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AQI

AIR QUALITY INDEX

A Guide to Air Quality and
Your Health



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*“It’s a code red day
for ozone.”*

*“Particle pollution levels are
forecast to be unhealthy
for sensitive groups.”*

*“Local air quality is very
unhealthy today.”*

You may hear these alerts on radio
or TV or read them in the newspaper.
But what do they mean if you:

- ▶ Are active outdoors?
- ▶ Have children who play outdoors?
- ▶ Are an older adult?
- ▶ Have heart or lung disease?

This booklet will help you understand
how to find out about air quality in
your area and protect your health.

Why is air quality important?

Local air quality affects how you live and breathe. Like the weather, it can change from day to day or even hour to hour. The U.S. Environmental Protection Agency (EPA) and your local air quality agency have been working to make information about outdoor air quality as easy to find and understand as weather forecasts. A key tool in this effort is the Air Quality Index, or AQI. EPA and local officials use the AQI to provide simple information about your local air quality, how unhealthy air may affect you, and how you can protect your health.



Air quality directly affects our quality of life.

What is the AQI?

The AQI is an index for reporting daily air quality. It tells you how clean or unhealthy your air is, and what associated health effects might be a concern. The AQI focuses on health effects you may experience within a few hours or days after breathing unhealthy air. The AQI is calculated for four major air pollutants regulated by the Clean Air Act: ground-level ozone, particle pollution, carbon monoxide, and sulfur dioxide. For each of these pollutants, EPA has established national air quality standards to protect public health.

EPA is currently reviewing the national air quality standard for nitrogen dioxide. If the standard is revised, the AQI will be revised as well.

How does the AQI work?

Think of the AQI as 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 or no potential to affect public health, while an AQI value over 300 represents air quality so hazardous that everyone may experience serious effects.

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. AQI values at or below 100 are generally thought of as satisfactory. 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 increase.

What do the AQI values mean?

The purpose of the AQI is to help you understand what local air quality means to your health. To make it easier to understand, the AQI is divided into six levels of health concern:

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
<i>When the AQI is in this range:</i>	<i>...air quality conditions are:</i>	<i>...as symbolized by this color:</i>
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 your community is between 0 and 50. Air quality is satisfactory and poses little or no health risk.
- **Moderate.** The AQI is between 51 and 100. Air quality is acceptable; however, pollution in this range may pose a moderate health concern for a very small number of individuals. People who are unusually sensitive to ozone or particle pollution may experience respiratory symptoms.
- **Unhealthy for Sensitive Groups.** When AQI values are between 101 and 150, members of sensitive groups may experience health effects, but the general public is unlikely to be affected.
 - *Ozone:* People with lung disease, children, older adults, and people who are active outdoors are considered sensitive and therefore at greater risk.
 - *Particle pollution:* People with heart or lung disease, older adults,¹ and children are considered sensitive and therefore at greater risk.
- **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 even more likely to be affected by serious health effects.

How is a community's AQI calculated and reported?

Each day, monitors record concentrations of the major pollutants at more than a thousand locations across the country.

¹ Due to the normal aging process, older adults may experience increased health risks from exposure to unhealthy air. Studies indicate that some people become more sensitive in their mid-60s. However, the risk of heart attacks, and thus the risk from particle pollution, may begin as early as the mid-40s for men and mid-50s for women.



Children active outdoors can be sensitive to air pollutants.

These raw measurements are converted into a separate AQI value for each pollutant (ground-level ozone, particle pollution, carbon monoxide, and sulfur dioxide) using standard formulas developed by EPA. The highest of these AQI values is reported as the AQI value for that day.²

In large cities (more than 350,000 people), state and local agencies are required to report the AQI to the public daily. Many smaller communities also report the AQI as a public health service.

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 that pollutant. If two or more pollutants have AQI values above 100 on a given day, agencies must report all the groups that are sensitive to those pollutants. For example, if a community's AQI is 130 for ozone and 101 for particle pollution, the AQI value for that day would be announced as 130 for ozone. The announcements would note that particle pollution levels were also high and would alert groups sensitive to ozone or particle pollution about how to protect their health.

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 strenuous outdoor activities for a time when air quality is better.

² For more information on how the AQI is calculated, see "Technical Assistance Document for the Reporting of Daily Air Quality—the Air Quality Index (AQI)" in the "Publications" section of www.airnow.gov.

