**What we know and don’t know about wildfire smoke’s health risks**

Acrid smoke continues to pollute skies in the western United States. On some recent days, the air quality in Portland, Seattle, San Francisco and Los Angeles has been so hazardous, it’s ranked among the worst in the world. It’s hard to predict when the smoke will fully clear. And with some parts of the West  having faced a week or more of extremely polluted air, the unusual, sustained nature of the assault is increasing worries about people’s health.There’s plenty of evidence that air pollution — a broad category that includes soot, smog, and other pollutants from sources such as traffic, industry and fires — can harm health. The list of medical ailments associated with exposure to dirty air includes respiratory diseases, cardiovascular disease and diabetes (SN: 9/19/17).Most of what’s known about the hazards of wildfire smoke has to do with particulate matter, the tiny bits of solids and liquids in polluted air. Wildfires are especially good at producing particles in a size range that can be dangerous to health. It isn’t clear yet if what fuels wildfire smoke — be it vegetation, a mix of trees and structures, or other human-made sources — affects the toxicity of particulate matter.A growing body of evidence points to a range of risks to health during or soon after wildfires, such as increased trips to the emergency room for chronic lung conditions. But there are many more questions than answers about the long-term risks for people struggling to cope with day upon day of polluted air, and facing longer and fiercer fire seasons each year due to climate change (SN: 8/27/20).Science News spoke with scientists about what’s in the air, the health risks and what more we need to learn.Wildfire smoke is a complex mixture of gases and particles that is similar to cigarette smoke but without the nicotine, says physician John Balmes of the University of California, San Francisco, who studies the effects of air pollution on health. “It has the same kind of mixture of nasty small particles and irritant gases.”The precise chemical makeup of the smoke varies by fire. It depends on “the type of fuel burned — including structures, intensity of the fire, atmospheric mixing, and distance or age of smoke,” says Tania Busch Isaksen, who studies public health effects of wildfire smoke at the University of Washington in Seattle.“Generally speaking, it’s a mixture of carbon dioxide, carbon monoxide, nitrogen oxides, particle matter — fine to coarse — hydrocarbons and other organic compounds,” she says. “Fine particulate matter, PM2.5, is what we are primarily concerned about when we consider impacts on health” (SN: 7/30/20).Those particles are 2.5 micrometers across or smaller, or about one-thirtieth the width of a human hair (SN: 8/22/18). Common in air pollution produced not only by wildfires, but also by power plants and cars, these particles are so tiny that they can be inhaled deeply into the lungs. There, they can trigger inflammation and possibly seep into the bloodstream.No. These particles are so tiny and difficult to see that “even if the air seems clear, PM2.5 could be at levels that are dangerous,” says Perry Hystad, an environmental epidemiologist at Oregon State University in Corvallis. In the United States, the most reliable gauge of PM2.5 is the Air Quality Index, or AQI, which is based on data from air quality monitoring stations that measure the concentrations of pollutants in the air.The U.S. Environmental Protection Agency developed the index to grade levels of common air pollutants, such as ozone, PM2.5  and carbon monoxide. On a scale from 0 to 500, higher numbers indicate dirtier air. The EPA assigns AQI scores to different types of pollution based on studies of each contaminant’s health effects.The EPA considers scores up to 100 — indicating an average 35.4 micrograms of particulate matter per cubic meter of air over 24 hours  — generally safe. Scores from 101 to 200 may pose particular risk to people in sensitive groups, such as children and those with heart or lung diseases. Those people are advised to limit or avoid prolonged or vigorous outdoor activity. Above 200, everyone should cut down on physical activity outside. At scores 300 or above, with at least 250.4 micrograms of PM2.5 per cubic meter of air, everyone should avoid going outside.Smoke blanketing the western United States has created hazardous, and at times off-the-chart, levels of pollution in many places. For instance, on the morning of September 17, areas of Oregon near Portland showed PM2.5 AQI levels up to around a hazardous 380. In regions of central California northeast of Fresno, AQI levels reached a staggering 780.“Especially under conditions that we’re experiencing here in the western United States, it would be wise to check the AQI on a daily basis,” says Kent Pinkerton, a biologist at University of California, Davis.“Wildfires, through the combustion process, create lots and lots of particles” in the size range of PM2.5, says Colleen Reid, an environmental epidemiologist and health geographer at the University of Colorado Boulder. A breath of these microscopic particles can send them all the way to the alveoli, the tiny sacs where the lungs and the blood swap oxygen and carbon dioxide.Research in lab dishes has found that the particles can lead to inflammation and oxidative stress, in which reactive molecules that contain oxygen build up and can damage cells. The smallest pollution particles may make their way into the bloodstream, possibly causing harm to the cardiovascular system.The research linking PM2.5 with health generally does not consider what types of materials are burning, so “at this point we are concerned about all PM2.5 regardless of source,” says Anthony Wexler, who studies particulate pollutants at the University of California, Davis. “But the source is likely important.”Historically, wildfires have burned mostly plant matter. But many of the recent devastating fires in the western U.S., such as the Camp Fire that destroyed the town of Paradise, Calif., in 2018, have devoured human-made structures (SN: 11/15/18). “Houses have paint and solvents and plastics and all this other terrible stuff going up in smoke, too, which may be increasing the toxicity of the material that’s being emitted,” says Wexler. He