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Particle Pollution



Ever look at dirty truck exhaust?

The dirty, smoky part of that stream of exhaust is made of particle pollution. Overwhelming evidence shows that particle pollution—like that coming from that exhaust smoke—can kill. Particle pollution can increase the risk of heart disease, lung cancer and asthma attacks and can interfere with the growth and work of the lungs.

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Where Does Particle Pollution Come From? Are Some Particles More Dangerous than Others? What Is Particle Pollution?

Particle pollution refers to a mix of tiny solid and liquid particles that are in the air we breathe. Many of the particles are so small as to be invisible, but when levels are high, the air becomes opaque. But nothing about particle pollution is simple. And it is so dangerous that it can shorten your life.

Size matters. Particles themselves are different sizes. Some are one-tenth the diameter of a strand of hair. Many are even tinier; some are so small they can only be seen with an electron microscope. Because of their size, you can't see the individual particles. You can only see the haze that forms when millions of particles blur the spread of sunlight.

The differences in size make a big difference in how they affect us. Our natural defenses help us to cough or sneeze larger particles out of our bodies. But those defenses don't keep out smaller particles, those that are smaller than 10 microns (or micrometers) in diameter, or about one-seventh the diameter of a single human hair. These particles get trapped in the lungs, while the smallest are so minute that they can pass through the lungs into the

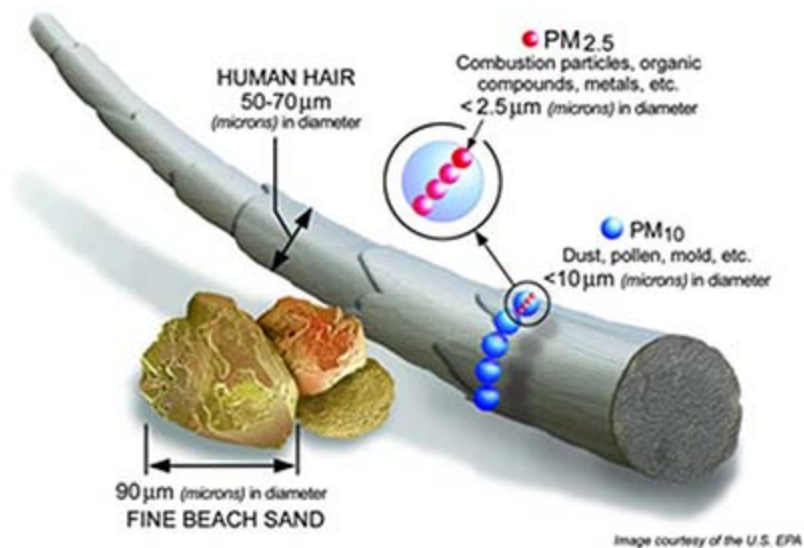


Image courtesy of the U.S. EPA

bloodstream, just like the essential oxygen molecules we need to survive.

Researchers categorize particles according to size, grouping them as coarse, fine and ultrafine. Coarse particles (shown as blue dots in the illustration) fall between 2.5 microns and 10 microns in diameter and are called PM_{10-2.5}. Fine particles (shown as pink dots in the illustration) are 2.5 microns in diameter or smaller and are called PM_{2.5}. Ultrafine particles (not shown) are smaller than 0.1 micron in diameter¹ and are small enough to pass through the lung tissue into the blood stream, circulating like the oxygen molecules themselves. No matter what the size, particles can harm your health.

"A mixture of mixtures." Because particles form in so many ways, they can be composed of many different compounds. Although we often think of particles as solids, not all are. Some are completely liquid; others are solids suspended in liquids. As EPA put it, particles are really "a mixture of mixtures."²

The mixtures differ between the eastern and western United States and in different times of the year. For example, the Midwest, Southeast and Northeast states have more sulfate particles than the West on average, largely due to the high levels of sulfur dioxide emitted by large, coal-fired power plants. By contrast, nitrate particles from motor vehicle exhaust form a larger proportion of the unhealthy mix in the winter in the Northeast, Southern California, the Northwest, and North Central U.S.³

Who Is at Risk?