The AQI is a national index, so the values and colors used to show local air quality and the levels of health concern are the same everywhere in the United States.

Where can I find the AQI?

Checking local air quality is as easy as checking the weather. You can find the latest AQI values on the Internet, in your local media, and on many state and local telephone hotlines. You can also sign up to receive AQI forecasts by e-mail:

- **AQI on the Internet.** EPA and its federal, tribal, state, and local partners have developed an AIRNow Web site to provide the public with easy access to national air quality information. At www.airnow.gov, you will find daily AQI forecasts and real-time AQI conditions for over 300 cities across the United States, with links to more detailed state and local air quality Web sites. AIRNow's reports are displayed as maps you can use to quickly determine if the air quality is unhealthy near you.



Example of a national AQI map available on the AIRNow Web site.

- **AQI via e-mail.** Sign up for EnviroFlash (www.enviroflash.info), a free service that will alert you via e-mail when air quality is forecast to be a concern in your area.

- **AQI in the media.** Many local media—television, radio, and newspapers—and some national media (such as *USA Today*, The Weather Channel, and CNN) provide daily air quality reports, often as part of the weather forecast. Here's the type of report you might hear:

Tomorrow will be a code red air quality day for Center City. The cold winter air, morning traffic, and wood smoke are expected to cause particle pollution to rise to unhealthy levels. People with heart or lung disease, older adults, and children should avoid prolonged or heavy physical activities.

What are typical AQI values in most communities?

In many U.S. communities, AQI values are usually below 100, with higher values occurring just a few times a year. Larger cities typically have more air pollution than smaller cities, so their AQI values may exceed 100 more often. AQI values higher than 200 are infrequent, and AQI values above 300 are extremely rare—they generally occur only during events such as forest fires. You can compare the air quality of U.S. cities and find out about quality trends in your area by visiting “Air Compare” at www.epa.gov/aircompare/.

AQI values can vary from one season to another. In winter, carbon monoxide may be high in some areas because cold weather makes it difficult for car emission control systems to operate effectively. Ozone is often higher in warmer months, because heat and sunlight increase ozone formation. Particle pollution can be elevated any time of the year.

AQI values also can vary depending on the time of day. Ozone levels often peak in the afternoon to early evening. Carbon monoxide may be a problem during morning or evening rush hours. And particle pollution can be high any time of day, and is often elevated near busy roadways, especially during morning or evening rush hours.

How can I avoid being exposed to unhealthy air?

You can take simple steps to reduce your exposure to unhealthy air. First, you need to find out whether AQI levels are a concern in your area. You can do this, as described previously, by visiting the AIRNow Web site, signing up for EnviroFlash, or checking your local media. If the AQI for ozone, particle pollution, carbon monoxide, or sulfur dioxide is a concern in your area, you can learn what steps to take to protect your health by checking the charts on the following pages. Two important terms you will need to understand are:

- **Prolonged exertion.** This means any outdoor activity that you'll be doing intermittently for several hours *and* that makes you breathe slightly harder than normal. A good example of this is working in the yard for part of a day. When air quality is unhealthy, you can protect your health by reducing how much time you spend on this type of activity.
- **Heavy exertion.** This means intense outdoor activities that cause you to breathe hard. When air quality is unhealthy, you can protect your health by reducing how much time you spend on this type of activity, or by substituting a less intense activity—for example, go for a walk instead of a jog. Be sure to reduce your activity level if you experience any unusual coughing, chest discomfort, wheezing, breathing difficulty, or unusual fatigue.



Heavy exertion means an intense activity that causes you to breathe hard.

OZONE

What is ozone?

Ozone is a gas found in the air we breathe. Ozone can be good or bad, depending where it occurs:

- **Good ozone** is present naturally in the Earth's upper atmosphere—approximately 6 to 30 miles above the Earth's surface. This natural ozone shields us from the sun's harmful ultraviolet rays.
- **Bad ozone** forms near the ground when pollutants (emitted by sources such as cars, power plants, industrial boilers, refineries, and chemical plants) react chemically in sunlight. Ozone pollution is more likely to form during warmer months. This is when the weather conditions normally needed to form ground-level ozone—lots of sun—occur.

Who is most at risk?

Several groups of people are particularly sensitive to ozone, especially when they are active outdoors. This is because ozone levels are higher outdoors, and physical activity causes faster and deeper breathing, drawing more ozone into the body.

