



DAVID GRAY/GETTY

Firefighters battle the bush fires that devastated Australia in 2019 and 2020.

## Fireproofing the lungs

People with conditions such as COPD are vulnerable to wildfire pollution, but there is little advice on how to keep safe. **By Anna Nowogrodzki**

A few days into the new year, an older person came into John Hunter Hospital in Newcastle, Australia, wheezing and short of breath. Respiratory physician Peter Wark was on call at the time. He wasn't surprised to see someone with respiratory problems – Australia was enduring an unprecedented and devastating bush-fire season. Smoke from fires that had been raging kilometres away for the past four weeks had caused the air quality in the city to plummet.

Wark's patient already had chronic obstructive pulmonary disease (COPD), and her medical team had tried to prepare her for this kind of event. She had done her best to keep her windows and doors closed, despite a lack of air conditioning and some brutally hot days. And she had the anti-inflammatory drug

prednisone on hand to ease her symptoms. But still, she found breathing more and more difficult.

COPD is a common condition – it is the third leading global cause of death. And people with respiratory conditions such as COPD are some of the most vulnerable to particulate matter from air pollution and wildfires. Data from previous Australian bush fires, as well as wildfires in California, Colorado and North Carolina, show that people who have COPD visit the emergency department more frequently than usual during these events.

Yet physicians don't have the evidence they need to tell these vulnerable people what to do to protect their health. And researchers don't know what the effect of this exposure will be for everybody in the long term. Data suggest that long-term exposure to air pollution

leads to faster lung-function decline even in people with otherwise healthy lungs. "Other parts of the world, I think, should be watching very closely," says Wark, particularly the wildfire-prone US west coast.

"I find it rather unsettling that there are all these unknown things," says Guy Marks, a respiratory and environmental epidemiologist at the University of New South Wales, Sydney. "The scale of the fire that we've just had is unprecedented. It represents to me a clear turning point in our experience of the consequences of climate change."

### Vulnerable lungs

Wark's patient improved just by being in the air-conditioned hospital. "We really didn't do anything else," he says. She was one of three or four older people with lung disease whom Wark remembers arriving at the hospital over the course of a few days. But he strongly suspects that many more people with respiratory diseases were suffering. "The ones who make it to the hospital are the tip of the iceberg," he says.

Wildfires are not good news for people with COPD. A 2019 review found evidence across multiple studies that visits to emergency departments increase for people with COPD<sup>1</sup>. However, the data on hospitalization were mixed. Some studies found an association

between wildfire smoke and hospitalizations overall, and others did not, says Colleen Reid, a health geographer at the University of Colorado Boulder and an author of the review.

The most concerning pollutant for those who find themselves downwind of a wildfire is fine particulate matter less than 2.5 microns in diameter, says Reid. These PM<sub>2.5</sub> particles are about four times smaller than a grain of pollen. In a 2019 paper, Reid found that PM<sub>2.5</sub> levels increased sixfold downwind of a wildfire, whereas levels of ozone – another pollutant that can harm the lungs – increased less than twofold<sup>2</sup>.

PM<sub>2.5</sub> travels farther into the lung tissue than larger particles, almost reaching the tiny grape-like sacs called alveoli where gas exchange happens, says Nicholas Kenyon, a pulmonologist at University of California, Davis. He says that *in vitro* experiments suggest that, once in the lung tissue, the particles exacerbate chronic bronchitis (inflammation of the airways) and disrupt the layer of epithelial cells that line the airways.

It isn't clear exactly which chemicals in PM<sub>2.5</sub> affect lung tissue, says Reid. "There could be a different chemical composition of the smoke depending on what's being burned," she says. Various studies have implicated different sets of chemicals in lung problems.

Scientists also don't know enough about the health impacts of ozone produced during wildfires, Reid says. Ozone causes airway inflammation and the formation of very unstable and highly reactive molecules. These free radicals can kill the lungs' epithelial cells, stripping the airways and leaving the lung tissue more vulnerable to viruses or allergens, says Kenyon. Research has found that higher ozone levels are correlated with increased hospital admissions and emergency-department visits for people with COPD<sup>3</sup>.

