

**Written Testimony of the American Thoracic Society
Regarding the Human Health Effects of Climate
Change Before the House Oversight Committee
Presented by Neeta Thakur, MD
On August 5, 2020**

Chairwoman Maloney, Ranking Member Comer, my name is Dr. Neeta Thakur. I am an adult pulmonologist and critical care physician at University of California-San Francisco and I work at San Francisco General Hospital. I am also the Medical Director of the San Francisco General Hospital Chest Clinic and a physician member of the San Francisco Department of Public Health Climate Change Coordination Committee. Lastly, I am also Chair of the Health Equality and Diversity Committee of the American Thoracic Society. In these roles, I care for patients with critical illness and severe lung disease, provide training for health providers on climate change, and I conduct research on the health effects of air pollution, including how pollutants due to climate change will likely impact the health of children and adults, particularly for those from historically disadvantaged communities. Today, I am testifying on behalf of the American Thoracic Society and want to thank the Committee for the opportunity to testify regarding the adverse human health effects of climate change. The American Thoracic Society is a medical professional organization with over 16,000 professionals and patients who are dedicated to the prevention, detection, treatment and cure of respiratory disease, critical care illnesses and sleep-disordered breathing. We pursue our mission through research, clinical care, education and advocacy. The American Thoracic Society has identified climate change as one of the most important health issues facing our patients.

Today I hope to make three main points:

- First, climate change will have significant and severe adverse health effects on humans.
- Second, physicians are already seeing the human health effects of climate change.
- Third, the adverse health effects of climate change will become more severe, with impacts felt most acutely in populations least able to adapt to a changing climate.

Health Effects of Climate Change

Perhaps the recent CDC report: Preparing for Regional Health Effects of Climate Change in the U.S. summarizes it best, saying;

“...changes in temperature and precipitation are increasing health risks associated with wildfire and ground-level ozone pollution. Rising air and water temperatures and more intense extreme events are expected to shift exposure to waterborne and foodborne diseases, affecting food and water safety. With continued warming, cold-related deaths are projected to decrease, and heat-related deaths are projected to increase, and in most regions, increases in heat-related deaths are

expected to outpace reductions in cold-related deaths. The frequency and severity of allergic illnesses, including hay fever, are expected to increase as a result of shorter winters and earlier and longer pollen seasons. Climate change is also projected to alter the geographic range and distribution of insects and pests, potentially exposing more people to ticks and mosquitoes that carry the agents that cause diseases like Lyme disease, Zika, West Nile and dengue. Communities in the Southeast, for example, are particularly vulnerable to the combined health impacts from heat and flooding, which can result in large populations of nuisance mosquitoes and potential disease risk. Finally, extreme weather and climate-related events can have lasting mental health consequences in affected communities, particularly if they result in degradation of livelihoods or community relocation (1).

The CDC report comprehensively evaluates and comments on the anticipated health effects of climate change. As a pulmonologist and air pollution researcher, I will limit my comments to four areas; heat, ozone, wildfires and pollen, because I have expertise in these areas and routinely care for patients suffering the consequences of these downstream effects of climate change. Please note, that the focused nature of my comments today should not distract or diminish the very broad and wide-ranging human health effects of climate change.

Heat Waves

The initial and likely most compelling health impact of climate change will be heat stress. The negative health effects of extreme heat are well documented. It is, therefore, highly concerning that climate models predict up to a 50 percent increase in the frequency in the hottest (ie, the top fifth percentile based on historical records) days by mid-century (5, 6). We are already observing heat island effect in cities, which are dense, more polluted, and with increased energy consumption and less green space (2,3). These characteristics increase daytime temperatures and decrease the natural cooling at night by trapping heat in the ground and atmosphere. In itself, this effect, as stated on the EPA website, causes “general discomfort, respiratory difficulties, heat cramps and exhaustion, non-fatal heat stroke, and heat-related mortality.” This effect disproportionately impacts low-income communities and communities of color who are more likely to live in urban environments than their white counterparts. These communities are also less likely to have air conditioning or other mechanisms of artificial cooling to reduce impact, this is especially relevant now as cooling centers (and malls) are closed due to the COVID-19 pandemic. Moreover, the overall rises in global temperature will worsen this heat island effect by impacting daytime and nighttime temperatures, reducing any nighttime respite from the heat, only worsening the health effects associated with extreme heat.