- **People with lung diseases, such as asthma, chronic bronchitis, and emphysema,** can be particularly sensitive to ozone. They will generally experience more serious health effects at lower levels. Ozone can aggravate their diseases, leading to increased medication use, doctor and emergency room visits, and hospital admissions.
- **Children,** including teenagers, are at higher risk from ozone exposure because they often play outdoors in warmer weather when ozone levels are higher, they are more likely to have asthma (which may be aggravated by ozone exposure), and their lungs are still developing.
- **Older adults** may be more affected by ozone exposure, possibly because they are more likely to have pre-existing lung disease.

- **Active people** of all ages who exercise or work vigorously outdoors are at increased risk.
- **Some healthy people** are more sensitive to ozone. They may experience health effects at lower ozone levels than the average person even though they have none of the risk factors listed above. There may be a genetic basis for this increased sensitivity.

In general, as concentrations of ground-level ozone increase, more people begin to experience more serious health effects. When levels are very high, *everyone* should be concerned about ozone exposure.

What are the health effects?

Ozone affects the lungs and respiratory system in many ways. It can:

- **Irritate the respiratory system**, causing coughing, throat soreness, airway irritation, chest tightness, or chest pain when taking a deep breath.
- **Reduce lung function**, making it more difficult to breathe as deeply and vigorously as you normally would, especially when exercising. Breathing may start to feel uncomfortable, and you may notice that you are taking more rapid and shallow breaths than normal.



The risk of exposure to unhealthy levels of ground-level ozone is greatest during warmer months. Children, who often play outdoors in warmer weather, are at higher risk.

- **Inflame and damage the cells that line the lungs.** Within a few days, the damaged cells are replaced and the old cells are shed—much like the way your skin peels after sunburn. Studies suggest that if this type of inflammation happens repeatedly, lung tissue may become permanently scarred and lung function may be permanently reduced.
- **Make the lungs more susceptible to infection.** Ozone reduces the lung's defenses by damaging the cells that move particles and bacteria out of the airways and by reducing the number and effectiveness of white blood cells in the lungs.
- **Aggravate asthma.** When ozone levels are unhealthy, more people with asthma have symptoms that require a doctor's attention or the use of medication. Ozone makes people more sensitive to allergens—the most common triggers for asthma attacks. Also, asthmatics may be more severely affected by reduced lung function and airway inflammation. People with asthma should ask their doctor for an asthma action plan and follow it carefully when ozone levels are unhealthy.
- **Aggravate other chronic lung diseases** such as emphysema and bronchitis. As concentrations of ground-level ozone increase, more people with lung disease visit doctors or emergency rooms and are admitted to the hospital.
- **Cause permanent lung damage.** Repeated short-term ozone damage to children's developing lungs may lead to reduced lung function in adulthood. In adults, ozone exposure may accelerate the natural decline in lung function that occurs with age.

How can I protect my health at different AQI values?

AQI Value	Actions to Protect Your Health From Ozone
Good (0–50)	None
Moderate (51–100*)	Unusually sensitive people should consider reducing prolonged or heavy outdoor exertion.
Unhealthy for Sensitive Groups (101–150)	The following groups should <u>reduce</u> prolonged or heavy outdoor exertion: <ul style="list-style-type: none"> • People with lung disease, such as asthma • Children and older adults • People who are active outdoors
Unhealthy (151–200)	The following groups should <u>avoid</u> prolonged or heavy outdoor exertion: <ul style="list-style-type: none"> • People with lung disease, such as asthma • Children and older adults • People who are active outdoors Everyone else should limit prolonged outdoor exertion.
Very Unhealthy (201–300)	The following groups should <u>avoid all</u> outdoor exertion: <ul style="list-style-type: none"> • People with lung disease, such as asthma • Children and older adults • People who are active outdoors Everyone else should limit outdoor exertion.

* An AQI of 100 for ozone corresponds to an ozone level of 0.075 parts per million (averaged over 8 hours).

PARTICLE POLLUTION

What is particle pollution?

Particle pollution (also known as “particulate matter”) consists of a mixture of solids and liquid droplets. Some particles are emitted directly; others form when pollutants emitted by various sources react in the atmosphere. Particle pollution levels can be very unhealthy and even hazardous during events such as forest fires. Particle levels can be elevated indoors, especially when outdoor particle levels are high.

