents' health.[62,63]

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THE LANCET COUNTDOWN

The Lancet Countdown: Tracking Progress on Health and Climate Change is an international, multi-disciplinary collaboration that exists to monitor the links between public health and climate change. It brings together 35 academic institutions and UN agencies from every continent, drawing on the expertise of climate scientists, engineers, economists, political scientists, public health professionals, and doctors. Each year, the Lancet Countdown publishes an annual assessment of the state of climate change and human health, seeking to provide decision-makers with access to high-quality evidence-based policy guidance. For the full 2019 assessment, visit www.lancetcountdown.org/2019-report .

THE AMERICAN PUBLIC HEALTH ASSOCIATION

The American Public Health Association (APHA) champions the health of all people and all communities. We strengthen the public health profession, promote best practices, and share the latest public health research and information. The APHA is the only organization that influences federal policy, has a nearly 150-year perspective, and brings together members from all fields of public health. In 2018, APHA also launched the Center for Climate, Health and Equity. With a long-standing commitment to climate as a health issue, APHA's center applies a health equity lens to help shape climate policy, engagement and action to justly address the needs of all communities regardless of age, geography, race, income, gender and more. APHA is the leading voice on the connection between climate and public health. Learn more at www.apha.org/climate.

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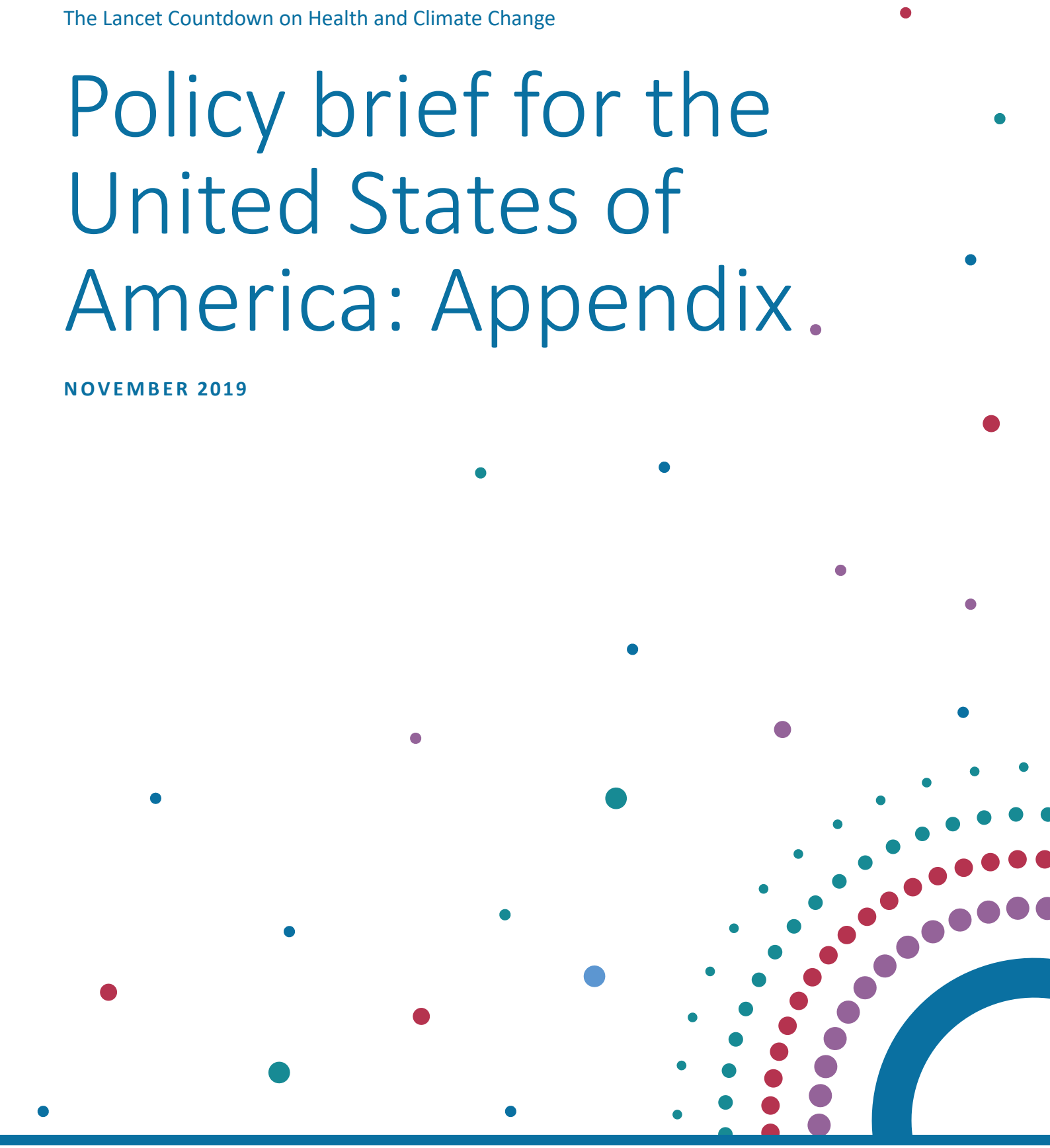
The Lancet Countdown on Health and Climate Change

Policy brief for the United States of America: Appendix

NOVEMBER 2019



LANCET COUNTDOWN: TRACKING PROGRESS ON HEALTH AND CLIMATE CHANGE

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Introduction

This Appendix accompanies the 2019 Lancet Countdown on Health and Climate Change Policy Brief for the United States of America. It contains case studies and supplemental materials referenced in the Policy Brief.

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Case Study

2018 Camp Fire: California's Deadliest Wildfire

Wildfires are becoming more frequent and are intensifying with substantial health harms that are anticipated to continue growing without climate action.[1] **Climate change played a driving role in California's 2018 wildfire season, which was the deadliest (106 lives lost), most destructive (1.8 million acres burned), most expensive in U.S. history, and the costliest international disaster in 2018 (25-27 billion USD)**.[2–4] Similarly, other recent wildfires have tallied up billions in health costs.[5] The Camp Fire (Figure 1A) was the single deadliest wildfire in California's history, killing 86 residents of Paradise, California and nearby towns.[3,6] The fire burned over 153,000 acres and claimed 4,000 homes, 4,293 other buildings, and 528 businesses.[7] The smoke caused dramatic reductions in regional air quality with accompanying health harms to vulnerable residents.[8,9]

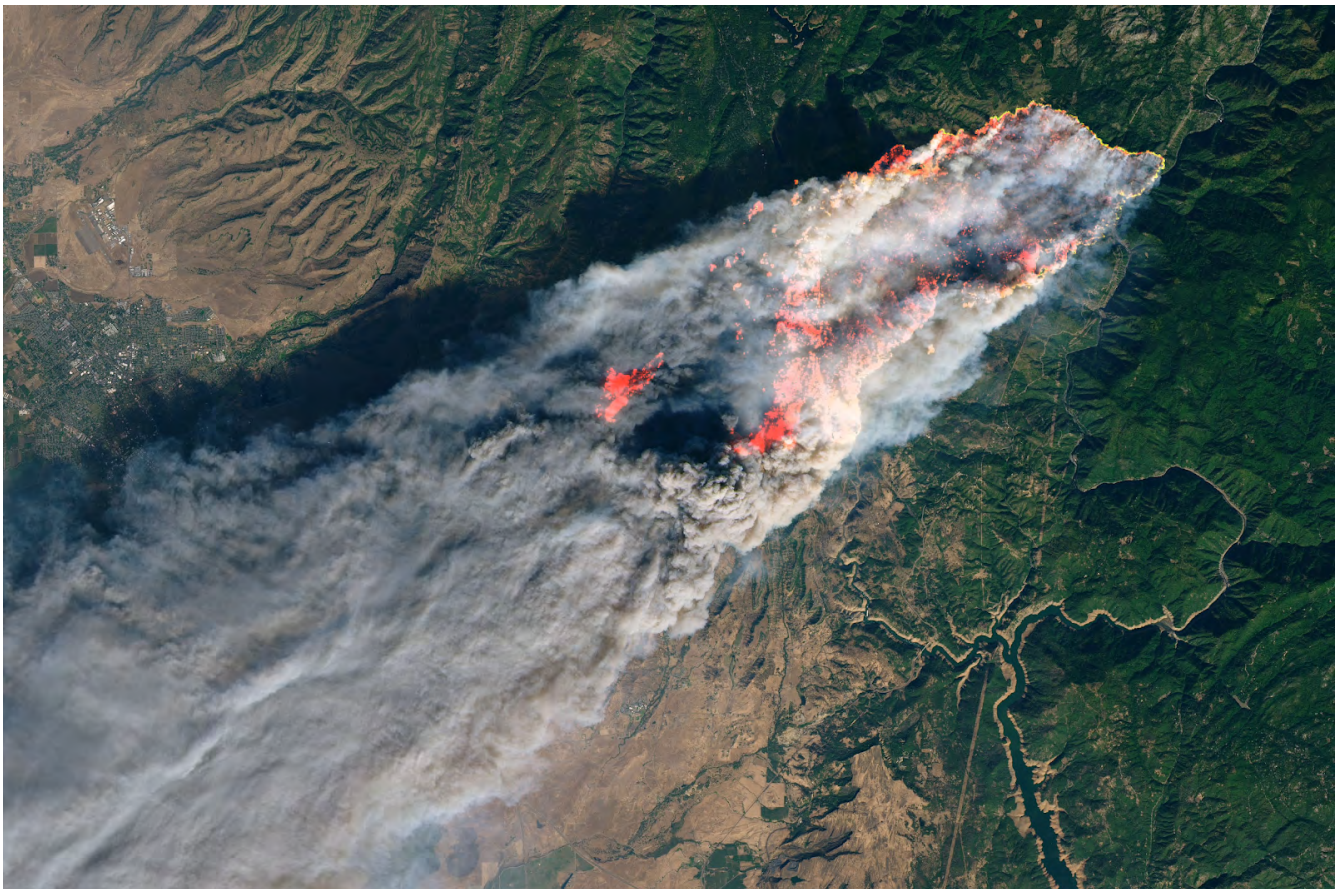

Figure 1A: The 2018 Camp Fire's smoke plume.[10]
Photo: NASA Landsat 8 Operational Land Imager.

News reports documented immediate health harms to people in the nearby and surrounding areas impacted by the Camp Fire.[11,12] In addition, research has documented long-term health harms in populations exposed to previous wildfires.[13] Direct fire exposure causes burns and inhalation injuries. Particulate air pollution can lead to early death and can worsen heart and chronic lung diseases. Displacement and property loss increase the risk of depression, anxiety, post-traumatic stress disorder, and other adverse mental health conditions among children and adults.[14,15]

While it will take time to assess the longer-term health harms from the Camp Fire, previous studies have linked prenatal exposure to wildfire smoke with lower birth weights,[16] premature deaths in children,[17] and exacerbation of existing health inequalities.[18,19] In addition, there is a persistent risk of premature death and increased healthcare visits for lung, heart, and stroke disease from exposure to smoke $PM_{2.5}$ long after a wildfire occurs.[14,20–22]

It has been estimated that over 29 million people in the U.S. are at a significant risk of wildfire exposure and over 40% of this at-risk group is socially vulnerable.[23] The risk unequally tracks along racial and ethnic lines as wildfire vulnerability is 50% higher for African Americans, Latinx, and Indigenous peoples. Thus, as officials grapple with how to best protect the lives and health of people living in the U.S., climate action to reduce both GHGs and health inequities is critical.

