



---

# Wildfire Smoke and Public Health: A Community Guide

Written by Anna Aiono

## Introduction

Wildfire season can hit our communities with brute force—a force growing even stronger as climate change exacerbates flame-fueling conditions like heat waves and droughts. Even communities that are not directly in the line of fire can suffer the health consequences of wildfire smoke. \_

In general, these health consequences vary depending on *what* the smoke is composed of, *who* the individual is, *where* they are in relation to the smoke, and *how long* the individual is exposed.

This resource focuses primarily on the *what* and *who*, examining *what* goes into smoke composition and *who* the most sensitive populations are. While we do not discuss in detail the methods to protect yourself against wildfire smoke, we present to you two key takeaways:

1. The single most effective way to protect yourself from wildfire smoke is a KN95 mask.
2. There is no such thing as a “safe” concentration of wildfire smoke. Any amount can result in negative health effects.

## Part I: Smoke Composition

Wildfire smoke may appear to be simple, but if you zoom in far enough, you’ll start to see something that looks more like stars in the night sky rather than a big gray mass.

Composed of thousands of unique chemical compounds, wildfire smoke is surprisingly complex. It normally contains gases, like carbon dioxide and carbon monoxide, and microscopic solids, called particulate matter (PM). It can also contain water vapor, hydrocarbons, other organics, nitrogen oxides, and noxious trace materials.

Not all wildfire smoke is the same. Anything that can burn is made up of various chemical “building blocks”; when something burns, those blocks disassemble and sometimes combine to create new compounds in the smoke.

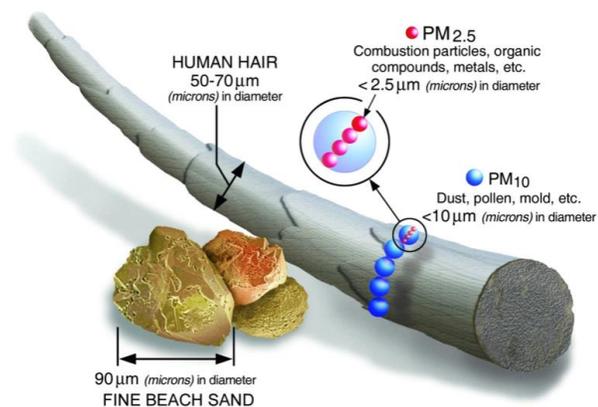
The burning of different source materials will produce different smoke. The chemical building blocks that make up brush or trees, for instance, are very different from those that make up man-made structures. As a result, smoke from fires in which brush or trees burn can vary greatly from smoke in which man-made structures burn.

To illustrate, consider the 2018 Camp Fire which burned through Paradise, California. [The California Air Resources board found dangerous levels of lead and other metals in the smoke.](#) Long-term exposure to heavy metals like lead has been found to negatively affect our health—especially in those with high blood pressure—and can lead to developmental problems in children.

Though these metals aren't usually found in wildfire smoke, in this case they came from residential and commercial structures which burned. These metals travelled far, blown over 150 miles away by the wind, at levels 50 times higher than normal concentrations. The 2018 Camp Fire is a prime example of how varied wildfire smoke composition can be.

Generally, however, particulate matter—or PM for short—is the most prevalent wildfire smoke component by mass. PM isn't a gas, but rather is a mixture of both liquid droplets and solid chunks of material. When wood burns, for instance, it releases carbon dioxide, but also particulate matter—small fragmented bits of wood—that are still in their solid state but travel with the cloud of wildfire smoke, behaving as if they were a gas.

[When talking about PM in a public health and air quality sense](#), there are two distinct types: PM10 (coarse PM) and PM2.5 (fine PM). The 10 and 2.5 stand for the *maximum diameter* in microns (aka a micrometer, or one millionth of a meter!) that each respective particle can have. PM10 describes all PM that are 10 microns *or less* in diameter, and PM2.5 for all PM that are 2.5 microns *or less* in diameter.



**Size comparisons for PM particles**

To give you some perspective, look at a strand of your hair. PM10 is one fifth the thickness of that strand of hair, whereas PM2.5 is one *thirtieth* of the thickness of the strand.



