

Resources for Teachers

Good

Moderate

Unhealthy for Sensitive Groups

Unhealthy

Very Unhealthy

Air Pollution and Health

Through regulation and voluntary change, levels of many air pollutants have decreased significantly in recent decades. Still, in many parts of the U.S. the air is often polluted at levels that can affect our health. Millions of people are exposed to unhealthy levels of ground-level ozone or particle pollution every year.

Ozone

What is ozone? Ozone is an odorless, colorless gas composed of three atoms of oxygen. Ozone occurs naturally in the Earth's upper atmosphere (the stratosphere) and as a pollutant at ground level. Stratospheric ozone protects us from the sun's harmful ultraviolet rays. This beneficial ozone is gradually being destroyed by manmade chemicals. At ground level, ozone is a harmful pollutant formed when emissions from vehicles, power plants, and industrial sources react in the presence of sunlight and heat.

When and where is ozone a concern? Because it needs heat to form, ozone pollution is a concern in warmer weather, particularly in the afternoon and early evening. Ozone can be transported by winds hundreds of miles from where it formed, so it can be found in both urban and rural environments.

Can we see ozone in the air? By itself, ozone in the air is invisible, so we can be breathing harmful ozone levels even when the air looks clear. When ozone mixes with particles (described below), it forms a brown summertime haze known as "smog."

Why is ozone pollution bad? Ozone can trigger a variety of health problems, even at relatively low levels. Health effects from ozone include aggravated asthma and increased susceptibility to respiratory illnesses like pneumonia and bronchitis. Symptoms to watch for when ozone is in the air include coughing, pain when taking a deep breath, and breathing difficulties, especially when you are active outdoors. But ozone damage can also occur without any noticeable signs. And, for some people, several months of repeated exposure to ozone can permanently damage the lungs. Ozone is also bad for our environment, damaging plants and trees and reducing crop and forest yields.

Who's at risk from ozone pollution? People with respiratory problems are most vulnerable, but even healthy people and children who are active outdoors can be affected when ozone levels are unhealthy. This is because during physical activity, ozone penetrates deeper into the parts of our lungs that are most vulnerable to ozone.

Particle Pollution

What is particle pollution? Particle pollution includes dust, soot, dirt, and liquid droplets. Some particles are large enough to be visible. Others can only be seen under a microscope. The smaller particles cause the greatest health concern because they penetrate deeper into the lungs and can even enter our bloodstream.

What causes particle pollution? Sources of particle pollution include vehicles, factories, and power plants, as well as natural sources such as forest fires and volcanoes.

When and where is particle pollution worst? Particle pollution can be high at any time of year. It can be especially bad during winter, when warm air above cold air causes "inversions"

that can trap pollutants in one area for a period of time. Particle pollution can be higher near busy roads and factories, and can reach very hazardous levels in areas downwind of forest fires. Particle pollution can be high indoors, especially when outdoor particle levels are high.

Why is particle pollution bad? Health effects from particles range from coughing and aggravated asthma to chronic bronchitis and even premature death. Many studies link particle pollution levels with increased hospital admissions and emergency room visits. If you have heart disease, particle exposure can cause serious problems in a short period of time—even heart attacks—with no warning signs. Particle pollution also has significant environmental effects. Particles are a major component of haze, which can reduce visibility, for example in national parks and other scenic vistas. Particles are a major contributor to “acid rain,” which harms the environment in a number of ways, including making lakes and other water bodies more acidic, which can harm the health of aquatic life; damaging trees and soils; and deteriorating buildings and statues.

Who's at risk from particle pollution? People with heart or lung disease are at risk because particle pollution can aggravate these diseases. Many studies show that when particle levels are unhealthy, older adults are more likely to be hospitalized, and some may die of aggravated heart or lung disease, perhaps because these diseases were previously undiagnosed in these patients. Children are at risk because their lungs are still developing and they are usually very active.