Extended Case Study

Heat-Related Illness and Vulnerability in the Workplace

Workers Increasingly Exposed to Life-Threatening Heat

Exposure to extreme heat is the leading cause of weather-related deaths in the U.S. and is particularly dangerous for workers who perform moderate to heavy labor in hot and humid environments.[24,25] According to the Bureau of Labor Statistics (BLS), work-related heat exposure killed 783 U.S workers and injured nearly 70,000 between 1992 and 2016[26]- yet these numbers are likely a considerable underestimate.[27]

Patient Case

During a sweltering day in June of 2016 on a live-fire training range at Fort Chaffee, Arkansas, the heat index climbed to 103°F before Sgt. Sylvester Cline was evacuated off the field to cool down.[28] He became unwell after training for nine hours in the heat, yet his illness was not recognized soon enough. During transport to the base clinic, Sgt. Cline, a veteran soldier and father of five, vomited, collapsed, and became unresponsive. Cardiopulmonary resuscitation was started immediately. Yet despite extensive medical efforts, he was pronounced dead two hours after being diagnosed with heat stroke. Reported cases of heat stroke or heat exhaustion, heat stroke's precursor, among active-duty service members have increased 60% over the past decade, from 1,766 cases in 2008 to 2,792 cases in 2018, with casualties across all branches of the military.[29]

The Number of Workers Killed or Injured by Heat Likely Greater than Reported

Inaccurate medical documentation and incomplete reporting limit our knowledge of how many workers are truly injured or die from heat. Heat can worsen pre-existing conditions, and it can be difficult to isolate heat's effect in medical records.[30] Additionally, workers may underreport heat injuries to authorities in fear of losing their jobs or other punitive action, a particular concern for undocumented workers and people in poverty.[31,32] Other issues result from dependence on employer reporting and exemptions for federal agencies and small firms.[33,34]

Strong evidence suggests that heat exposure is associated with an increased risk of outdoor and indoor workplace injuries.[35–38] Even with incomplete documentation, heat-related injuries are one of the largest contributors to worker compensation claims,[39] which total approximately $250 billion per year in the U.S. alone.[40]

Health Risks Vary by Sector and Worker Health Status

The risk heat poses to workers varies by labor sector. At the individual level, a worker's heat risk is influenced by their health status, immigration status, ethnicity, race, and socioeconomic status.[41] Construction workers are most at risk, accounting for roughly 36% of the heat-related deaths nationwide.[42] Compared to workers from other industries, construction workers are 13 times more likely to die from a heat-related illness, and the health risks of construction work are projected to grow with rising temperatures.[42,43]

One in five heat-related deaths occurs in the agricultural sector, and the U.S. Centers for Disease Control and Prevention (CDC) reports that agricultural workers die from heat-related illness at a rate nearly 20 times greater than all U.S. civilian workers. Other occupations at risk of environmental heat exposure and heat illness include landscapers, road maintenance crews, military personnel, firefighters, relief workers, truck drivers, oil-field workers, waste management workers, and forestry and fishing workers.[39,44,45] Indoor workers are also vulnerable, accounting for roughly 20% of heat-related illnesses.[39] For indoor workers, high outdoor temperatures can exacerbate the heat from indoor heat sources, such as laundry, engines or other machinery, particularly when indoor engineering has not accounted for the added risk of high outdoor heat.[39,45]

Health Risks of Heat Are Even Higher for Certain Worker Populations

There are certain sub-populations of workers living in the U.S. that are at an even higher risk. For example, individuals who are not U.S. citizens, and especially the Latinx workforce, are found to be at a higher risk of dying from heat than U.S. citizens.[46] In addition, according to the National Agricultural Workers Survey, 2-3 million, or 72%, of all farm workers in the U.S. are born outside the U.S.,[24,44,47] suggesting that these workers are disproportionately exposed to heat risk.

Migrant workers and day laborers often have poor or inadequate housing, a lack of access to air conditioning, or an inability to pay for the electricity to keep it running.[32] These factors limit their ability to cool down at home and increase their risk of heat exposure. Compounding these heat risks, it has been shown that migrant workers can have limited health insurance coverage, less family support, a lack of transportation, and limited knowledge of health services in the community, all of which contribute to decreased healthcare access and use.[48] Lastly, workers with limited English proficiency face additional challenges including limited health literacy as well as higher rates of medical errors and worse clinical outcomes.[49,50]

Figure 2A: Agricultural workers during the summer months in Iowa.
Photo: Preston Keres at U.S. Department of Agriculture (Public Domain).

Lack of Regulation Leaves Hundreds of Thousands Vulnerable

Currently there is no dedicated federal standard specifically addressing occupational heat exposure. The National Institute for Occupational Safety and Health (NIOSH) develops recommendations for preventing disease and hazardous conditions in the workplace. NOISH generated three criteria documents (in 1972, 1986, and 2016) advising the Occupational Safety and Health Administration (OSHA) to develop a heat standard, but no standards have been created.[27,51]

California and Washington are the only states to mandate heat-safety practices for outdoor workers,[51–53] and Minnesota regulates indoor worker heat standards.[54] NIOSH recently estimated that two in every 1,000 workers are at risk of heat stress,[55] suggesting that at least 260,000 workers outside of California, Washington, and Minnesota are at risk for heat-related illness and death in the absence of a federal standard to protect them.[56]

Recommendation: Urgent Action is Needed to Protect the Health of U.S. Workers

Even with rapid implementation of interventions to reduce greenhouse gas (GHG) emissions, extreme temperatures will likely have a growing impact on U.S. workers in this century. The U.S. Environmental Protection Agency (EPA) estimates that under high emission scenarios, approximately 1.9 billion labor hours might be lost per year by 2090, costing an estimated $160 billion in lost wages, double the losses that would occur under a low emissions scenario. In addition to reducing GHG emissions, a renewed commitment to worker health – including the creation of OSHA workplace heat exposure standards – is needed to protect workers in a changing climate.

Supplemental Section

Rising Energy Consumption in the U.S. and Need for Indoor Climate Control

Since about 1980, the overall number of days requiring indoor heating has decreased and days requiring cooling technology has increased from the 20th century average (Figure 3A).[57] While an increasing number of hot days is an outcome of climate change, the warming of the planet is also weakening the northern jet stream, leading to an increasing number of "polar vortex" incidents where arctic air extends further south creating record cold temperatures.[58] As a result, people in the U.S. are using more energy to maintain a comfortable temperature that promotes health.

Following a decade of declining energy use, the U.S. energy consumption increased by 4% between 2017 and 2018. This was the highest year-on-year increase in energy consumption in three decades, reaching a record annual high of 101.3 quadrillion British thermal units (BTU).60 This increased energy consumption occurred in the setting of a unique phenomenon- the combined number of U.S. heating and cooling days in 2018 reached its highest point since the 1950s.[61]

The U.S. energy system's current reliance on fossil fuels leads to negative health impacts.[13] Given the current electricity mix (~30% generated from coal), an additional 1,000 deaths could occur from the air pollution generated from increased air conditioning energy consumption alone.[62] As energy demands increase, it is important to ensure that U.S. energy sources are not harming people's health, and that the country's electrical grids can handle the increased strain to power society, including hospitals and electricity-dependent medical equipment.

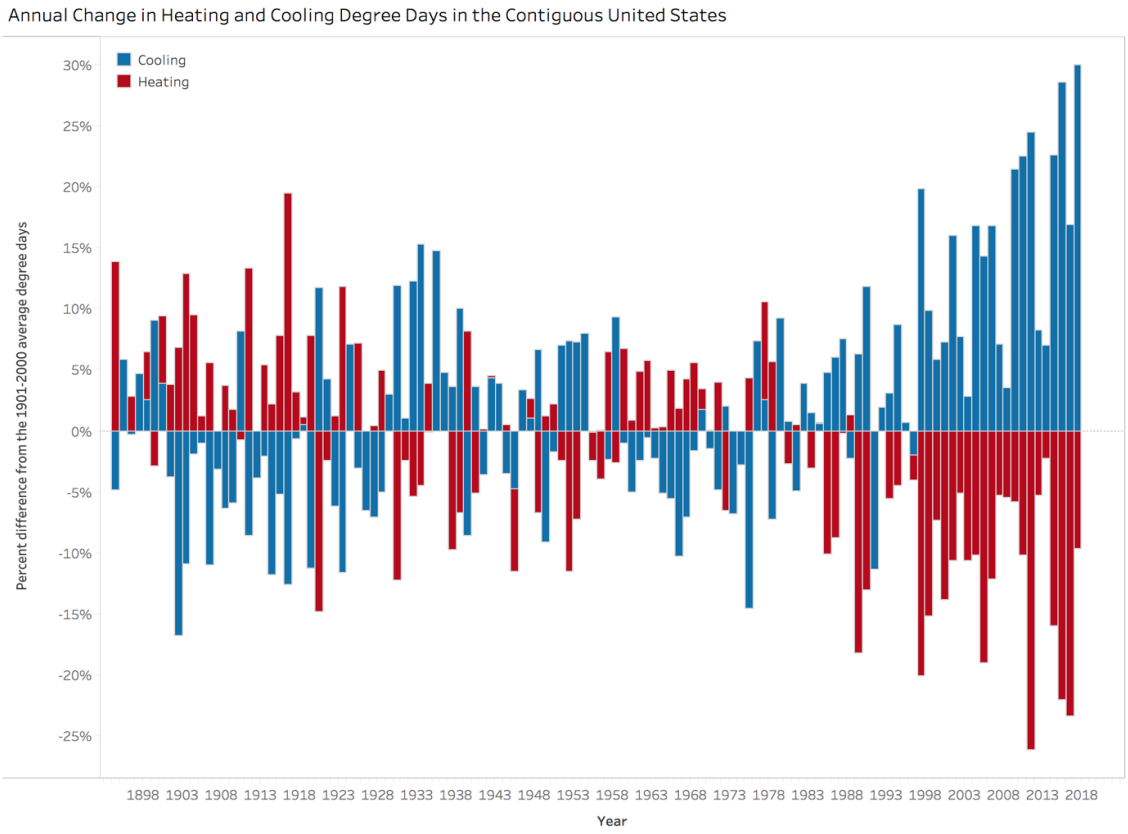

Figure 3A: Annual heating and cooling degree days in the contiguous U.S.[57,59]

This figure highlights the difference between the number of degree days in each year and the average number of degree days throughout the 20th century defined as 1901-2000. A cooling degree day occurs when the average daily temperature is above a 65°F baseline, while a heating degree day is below the 65°F baseline. In addition, U.S. Census Bureau data is utilized for population-weighting; thus, the same temperature leads to a higher number of degree days in a more densely populated area (e.g, Chicago will be higher than rural Iowa).

The Consequences of Climate Change on Clinical Practice and Healthcare Delivery: Opportunities for the Healthcare Sector

There is a growing recognition in the medical community that climate change has consequences for clinical practice and healthcare delivery.[63,64] This represents a critical opportunity to better understand how to best protect the health of patients, how climate change impacts healthcare systems, and how to ensure our healthcare systems are resilient in the face of climate change.

Clinicians need to consider their patients' climate-specific risk factors, such as heat and asthma action plans. For example, clinicians could assess how certain medications may increase a patient's risk of developing life-threatening heat stroke (e.g., medications commonly prescribed for high blood pressure, heart failure, or mental health)[65,66] and how extreme heat may render medications less effective (e.g., asthma inhaler left in a hot car during a heatwave).[67]

Additionally, healthcare system leaders need to ensure their facilities can continue providing care as climate change intensifies extreme weather events, including flooding, hurricanes, droughts, or prolonged periods of heat (Figure 4A). Such events threaten medical supply chains (e.g., intravenous saline shortages)[68] and potentially stress energy grids due to increased air conditioner use during heatwaves, increasing the risk of a power outage.[69] These impacts require proactively understanding risks and putting into place clinical practice recommendations, public health interventions, and solutions that address health system and medical supply chain vulnerabilities.

Figure 4A: Physicians Hospital damaged by levee failure flood during Hurricane Katrina in New Orleans, Louisiana in 2005.[70]
Photo: Bart Everson (Wikimedia Commons), converted to black and white.

The U.S. health sector is estimated to be responsible for 10% of the country's GHG emissions.[68] Thus, U.S. healthcare organizations should seek to rapidly reduce their own GHG emissions through improved energy efficiency and transitioning to renewable energy sources to reduce harms associated with healthcare delivery. Healthcare organizations should also divest from the fossil fuel industry, consistent with their mission to "first, do no harm."

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LANCET COUNTDOWN: TRACKING PROGRESS ON HEALTH AND CLIMATE CHANGE

APHA
AMERICAN PUBLIC HEALTH ASSOCIATION
For science. For action. For health.

2018 Lancet Countdown on Health and Climate Change Brief for the United States of America

November 28, 2018

Introduction

This Brief focuses on connections between climate change and health in the United States (U.S.) in 2017. It draws out some of the most nationally-relevant findings of the global 2018 *Lancet* Countdown on Health and Climate Change report with U.S.-specific data to highlight the key threats and opportunities climate change poses for the health of Americans.

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2018 Lancet Countdown on Health and Climate Change Brief for the United States of America

Executive Summary

This Brief focuses on connections between climate change and health in the United States (U.S.) in 2017. It draws out some of the most nationally-relevant findings of the global 2018 *Lancet* Countdown on Health and Climate Change report with U.S.-specific data to highlight the key threats and opportunities climate change poses for the health of Americans.

Climate Change Threatens Americans' Health Now

Increases in heat and heatwaves pose a serious threat to health and labor productivity. More Americans are being exposed to extreme heat as a result of above-average and record-setting temperatures in the U.S., and heatwaves have been getting more frequent and lasting longer. This puts people at risk for heat exhaustion and heat stroke while worsening chronic conditions such as lung, heart, and kidney disease, which increases healthcare utilization and costs. Increased heat has health implications for laborers and has contributed to the loss of approximately 1.1 billion labor hours in the U.S. between 2000 and 2017.

