Medical News & Perspectives | CLIMATE CHANGE AND HEALTH

Raging Wildfires Are Exposing More People to Smoky Air—Here's What That Means for Health

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This past June, New York City's skyline became blanketed in a hazy, orange hue. The air was thick with smoke from wildfires raging in Canada. Officials declared that the country's ongoing wildfire season is the worst on record.

Canada isn't alone. From the beaches of Hawai'i to the forests of the Siberian Arctic, wildfires are engulfing landscapes across the globe. Recent wildfires on Maui are among the deadliest in US history. This year, cataclysmic flames have also swept through Algeria, Chile, and Greece—to name a few countries.

Wildfires, of course, are nothing new. What *is* new is the uptick and intensity. A 2022 United Nations report projected that by 2050, the number of extreme wildfires will rise by up to 30%. That also means more smoke will transcend far beyond country borders and affect health worldwide.

Wildfire smoke floating into the US from Canada this year resulted in several Midwestern cities having days with the planet's worst air quality. Already, cities across the Midwest and West Coast are annually exposed to more than 30 days of wildfire smoke. And in the past decade, about 87% of the US population has experienced increases in the number of days they're exposed to heavy levels of the smoke, according to a recent study. A new report in *Nature* found that in 41 continental US states, wildfire smoke is even stalling or reversing air quality improvements made since the beginning of the century.

Multimedia

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Although wildfires used to be seasonal, "due to climate change, it can easily be argued that the fire season is now year-round," Joseph Wilkins, PhD, an assistant professor of atmospheric science at Howard University, said in an interview with *JAMA*.

Yuki Iwamura/AP Images

Fanning the Flames

While research shows that lightning and human activity, such as arson and campfires, are often to blame for igniting US wildfires, higher temperatures and increased drought are among the factors responsible for the rising intensity, according to the US Geological Survey. John Balmes, MD, a physician member of the California Air Resources Board (CARB), said that over the past several years, his state has had less snowpack than usual, leading to dry forests and dying trees.

Annual October rain used to mark the end of California's wildfire season. Now, the rain doesn't always come on schedule. Coupling that with intense winds blowing down the Sierra Nevada is a recipe for raging flames.

"I've been in California since 1982, and we didn't have these catastrophic fires," Balmes said in an interview. "There would be wildfires, but not at the level that we've had in the last 10 years."

According to Dave Matheny, an aerial firefighter based in Delta Junction, Alaska, cyclical seasonal patterns in Interior Alaska have also changed. The highest fire activity used to occur in late May and into June, with fires dwindling as August approached—historically, the beginning of the Interior's rainy season. But this year was different.

Even though Alaska's most active wildfire seasons on record have transpired during the last 2 decades, "this is the first time I can recall in 20 seasons of fighting fire that our big fires didn't kick off until just before August, like the last few days of July," Matheny said in an interview, noting that the delay likely stemmed from an usually cool summer. "We went from around 2000 acres burned, which would have been a record low, to over 200 000 in just a couple of weeks."

And as of September, nearly 300 000 acres had burned, according to the latest situation report released by the Alaska Interagency Coordination Center.

"Alaska is one of the most rapidly warming parts of the world," Matheny added. "We would have weeks of 40 below when I was

How to Be Prepared

When preparing for increasingly smoky air, "the old adage, 'an ounce of prevention is worth a pound of cure' is applicable," Cornfield said. "Make sure you have masks, good air filters, and that you have a safe place to harbor indoors—even if there aren't wildfires currently in your region."

There are ways to determine whether air quality will be poor in a specific area. Cornfield recommended checking the EPA's Air Quality Index. A rating higher than 150 means the air quality is unhealthful for the general public, and that otherwise healthy individuals may experience negative health effects. The Fire and Smoke map on AirNow.gov offers another approach to monitor air quality and smoke concentration at a neighborhood level. People can also register with EnviroFlash, a service provided by the EPA and local and state agencies, to receive emails about local air quality.

When air quality levels are unhealthful, it's best to stay indoors with the windows closed, according to Theresa Pistochini, MS, PE, of the Energy Efficiency Institute and Western Cooling Efficiency Center at the University of California, Davis. The ideal method to eliminate particles that make it inside is to filter the home with a portable air cleaner or purifier, preferably equipped with a high-efficiency particulate air filter, also known as a HEPA filter, she said. If you only have access to one device, you can strategically move it with you throughout the day.

When purchasing portable devices, it's important to review the clean air delivery rate (CADR), which measures the particle removal rate. The higher the number, the faster the room can be filtered. For optimal performance, a CADR number typically should be equal to at least two-thirds of a room's area in square feet. But for filtering wildfire smoke, the Association of Home Appliance Manufacturers recommends a smoke CADR equivalent to the room's entire area. And that can be costly.

"It's generally about $1 [per] CADR, so an air cleaner with a CADR of 300 might cost about $300," Pistochini said in an interview.

