"Wildfire Smoke: A Guide for Public Health Officials"

Revised May 2016[1]

Introduction: Smoke rolls into town, blanketing the city, turning on streetlights, creating an eerie and choking fog. Switchboards light up as people look for answers. Citizens want to know what they should do to protect themselves. School officials want to know if outdoor events should be cancelled. The news media want to know how dangerous the smoke really is.

Smoke events can occur without warning – but we can be prepared. This guide is intended to provide local public health officials with information they need to be prepared for smoke events and, when wildfire smoke is present, adequately communicate health risks and take measures to protect the public. This guide is the product of a collaborative effort by scientists, air quality specialists, land managers and public health professionals from federal, state, and local agencies.

Composition of Smoke: Smoke is a complex mixture of carbon dioxide, water vapor, carbon monoxide, particulate matter, hydrocarbons and other organic chemicals, nitrogen oxides, and trace minerals. The individual compounds present in smoke number in the thousands. Smoke composition depends on multiple factors, including how efficiently a fuel burns, the fuel type and moisture content, the fire temperature, wind conditions and other weather-related influences, whether the smoke is fresh or "aged," and other variables. Different types of wood and vegetation are composed of varying amounts of cellulose, lignin, tannins and other polyphenols, oils, fats, resins, waxes, and starches, which produce different compounds that are released as smoke when burned.

[1] Extracted from: United States. Environmental Protection Agency. Wildfire Smoke: A Guide for Public Health Officials, report, May 2016; Washington D.C.. (digital.library.unt.edu/ark:/67531/metadc948853/: accessed April 18, 2018),University of North Texas Libraries, Digital Library, digital.library.unt.edu; crediting UNT Libraries Government Documents Department. Available: https://digital.library.unt.edu/ark:/67531/metadc948853/

Particulate Matter (PM): Particulate matter is the principal pollutant of concern from wildfire smoke for the relatively short-term exposures (hours to weeks) often experienced by the public. Particulate matter is a term for particles suspended in the air, typically as a mixture of solid particles and liquid droplets.

Particulate matter is usually measured as "PM2.5," the amount (in micrograms) of particulates less than 2.5 micrometers in diameter per cubic meter of air. Particles in smoke tend to be very small, with a size range near the wavelength of visible light (0.4 – 0.7 micrometers). Therefore, they scatter light and reduce visibility. Moreover, these particles can be inhaled into the deepest recesses of the lungs.

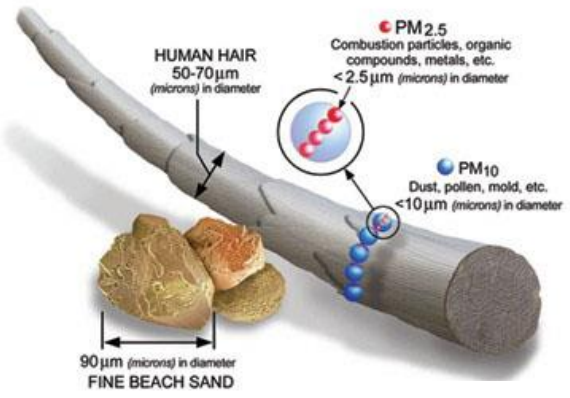

Image: www.airnow.gov

Another pollutant of concern during smoke events is carbon monoxide, which is a colorless, odorless gas produced by incomplete combustion of wood or other organic materials. Carbon monoxide levels are highest during the smoldering stages of a fire, especially in very close proximity to the fire.

Other air pollutants, such as the potent respiratory irritants acrolein and formaldehyde, are present in smoke, but at much lower concentrations than particulate matter and carbon monoxide.