Increases in extreme weather events significantly threaten both health and health systems. In 2017, there were 16 extreme weather disasters in the U.S., from severe hurricanes to extensive wildfires, that each cost more than a billion dollars and together cost over $313 billion. While each type of disaster poses different threats to human health, they all can lead to death. The official death toll was estimated at 3,278 lives, though the actual number is likely much higher, highlighting the need for better surveillance.

Climate change is elevating the risk of mosquito-, tick-, and water-borne diseases. Climate-sensitive vector-borne illnesses transmitted by mosquitoes, ticks, and fleas, including Lyme disease and West Nile virus, tripled between 2004-2016. Longer warm water seasons and increased water temperatures support pathogens and bacteria, like *Vibrio*, which can cause gastrointestinal illnesses, food poisoning, skin infections, and even death.

Prevention of Further Dangerous Climate Change: Transitioning to Renewable Clean Energy

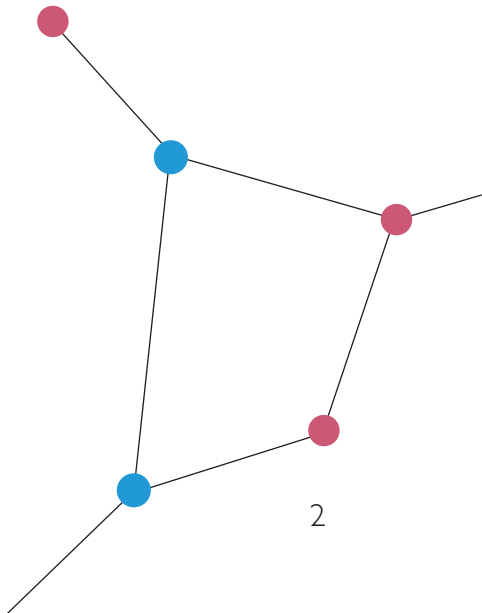
Hospitals can lead America's efforts to transform the energy system. Increasingly affordable renewable energy sources in the U.S. have created the opportunity for a transition towards solar and wind energy, which results in cleaner air and water with fewer greenhouse gas (GHG) emissions. While this change is already happening, it must accelerate. Healthcare systems are major energy consumers, are well-placed to lead, and should ensure that their own operations are powered by renewable energy in order to minimize harm from their activities. Healthcare should extend its commitment to "do no harm" by divesting from the fossil fuel industry and investing in innovative solutions that will improve health now and for future generations.

Adaptation to Climate Change: Public Health Department Preparation and Climate Change Adaptation Spending on Health

While public health departments across America are responding to climate change, health-related adaptation spending is inadequate for the challenge ahead.
Forward-thinking public health departments and cities across America are already developing short- and long-term strategies that will reduce the negative health impacts of climate change and enhance resilience. However, these efforts are not widespread and are significantly underfunded. Only 14% of total U.S. adaptation spending was directed towards the healthcare-related sectors in the 2016-2017 fiscal year.

Training the Next Generation and Educating the Public on the Health Impacts of Climate Change

Educating health professionals is key to preparedness.
Describing climate change in terms of human health reinforces that climate change is impacting Americans now. Evidence shows that health professionals are highly trusted to deliver this message. Training both current health professionals and the next generation to recognize, respond, facilitate preparedness, and educate others is essential to preparing for climate impacts on health.



About the Lancet Countdown

The *Lancet* is one of the world's leading medical journals. The *Lancet* Countdown: Tracking Progress on Health and Climate Change is a global, independent, interdisciplinary research collaboration between 27 leading academic institutions, the United Nations, and intergovernmental agencies. It draws on world-class expertise from climate scientists; ecologists; mathematicians; geographers; engineers; energy, food, livestock and transport experts; economists; social and political scientists; public health professionals; and medical doctors. The Countdown monitors and reports annually on the relationship between health and climate, and its implications for national governments.

The *Lancet* Countdown was launched following the 2015 *Lancet* Commission on Health and Climate Change, which concluded that unmitigated climate change would undermine 50 years of public health gains. In contrast, it found that responding to climate change could represent "the greatest global health opportunity of the 21st century."

The 2018 report presents data for 2017 on 41 indicators across five domains: climate change impacts, exposures, and vulnerability; adaptation planning and resilience for health; mitigation actions and health co-benefits; economics and finance; and public and political engagement. New indicators were developed and existing ones improved upon from the prior year.

About the American Public Health Association

The American Public Health Association (APHA) champions the health of all people and all communities. We strengthen the public health profession, promote best practices, and share the latest public health research and information. The APHA is the only organization that influences federal policy, has a nearly 150-year perspective, and brings together members from all fields of public health. Learn more at www.apha.org.

2018 Lancet Countdown on Health and Climate Change Brief for the United States of America

U.S. Momentum to Curb Climate Change Continues

Despite the U.S.'s intended withdrawal from the Paris Agreement, city, regional, and business commitments are currently on track to achieve about half of the U.S. carbon emissions reduction commitment.[1] Initiatives such as the *Compact of Mayors, We Are Still In,* and *C40 Cities* are gaining momentum. *We Are Still In* represents entities in all 50 states, more than 154 million Americans, $9.46 trillion of the U.S. economy, and healthcare institutions.[2]

Climate Change is Harming the Health of Americans

Humans need clean air, safe water, and vibrant communities in order to thrive, and climate change threatens these foundations of health and well-being. While the health of all Americans is at risk, climate change worsens health inequities with unequally distributed harms to health. There are broad health risks, as outlined in Figure 1, stemming from exposures like extreme weather, heatwaves, exacerbation of air pollution, changes in vector ecology, and population displacement.[3,4] People of color are disproportionately exposed to these health risks, and vulnerable populations, including children, the elderly, the chronically ill, and the poor, are often most affected. The Lancet Countdown's findings reinforce those of the U.S. Global Change Research Program's Fourth National Climate Assessment: Volume I and the Climate and Health Assessment that show climate change is already harming Americans' health.[3,4]

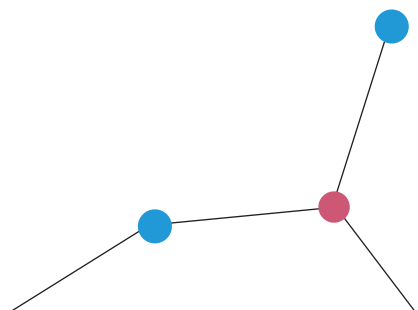


Figure 1: Climate Change is Harming the Health of Americans.

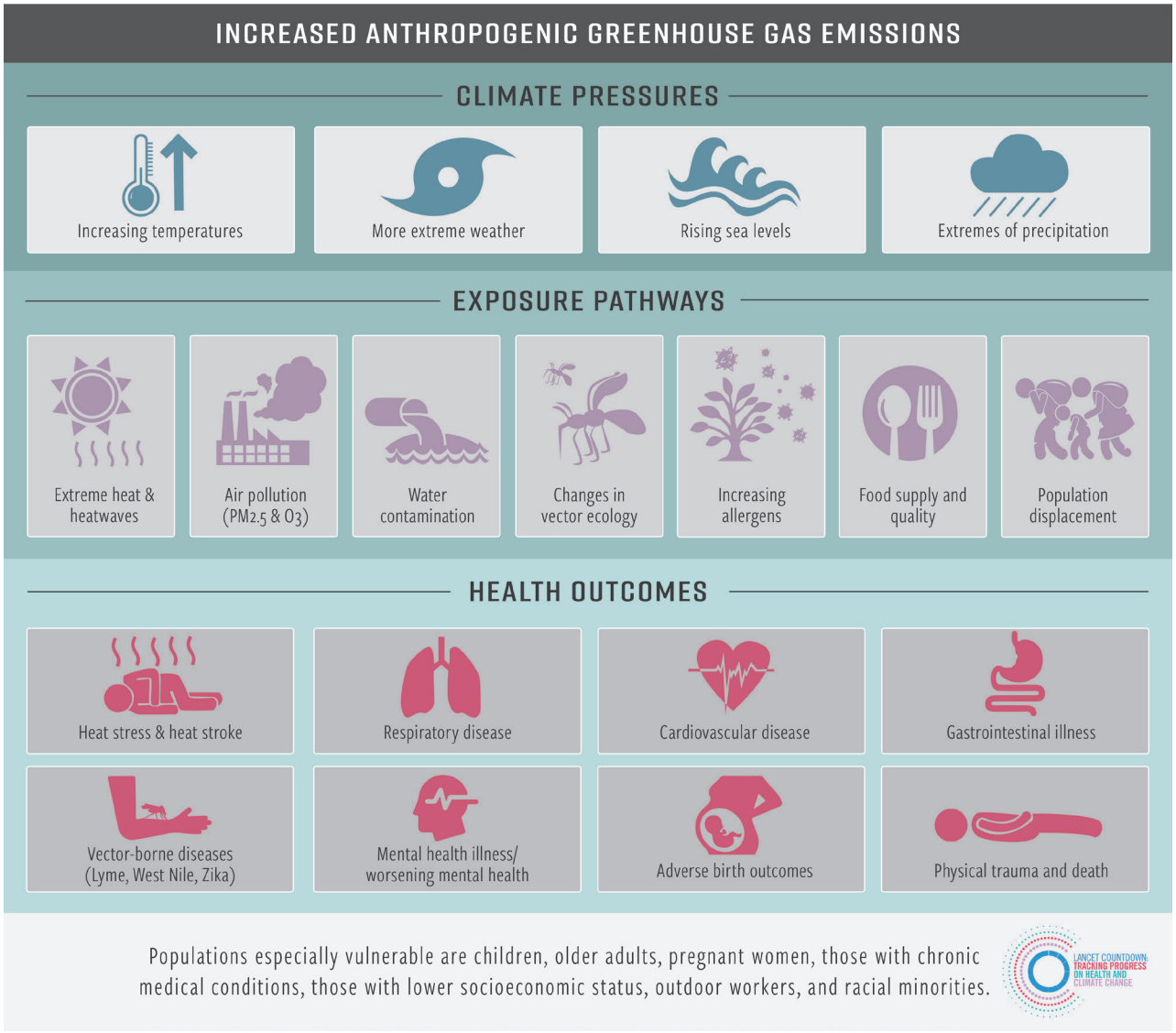


Figure created for Brief by M. Lee (Climate Nexus).

Negative Health Impacts of Heat

Data from the U.S.

Heatwaves are associated with increased rates of heat stress and heat stroke, increased aggression and violence, and other widespread health impacts as shown in Figure 2.[4] Emerging evidence demonstrates links between hotter temperatures and increased bacterial resistance to antibiotics,[5] declines in cognitive function,[6] worsening mental health conditions,[7] and increased suicides.[8] Exposure to extreme heat is the leading cause of weather-related deaths in the U.S.,[9,10] and one estimate predicts that by 2050, approximately 3,400 more Americans will die prematurely each year as a result of increased heat.[11]

These spikes in deaths, emergency department visits, and hospital admissions disproportionately affect pregnant women, the young and old, the chronically ill, minorities, low-income families, and outdoor workers.[4] The cost of hospitalizations, emergency department encounters, and outpatient visits related to just one heatwave event was estimated at $179 million.[12]

Figure 2: Extreme Heat is Harming the Health of Americans.