Running an air conditioning system with a minimum efficiency reporting value (MERV) filter rating of at least 13 also helps to trap smoke particles. However, leaks in air conditioning ducts may bring smoky outside air into the building, Pistochini cautioned. Testing ducts for leakage and sealing them if needed can reduce this problem and improve air conditioning system efficiency.

"Most places have HVAC [heating, ventilation, and air conditioning] systems bringing air from the outside, so make sure that that air is filtered," Cornfield added. Running the air conditioning on a recirculation mode can also limit the amount of outdoor pollution from seeping into the home.

For people who can't afford an HVAC system or other air cleaning devices, there's another option: building a do-it-yourself portable air cleaner—also known as a Corsi-Rosenthal box. "You assemble filters in a box shape around a box fan, and that also works well to clean your air indoors," Pistochini said. "I have one in my house."

If needed, Balmes suggests going to a public facility, such as a library, that has good filtration. He said the US should create a program similar to one in Canada's British Columbia, which has clean air spaces for short-term relief when air quality is especially poor.

For people who must venture outside during those times, Balmes advises wearing a mask—if possible, an N95 or equivalent.

"You can actually wear ones with an exhalation valve, which aren't appropriate for health care use or concern about COVID," he said, "but an exhalation valve makes it more comfortable, and all the air that you breathe in has been filtered."

But when air pollution is high, be it from wildfire smoke or other sources, Wilkins warns only to go outside if it's urgent.

"A lot of people don't understand that air quality should be taken as seriously as a tornado or hurricane," he cautioned. "You're not going to run outside and play football during a tornado warning…you would wait until it's over."

a kid in the '70s and '80s, for weeks on end, and that just isn't a reality anymore."

These long durations of cold temperatures are necessary to control the bark beetle populations. Trees killed by the insects become dry fuel on the verge of igniting.

Up in Smoke

Residual smoke from wildfires can affect people even if they're far from the burning area. The hotter the fire burns, the greater the chance of larger smoke plumes—and the more likely that smoke will rise higher and travel farther, Wilkins said. But a plume's journey also depends on wind patterns and speed.

"Pollution takes a ride on the weather," he noted, which is how smoke from Canada made its way to the US earlier this year. "The winds just happened to face our direction, down south."

Although it may seem like the smoke traveled a great distance, it's all relative.

"Hundreds of miles of separation is really not that far from a global perspective, and it's less far from an atmospheric perspective," David Cornfield, MD, the director of the Center for Excellence in Pulmonary Biology in the Department of Pediatrics at Stanford University, explained in an interview.

Wildfire smoke can also travel up and destroy the ozone layer. After rising into the stratosphere, the smokes "can stay up there for months," Wilkins said. "We can track these things with satellites, and we've got a bunch of pictures from NASA [the National Aeronautics and Space Administration] showing plumes just flying around."

Once wildfire smoke reaches the stratosphere, it's able to spread to faraway places. But the severity of health effects and the mortality risk from wildfire pollution varies in different regions.

"As the planet warms, we will all suffer but not equally," Wilkins warned, adding that countries in sub-Saharan Africa and Southeast Asia currently experience the highest mortality rates from wildfire smoke. While resources and mitigation strategies are limited in many of these regions, the high mortality rate is mostly due to the number of fires and amount of smoke, he said.

Choking Public Health

Smoke is a blend of water vapor, fragmented solid matter, and gases like carbon monoxide. As smoke travels further from a fire source, gases become less of an issue, noted Balmes, who is also a professor emeritus of medicine at the University of California, San Francisco, and of environmental health sciences at the University of California, Berkeley. The problem is that particulate matter can travel hundreds of miles away.

Such matter often comprises small pieces of debris, like burnt wood or leaves, Cornfield said. Fine particulate matter,

which is defined as particles that are 2.5 microns or less in diameter, makes up about 90% of wildfire smoke's total particle mass, according to the US Environmental Protection Agency (EPA). These particles, referred to as $PM_{2.5}$, can travel deep into the lungs, where they can cause inflammation. They may also enter the bloodstream and travel to other organs.