Health Effects of Particulate Matter: Particulate matter exposure is the principal public health threat from short-term exposures to wildfire smoke. The effects of smoke range from eye and respiratory tract irritation to more serious disorders, including reduced lung function, bronchitis, exacerbation of asthma and heart failure, and premature death. Most of our understanding on the health effects of wildfire smoke are derived from studies of urban particulate matter, specifically fine particulate matter. These studies have found that short-term exposures (i.e., days to weeks) to fine particles, a major component of smoke, are linked with increased premature mortality and aggravation of pre-existing respiratory and cardiovascular disease. Children, pregnant women, and elderly are also especially vulnerable to smoke exposure. In addition, fine particles are respiratory irritants, and exposures to high concentrations can cause persistent cough, phlegm, wheezing, and difficulty breathing. Exposures to fine particles can also affect healthy people, causing respiratory symptoms, transient reductions in lung function, and pulmonary inflammation. Particulate matter may also affect the body's physiological mechanisms that remove inhaled foreign materials from the lungs, such as pollen and bacteria.

Health Effects of Carbon Monoxide: Carbon monoxide (CO) enters the bloodstream through the lungs and reduces oxygen delivery to the body's organs and tissues. CO concentrations typical of wildfire smoke do not pose a significant hazard, except to some sensitive individuals and to firefighters very close to the fire line. Individuals who may experience health effects from lower levels of CO are those who have cardiovascular disease: they may experience chest

pain or cardiac arrhythmias. At higher levels (such as those that occur in major structural fires), CO exposure can cause headache, weakness, dizziness, confusion, nausea, disorientation, visual impairment, coma, and death, even in otherwise healthy individuals.

Health Effects of Other Air Pollutants: Wildfire smoke also contains significant quantities of respiratory irritants, which can act in concert to produce eye and respiratory irritation and potentially exacerbate asthma. Formaldehyde and acrolein are two of the principal contributors to the cumulative irritant properties of smoke.

Long-Term Effects: One concern that may be raised by members of the general public is whether they run an increased risk of cancer or of other chronic health conditions (e.g. heart disease) from short-term exposure to wildfire smoke. It is well known that smoke contains carcinogenic components with polycyclic aromatic hydrocarbons (PAHs) comprising the largest percent, and to a lesser extent benzene and formaldehyde. People exposed to toxic air pollutants, such as the ones mentioned above, at sufficient concentrations and durations may have slightly increased risks of cancer or of experiencing other chronic health problems. However, in general, the long-term risks from short-term smoke exposures are quite low. Short-term elevated exposures (i.e., over days to weeks) to carcinogens found in wildfire smoke are also small relative to total lifetime exposures to carcinogens in other, more common combustion sources. For example, epidemiological studies have shown that urban firefighters who are occupationally exposed to smoke over an entire working lifetime are at increased risk of developing lung cancer (Hansen 1990) and other cancers (Daniels et al. 2014).

It is important to recognize that not everyone who is exposed to thick smoke from wildfires will have health problems. The level and duration of exposure, age, individual susceptibility, including the presence or absence of pre-existing lung disease or heart disease, and other factors play significant roles in determining whether someone will experience smoke-related health problems. The types of potential responses should be discussed in public warnings about risks and the need to avoid exposure to smoke.

Overall: It appears that risk to fine particle-related health effects varies throughout a lifetime, generally being higher in early childhood, lower in healthy adolescents and younger adults, and increasing in middle age through old age as the incidence of heart and lung disease and diabetes increases. Therefore, certain life stages (e.g., children) and populations (e.g., people with pre-existing respiratory and cardiovascular disease) should take precautions to limit exposure to wildfire smoke. If individuals with heart or lung disease are concerned about the potential health implications of exposure to wildfire smoke and actions they can take to limit exposures, they should discuss this with their primary healthcare provider. They should also check the Air Quality Index each day for the air quality forecast and for information about ways to reduce exposure, if necessary. Overall, the potential for increased frequency and severity of wildfires due to climate change could have important population-level effects.

For specific strategies to reduce smoke exposure, including information on HEPA air filters, see the full article: https://digital.library.unt.edu/ark:/67531/metadc948853/.