Extreme heat waves will increase mortality, especially among the elderly and those with chronic disease (cardiorespiratory diseases and diabetes) and by increasing accidents,

homicides, and suicides (4). Where heat waves happen matters. A 102°F day in Phoenix will have little impact due to prior adaptation including infrastructure supports and robust public health response; however, a 102°F day in Detroit will have significant adverse health impacts for human health. But global climate change means both Detroit and Phoenix will see higher temperatures and longer spells of extreme heat. Simply put, all regions of the U.S. will be impacted by rising heat.

We have already seen the severe health consequences of heat waves. In August 2003, Europe experienced a prolonged heat wave that resulted in 32,000 excess deaths (5). France alone experienced a loss of 15,000 individuals with 2,000 heat-related deaths in one day (6,7). The elderly population, especially those living without air conditioning, were most at risk. Further, in one study, patients in Lyon, France who survived hospitalization for heat stroke were observed to have elevated mortality rates at one-month (58 percent) and two year follow up periods (71 percent).

In July 1995, Chicago experienced a heat wave that resulted in more than 600 excess deaths, 3,300 excess emergency department visits, and a large number of intensive care unit admissions for near-fatal heat stroke (8). Notably, these excess deaths were experienced by Black communities, communities with less infrastructure support due to decades of policies that have led to divestment from these neighborhoods. Heat stroke patients admitted to the intensive care unit suffered from brain impairment, kidney failure and (2) derangement of the clotting system, and 21 percent died during their hospital admission (8).

In 2018, a prolonged heat wave in Japan led to 1,032 heat-related deaths (9). Researchers in Japan used an event attribution study to estimate the contribution of climate change due to human-caused global warming to this extreme heat event. The researchers concluded that “the warm event in July 2018 would never have happened without human-induced climate change” (9).

These represent three examples of extreme heat waves that led to measurable increase in mortality. They are not the only cases, just the most extreme. It is also important to recognize that extreme heat also impairs outdoor worker productivity, because unprotected outdoor work in extreme heat can lead to heat stroke and heat exhaustion, electrolyte disturbances and dehydration. This has already impacted our safety recommendations, including those developed by the Occupational Safety & Health Administration (OSHA) and the U.S. army, to establish safe temperature ranges for outdoor work of varying work intensities (19, 20). One study estimated that global warming since the pre-1960 baseline has decreased global working capacity by 3 percent during the peak summer season, and predicts that if greenhouse gas emissions rates continue along their historical trajectory, future global working capacity will drop to below 40 percent during the peak summer season (21).

Without abatement, current greenhouse gas emission levels will increase the frequency of days with heat levels that are unsafe for continuous outdoor work, and increase mortality among many Americans.