Particles come in a wide range of sizes. Those less than 10 micrometers in diameter (smaller than the width of a single human hair) are so small that they can get into the lungs, where they can cause serious health problems.

- **Fine particles.** The smallest particles (those 2.5 micrometers or less in diameter) are called “fine” particles. These particles are so small they can be detected only with an electron microscope. Major sources of fine particles include motor vehicles, power plants, residential wood burning, forest fires, agricultural burning, some industrial processes, and other combustion processes.
- **Coarse particles.** Particles between 2.5 and 10 micrometers in diameter are referred to as “coarse.” Sources of coarse particles include crushing or grinding operations, and dust stirred up by vehicles traveling on roads.

What are the health effects and who is most at risk?

Particles smaller than 10 micrometers in diameter can cause or aggravate a number of health problems and have been linked with illnesses and deaths from heart or lung disease. These effects have been associated with both short-term exposures (usually over 24 hours, but possibly as short as one hour) and long-term exposures (years).

Sensitive groups for particle pollution include people with heart or lung disease (including heart failure and coronary artery disease, or asthma and chronic obstructive pulmonary

disease), older adults (who may have undiagnosed heart or lung disease), and children. The risk of heart attacks, and thus the risk from particle pollution, may begin as early as the mid-40s for men and mid-50s for women.

- When exposed to particle pollution, people with heart or lung diseases and older adults are more likely to visit emergency rooms, be admitted to hospitals, or in some cases, even die.
- Exposure to particle pollution may cause people with heart disease to experience chest pain, palpitations, shortness of breath, and fatigue. Particle pollution has also been associated with cardiac arrhythmias and heart attacks.
- When exposed to high levels of particle pollution, people with existing lung disease may not be able to breathe as deeply or vigorously as they normally would. They may experience symptoms such as coughing and shortness of breath. Healthy people also may experience these effects, although they are unlikely to experience more serious effects.
- Particle pollution also can increase susceptibility to respiratory infections and can aggravate existing respiratory



Smoke from old, uncertified wood stoves is a major source of particle pollution in some communities. For information on cleaner-burning wood stoves that are more energy efficient, go to www.epa.gov/woodstoves.

diseases, such as asthma and chronic bronchitis, causing more use of medication and more doctor visits.

How can I protect my health at different AQI values?

AQI Value	Actions To Protect Your Health From Particle Pollution
Good (0–50)	None
Moderate (51–100*)	Unusually sensitive people should consider reducing prolonged or heavy exertion.
Unhealthy for Sensitive Groups (101–150)	The following groups should <u>reduce</u> prolonged or heavy exertion: <ul style="list-style-type: none"> • People with heart or lung disease • Children and older adults
Unhealthy (151–200)	The following groups should <u>avoid</u> prolonged or heavy exertion: <ul style="list-style-type: none"> • People with heart or lung disease • Children and older adults Everyone else should reduce prolonged or heavy exertion.
Very Unhealthy (201–300)	The following groups should <u>avoid all</u> physical activity outdoors: <ul style="list-style-type: none"> • People with heart or lung disease • Children and older adults Everyone else should avoid prolonged or heavy exertion.

* For particles up to 2.5 micrometers in diameter: An AQI of 100 corresponds to 35 micrograms per cubic meter (averaged over 24 hours).

For particles up to 10 micrometers in diameter: An AQI of 100 corresponds to 150 micrograms per cubic meter (averaged over 24 hours).

CARBON MONOXIDE

What is carbon monoxide?

Carbon monoxide is an odorless, colorless gas. It forms when the carbon in fuels does not completely burn. Vehicle exhaust contributes roughly 75 percent of all carbon monoxide emissions nationwide, and up to 95 percent in cities. Other sources include fuel combustion in industrial processes and natural sources such as wildfires. Carbon monoxide levels typically are highest during cold weather, because cold temperatures make combustion less complete and cause inversions that trap pollutants close to the ground.

What are the health effects and who is most at risk?

Carbon monoxide enters the bloodstream through the lungs and binds to hemoglobin, the substance in blood that carries oxygen to cells. It reduces the amount of oxygen reaching the body's organs and tissues.



About half of all carbon monoxide emissions nationwide come from the exhaust of roadway vehicles. Exhaust from all types of vehicles (including marine vessels, aircraft, locomotives, and mobile equipment) contributes around three-quarters of all carbon monoxide emissions in the United States.