Anyone who lives where particle pollution levels are high is at risk. Some people face higher risk, however. People at the greatest risk from particle pollution exposure include:

Infants, children and teens;⁴

People over 65 years of age;⁵

People with lung disease such as asthma and chronic obstructive pulmonary disease (COPD), which includes chronic bronchitis and emphysema;

People with heart disease⁶ or diabetes;⁷

People with low incomes;⁸ and

People who work or are active outdoors.⁹

Diabetics face increased risk at least in part because of their higher risk for cardiovascular disease.¹⁰

People with lung cancer also appear to be at higher risk from particle pollution, according to a 2016 study of more than 350,000 patients in California. Researchers looked at the exposure they experienced between 1988 and 2011 and found that where higher concentrations of particle pollution existed, people with lung cancer had poorer survival.¹¹

What Can Particles Do to Your Health?

Particle pollution can be very dangerous to breathe depending on the level. Breathing particle pollution may trigger illness, hospitalization and premature death, risks that are showing up in new studies that validate earlier research.

Thanks to steps taken to reduce particle pollution, good news is growing from researchers who study the drop in year-round levels of particle pollution.

Looking at air quality in 545 counties in the U.S. between 2000 and 2007, researchers found that people had approximately four months added to their life expectancy on average due to cleaner air. Women and people who lived in urban and densely populated counties benefited the most.¹²

Another long-term study of people in six U.S. cities tracked from 1974 to 2009 added more evidence of the benefits. The findings suggest that cleaning up particle pollution had almost immediate health benefits. The researchers estimated that the U.S. could prevent approximately 34,000 premature deaths a year if the nation could lower annual levels of particle pollution by 1 $\mu\text{g}/\text{m}^3$.¹³

Other researchers estimated that reductions in air pollution can be expected to produce rapid improvements in public health, with fewer deaths occurring within the first two years after reductions.¹⁴

These studies add to the growing research that cleaning up air pollution improves life and health.

Short-Term Exposure Can Be Deadly

First and foremost, short-term exposure to particle pollution can kill. Peaks or spikes in particle pollution can last from hours to days. Premature deaths from breathing these particles can occur on the very day that particle levels are high, or within one to two months afterward. Particle pollution does not just make people die a few days earlier than they might otherwise—these are deaths that would not have occurred so early if the air were cleaner.¹⁵

Even low levels of particles can be deadly. A 2016 study found that people aged 65 and older in New England faced a higher risk of premature death from particle pollution, even in places that met current standards for short-term particle pollution.¹⁶ Another study in 2017 looked more closely at Boston and found a similar higher risk of premature death from particle pollution in a city that meets current limits on short-term particle pollution.¹⁷ Looking nationwide in a 2017 study, researchers found more evidence that older adults faced a higher risk of premature death even when levels of short-term particle pollution remained well below the current national standards. This was consistent whether the older adults lived in cities, suburbs or rural areas.¹⁸

Particle pollution also diminishes lung function, causes greater use of asthma medications and increased rates of school absenteeism, emergency room visits and hospital admissions. Other adverse effects include coughing, wheezing, cardiac arrhythmias and heart attacks. According to extensive research, short-term increases in particle pollution have been linked to:

death from respiratory and cardiovascular causes, including strokes;¹⁹ , ²⁰ , ²¹ , ²²

increased mortality in infants and young children;²³

increased numbers of heart attacks, especially among the elderly and in people with heart conditions;²⁴

inflammation of lung tissue in young, healthy adults;²⁵
 increased hospitalization for cardiovascular disease, including strokes and congestive heart failure;^{26 , 27 , 28}
 increased emergency room visits for patients suffering from acute respiratory ailments;²⁹
 increased hospitalization for asthma among children;^{30 , 31 , 32} and
 increased severity of asthma attacks in children.³³
 Again, the impact of even short-term exposure to particle pollution on healthy adults was demonstrated in the Galveston lifeguard study. In addition to the harmful effects of ozone pollution, lifeguards had reduced lung volume at the end of the day when fine particle levels were high.³⁴