Ozone Air Pollution

Ozone, the primary ingredient in smog, is a dangerous air pollutant that triggers a wide range of adverse effects including shortness of breath, asthma attacks, missed school and workdays, ER visits, hospitalization and even death. Ozone is formed when oxides of nitrogen and volatile organic compounds interact in the air. Heat, in addition to its direct health impacts, also increases the formation of ground level ozone. U.S. epidemiological studies show that a 10 °C increase in temperature on the same summer day increased cardiovascular mortality by 1.17 percent, and there was an 8.3 percent mortality difference comparing the highest level of ozone to the lowest among the 95 cities in the National Morbidity and Mortality Study (10). Schwartz and colleagues found an association between elevated temperatures and short-term increases in cardiovascular-related admissions for 12 U.S. cities (11,12). In fact, recent heat waves have been associated with ozone levels that exceeded air quality standards (25). Because ozone is a lung and airway irritant (26, 27), people with pre-existing lung disease like asthma or chronic obstructive pulmonary disease are particularly susceptible to adverse health effects of ozone exposure. A substantial body of evidence has shown that modest short-term increases in ground-level ozone increase risk of acute care visits and hospitalization for asthma (28–31) and chronic obstructive pulmonary disease (32, 33). Ozone exposure has also been associated with deterioration in asthma control, resulting in increased medication use and missed school and work days (34, 35). More ozone means more missed school, asthma attacks, hospitalizations and avoidable deaths. For communities where ozone already is a problem, we are likely to see compounded effect on health. For communities that currently do not experience high ozone pollution, climate forced heat may lead to increased ozone pollution and associated health effects.

Forest Fires

Climate models indicate that with 1°C of warming, wildland fire risk may increase two- to six-fold over the 1950-2003 baseline in most of the continental U.S. west of the Mississippi (13). When forests burn, they release a range of pollutants, from particulate matter and acrolein (a respiratory irritant) to carcinogens such as formaldehyde and benzene. For example, a wildfire in the Pocosin Lakes National Wildlife refuge in North Carolina produced smoke and haze intermittently for a number of weeks in 2008. Maximum daily smoke-related fine particulate matter levels reached as high as 129 µg/m³, which is nearly four times the current EPA daily standard of 35 µg/m³ for fine particulate matter (14). Studies suggest that particles in wildfire smoke are more toxic to the lung than particulate matter from other sources of pollution (15).

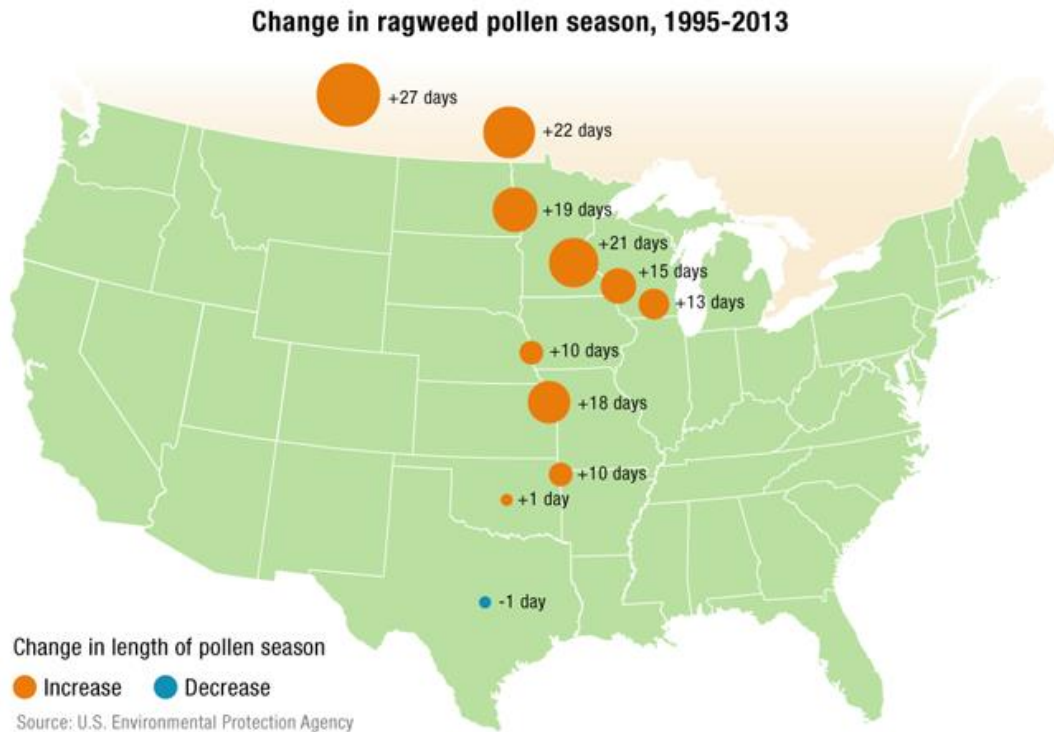
The number of wildfires over 1,000 acres in size in the region stretching from Nebraska to California increased by a rate of seven fires a year and 88,000 acres burned per year from 1984 to 2011 (16). Although forest fires may ignite in only certain regions, their

