Wildfire smoke may harm in a number of ways

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Spring and summer in the U.S. now come with a new normal: days and even weeks where the acrid overhang of wildfire smoke forces us indoors. At its worst, not even shuttered windows can protect us from its effects—the stinging eyes, runny noses and burning lungs.

As the Earth's climate warms, wildfires tear through a larger swath of

land each year. As Bloomberg Opinion columnist Mark Gongloff has explained, in some parts of the U.S., the fire season now stretches a month longer than in 1973. These more intense, longer wildfire seasons are pushing this specific brand of pollution into parts of the country not accustomed to orange skies and unbreathable air.

That's compromising our health—not just when the smoke is thick, but for years after. Researchers are increasingly recognizing that wildfire smoke can bring health problems wherever it drifts.

Many of the near-term problems with wildfire smoke exposure are now well understood.

The most serious, of course, is death. A recent working paper for the National Bureau of Economic Research estimated that the U.S. would see nearly 28,000 more deaths each year by 2050 due to the climate-driven rise in wildfire smoke—that's 76% higher than the average annual deaths between 2011 and 2020.

More people experience milder but still serious consequences, like worsening asthma and debilitating headaches. When smoke from Canadian wildfires wafted thousands of miles to hang over large tracts of the U.S. last summer, it led to a 17% rise in asthma-related ER visits, according to the Centers for Disease Control and Prevention.

More recently, less-obvious health issues have come to light. Multiple studies have found a connection between wildfire smoke and pregnancy complications, including preeclampsia (a form of dangerously high blood pressure) and premature births.

But unraveling the long-term health effects has been trickier. For much of the year, we aren't exposed to any wildfire smoke, and then it can suddenly surge. "How the human body handles that and what the long-

term repercussions are remain very understudied and somewhat unknown," says Joan Casey, an environmental epidemiologist at the University of Washington.

And of course, we're also exposed to other forms of air pollution that affect our health. Separating the impact of wildfire smoke from that of other pollutants has been challenging. One problem is that most air-quality monitors are in cities, creating a frustrating information gap for researchers.

"We have these huge, rural areas where we really don't know what the air quality is like—and that's where people are often most exposed to wildfires," Casey says.

Ideally, researchers trying to unravel the health impacts of wildfire smoke want to understand how often someone was exposed to the smallest particles, known as $PM_{2.5}$, how intense the exposure was, and how many days it lasted. And then they'd want to follow them over time and compare them to a similar group that has had the advantage of a smoke-free environment.

But nothing is ever that cut and dried in the real world. For example, wildland firefighters are an obvious choice, but less obvious is who they should be compared to, says Marshall Burke, deputy director of Stanford University's Center on Food Security and the Environment.

They could be compared to regular firefighters, but the two groups also might make lifestyle choices—take more risks or be more outdoorsy, for example—that could factor into their long-term health.

Researchers can try to control for those differences, but "that's really hard to do in a convincing way," Burke says. Another limitation is that wildland firefighters, overwhelmingly white and male, don't represent

the U.S. population at large.

Nevertheless, researchers are finding creative ways to disentangle the effects of wildfire smoke from those of other pollutants. Recent work led by Casey, for example, linked geographical information to a decade of insurance data for some 1.2 million Californians over the age of 60.

That allowed researchers to estimate how much of their $PM_{2.5}$ exposure came from wildfire smoke compared to other forms of pollution. They found inhaling wildfire smoke raised the risk of dementia—a risk exacerbated by someone's poverty level.

The best information would come from tracking people exposed to wildfire smoke over time. An ambitious project in Hawaii is studying people living near the wildfires that devastated parts of Maui in 2023. This kind of prospective study will take time to get answers, and also faces a challenge: it needs long-term, sustainable funding to keep tabs on people for decades..

"Everything we found in our work, consistent with other work on air pollution more broadly, is that there's no safe exposure. The more you get, the worse the outcome is," Burke says.

Wearing a high quality mask can greatly reduce exposure outside. Investing in HEPA filtration for schools, workplaces and homes may be the best chance to give the lungs respite from the smoke.

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