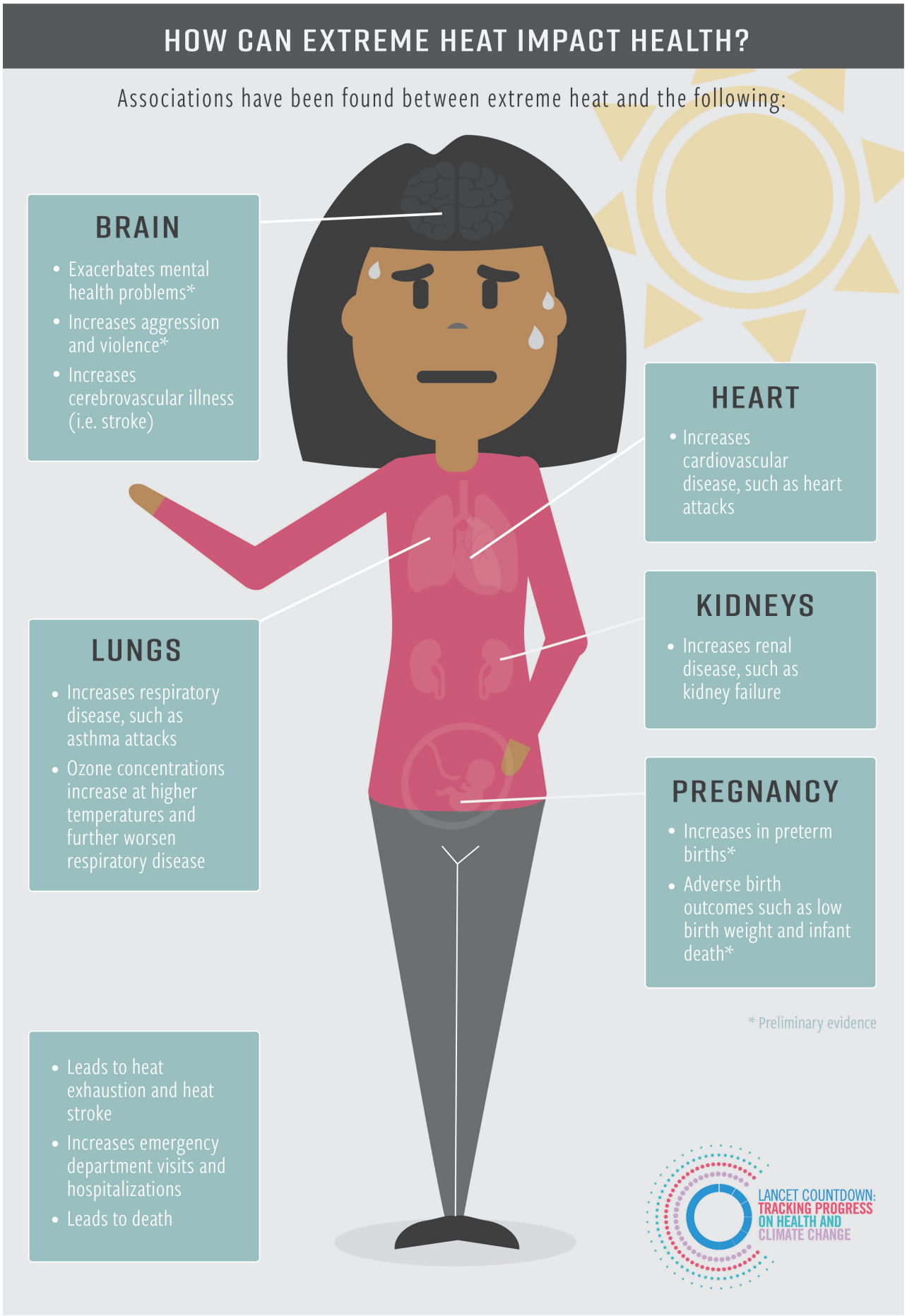


Figure created for Brief by M. Lee (Climate Nexus).

Heat exposure in the U.S. is increasing as hot days and extreme heatwaves become more frequent. While U.S. yearly temperatures can be variable, the trend reveals a steady 0.15°F per decade rise since 1895. In 2017, the majority of Americans experienced temperatures that were well above average or the warmest ever recorded (Figure 3)[13], with increasing frequency and intensity of heatwaves (Figure 4).[14]

Figure 3: 2017 Mean Annual Temperature Percentiles as Rankings Compared to Baseline Data (1985-2017).[13]

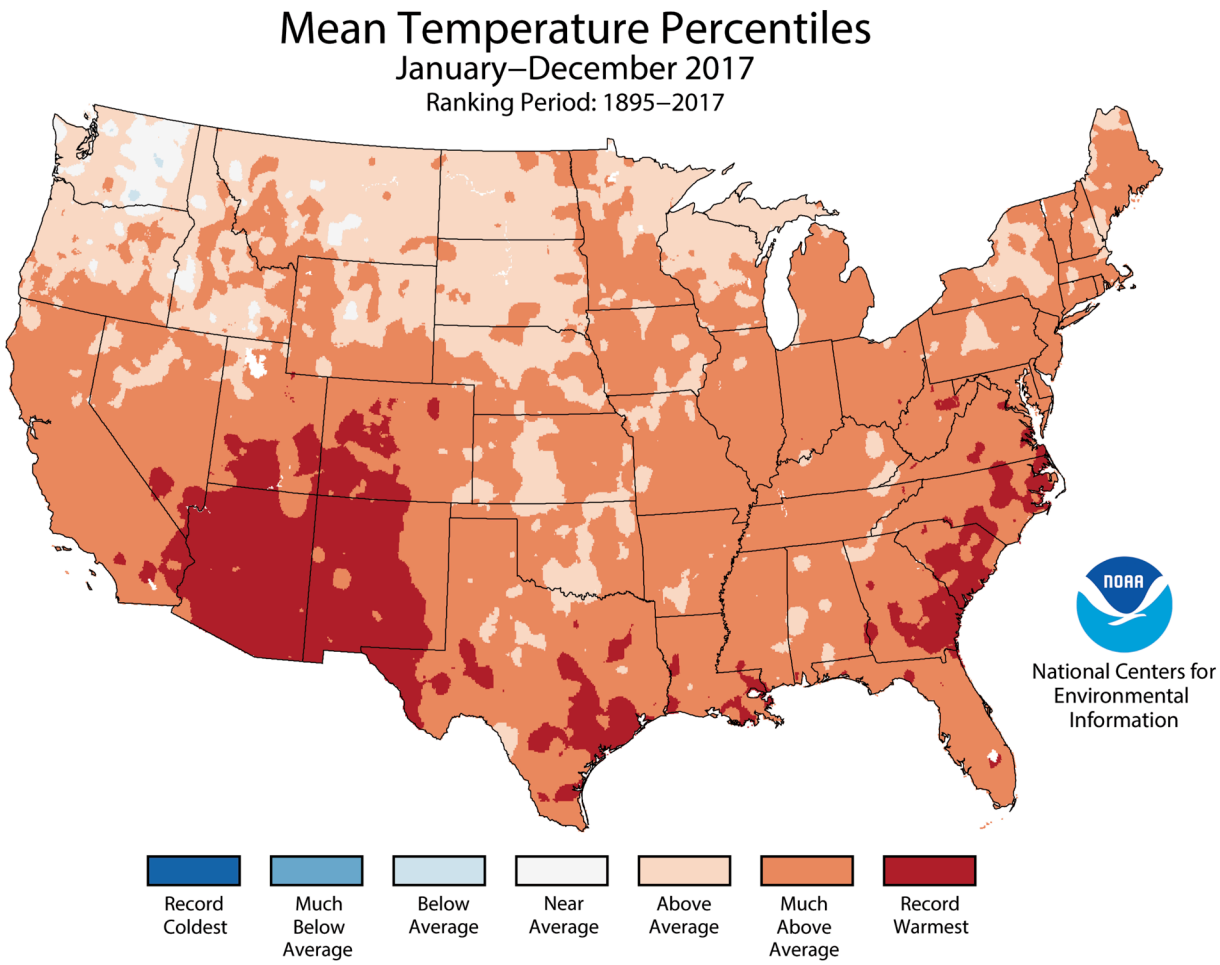


Figure Source: National Oceanic and Atmospheric Administration's National Centers for Environmental Information, 2018.

Figure 4: Heatwave Characteristics in 50 Large U.S. Cities Between 1961-2017.[14]

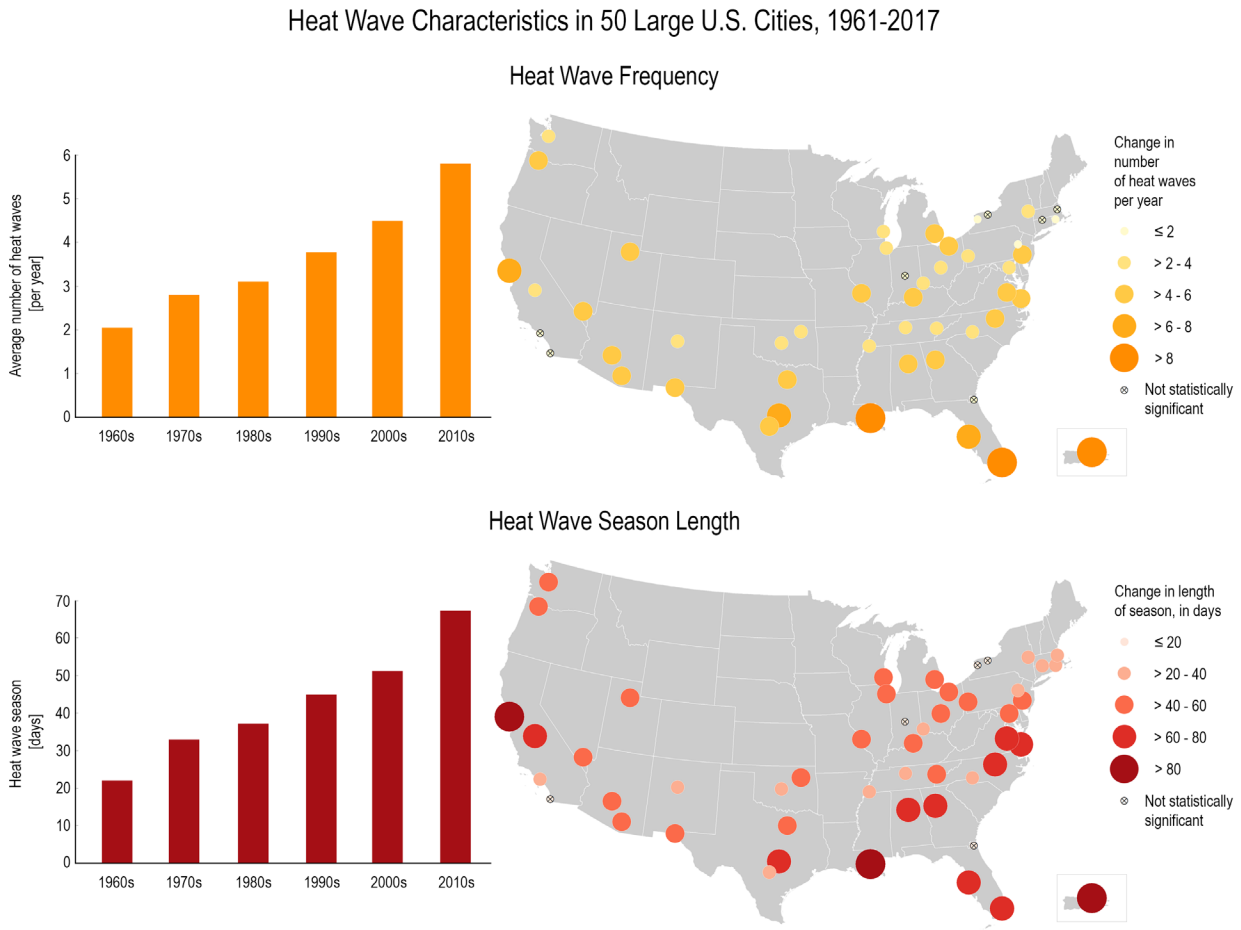


Figure Source: U.S. Global Change Research Program, 2018.

Adaptation to increased heat requires a multi-prong approach including heat alert systems, real-time data surveillance, public health education and access to cooling.[15] If America maintains its current electricity mix with 30% from coal, as many as 1,000 additional deaths may occur annually by mid-century from air pollution due to the electricity generation for air conditioning alone.[16] A transition towards less-polluting electricity sources is key.

Headline Finding: Health Effects of Temperature Change (Indicator 1.2)

The average summer temperature in the U.S. is steadily increasing, with the summer of 2016 having a mean increase of 2.2°F (1.2°C) from the 1986-2005 average.[17]

Headline Finding: Health Effects of Heatwaves (Indicator 1.3)

Heatwaves in the U.S. are lasting longer. The largest mean change since the year 2000 was in 2011, with a heatwave length increase of 3.6 days as compared to the 1986-2005 baseline.