is currently preparing an experiment to compare the toxicity of the smoke from burnt household materials with that from woody materials.The impact of extended exposures to wildfire smoke also needs more research. Wildfires put a lot of pollution into the air, more than what’s generally produced from industrial and traffic sources, Reid says. But it’s often for a short period of time. “What’s going on right now in Oregon and Washington and California, where they’ve had essentially a week of very unhealthy levels of air pollution, is less common,” she says.Breathing in smoky air can irritate the respiratory tract, leading to coughing, sore throats and itchy, watery eyes. The foul air can also cause headaches and fatigue.Hospital visits for lung care go up during wildfires compared to periods without them, according to studies of emergency department traffic. For instance, an increase in PM2.5 exposure related to wildfires in northern California in 2008 was associated with an increase in risk for emergency department visits and hospitalizations for asthma, Reid and colleagues reported in Environmental Research in 2016. The 2012 wildfires in Colorado were linked to a rise in emergency department visits for asthma and chronic obstructive pulmonary disease, according to a 2016 study in Environmental Health. There’s some evidence of increased trips to the hospital for cardiovascular health problems during wildfires as well.Medical visits for kids go up during wildfires too. During the 2017 Lilac Fire in San Diego county, visits for respiratory problems to a children’s hospital rose due to increased exposure to PM2.5, according to a 2020 study in the Annals of the American Thoracic Society.Children, especially the very young and those with diseases like asthma, can be more vulnerable to health effects from wildfires. “They breathe more air per minute compared to adults” to meet their physiological needs, says Marissa Hauptman, a pediatrician at Boston Children’s Hospital. That can add up to more exposure. And developing lungs “are more susceptible to injury,” she says. A developing fetus may also be at risk from exposure to PM2.5. In a 2012 study in Environmental Health Perspectives, Reid and colleagues reported a slight decrease in birth weight for infants from pregnancies that occurred during the 2003 wildfires in Southern California. Mothers exposed to smoke from Colorado wildfires during the second trimester were more likely to give birth prematurely, according to a 2019 study in the International Journal of Environmental Research and Public Health. Infants born early or smaller than usual can face developmental delays.Not much. But a few studies provide some initial clues.One examined how wildfires that scorched large areas of Indonesia in 1997 impacted health 10 years later. This population-wide study found that males and the elderly were worse off in 2007 for health measures such as lung function, the researchers reported in Economics & Human Biology in 2017.In the United States, the wildfire smoke that plagued the Seeley Lake community in Montana in 2017 has parallels to the prolonged, hazardous exposures happening now in the West. The wildfires produced extremely high levels of PM2.5 from July 31 to September 18 that year; the daily average was 221 micrograms per cubic meter of air. Christopher Migliaccio, a respiratory immunology researcher at the University of Montana in Missoula, and his colleagues screened adults in the community right after the last day of increased smoke and two more times in each of the following two years.Compared with members of a Montana community that hadn’t been exposed to the same levels of smoke, the participants from the Seeley Lake area had poorer lung function one and two years out, Migliaccio and his colleagues reported in Toxics in August. “I thought people might be worse right after,” he says, “but it’s a little bit of a delayed response.”Migliaccio and colleagues had planned to screen the participants again this year, but COVID-19 got in the way. Eventually they hope to see whether, in participants that still have worse lung function, the condition is treatable or if it’s “the new normal.”It depends on the type of mask. “Cloth masks, which are effective at preventing transmission of SARS-CoV-2 [the virus that causes COVID-19] … don’t do anything to protect the wearer from exposure to wildfire smoke,” Balmes says (SN: 6/26/20). Surgical masks provide some protection. But “an N95 is the best protection.” N95 masks are designed to filter out at least 95 percent of airborne particles.But N95 masks are in short supply, and those masks have not been certified for use by children as they don’t fit properly. So the best protection is to avoid exposure. “People should stay indoors as much as possible with the windows closed,” Balmes says.“If they have central ventilation, they should turn that to recirculation,” Balmes says. That can reduce the amount of smoke that enters the home. People can also use a High Efficiency Particulate Air, or HEPA purifier to smoke-proof a single room. And those who cannot afford a HEPA cleaner can put together a makeshift purifier using a MERV-13 furnace filter and a box fan, Balmes says. “They’re not as good as the proper devices, but they do provide some protection.”People hunkered down indoors can also keep the air clear by not burning gas stoves or candles, or even vacuuming — which can stir up particles inside the home.But some people don’t have a home to escape to. King County in Washington announced on September 11 the opening of a clean air shelter for people experiencing homelessness.The toll that the wildfires have on mental health could also be significant. The past month in the Pacific Northwest has brought images reminiscent of a science fiction novel: hazy, deep orange skies that sometimes completely obscured the sun, turning day to night.Extreme wildfires, with the potential for long periods of time in which the air is a danger, can upend people’s lives and add to stress levels. One of the few respites to the COVID-19 pandemic — going out for a breath of fresh air — has been shut off for millions of people. And there are many that have no choice but to work or live outdoors, exposed to hazardous air. “There could be a psychological impact of that,” says Reid. “That needs to be explored.”