Protect Your Health

Because ozone and particles remain a significant public health concern in many areas of the U.S., the U.S. EPA, in partnership with federal, state, and local agencies and tribes, have set up a nationwide network for reporting daily air quality information and forecasts for these two pollutants, as well as three others. This information is available on the Internet at: www.airnow.gov, in newspapers, via radio and television announcements, and in many areas via air quality notifications sent to your email or cell phone (www.airnow.gov/enviroflash). Daily air quality is reported using a standard, color-coded scale called the Air Quality Index, or AQI. The AQI makes air quality reports as easy to understand as weather reports.

The best way to protect your health is to check the air quality level and forecast daily for your area, and the related health messages provided by the AQI. By doing so, you can find out when ozone or particle levels are elevated. You can also take simple precautions to minimize exposure, even when you don't feel obvious symptoms. Precautions include:

- When possible, plan activities and exercise when pollution levels are lower (e.g., typically morning or evening for ozone).
- If pollution levels are unhealthy, take it easy when you are active outside. For example, reduce the intensity of your activity (e.g., go for a walk instead of a jog) or reduce the length of your activity. You can also choose to exercise at another time or on another day when the air quality is better. That way, you will reduce the amount of pollution you breathe.
- To reduce exposure to particle pollution, exercise away from busy roadways and other pollution sources.
- Check with your health care provider if you notice any symptoms (such as coughing, wheezing, difficulty breathing, or chest pain) when the air is polluted. This is especially im-

portant if you are a member of a sensitive group (i.e., for ozone—active children or adults, and people with lung disease; for particle pollution—people with heart or lung disease, older adults, and children).

What Is the Air Quality Index (AQI)?

The AQI is an index for reporting daily air quality. It uses a simple color-coded scale to tell you how clean or polluted your air is, and how you can protect your health at different levels of pollution. The AQI helps to make daily air quality information as easy to understand as weather forecasts.

How Does the AQI Work?

The AQI is essentially a yardstick that runs from 0 to 500. The higher the AQI value, the greater the level of air pollution and the greater the health concern. For example, an AQI value of 50 represents good air quality with little potential to affect public health, while an AQI value over 300 represents hazardous air quality.

An AQI value of 100 generally corresponds to the national air quality standard for the pollutant, which is the level EPA has set to protect public health. When AQI values are above 100, air quality is considered to be unhealthy—at first for certain sensitive groups of people, then for everyone as AQI values get higher.

Understanding the AQI

To make it easier to understand, the AQI is divided into six categories:

Air Quality Index Values	Levels of Health Concern	Colors
When the AQI is in this range:	...air quality conditions are:	...as symbolized by this color:
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

Each category corresponds to a different level of health concern:

- **"Good"**—The AQI value for a particular community is between 0 and 50. Air quality is considered satisfactory, and air pollution poses little or no risk.
- **"Moderate"**—The AQI for a community is between 51 and 100. Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people. For example, people who are unusually sensitive to ozone may experience respiratory symptoms.
- **"Unhealthy for Sensitive Groups"**—When AQI values are between 101 and 150, members of sensitive groups may experience health effects. This means they are likely to be affected at lower levels than the general public. For example, people with lung disease are at greater risk from exposure to ozone, while people with either lung disease or heart disease are at greater risk from exposure to particle pollution. The general public is not likely to be affected when the AQI is in this range.

- **"Unhealthy"**—Everyone may begin to experience health effects when AQI values are between 151 and 200. Members of sensitive groups may experience more serious health effects.
- **"Very Unhealthy"**—AQI values between 201 and 300 trigger a health alert, meaning everyone may experience more serious health effects.
- **"Hazardous"**—AQI values over 300 trigger health warnings of emergency conditions. The entire population is more likely to be affected.

How Is a Community's AQI Calculated?

Air quality is measured by monitors that record the concentrations of the major pollutants each day at more than a thousand locations across the country. These raw measurements are then converted into AQI values using standard formulas developed by EPA. An AQI value is calculated for each pollutant in an area (ground-level ozone, particle pollution, carbon monoxide, sulfur dioxide, and nitrogen dioxide). The highest AQI value for the individual pollutants is the AQI value for that day. For example, if on July 12 a certain area had AQI values of 90 for ozone and 88 for sulfur dioxide, the AQI value would be 90 for the pollutant ozone on that day.