Subsequently, 24 million more Americans were exposed to extreme heat in 2011 and 12.3 million more in 2016 when compared to this same baseline.[17]

Headline Finding: Change in Labor Capacity (Indicator 1.4)

Warming is reducing American labor productivity. Between 2000-2017, it is estimated the U.S. lost nearly 1.1 billion labor hours, particularly in industry and agriculture (Figure 5).[17]

Agricultural and construction workers have been shown to be at highest risk for occupational heat-related deaths.[18] One estimate shows that, compared to 2005, there could be an annual loss of 880 million labor hours and $44 billion in lost wages in 2050.[11]

Figure 5: Total Labor Hours Lost in the U.S. Due to Heat by Year and Sector.[17]

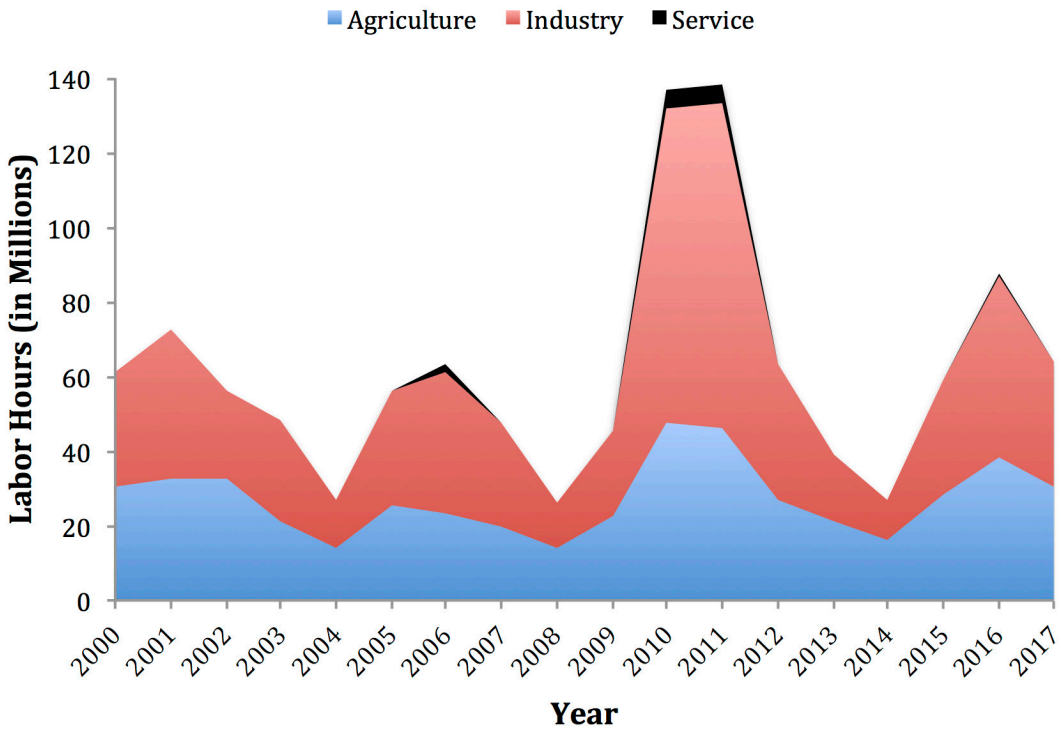


Figure Source: Lancet Countdown Indicator 1.4 (2018 Report).

Negative Health Impacts of Extreme Weather

Data from the U.S.

Depending on the type of event, extreme weather can directly impact health through associations with drownings, other injuries, infectious diseases, hypothermia and other problems. Health is also affected indirectly through prolonged infrastructure damage (e.g. mold), mental health issues (e.g. post-traumatic stress), population displacement, and disaster-related healthcare system failures.[19] The risks of extreme weather health impacts are especially high for children.[20]

Since 1980, there has been a steady rise in billion-dollar weather and climate disasters in the U.S. (Figure 6).[21] In 2017, a record-tying 16 events cost an estimated $313 billion USD with damage calculations that included insured and uninsured losses, such as structural and agricultural, but did not take health costs into consideration.[21] These damages significantly undermine people's physical and mental health, particularly for those who are not insured.[22,23]

Figure 6: Trends in Year-to-Date United States Billion-Dollar Disaster Event Frequency (through October 2018).[21]

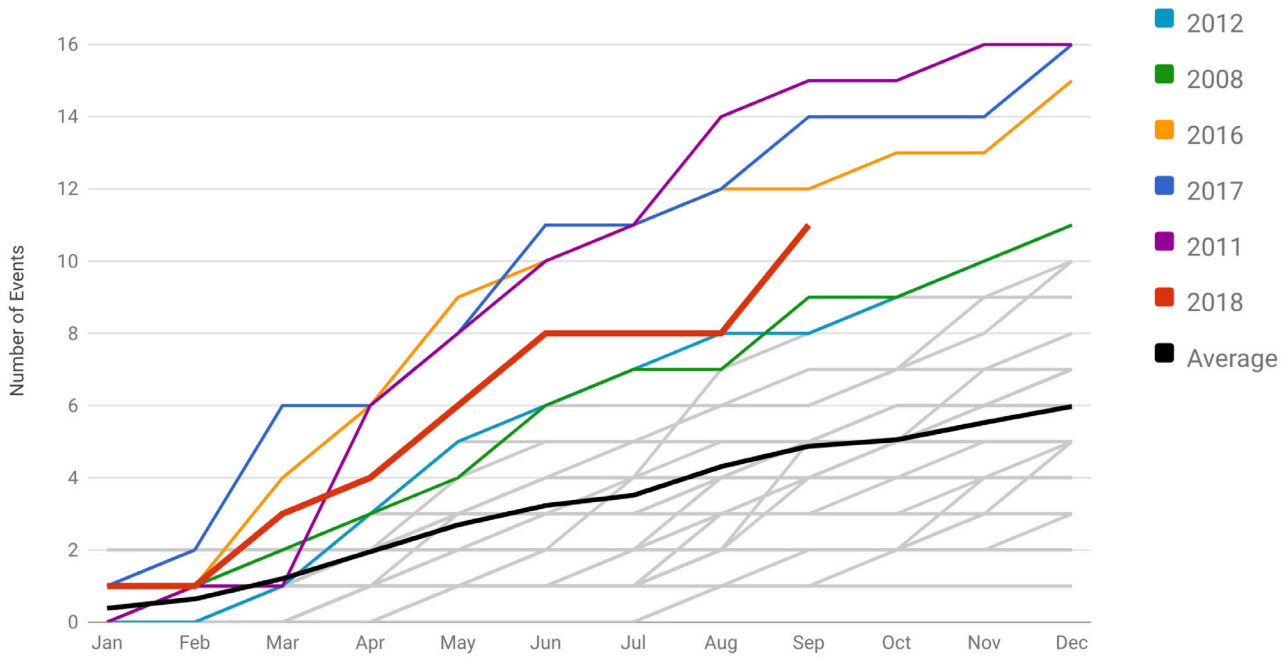


Figure Source: National Oceanic and Atmospheric Administration's National Centers for Environmental Information, 2018.

Headline Finding: Economic Losses due to Climate-related Extreme Events (Indicator 4.1)

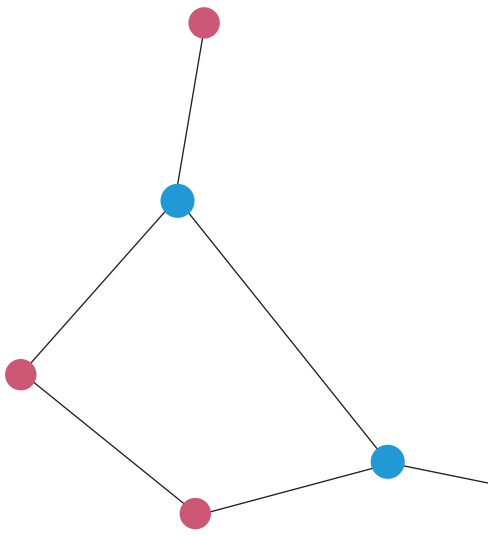
For climate-related extreme events in 2017, the U.S. experienced absolute economic losses valued at $80 billion USD for insured losses and $94 billion USD in uninsured losses.[17]

The *Lancet* Countdown Indicator 4.1 data was obtained from the Munich Re's NatCatSERVICE. It is lower than the 2017 billion-dollar National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Information (NCEI) data above. This highlights the complexity of accurately determining these figures.

Headline Finding: Lethality of Weather-related Disasters (Indicator 1.6)

The Emergency Events Database reports that in 2017, 284 lives were lost in the U.S. over the course of 23 events (floods, storms, and wildfires) with approximately 866,835 individuals affected and 109,108 with destroyed homes.[24]

Other estimates are considerably higher, reflecting differences in methods for counting disaster health impacts. This is particularly evident for events like Hurricane Maria (see Case Study).



Case Study on Hurricane Maria in Puerto Rico: Accurate Mortality, Population Displacement, and Shortages of Intravenous Fluids Across the U.S.

Accurate Mortality

Hurricane Maria made landfall in Puerto Rico on September 20, 2017, striking an area that had been hit by Hurricane Irma only two weeks before. While it caused an estimated $91.8 billion in damage, the true number of deaths depends on what is defined as attributable to the event.[21]

In December 2017, Puerto Rico's Department of Public Safety listed the official death toll as 64.[25] In Puerto Rico, every disaster-related death must be confirmed by the Institute of Forensic Sciences. This requires that bodies be brought to San Juan or that a medical examiner travel to the local municipality to verify the death. However, the Vital Statistics Office was without power and utilizing paper records. Furthermore, indirect deaths resulting from impacts such as water and electricity shortages, worsening chronic conditions, or delayed medical treatment may not be captured. These factors led researchers and media outlets to question the accuracy of the initial figure.[26]

In response, a group of researchers used a community-based survey methodology of randomized door to door visits of approximately 3,300 households to provide an estimate of the Hurricane-Maria-related deaths in Puerto Rico congruent with the Centers for Disease Control and Prevention (CDC) definition of an attributable death.[25] This avoided the pitfalls of the administrative process and death-certificates. They estimated a total of 4,465 excess deaths: adjustment for biases raised this estimate to 5,740 excess deaths (Figure 7). In addition, a separate commissioned study estimated 2,975 deaths.[27] Comprehensive estimates must also take delayed deaths into account. One study found a 16% increase in suicides in the first four months and a 26% increase in the first six months post-landfall compared to the year before.[28] Even the conservative estimates are approximately 0.1% of the total population in Puerto Rico, which would be the equivalent to losing the entire city of Cincinnati, Ohio on the mainland U.S.

Figure 7: Representation of Death Count Discrepancy in Puerto Rico after Hurricane Maria.[25,27]

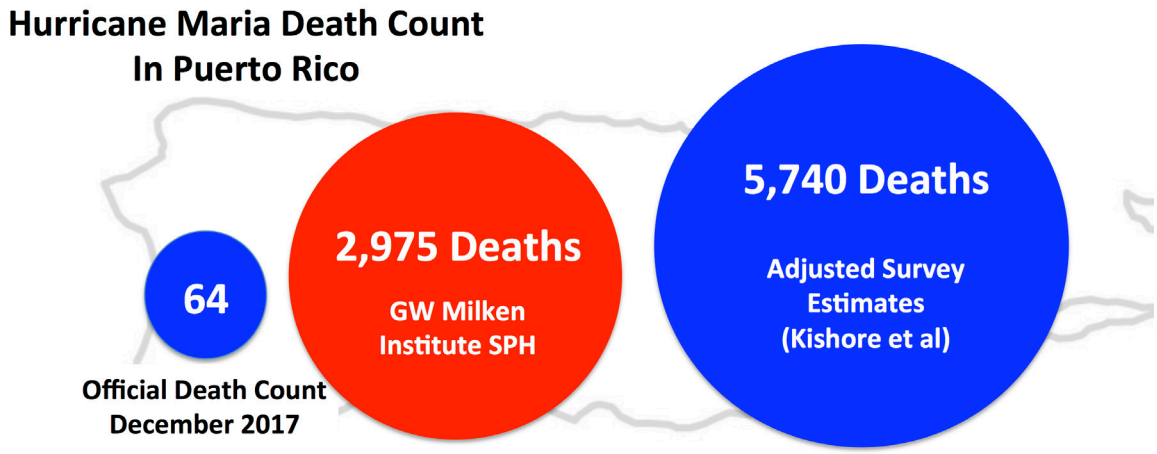


Figure created for Brief by R. Salas.

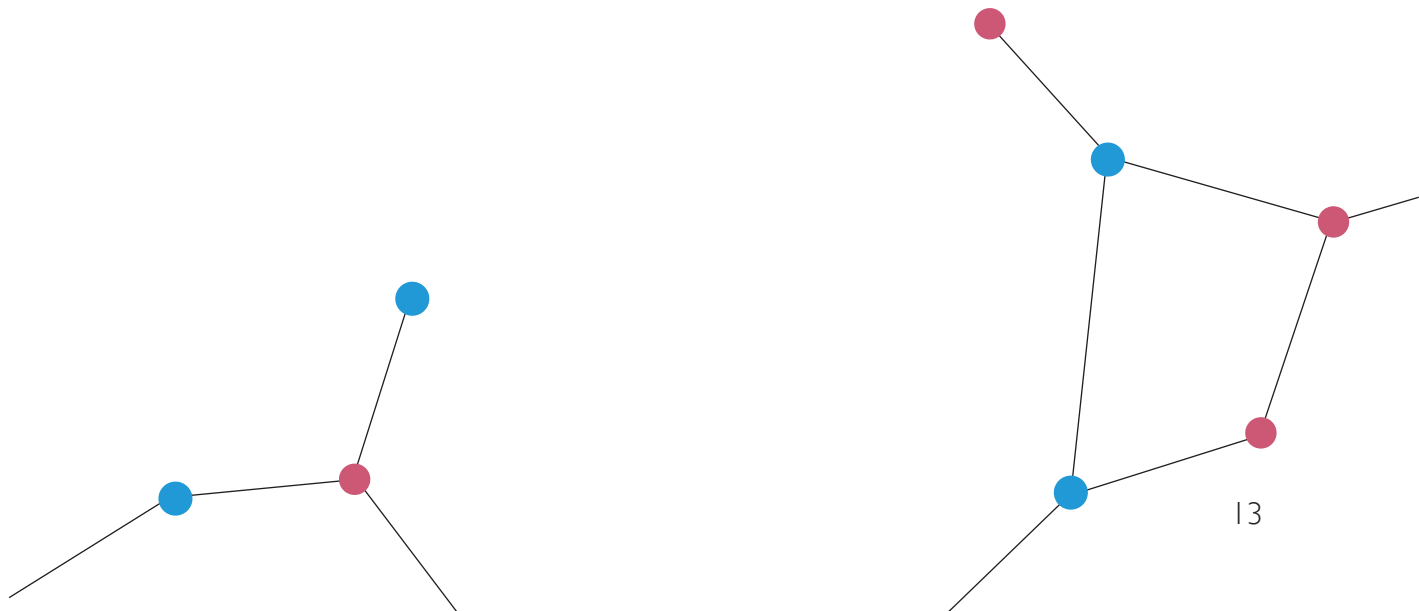
The stark discrepancies between death counts highlight the difficulty of characterizing the true impacts of extreme weather events on health and lives lost. This is a significant concern. Without being able to accurately determine how many people were impacted, the ability to allocate post-disaster resources and plan for future disasters is hindered.