smoke plumes may extend over great distances. During the Russian heat wave of 2010, for instance, smoke from more than 500 wildfires stretched across more than 1800 miles – roughly the distance from San Francisco to Chicago (17). Exposure to wildland fire smoke has been associated with asthma and chronic obstructive pulmonary disease emergency room visits and hospitalizations (18,19,20), congestive heart failure episodes (14) and overall mortality (21). For example, the 2008 wildfires in North Carolina increased risk of asthma hospitalization by 66 percent for every 100 $\mu\text{g}/\text{m}^3$ increase in fine particulate matter (14).

In the western U.S., since 1980, wildfire season has increased by more than two months, and the number of large wildfires has doubled. The average duration of fires has increased five-fold. Epidemiological studies of fire smoke exposure show an increase of 10 $\mu\text{g}/\text{m}^3$ in PM_{10} from wildfires results in an approximately 1 percent increase in non-accidental mortality (22). Time series analyses found California wildfires in 2015 were significantly associated with Emergency Department visits for ischemic heart disease, dysrhythmia, heart failure, pulmonary embolism, stroke, and respiratory conditions, especially in those >65 years of age (22). In 2018 the Camp Fire wildfire obliterated the community of Paradise, California, and 89 lives were lost. This fire began in extremely dry forest, and 50 mph winds spread it at the rate of one football field per second. It covered 153,000 acres and destroyed >18,800 buildings. Governor Jerry Brown, in attributing this disaster to climate change, said this was the new abnormal.

Pollen Season

Higher levels of carbon dioxide and a warming climate have worsened the global burden of allergic disease, which has been increasing in prevalence in the industrialized world for more than 50 years (23). Worldwide, between 10 and 30 percent of people suffer periodically from seasonal allergies and up to 40 percent show evidence in their blood of sensitivity to allergens in the environment (23). Warmer temperatures lengthen the pollen season because plants bloom earlier in the spring. Between 1995 and 2009, the pollen season lengthened 13-27 days above 44 degrees north in the U.S. (24). Ragweed pollen season has lengthened by 24 days in the Minnesota-North Dakota region between 1995 and 2011 (25). Higher levels of carbon dioxide in the atmosphere have also been found to increase pollen productivity and the allergic potency of pollen (26, 27).



Higher pollen levels are linked to allergic sensitization in the blood (28) and more health care utilization for allergic disease, measured in terms of over-the-counter allergy medication use (29), and emergency room and physician office visits for allergic disease (30, 31). Longer, more potent allergy seasons are especially detrimental to people with asthma. Numerous studies have found increases in asthma and wheeze-related emergency room visits when pollen levels are higher (32,33,34,35).

Today, U.S. physicians are already seeing these adverse health effects in patients they treat.

U.S. physicians are already seeing the impacts of climate change on the patients they serve. A recent survey conducted by the American Thoracic Society showed that a majority of survey respondents are observing the impacts of climate change in their patients today. Specifically, 65 percent of respondents reported climate change is relevant to direct patient care. Free text responses indicate physicians believe they are seeing climate change-related health effects in patients today (36). A follow up study of international ATS members confirmed these findings. International respondents further noted the following as the most common health effects of climate change among their patients, including severity of chronic disease (88 percent), increased allergic symptoms

(72 percent) heat-related effects (70 percent), injuries due to severe weather (69 percent), vector-borne infections (59 percent), and diarrhea from food/water-borne illnesses (55percent) (37).