When and How Is the AQI Reported to the Public?

In large cities (more than 350,000 people), state and local agencies are required to report the AQI to the public daily. When the AQI is above 100, agencies must also report which groups, such as children or people with asthma or heart disease, may be sensitive to those pollutants. Many smaller communities also report the AQI as a public health service.

Many cities also provide forecasts for the next day's AQI. These forecasts help local residents protect their health by alerting them to plan their vigorous activities for a time when air quality is better.

The AQI is a national index, so the value and colors used to show local air quality and the levels of health concern will be the same everywhere in the U.S. You can always find AQI reports for areas across the U.S. on the Internet at EPA's AIRNow web site: www.airnow.gov. The AQI is also frequently reported in local newspapers, on local television and radio stations, and on many state and local telephone hotlines.

What Are Typical AQI Values in Most Communities?

In many U.S. communities, AQI values are usually below 100, with values greater than 100 occurring just several times a year. Typically, larger cities have more severe air pollution problems, and the AQI in these areas may exceed 100 more often than in smaller cities. AQI values higher than 200 are infrequent, and AQI values above 300 are extremely rare.

AQI values can vary from one season to another. In winter, for example, carbon monoxide may be high in some areas because the cold weather makes it difficult for car emission control systems to operate effectively. In summer, ozone may be a significant air pollutant because it forms in the presence of heat and sunlight. Particle pollution can be elevated at any time of the year.

AQI values also can vary depending on the time of day. For example, ozone levels often peak in the afternoon, while carbon monoxide is usually a problem during morning or evening rush hours. Particle pollution can be high at any time of day.

Additional Air Quality Resources

Curricula, Lesson Plans, and Activities

Air Pollution: What's the Solution?

This educational project uses online, real-time air quality and weather data to guide Grades 6-12 students in understanding the science behind the causes and effects of ground-level ozone pollution. Available at: www.k12science.org/curriculum/airproj/

Air Quality Education Program

The Delaware Department of Natural Resources and Environmental Control's Air Quality Education Program for Grades 6-12 includes detailed lesson plans. Available at: www.dnrec.state.de.us/DNREC2000/Divisions/AWM/aqm/education/Contnt.htm

AirNow Teacher's Air Quality Resources

This webpage provides curriculum resources, environmental education materials and classroom activities. www.airnow.gov/teachers

AQI Toolkit for Weathercasters

EPA's AQI Toolkit for Weathercasters is a companion to this AQI Toolkit for Teachers. The weathercasters toolkit includes presentations on air quality, weather, the AQI, ozone, particle pollution, and health for Grades 3-8 and adults, and earlier versions of the lesson plans in this toolkit. Available at: www.airnow.gov/index.cfm?action=aqifor.weathercast

Clean Air Campaign

The Clean Air Campaign and the Georgia Environmental Protection Division provide air quality lesson plans as well as school programs and children's activities. Available at: www.cleanaircampaign.org/Your-Schools

Eco Badge® Educational Products

Vistanomics' "eco store" sells air quality educational materials, including the Eco Badge® (a compact, easy-to-use device to measure ozone levels at home or in the work environment). The site also provides examples of successful teacher programs using the Eco Badge. Available at: www.ecobadge.com

EPA Teaching Resources—Air

This Web page provides links to curricula and activities on a variety of environmental topics, including ozone and the AQI. Available at: www.epa.gov/students/teachers.html

Flight for Life

The New Brunswick Lung Association provides educational resources on respiration, indoor and outdoor air quality, climate change, and health for elementary, middle school, and high school teachers and students. Available at: www.nb.lung.ca/FFL

In The Air

Provides environmental education materials for Grades K-12 and adults on airborne toxics. Developed by the Missouri Botanical Garden's Earthways Center and the EPA. Available at: www.intheair.org