Population Displacement

In addition to mortality impacts, Hurricane Maria is estimated to have displaced 10,600 people from Puerto Rico alone, with Puerto Rican Americans moving to every U.S. state.[29-31] These numbers are likely significant underestimates. Displaced populations have increased health risks and face new psychosocial challenges.[32–35]

Intravenous Fluid Shortages Across U.S.

Puerto Rico supplies 44% of the intravenous (IV) fluid for the U.S.[36] While the U.S. has suffered intermittent shortages since 2014, Hurricane Maria damaged the factory of a leading producer of IV fluid, leading to months-long shortages at hospitals across the country and beyond.[37] Hospitals and health professionals sought alternative solutions collaboratively to manage the crisis, such as utilizing oral rehydration therapy and changing the route of medication administration.[36,37] The widespread impact of this one storm in the U.S. exposed vulnerabilities in healthcare system supply chains and highlighted the need to create climate-resiliency.

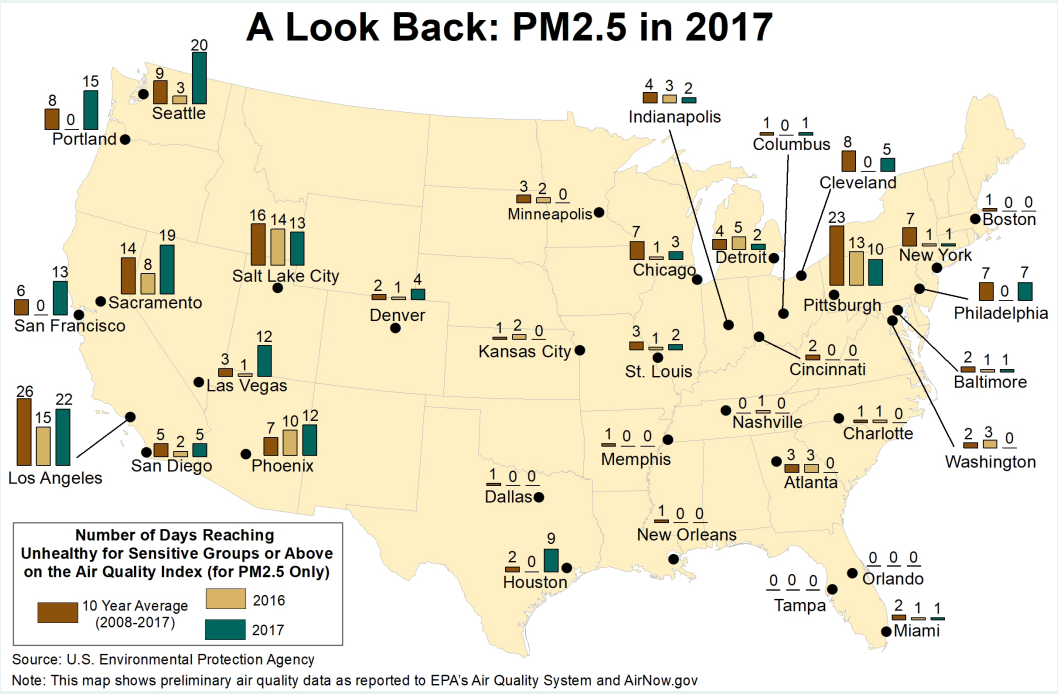


Negative Health Impacts of Wildfire Smoke Exposure

Data from the U.S.

The 2017 wildfire season in the U.S. was historically destructive. It burned 9.8 million acres and killed at least 44 people with extreme, difficult-to-extinguish wildfires,[13] which are expected to become more common as the climate changes.[38] Wildfire smoke releases fine particulate matter (e.g. $PM_{2.5}$) and ozone precursors which are harmful to cardiorespiratory health.[4,39] While $PM_{2.5}$ concentrations have been decreasing across the country since 1988, they are rising in some western U.S. states (Figure 8).[40,41]

Figure 8: Number of Days Reaching Air Quality Index (AQI) Levels Unhealthy for Sensitive Groups in Multiple Cities in 2016 and 2017 for $PM_{2.5}$.[41]



Note: The EPA's Air Quality Index (AQI) assess air quality on a yardstick that runs from 0 to 500, where higher numbers indicate greater levels of air pollution. For $PM_{2.5}$, the AQI has set a goal level of 100 or below. When levels become 101-150, it is felt to be unhealthy for sensitive groups, such as children, the elderly, and those with respiratory diseases. Any level above 151 is felt to be unhealthy for all individuals.[42]

Figure Source: U.S. Environmental Protection Agency, 2018.

In addition to the stress, direct trauma, and immediate deaths associated with wildfires, wildfire smoke has been associated with increased asthma and chronic obstructive pulmonary disease exacerbations. There is emerging evidence supporting an association between wildfire smoke exposure and cardiac and stroke visits, as well as an overall increased mortality.[4,43–47] Wildfire health damages in the U.S. in 2017 were likely higher than prior annual estimates for time periods with less active wildfires (2008-2012), which still accounted for a staggering $87-$150 billion per year.[48] While educating communities about clear evacuation plans, ensuring patients have adequate respiratory-related medications, and improving smoke forecasts to assist in outdoor travel planning will help populations cope, climate mitigation is urgently needed to prevent intolerable wildfire seasons in years to come.

Negative Health Impacts of Vector-borne Diseases

Data from the U.S.

Climate change is altering the ecology, geographic range, and abundance of vectors that carry diseases in the U.S. The most common vectors are ticks and mosquitoes, which can transmit vector-borne diseases (VBD) such as West Nile Virus, Zika, and Lyme. There was a tripling in vector-borne illnesses from mosquitoes, ticks, and fleas when comparing 2016 to 2004 (Figure 9).[49]

Figure 9: Number of Reported Vector-borne Diseases (Mosquito, Tick, and Flea) in U.S. States and Territories During 2004–2016.[50]

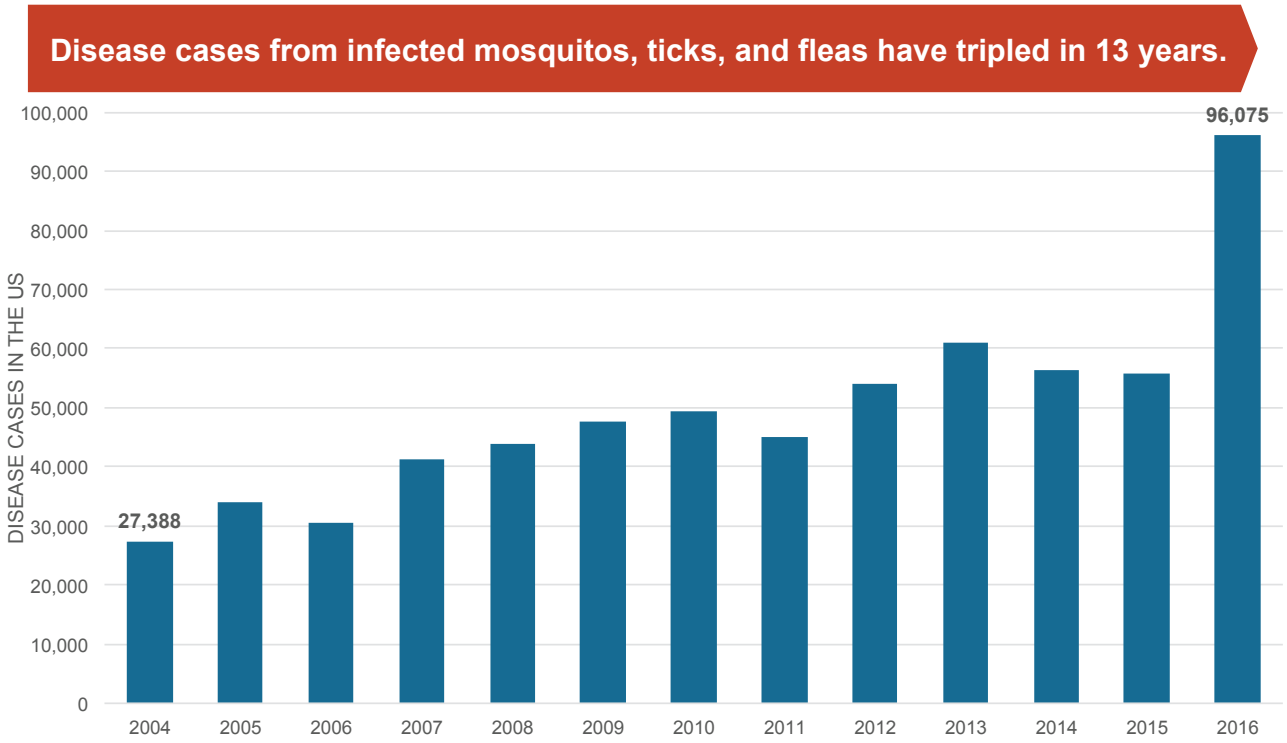


Figure Source: Center for Disease Control and Prevention, 2018.

North America is one of the continents that is expected to experience the largest climate-driven increase in the percentage of people exposed to the mosquito *Aedes aegypti,* which transmits diseases such as Zika and dengue.[51] Mosquito-borne diseases have been especially prone to epidemic outbreaks. West Nile is the most commonly transmitted mosquito-borne infection, despite significant under-reporting.[52] In addition, there was a significant Zika epidemic in 2016, which was linked to birth defects.[49] Researchers are seeking to better understand the role that climate change plays, along with other factors like travel and development, in the spread of VBDs.

Headline Finding: Suitability for U.S. Outbreaks of Pathogenic *Vibrio*, a Water-borne Infectious Disease (Indicator 1.8)

The U.S. Northeast has had a 27% increase in the area of coastline with suitability for the pathogenic water-borne *Vibrio* bacteria in the 2010s versus the 1980s baseline (Figure 10).[17]

Figure 10: Percentage of Coastal Area in the Northeast U.S. that is Suitable for a *Vibrio* (*Vibrio parahaemolyticus*, *V. vulnificus*, and non-toxigenic *V. cholerae* (non-O1/non-O139)) Outbreak.[17]

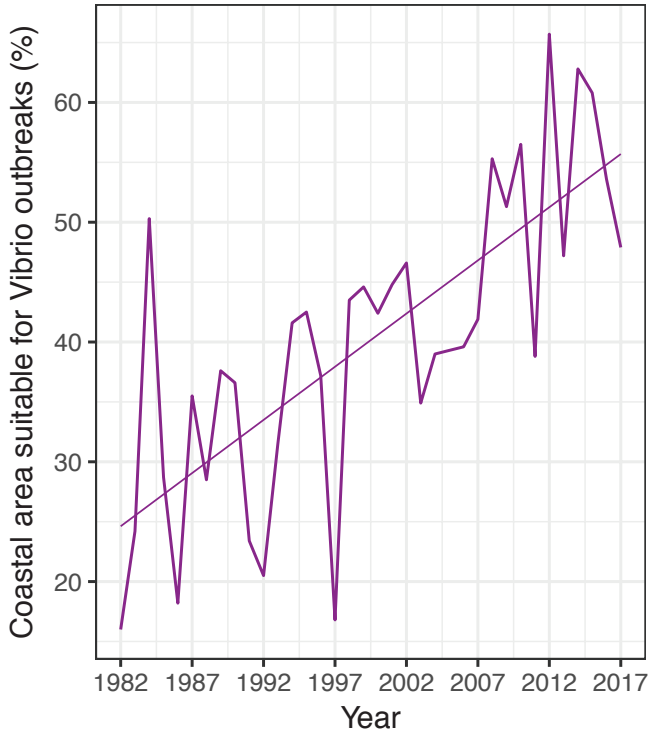


Figure Source: Lancet Countdown Indicator 1.8 (2018 Report).