- People with cardiovascular disease, such as coronary artery disease, are most at risk. They may experience chest pain and other cardiovascular symptoms if they are exposed to carbon monoxide, particularly while exercising.
- People with marginal or compromised cardiovascular and respiratory systems (for example, individuals with congestive heart failure, cerebrovascular disease, anemia, or chronic obstructive lung disease), and possibly young infants and fetuses, also may be at greater risk from carbon monoxide pollution.
- In healthy individuals, exposure to higher levels of carbon monoxide can affect mental alertness and vision.

How can I protect my health at different AQI values?

AQI Value	Actions To Protect Your Health From Carbon Monoxide
Good (0–50)	None
Moderate (51–100*)	None
Unhealthy for Sensitive Groups (101–150)	People with heart disease, such as angina, should reduce heavy exertion and avoid sources of carbon monoxide, such as heavy traffic.
Unhealthy (151–200)	People with heart disease, such as angina, should reduce moderate exertion and avoid sources of carbon monoxide, such as heavy traffic.
Very Unhealthy (201–300)	People with heart disease, such as angina, should avoid exertion and sources of carbon monoxide, such as heavy traffic.

* An AQI of 100 for carbon monoxide corresponds to a level of 9 parts per million (averaged over 8 hours).

SULFUR DIOXIDE

What is sulfur dioxide?

Sulfur dioxide, a colorless, reactive gas, is produced when sulfur-containing fuels such as coal and oil are burned. Generally, the highest levels of sulfur dioxide are found near large industrial complexes. Major sources include power plants, refineries, and industrial boilers.

What are the health effects and who is most at risk?

Sulfur dioxide is an irritant gas that is removed by the nasal passages. Moderate activity levels that trigger mouth breathing, such as a brisk walk, are needed for sulfur dioxide to cause health effects in most people.

- People with asthma who are physically active outdoors are most likely to experience the health effects of sulfur dioxide. The main effect, even with very brief exposure (minutes), is a narrowing of the airways (called bronchoconstriction). This may be accompanied by wheezing, chest tightness, and shortness of breath, which may require use of medication that opens the airways. Symptoms increase as sulfur dioxide levels or breathing



Children and adults with asthma who are active outdoors are most vulnerable to the health effects of sulfur dioxide.

rate increases. When exposure to sulfur dioxide ceases, lung function typically returns to normal within an hour, even without medication.

- At very high levels, sulfur dioxide may cause wheezing, chest tightness, and shortness of breath even in healthy people who do not have asthma.
- Long-term exposure to sulfur dioxide may cause respiratory symptoms and illness, and aggravate asthma. People with asthma are the most susceptible to sulfur dioxide. However, people with other chronic lung diseases or cardiovascular disease, as well as children and older adults, may also be susceptible to these effects.

How can I protect my health at different AQI values?

AQI Value	Actions To Protect Your Health From Sulfur Dioxide
Good (0–50)	None
Moderate (51–100*)	None
Unhealthy for Sensitive Groups (101–150)	People with asthma should consider reducing exertion outdoors.
Unhealthy (151–200)	Children, asthmatics, and people with heart or lung disease should reduce exertion outdoors.
Very Unhealthy (201–300)	Children, asthmatics, and people with heart or lung disease should avoid outdoor exertion. Everyone else should reduce exertion outdoors.

* An AQI of 100 for sulfur dioxide corresponds to a level of 75 parts per billion (averaged over one hour).

Where can I get more information?

For information and resources about air quality, visit the AIRNow Web site at www.airnow.gov. There you can:

- **Access maps and information** on air quality in your area. Find out how to protect your health and how to reduce air pollution.
- **Sign up for EnviroFlash** (www.enviroflash.info), a free service that will alert you via e-mail when air quality in your area is forecast to be a concern.
- **Download the App** to see the air quality for your area on your smartphone or tablet.
- **Access brochures, movies, games,** and other air quality educational resources for adults and kids.
- **Visit Air Compare** (www.epa.gov/aircompare/), where you can compare the air quality of U.S. cities and find out about air quality trends in your area.
- **Access Web cameras** that provide real-time pictures of visibility at many locations across the United States.
- **Access training and tools.** If you are a health care provider, teacher, or weathercaster, you can use these resources to help adults and children understand how air pollution affects their health and how they can protect their health.