Ozone Action

The West Michigan Clean Air Coalition offers educational packets with lesson plans and activities for Grades K-12. Available at: www.wmcac.org/resources/education.html

The KnowZone

Developed by the California Air Resources Board, The KnowZone offers a variety of teacher and student resources, including lesson plans, a video, a presentation, and Safe Routes to Schools information. Available at: <http://www.arb.ca.gov/knowzone/knowzone.htm>

SunWise School Program

An environmental and health education program designed to teach children and their caregivers how to protect themselves from overexposure to the sun. Available free of charge to schools, the SunWise Tool Kit contains classroom lessons and background information for Grades K-8. Available at: www.epa.gov/sunwise

Walking for Health and the Environment Curriculum

This curriculum for Grades K-5 helps students make connections between exercise, health, and the environment. Developed by Walk Boston and Eastern Research Group, Inc. (ERG). Available at: <http://www.walkboston.org/what-we-do/initiatives/safe-routes-school>

Selected Web Sites

AIRNow Web site

The AIRNow Web site provides the public with easy access to air quality information. The Web site provides real-time air quality conditions and daily air quality forecasts for over 300 cities across the U.S., teacher and student resources, links to more detailed state and local air quality Web sites, and real-time images of air quality and visibility via webcams. Available at: www.airnow.gov.

AIRNow's air quality resources for teachers can be found at: www.airnow.gov/teachers

AIRNow's Air Quality Index Kids Page can be found at: www.airnow.gov/kids

Smog City 2

The Smog City 2 Web site explores particle pollution and ozone pollution in a hypothetical city. Users can change variables such as weather conditions, emission levels, and population, and see how these changes affect air quality. Developed by the U.S. EPA and the Sacramento Air Quality Management District. Available at: www.smogcity2.org

Selected EPA Air Quality Publications

The following U.S. EPA publications are available online (print versions may be available free of charge) at: <http://www.airnow.gov/index.cfm?action=pubs.index>

- **Air Quality Index—A Guide to Air Quality and Your Health.** This booklet explains EPA's Air Quality Index (AQI) and the health effects of major air pollutants.
- **Air Quality Guide for Ozone.** This guide provides information about ways to protect your health when ozone levels reach the unhealthy range, and ways you can help reduce ozone air pollution.
- **Air Quality Guide for Particle Pollution.** This guide provides information about ways to protect your health when particle pollution levels reach the unhealthy range, and ways you can help reduce particle air pollution.
- **Particle Pollution and Your Health.** This short, colorful pamphlet describes who is at risk from exposure to particle pollution (also known as particulate matter), what health effects may be caused by particles, and simple measures that can be taken to reduce health risk.
- **Ozone and Your Health.** This short, colorful pamphlet describes who is at risk from exposure to ozone, what health effects are caused by ozone, and simple measures that can be taken to reduce health risk.
- **Ozone: Good Up High, Bad Nearby.** This publication provides information about ground-level and high-altitude ozone and their different effects.
- **Smog Who Does it Hurt?** This 8-page booklet provides more detailed information than "Ozone and Your Health" about ozone health effects and how to avoid them.
- **Summertime Safety: Keeping Safe from Sun Smog.** This document discusses summer health hazards that pertain particularly to children and includes information about EPA's Air Quality Index and UV Index tools.
- **"Why is Coco Orange?"** This picture book introduces the AQI colors to children in grades K-2, teaches them what the different colors mean, how to recognize health symptoms and what actions to take when air quality is bad (www.airnow.gov/picturebook).
- **School Flag Program.** A school based program that protects children's health. Schools fly a flag based on the color of the AQI to indicate the local air quality conditions. Information and resources are available on the flag program website at: www.airnow.gov/schoolflag
- **Effects of Common Air Pollutants Poster.** This 18"x 24" poster depicts and illustrates respiratory and cardiovascular effects of air pollution and symptoms. http://www.airnow.gov/index.cfm?action=health_providers.index