Year-Round Exposure

Breathing high levels of particle pollution day in and day out can also be deadly, as landmark studies in the 1990s conclusively showed²⁵ and as later studies confirmed.³⁶ Chronic exposure to particle pollution can shorten life by one to three years.³⁷ Recent research has confirmed that long-term exposure to particle pollution still kills, even with the declining levels in the U.S. since 2000³⁸ and even in areas, such as New England, that currently meet the official limit, or standard, for year-round particle pollution.³⁹ In 2013, the International Agency for Research on Cancer (known as IARC), part of the World Health Organization, concluded that particle pollution causes lung cancer. The IARC based its decision on the review of multiple studies from the U.S., Europe, and Asia and the presence of carcinogens on the particles.⁴⁰ Year-round exposure to particle pollution has also been linked to:
 increased hospitalization for asthma attacks for children living near roads with heavy truck or trailer traffic;^{41 , 42}
 slowed lung function growth in children and teenagers;^{43 , 44}
 development of asthma in children up to age 14;⁴⁵
 significant damage to the small airways of the lungs;⁴⁶
 increased risk of death from cardiovascular disease;⁴⁷ and
 increased risk of lower birth weight and infant mortality.⁴⁸
 Research has found evidence that long-term exposure to particle pollution may increase the risk of developing diabetes. Two independent reviews of published research found that particle pollution may increase the risk of developing type 2 diabetes mellitus.⁴⁹ Studies examining the impact on the nervous system of long-term exposure to particle pollution have found links to cognitive affects in adults including dementia and Alzheimer's Disease.⁵⁰ Scientists have found links between particle pollution and other mental health concerns. ^{51 52}
 The EPA is conducting their new review of the current research on particle pollution. Their findings from the last review, completed in December 2009,⁵³ are highlighted in the box below.

EPA Concludes Fine Particle Pollution Poses Serious Health Threats (2009)

Causes early death (both short-term and long-term exposure)
 Causes cardiovascular harm (e.g., heart attacks, strokes, heart disease, congestive heart failure)
 Likely to cause respiratory harm (e.g., worsened asthma, worsened COPD, inflammation)
 May cause cancer
 May cause reproductive and developmental harm
 —U.S. Environmental Protection Agency, Integrated Science Assessment for Particulate Matter, December 2009. EPA 600/R-08/139F

Where Does Particle Pollution Come From?

Particle pollution is produced through two separate processes—mechanical and chemical. Mechanical processes break down bigger bits into smaller bits with the material remaining essentially the same, only becoming smaller. Mechanical processes primarily create coarse

particles.⁵⁴ Dust storms, construction and demolition, mining operations, and agriculture are among the activities that produce coarse particles. Tire, brake pad and road wear can also create coarse particles. Bacteria, pollen, mold, and plant and animal debris are also included as coarse particles.⁵⁵

By contrast, chemical processes in the atmosphere create most of the tiniest fine and ultrafine particles in the air. Burning fuels or other human activity or by natural sources emit gases that form particles in the air. These gases can oxidize and then condense to become a particle of a simple chemical compound. Or they can react with other gases or particles in the atmosphere to form a particle of a different or of multiple chemical compounds. Particles formed by this latter process come from the reaction of elemental carbon (soot), heavy metals, sulfur dioxide (SO₂), nitrogen oxides (NO_x) and volatile organic compounds with water and other compounds in the atmosphere.⁵⁶ Burning fossil fuels in factories, power plants, diesel- and gasoline-powered motor vehicles (cars and trucks) and equipment generate a large part of the raw materials for fine particles. Other sources include burning wood in residential fireplaces and wood stoves or wildfires.

Are some particles more dangerous than others?

With so many sources of particles, researchers want to know if some particles pose greater risk than others. Researchers are exploring possible differences in health effects of the sizes of particles and particles from different sources, such as diesel particles from trucks and buses or sulfates from coal-fired power plants. Recent studies have tried to answer this question. So far, the answers are complicated.

Each particle may have many different components. The building blocks of each can include several biological and chemical components. Bacteria, pollen and other biological ingredients can combine in the particle with chemical agents, such as heavy metals, elemental carbon, dust and secondary species like sulfates and nitrates. These combinations mean that particles can have complex effects on the body.⁵⁷

Some studies have found different kinds of particles may have greater risk for different health outcomes. ^{58 ,59 ,60}

Other studies have identified the challenges of exploring all the kinds of particles and their health effects with the limited monitoring across the nation.⁶¹ Some particles serve as carriers for other chemicals that are also toxic, and the combination may worsen the impact.^{62 , 63}

The best evidence shows that having less of all types of particles in the air leads to better health and longer lives.

[Sources](#)

News & Events

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