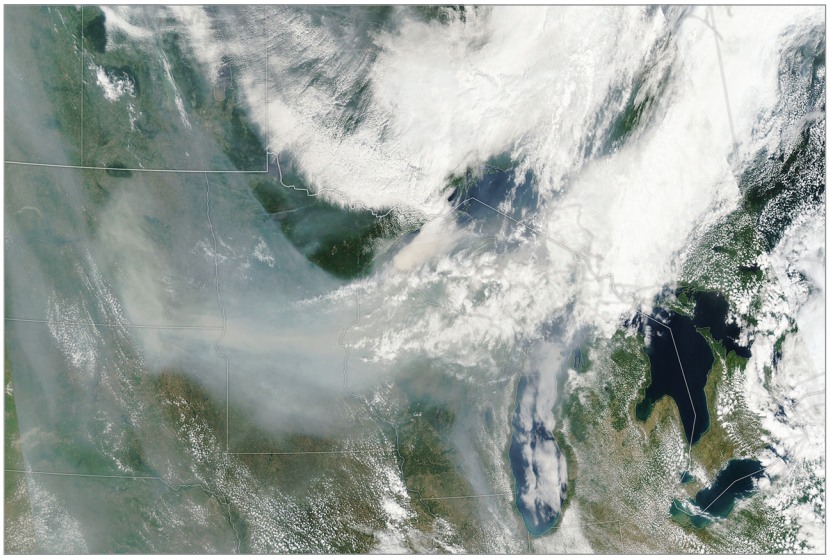
"The reason why the smaller particulate matter is such an important thing to consider is because those are molecules that get easily inhaled all the way down into the smallest airways, as opposed to getting deposited in upper airways—the nose, the throat, or the trachea," explained Cornfield, who is also the chief of pulmonary, asthma, and sleep medicine at Stanford Medicine Children's Health. "But it's not fair to say that getting larger molecules in your nose and larger airways isn't also problematic."

When exposed to wildfire smoke, even over a few days, people may develop a cough, phlegm, or difficulty breathing, according to the EPA. Even if they're healthy, individuals can experience temporarily decreased lung function and pulmonary inflammation because of $PM_{2.5}$. The CDC also warns that inhaling wildfire smoke causes other immediate effects, including headaches, chest pain, and tachycardia. Both the CDC and EPA provide resources for clinicians and the public to better understand the health repercussions of wildfire smoke and reduce exposure.

As a firefighter, Matheny has experienced the negative effects of wildfire smoke on the frontlines and cautions others to pay heed.

"When I get any kind of respiratory illness, even just colds, I have a cough every time now, where that wasn't the case before starting firefighting in 2004," he said. "I've had coughs develop from one day on fire duty that last me a month."

Research suggests that wildfire-specific $PM_{2.5}$ may be especially toxic. Upon examining 14 years of hospital admissions data in Southern California, a 2021 study found that fine particulate matter from wildfire smoke correlated with more respiratory hospitalizations than other forms of ambient $PM_{2.5}$. And a study published this August in *JAMA Internal Medicine* found that $PM_{2.5}$ pollution from agriculture and wildfire smoke was more strongly associated with dementia risk, possibly via neuroinflammation, than pollution from sources such as dust, traffic, and coal combustion.



Smoke from intense wildland fires in Canada billowed over the upper Midwest in June 2023, causing hazy skies and hazardous air quality in Canada and across several US states.

NASA

The Most Vulnerable

Wildfire smoke also can exacerbate health conditions.

"There's a lot of data emerging [that indicates] anyone with a preexisting respiratory illness is going to experience difficulties associated with wildfire smoke," Cornfield said. He added that people with conditions such as asthma or chronic obstructive pulmonary disease may experience exacerbation of their illness shortly after going outside.

A recent report that assessed emergency department visits from roughly 6000 US facilities found that between April 30 of this year—when wildfires in Canada began—and August 4, asthma-related visits were 17% higher than expected among all ages and regions. In New York, such visits increased by almost 82% across the state on June 7, a day of exceptionally poor air quality due to smoke from Eastern Canada, compared with earlier in the month. A new research letter in *JAMA* notes similar results.

Wildfire smoke may also trigger an acute cardiovascular event in people with underlying cardiovascular disease. And it may be particularly dangerous to children, especially those younger than 5 years.

"Children can have significant effects owing to both their developing lungs, their more rapid respiratory rates, and the greater amount of oxygen that they breathe for their body size, relative to adults," Cornfield said.

Balmes echoed that he's especially concerned about children. "There are chronic effects of growing up where there's polluted air," he said. "Kids are chronically exposed in Los Angeles, Beijing, and New Delhi, where pollution is really bad, but they're recurrently exposed in Northern California. What those recurrent exposures are doing to their health is a major concern."

Older adults may also be at a higher risk from wildfire smoke.

"Even if they don't have preexisting disease that's been diagnosed, they could have conditions related to aging that make them more at risk for health effects," Balmes said.

Exposure to chronic or persistent wildfire smoke may affect mental health and suicide risk, but evidence is limited. What is known is that wildfire smoke disproportionately harms historically marginalized groups, including socioeconomically disadvantaged communities. For example, researchers have observed that compared with people from other racial and ethnic groups in the US, Alaska Native and Black people were at a higher risk of hospital visits because of wildfire smoke-related respiratory issues.

Both location and susceptibility are key factors. For example, living in an underserved community that has chronically high

levels of air pollution may weaken someone's immune system, and being exposed to wildfire smoke could exacerbate health issues, Wilkins pointed out. "This is why environmental justice and equity is of the highest importance, because pollution is not fairly distributed." ■

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