While both are hazardous to health, PM<sub>2.5</sub> is the real culprit of respiratory system damage. Our bodies have [natural defense mechanisms against particles larger than PM<sub>2.5</sub>](#), but very small particles like PM 2.5 can enter and stress the deep interior of our lungs.

Think about what would happen if tiny rocks made their way through your nose, down your throat, and into the bronchial tubes of your lungs. These particles, being small enough, could travel through even the narrowest pathways—or bronchioles—that lead to air sacs—or alveoli—within your lungs, all the while bouncing off, irritating, and inflaming the tissue that lines them. [When our lungs become inflamed](#), our air sacs swell, reducing the amount of oxygen which passes to the bloodstream.

PM<sub>2.5</sub> acts just like those tiny rocks, and can greatly threaten all bodily systems through inflammation. Though your body has developed specialized immune cells to eliminate PM, as more and more PM<sub>2.5</sub> enters the lungs, the cells become overloaded and stop functioning properly, leading to greater PM<sub>2.5</sub> infiltration.

Studies on wildfire smoke have shown clearly that—to quote Marshall Burke, a Stanford environmental economist and co-author of [one such study](#)— “there’s no safe level of exposure to particulate matter. Any exposure above zero can worsen health impacts.”

**Because there is no such thing as a “safe” amount of smoke, the single most effective way to protect yourself is by wearing a KN95 mask.**

## **Part II: Health Effects**

Wildfire smoke is a health threat. In addition to individual susceptibility, the duration, dose, and frequency of exposure all play a role in health outcomes. The more *extreme* any of these variables is, the more likely adverse health effects will occur. Enough smoke can make anyone sick, no matter their health conditions.

If you are in a heavily smoky area and are experiencing burning eyes, runny nose, cough, phlegm, wheezing, and/or difficulty breathing, smoke is likely making you sick. The best course of action is to visit a doctor or call 911.

Aside from these milder symptoms, smoke exposure can potentially aggravate existing lung and cardiovascular diseases like asthma and COPD. In intense and acute scenarios—and depending on your health conditions—smoke exposure can also lead to premature death.



Carbon monoxide (CO) can also impact health. CO is a colorless, odorless gas, largely produced when wildfires are *smoldering*, burning slowly and smoking without flame. Like PM, CO enters the bloodstream through the alveoli and reduces the amount of oxygen delivered to the body's organs and tissues. Note that these are the same alveoli which become inflamed from PM2.5—so when CO and PM2.5 are inhaled together, *both* act to disrupt the cardiovascular system.

Lasting effects of CO and PM2.5 can occur for the cardiovascular system and may alter the functions of the entire circulatory system, increasing risk of blood clots, heart attack, and stroke.

Low levels of CO exposure can still greatly impact those with cardiovascular diseases. Higher levels of CO exposure can cause headaches, dizziness, visual impairment, reduced work capacity, and/or reduced manual dexterity for anyone. In extreme cases, CO exposure is deadly.

Finally, exposure to other noxious trace materials in wildfire smoke—like the lead concentrations from the 2018 Camp Fire—can increase risk of cancer and pose other serious health consequences.

### **Part III: Sensitive Populations**

Smoke effects are context-sensitive. Enough smoke can make anyone sick for at least a short period of time, but certain populations can suffer more extreme sickness and face potential long-term to lifelong health impacts. These individuals are more sensitive to the above physical effects of PM2.5, CO, and other hazardous air pollutants.

Other factors, such as regional climate, pre-existing air pollutant levels, and COVID-19 rates, can further complicate effects. Across the board, however, it must be restated that the single most effective way to be protected against wildfire smoke is to wear a KN95 mask, and no amount of PM2.5 exposure is “safe”.

Below, we highlight many groups which are more sensitive to wildfire smoke.

- **Those with cardiovascular conditions**, such as COPD, CF, high blood pressure, angina pectoris, and hardening of the arteries, as well as those prone to heart attacks and strokes.  
PM2.5 and CO can aggravate symptoms of cardiovascular conditions and increase risk of heart attack. Since PM2.5 can induce lung inflammation and weaken respiratory defenses, the lungs are more permeable to foreign material and fluid

accumulation. This can lead to blood clotting and increased risk of stroke, especially in individuals with cardiovascular conditions.