As a health provider for the most vulnerable populations in San Francisco, the 2018 Camp Fire had personal impact on my patients, many with severe asthma and chronic obstructive pulmonary disease. Due to poor air quality days, upwards of the maroon zone per the AQI website, my patients reported increased shortness of breath, wheeze and cough. In the most extreme cases, those with flare ups of their disease, we gave steroids – a potent medication associated with negative side effects, but our only remedy in the moment. As health professionals, we are limited in our ability to respond to patients' needs. All we could do at the time was to instruct them to keep inside and keep their windows closed, which felt particularly unsettling as we were also experiencing unusually high temperatures at the time, demonstrating two down-stream effects of climate change simultaneously impacting the day-to-day health of my patients.

The adverse health effects of climate change will only get worse, with the most acute impacts felt by people the least able to adjust and adapt.

For nearly the entire existence of humankind, the majority of the earth's population has lived in areas on earth that have a mean average temperature of 11°C to 15°C. However, since the industrial era, human activity has caused global warming by directly influencing the production of green gas emissions, and Xu and colleagues estimate that within 50 years, absent massive human migration, a third of the world's population will live in areas where the mean average temperature exceeds 29°C, with the effected regions including some of the poorest regions in the world (38). Currently only 0.8 percent of world's land has mean average temperatures at more than 29°C – and this is mostly in Sahara Desert, a place we historically associate with heat-intolerable conditions. For the United States, these forecasted changes, and the changes we have already seen with climate change, including extreme heat and air pollution, disproportionately impact low socioeconomic communities and communities of color.

It is clear that climate change exacerbates structural and social determinant of health that disproportionately burden communities of color. For example*:

- African Americans are more likely to live in neighborhoods with few trees and more heat-trapping pavement (39).
- The rate of heat-related deaths in African Americans is 150–200 percent greater than that for non-Hispanic Whites (39).
- African Americans have a 36 percent higher rate of asthma incidents and are three times more likely to die or visit the emergency room from asthma-related complication than non-Hispanic Whites (40).

- One out of five of African American families live in poverty, compared to one out of 15 White families. During an extreme weather event, these households have a smaller cushion against property damage or injuries, further complicated by lack of access to medical care and insurance (40).
- Traditional Native Americans and Alaska Natives (NA/AN) diets and subsistence hunting and fishing are at risk due to climate change (41).
- NA/AN communities lack access to clean, potable drinking water at higher rates than others(41).
- Warmer water temperatures may exacerbate already-high rates of diarrhea-associated hospitalizations for Native American and Alaskan Native children (42).
- Nearly one in two Latinos live in counties with poor air quality. Latino children are twice as likely to die from asthma as non-Latino whites, and Latino children living in areas with high levels of air pollution have a heightened risk of developing Type 2 diabetes (43,44).
- Over 1.8 million Latinos live within a half-mile radius of oil and gas development(43).
- A higher proportion of Pacific Islanders in the United States live in counties with pollution exceeding the federal air quality standards when compared with Asians and other racial groups (45).
- Native Hawaiian and Pacific Islander communities experience high rates of asthma, expected to worsen as climate change worsens air quality (46).

If greenhouse gas emissions continue without abatement, the health system infrastructure will need to be further bolstered to accommodate this increase in disease and disease morbidity associated with worse air quality due to climate change. Moreover, the need for measures such as widespread subsidies for air conditioning for low income families, the construction of cooling centers, and surveillance programs for the frail and elderly to prevent premature death and hospitalization due to extreme heat is likely to become an essential public health priority in cities across the United States.

Conclusion

People across the United States with lung, heart and allergic disease, and especially children, the frail and elderly, are already suffering the health consequences of climate change. Communities of color are suffering from climate change. Physicians of the

American Thoracic Society are observing these symptoms among our patients in our clinics, emergency departments and intensive care units nationwide. We must act now to reduce greenhouse gas emissions for the sake of human health.

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