### Uncertain response

There isn't enough research into how to protect the health of people with lung conditions from the spiralling effects of climate change, says Rupa Basu, an epidemiologist in the Office of Environmental Health Hazard Assessment at the California Environmental Protection Agency in Oakland. "Sometimes people look at all respiratory disease, which may not be the best way," she says. Lumping conditions together misses any differences in how people with, for example, COPD, asthma or cystic fibrosis are affected.

During wildfires, public-health officials often tell people to shelter in place, but there is limited research on how this affects people's health, Reid says. The benefit "really depends on where that place is", she says.

Poorly maintained properties and older homes tend to be leaky and let in smoke even with windows and doors closed, she explains. And people without air conditioning often leave their windows open. A study of indoor air quality during the 2016 and 2017 wildfire seasons in Denver, Colorado, found that most of the 28 low-income homes studied kept a window open for more than 12 hours a day, which more than doubled the levels of some pollutants in their homes<sup>4</sup>.

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If people do shelter in place, evidence suggests that air purifiers such as high-efficiency particulate air (HEPA) filters in the home decrease particulate-pollution levels, says Reid. It is less clear whether purifiers improve the respiratory health of people with COPD. One study of 35 people with COPD found that HEPA filters had no effect on respiratory symptoms when used for 6 weeks<sup>5</sup>. Still, the reduction in particulates in the home is reason enough for many clinicians to recommend purifiers – especially to people who live very close to busy roads or notice soot on their windows. "I encourage them to get air purifiers," says Mary Rice, a pulmonary and critical care physician at Beth Israel Deaconess Medical Center in Boston, Massachusetts.

The costs can add up quickly, however, putting HEPA filters out of reach for people with low incomes. Air purifiers cost US\$100–600 in the United States. When used continuously, HEPA filters (costing \$90–175 each) need to be replaced every three months and use about \$30–90 of electricity per year – although running a purifier only during wildfires would cost less. And each room requires its own purifier.

When the smoke pollution is particularly bad, many people use N95 particulate respirator masks. These fit tighter than surgical masks and are designed to keep out particles as small as 0.3 microns – more than eight times smaller than PM<sub>2.5</sub>. But many health professionals are concerned that people don't wear the masks properly or they don't fit well, and can therefore give people a false sense of security. "They can be helpful if they are put on properly on an individual that they fit correctly," says Reid. But, she explains, the masks don't fit well on people with facial hair, children or adults with smaller-than-average heads. Many people don't get a professional to test the fit of the

mask to ensure that it filters out particles as it is supposed to. Marks says there's not enough evidence to say whether N95 masks are beneficial for people with COPD. One study found that, for 14 people with mild COPD, wearing either an N95 mask or a mask that covered half the face affected breathing – in particular by limiting how quickly the person could exhale<sup>6</sup>.

Although it's not clear how people with COPD can protect themselves from the effects of smoke particles, medical interventions can help them if their symptoms worsen and breathing becomes more difficult. Ipratropium bromide and  $\beta$ -adrenergic agonists such as salbutamol can be taken to widen the bronchi. And prednisone – taken orally to reduce inflammation – helps some people. A 2003 study of people who had recently been discharged from hospital following an exacerbation of COPD showed that those who took prednisone for 5 days were considerably less likely to visit an emergency department within 30 days than were those who did not take it<sup>7</sup>. However, these strategies have not been tested specifically in people with acute severe smoke exposure in controlled trials, says Wark.

If needed, oxygen therapy and antibiotics can be provided in hospital, so it is also advised that people with COPD who live in at-risk locations have an action plan for getting to a medical centre during a wildfire.

Wildfires are short-term events, but climate change is already increasing their frequency, meaning that people in fire-prone areas will probably be exposed to wildfire smoke more often. There are few studies of the long-term health impacts of repeated wildfire-smoke exposure on either healthy people or those with COPD. But more generally, Rice says that long-term exposure to air pollution allowable within the current US Environmental Protection Agency standards "is associated with more rapid decline in lung function".

"I find myself rather frustrated at not having the answers," says Marks. As a COPD researcher, he says, "I get frequently asked, 'What are the risks and what should we do to protect ourselves?' And I give more or less the same answer: that we don't really know."

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