- **Those with asthma and other respiratory conditions.**

Wildfire smoke can cause greater inflammation of the lungs—leading to aggravated wheezing and/or coughing which can be particularly exacerbated for those with asthma and other respiratory conditions. In short, inflammation makes it even harder for these individuals to breathe.

- **The elderly.**

Elderly people have cardiovascular and respiratory conditions in greater numbers. Moreover, certain respiratory defenses weaken as we age, which makes it harder for older individuals to clear particles from their lungs or to fight off respiratory infections. PM2.5 exposure weakens these defenses even more.

- **Children and teens.**

Lungs do not fully develop until 20-25 years old. Young children are particularly vulnerable because they breathe in *more* relative to their size.

Both of these factors leave children susceptible to increased respiratory ailments, including decreased lung function, aggravated coughing, and difficulty/pain in breathing. This, in turn, can lead to reduced participation in school, medical bills, and limitations in normal childhood activities.

- **Pregnant women.**

Greater exposure to wildfire smoke during pregnancy can lead to adverse health effects for both mother and fetus. [A recently conducted study with Stanford University](#) found that intense smoke exposure during the second trimester strongly correlated to preterm births; during the first trimester correlated to lower birth weight; and during any trimester increased chances of gestational diabetes and high blood pressure.

These effects may well owe to the body's inflammatory response to PM2.5., which can trigger early delivery and complicate the placenta's blood supply—overall altering the growth of the fetus.

- **Weakened lungs from other pollutants,** such as tobacco, second-hand smoke, exhaust fumes, and heavy CO concentrations.

Heavy exposure to these pollutants will have already inflamed and damaged the lungs. Smoking in particular destroys both the tiny air sacs that are compromised by PM2.5, as well as the tiny brush-like hairs (cilia) that line our airways and sweep larger particles (like PM10) out of our lungs. Wildfire smoke can exacerbate already existing conditions such as chest pain, wheezing, or coughing, for these individuals.

- **Other Factors.**

The greater one's exposure and/or the less access to treatment, the greater the risk. Outdoor workers, people with limited health care and/or lower socioeconomic



status, and people experiencing homelessness are all more vulnerable to wildfire smoke related illnesses.

### [In the context of COVID-19](#)

[The CDC reports that exposure to air pollutants](#), like wildfire smoke, increases susceptibility to, as well as the symptoms and outcomes of respiratory infections, like COVID-19. Recent studies have found a correlation between PM2.5 exposure and more extreme COVID-19 contraction, where longer-term exposure may make COVID-19 more deadly. [One particular nationwide study](#) saw that even small increases in PM2.5 exposure were associated with large increases in death rates from COVID-19.

Those who have been affected by COVID-19 may also be more vulnerable to wildfire smoke health effects. This includes those who are immunocompromised or taking substances to suppress one's immune system, those who have contracted COVID-19, and those who are recovering from COVID-19.

Respiratory symptoms like dry cough, sore throat, and difficulty breathing are common to both wildfire smoke sickness and COVID-19. If experiencing any additional COVID-specific symptoms, such as fever or chills, diarrhea, loss of smell and taste, and nausea/vomiting, it could be COVID-19. Utilize the [CDC's self-checker](#) to learn more. If unsure whether or not you have COVID-19, or if experiencing severe symptoms, like difficulty breathing or chest pain, contact your healthcare provider.

### [Conclusion](#)

Wildfire smoke is complex and often daunting. While we have no control over the first matter, the more informed we are about smoke exposure, the better we can prepare to protect our health and that of our loved ones.

Wildfire smoke is composed of many particles with differing properties, the two most prevalent and harmful of which are PM2.5 and CO. These can adversely affect one's health in many ways depending on various factors such as pre-existing conditions. There are certain identifiable populations who are more sensitive to smoke exposure than others, but no amount of PM2.5 exposure—and thus no amount of smoke exposure—is a “safe” amount.

While COVID-19 may complicate wildfire smoke symptoms, it has kept us in the good habit of utilizing masks to prevent particle exposure. This habit is important to continue—especially a KN-95 mask—at any point when wildfire smoke is prevalent in your area.