Warmer sea surface temperatures (SST) are associated with increased prevalence of pathogenic *Vibrio* bacteria species. Thus, this indicator addresses the suitability of living conditions for *Vibrio* based on increasing coastline SST as an early warning sign that infections may increase in the future.[17]

Vibrio is a family of bacteria that includes species of concern in the U.S. that can cause various diseases in humans. According to the CDC, Vibriosis causes an estimated 80,000 illnesses and 100 deaths in the United States each year.[53] These infections span from life-threatening bloodstream infections, to gastroenteritis, to ear and wound infections (leading some to describe it as flesh-eating bacteria). As the suitability for this bacteria increases in certain areas of the U.S., human exposure may increase through direct contact (e.g. swimming) or ingestion (e.g. eating contaminated raw oysters).

Opportunities to Save Lives and Improve Health in the U.S.

Prevention of Further Dangerous Climate Change: Transitioning to Renewable Clean Energy

The U.S. ranks second in the world for carbon emissions from fossil fuel combustion.[54] The amount of per capita carbon emissions produced by states is outlined in Figure 11. To reach the Paris Agreement goal of net zero emissions between 2050 and 2100, the U.S. would need to rapidly phase out fossil fuel use, which would have profound benefits to health and save lives.

Figure 11: 2015 Per Capita Energy-Related Carbon Dioxide Emissions by State.[55]

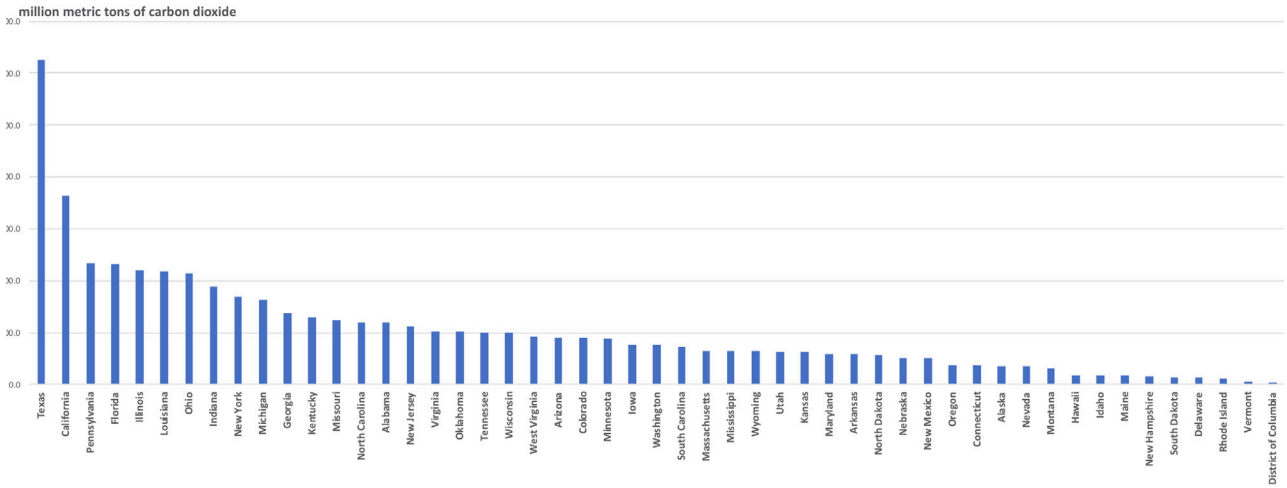


Figure Source: U.S. Energy Information Administration, 2018.

Responsible for approximately 10% of U.S. greenhouse gas emissions by most recent estimates, the U.S. health sector is a major contributor to climate change.[56] Furthermore, the mortality burden from air pollution generated by the health sector's fossil fuel use has been estimated to be comparable to mortality due to medical errors.[57] The U.S. health sector is beginning to shift away from fossil fuel energy sources and recently 28 healthcare organizations made a pledge to the U.S. Paris Agreement commitments.[58]

Headline Finding: Carbon Intensity of the Energy System in the U.S. (Indicator 3.1)

Since 1971, the carbon intensity of the total primary energy supply (TPES) in the U.S. has declined. In 2015, TPES reached a recorded low of 54.5 metric tons of CO_2 emitted for each terajoule (TJ) of primary energy (Figure 12).[17]

Figure 12: Carbon Intensity of the Energy System for the U.S. by Tons of CO_2 (tCO_2) Emitted for Each Unit (TJ) of Primary Energy Supplied. Indicator Based on Total CO_2 Emissions from Fossil Fuel Combustion Divided by Total Primary Energy Supply (TPES).[17]

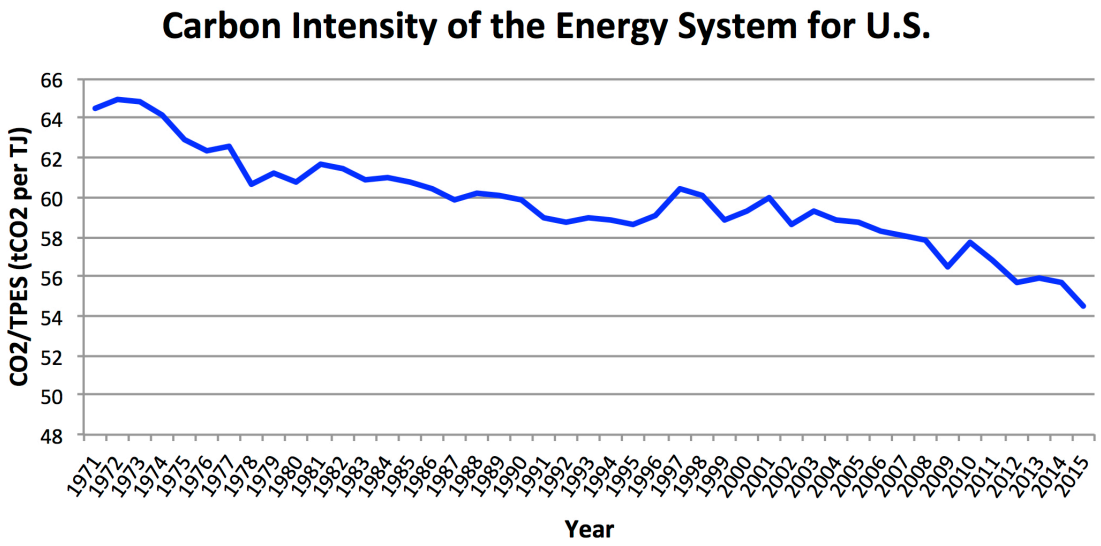


Figure Source: Lancet Countdown Indicator 3.1 (2018 Report).

Headline Finding: Zero-Carbon Emission Electricity in the U.S. (Indicator 3.3)

Since 1971 there has been a steady rise in low-carbon emission electricity, with a total of 1,411 Terawatt Hours (TWh) installed by 2016 (Figure 13).[17]

Figure 13: Absolute Total Low-Carbon Electricity Generation in Terawatt Hour (TWh).[17]

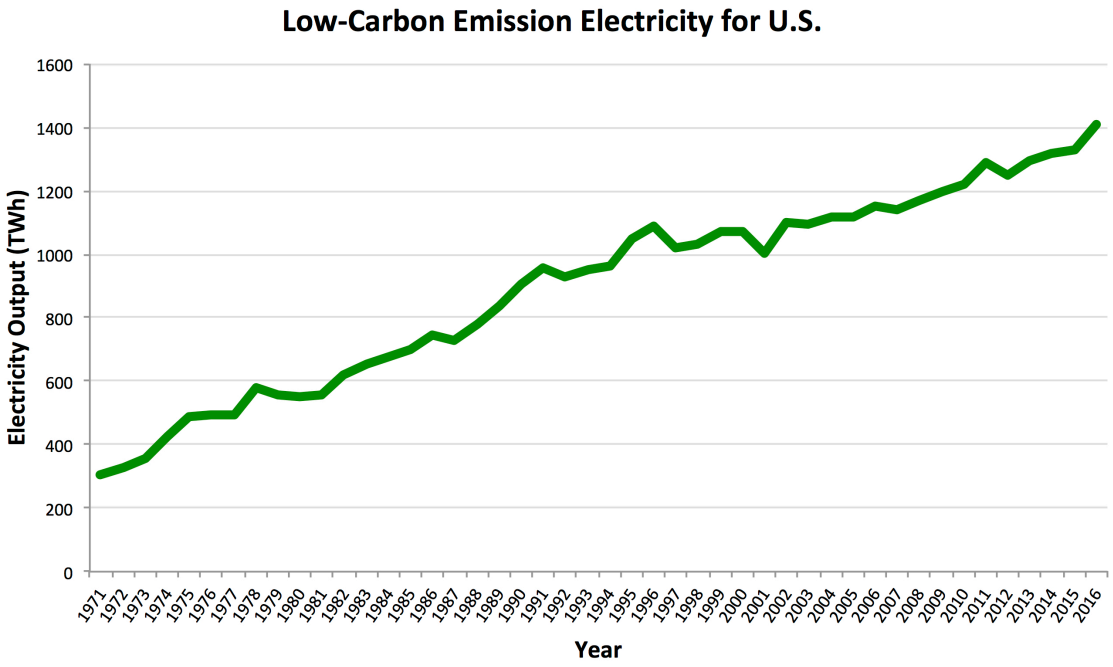


Figure Source: Lancet Countdown Indicator 3.3 (2018 Report).

Low-carbon energy includes power from sources such as wind, solar, nuclear, and hydropower. The increasing trend seen here must accelerate quickly in order to reach the Paris Agreement commitment. A recent report stresses the significant opportunity of aggressively reducing U.S. GHG emissions even beyond Paris Agreement commitments, to keep warming below 2.7°F (1.5°C), as this would maintain the viability of some coral reefs, reduce heat illness and maintain food yields, amongst other benefits to health.[59,60]

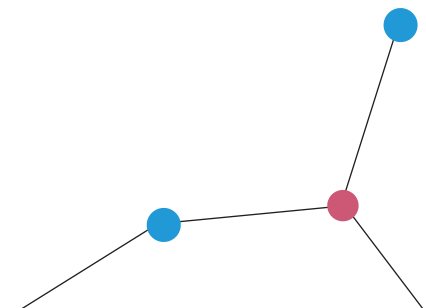
The following U.S. health systems have committed to 100% renewable electricity: Boston Medical Center, Gundersen Health System, Kaiser Permanente, Partners HealthCare, Rochester Regional Health System, University of California Health, and University of Vermont Medical Center.[61]

Headline Finding: Funds Divested from Fossil Fuels (Indicator 4.5)

Globally, healthcare organizations committed to divest $3.28 billion from fossil fuels in 2017, which is 0.77% of the cumulative global total of $33.6 billion across all sectors.[17]

Divesting from fossil fuels is a way for health-related organizations to demonstrate that they are "doing no harm" with their investments. It also protects investments against future potential losses as the world transitions to a low-carbon economy.[17]

Some U.S. healthcare organizations have already divested from fossil fuels including: American Public Health Association, Chicago Medical Society, Dignity Health, Gundersen Health System, Health Care Without Harm, Practice Greenhealth, Society for the Psychological Study of Social Issues, and SSM Health.[61] The American Medical Association has passed a resolution to divest.[62]



Adaptation to Climate Change

Public Health Department Preparation and Climate Change Adaptation Spending on Health

Local health departments and other city departments across the U.S. recognize the importance of adaptation to reduce the negative health impacts of climate change within their communities (Figure 14).[63,64] Public health adaptation reflects short- or long-term strategies aimed at reducing the negative health impacts and working across sectors for resilience to climate change.[65] Critical components of local health sector adaptation include cross-sectoral collaboration and educating policy makers about the connection between climate change and health.[66]

Figure 14: Representative Local Public Health Departments and Cities in the U.S. Preparing for Climate Change Health Impacts.[63]

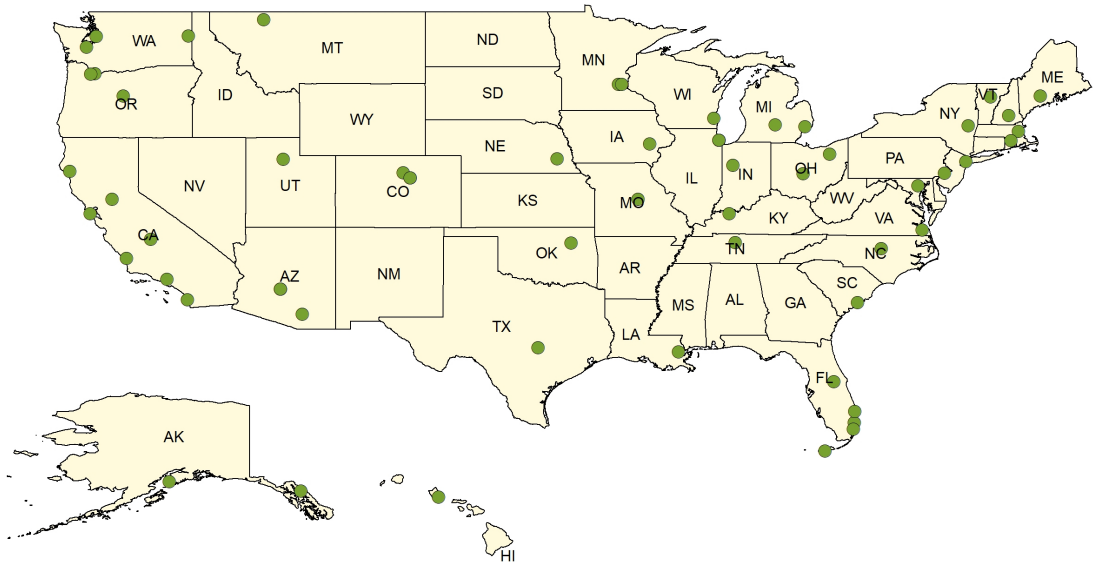


Figure created for Brief by National Association of County and City Health Officials (NACCHO).

Headline Finding: Spending on Adaptation for Health and Health-Related Activities in the U.S. (Indicator 2.7)

For the 2016-2017 financial year, the U.S. spent $67.2 billion on Adaptation and Resilience to Climate Change (A&RCC), which was a 5% increase from 2015-2016. Of this total spending, the U.S. spent:

- **5% ($3.5 billion) on climate change health adaptation, which was an 8% increase from 2015-2016. Health adaptation is defined as adaptation occurring within the formal healthcare sector only.**
- **14% ($9.4 billion) on climate change health-related adaptation for climate change, which was a 5% increase from 2015-2016. Health-related adaptation is defined as within the healthcare sector plus disaster preparedness and agriculture.[17]**

Though it is important to invest in U.S. climate change adaptation across all sectors, committing funds specifically to health and health-related adaptation is critical to save lives. Climate change adaptation requires more substantial funding to protect the health of Americans.

Training the Next Generation and Educating the Public on the Health Impacts of Climate Change

Correlates with Lancet Working Group 5: Public and Political Engagement

Healthcare professionals need to be educated about the ways climate change is harming Americans' health and well-being. These professionals include physicians, nurses, public health workers, and professionals in other health sciences.

The International Federation of Medical Students Association (IFMSA) has created a *2020 Vision for Climate-Health in Medical Curricula* as a call to action to include an element of climate-health in every medical school curriculum by 2020.[67] The Global Consortium on Climate and Health Education (GCCHE), hosted at the Columbia University Mailman School of Public Health, has developed *Climate and Health Core Competencies* for health professional students which can act as an institutional guide.[68]

Recent polls show that nearly half of Americans (49%) are "extremely or very sure" that climate change is happening versus only 7% who are "very sure" climate change is not occuring.[69] Given that the bedrock of public health is education about threats to health, it is critical that health providers inform their patients, communities, and policy makers about the health harms of climate change.

Evidence shows that primary care providers are among the most trusted voices to deliver this message (Figure 15)[70], while nurses are the most trusted profession in the country across all sectors.[71] It has been shown that educating Americans about the health impacts of climate change can increase public engagement and decrease political polarization.[72]

Figure 15: Degree of Trust in Sources of Health Impacts of Climate Change.[70]

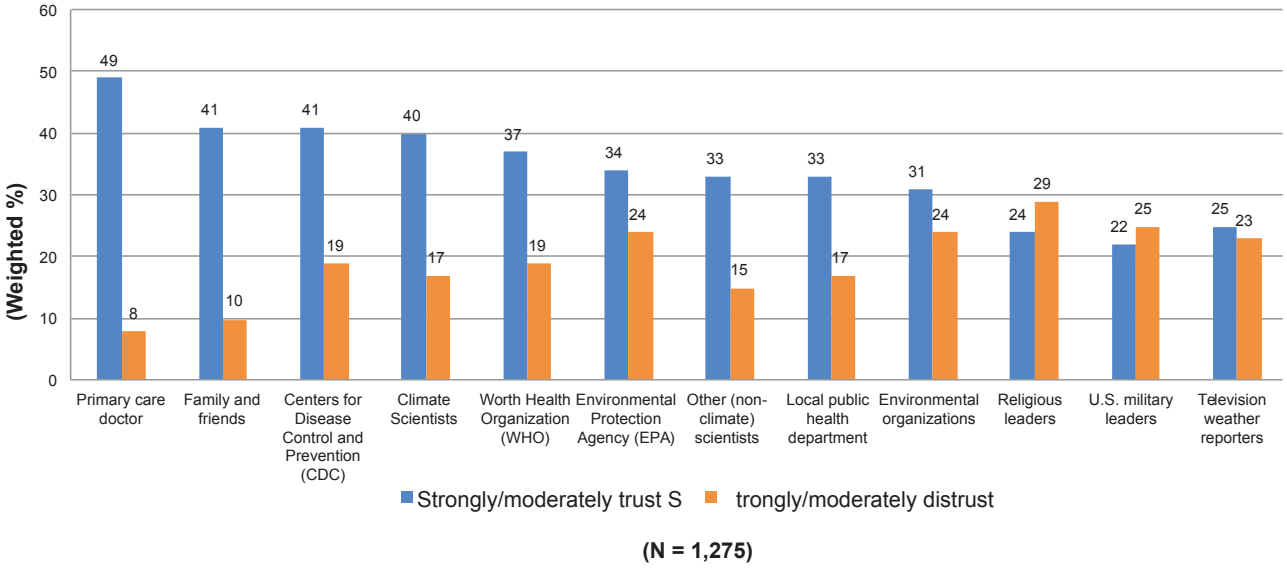


Figure Source: Recreated from Maibach EW et al, 2018.

Recommendations to Improve Health and Save Lives

Climate Change Threatens Americans' Health Now

- U.S. federal and state funds should be committed for improved preparation, including surveillance and targeted interventions, that will reduce the burden of disease from heat, extreme weather, and infectious disease. This specifically includes protection of labor workers from heat-related disease and death and robust monitoring of the health impacts of extreme weather.

- Robust U.S.-based climate and health research and education funding mechanisms should be created. This will allow researchers and educators to address the steep knowledge gaps and generate evidence-based health adaptation strategies.

Prevention of Further Dangerous Climate Change: Transitioning to Renewable Clean Energy

- The U.S. needs local, regional, and state-level policies, combined with renewed federal leadership, to ensure GHG emissions are reduced to levels that meet or surpass Paris Agreement commitments.

- Health organizations and health professionals should advocate for state laws that transition away from fossil fuels, following the precedent set by Hawaii and California that requires state utilities to generate electricity from 100% carbon-free sources by 2045. This will create cleaner air and water, mitigate climate change, improve health, and save lives.

- U.S. health and healthcare organizations should seek to rapidly reduce their own GHG emissions and transition to renewable energy sources, thus improving the health of their communities and reducing costs.

Adaptation to Climate Change: Public Health Department Preparation and Climate Change Adaptation Spending on Health

- U.S. federal and state bodies should dedicate funding for climate change preparation in health and health-related sectors to improve emergency preparedness, supply chain resilience, and protect vulnerable communities.

Training the Next Generation and Educating the Public on the Health Impacts of Climate Change

- Climate change and health education should be rapidly integrated into U.S. health professional curricula and continuing medical education.

- The trusted voices of the U.S. health sector should be unified and elevated in order to better explain the health impacts of climate change and motivate aggressive GHG reduction. This is an opportunity to create a safer and healthier America and a more promising future for today's children.

Lancet Countdown Indicator Data Sources and Clarifications (In Order Presented)

1. Indicator 1.2: Weather data from European Centre for Medium-Range Weather Forecasts (ECMWF) and population data from NASA Gridded Population of the World v4. Summer is defined as June, July, and August for the Northern Hemisphere.

2. Indicator 1.3: Weather data from European Centre for Medium-Range Weather Forecasts (ECMWF) and population data from NASA Gridded Population of the World v4. Heatwaves are defined as periods of four or more consecutive summer days where the minimum daily temperature is greater than the 99th percentile of the reference period 1986-2005.

3. Indicator 1.4: Calculated utilizing weather data from European Centre for Medium-Range Weather Forecasts (ECMWF), population data from NASA Gridded Population of the World v4, and demographic data from UN World Population Prospects (WPP).

4. Indicator 4.1: Munich Re's NatCatSERVICE.

5. Indicator 1.6: EM-DAT at the Center for Research on the Epidemiology of Disasters (CRED) at the Université Catholique de Louvain, Belgium.

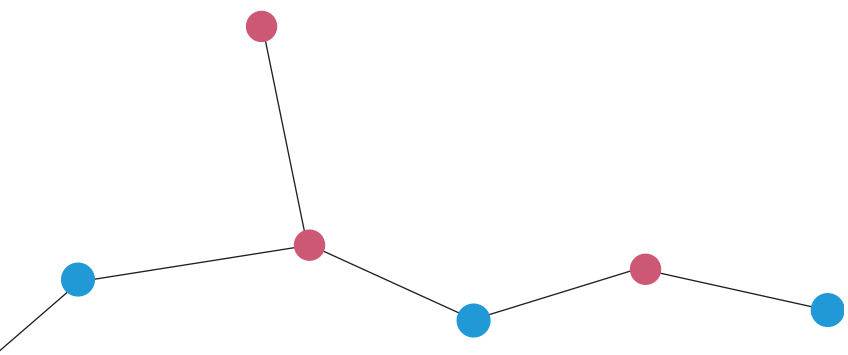
6. Indicator 1.8: As noted in Watts et al (2018) Lancet Countdown global report in Appendix 2.

7. Indicator 3.1: International Energy Agency (2017) CO2 Emissions from Fuel Combustion: CO2 Indicators.

8. Indicator 3.3: International Energy Agency (2017) World Extended Energy Balances.

9. Indicator 4.5: 350.org.

10. Indicator 2.7: Adaptation and Resilience to Climate Change (A&RCC) dataset, created by data research firm kMatrix and other stakeholders, that measures climate change adaptation and resilience spending through a system called "profiling."



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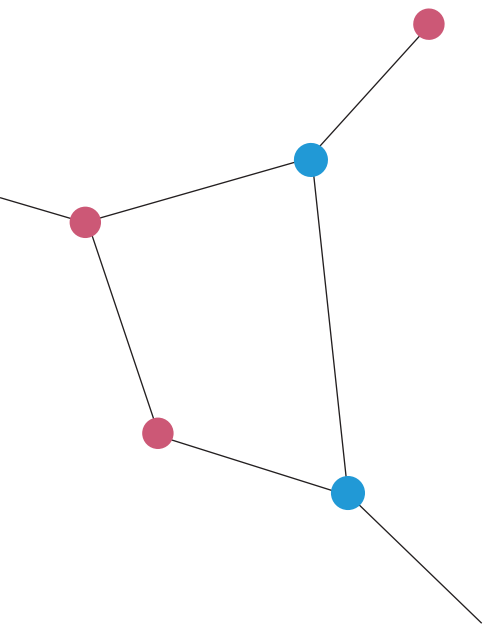

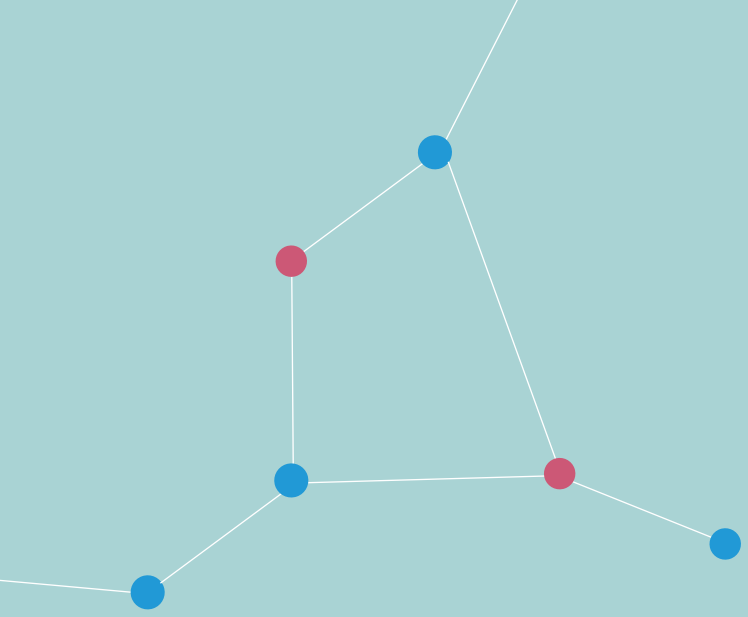

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