**Air pollution:**

**Air pollution** is the introduction of [particulates](https://en.wikipedia.org/wiki/Particulates), [biological molecules](https://en.wikipedia.org/wiki/Biomolecule), or other harmful materials into [Earth's atmosphere](https://en.wikipedia.org/wiki/Earth%27s_atmosphere), causing diseases, death to humans, damage to other living organisms such as animals and food crops, or the [natural](https://en.wikipedia.org/wiki/Natural_environment) or [built environment](https://en.wikipedia.org/wiki/Built_environment). Air pollution may come from [anthropogenic](https://en.wikipedia.org/wiki/Anthropogenic) or natural sources.

The atmosphere is a complex natural gaseous system that is essential to support life on planet [Earth](https://en.wikipedia.org/wiki/Earth). [Stratospheric](https://en.wikipedia.org/wiki/Stratosphere) [ozone depletion](https://en.wikipedia.org/wiki/Ozone_depletion) due to air pollution has been recognized as a threat to human health as well as to the Earth's [ecosystems](https://en.wikipedia.org/wiki/Ecosystems).

Indoor air pollution and urban air quality are listed as two of the worlds worst toxic pollution problems in the 2008 [Blacksmith Institute](https://en.wikipedia.org/wiki/Blacksmith_Institute) World's Worst Polluted Places report. According to the 2014 [WHO](https://en.wikipedia.org/wiki/WHO) report, air pollution in 2012 caused the deaths of around 7

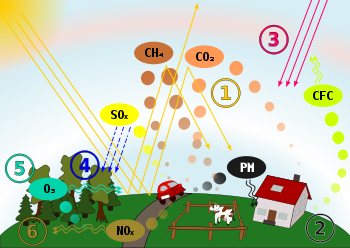
[](https://en.wikipedia.org/wiki/File:AlfedPalmersmokestacks.jpg)

Air pollution from a [fossil-fuel power station](https://en.wikipedia.org/wiki/Fossil-fuel_power_station)

## Pollutants

An air pollutant is a substance in the air that can have adverse effects on humans and the ecosystem. The substance can be solid particles, liquid droplets, or gases. A pollutant can be of natural origin or man-made. Pollutants are classified as primary or secondary. Primary pollutants are usually produced from a process, such as ash from a volcanic eruption. Other examples include [carbon monoxide](https://en.wikipedia.org/wiki/Carbon_monoxide) gas from motor vehicle exhaust, or the [sulfur dioxide](https://en.wikipedia.org/wiki/Sulfur_dioxide) released from factories. Secondary pollutants are not emitted directly. Rather, they form in the air when primary pollutants react or interact. [Ground level ozone](https://en.wikipedia.org/wiki/Ground_level_ozone) is a prominent example of a secondary pollutant. Some pollutants may be both primary and secondary: they are both emitted directly and formed from other primary pollutants.

Before [flue-gas desulfurization](https://en.wikipedia.org/wiki/Flue-gas_desulfurization) was installed, the emissions from this power plant in [New Mexico](https://en.wikipedia.org/wiki/New_Mexico) contained excessive amounts of [sulfur dioxide](https://en.wikipedia.org/wiki/Sulfur_dioxide).

[](https://en.wikipedia.org/wiki/File:Air_Pollution-Causes%26Effects.svg)

Schematic drawing, causes and effects of air pollution: (1) greenhouse effect, (2) particulate contamination, (3) increased UV radiation, (4) acid rain, (5) increased ground level ozone concentration, (6) increased levels of nitrogen oxides.

Major primary pollutants produced by human activity include:

* [Sulfur oxides](https://en.wikipedia.org/wiki/Sulfur_oxide) (SOx) - particularly sulfur dioxide, a chemical compound with the formula SO2. SO2 is produced by volcanoes and in various industrial processes. Coal and petroleum often contain sulfur compounds, and their combustion generates sulfur dioxide. Further oxidation of SO2, usually in the presence of a catalyst such as NO2, forms H2SO4, and thus rain. This is one of the causes for concern over the environmental impact of the use of these fuels as power sources.
* [Nitrogen oxides](https://en.wikipedia.org/wiki/Nitrogen_oxide) (NOx) - Nitrogen oxides, particularly [nitrogen dioxide](https://en.wikipedia.org/wiki/Nitrogen_dioxide), are expelled from high temperature combustion, and are also produced during [thunderstorms](https://en.wikipedia.org/wiki/Thunderstorms) by [electric discharge](https://en.wikipedia.org/wiki/Electric_discharge). They can be seen as a brown [haze](https://en.wikipedia.org/wiki/Haze) dome above or a [plume](https://en.wikipedia.org/wiki/Plume_%28hydrodynamics%29) downwind of cities. Nitrogen dioxide is a chemical compound with the formula NO2. It is one of several nitrogen oxides. One of the most prominent air pollutants, this reddish-brown toxic gas has a characteristic sharp, biting odor.
* [Carbon monoxide](https://en.wikipedia.org/wiki/Carbon_monoxide) (CO) - CO is a colorless, odorless, toxic yet non-irritating gas. It is a product by [incomplete combustion](https://en.wikipedia.org/wiki/Incomplete_combustion) of fuel such as natural gas, coal or wood. Vehicular exhaust is a major source of carbon monoxide.
* [Volatile organic compounds](https://en.wikipedia.org/wiki/Volatile_organic_compounds) (VOC) - VOCs are a well-known outdoor air pollutant. They are categorized as either methane (CH4) or non-methane (NMVOCs). Methane is an extremely efficient greenhouse gas which contributes to enhance [global warming](https://en.wikipedia.org/wiki/Global_warming). Other hydrocarbon VOCs are also significant greenhouse gases because of their role in creating ozone and prolonging the life of methane in the atmosphere. This effect varies depending on local air quality. The aromatic NMVOCs benzene, toluene and xylene are suspected carcinogens and may lead to leukemia with prolonged exposure. 1, 3-butadiene is another dangerous compound often associated with industrial use.
* [Particulates](https://en.wikipedia.org/wiki/Particulates), alternatively referred to as particulate matter (PM), atmospheric particulate matter, or fine particles, are tiny particles of solid or liquid suspended in a gas. In contrast, aerosol refers to combined particles and gas. Some particulates occur naturally, originating from volcanoes, dust storms, forest and grassland fires, living vegetation, and sea spray. Human activities, such as the burning of fossil fuels in vehicles, power plants and various industrial processes also generate significant amounts of aerosols. Averaged worldwide, anthropogenic aerosols—those made by human activities—currently account for approximately 10 percent of our atmosphere. Increased levels of fine particles in the air are linked to health hazards such as heart disease, altered lung function and lung cancer.
* [Persistent free radicals](https://en.wikipedia.org/wiki/Radical_%28chemistry%29#Persistent_radicals) connected to airborne fine particles are linked to cardiopulmonary disease.
* Toxic [metals](https://en.wikipedia.org/wiki/Metal), such as [lead](https://en.wikipedia.org/wiki/Lead) and [mercury](https://en.wikipedia.org/wiki/Mercury_%28element%29), especially their compounds.
* [Chlorofluorocarbons](https://en.wikipedia.org/wiki/Chlorofluorocarbons) (CFCs) - harmful to the [ozone layer](https://en.wikipedia.org/wiki/Ozone_layer); emitted from products are currently banned from use. These are gases which are released from air conditioners, refrigerators, aerosol sprays, etc. CFC's on being released into the air rises to [stratosphere](https://en.wikipedia.org/wiki/Stratosphere). Here they come in contact with other gases and damage the [ozone layer](https://en.wikipedia.org/wiki/Ozone_layer). This allows harmful ultraviolet rays to reach the earth's surface. This can lead to skin cancer, disease to eye and can even cause damage to plants.
* [Ammonia](https://en.wikipedia.org/wiki/Ammonia) (NH3) - emitted from agricultural processes. Ammonia is a compound with the formula NH3. It is normally encountered as a gas with a characteristic pungent odor. Ammonia contributes significantly to the nutritional needs of terrestrial organisms by serving as a precursor to foodstuffs and fertilizers. Ammonia, either directly or indirectly, is also a building block for the synthesis of many pharmaceuticals. Although in wide use, ammonia is both caustic and hazardous. In the atmosphere, ammonia reacts with oxides of nitrogen and sulfur to form secondary particles.
* [Odours](https://en.wikipedia.org/wiki/Odor) — such as from garbage, sewage, and industrial processes
* [Radioactive pollutants](https://en.wikipedia.org/wiki/Radioactive_pollutants) - produced by [nuclear explosions](https://en.wikipedia.org/wiki/Nuclear_explosions), nuclear events, war [explosives](https://en.wikipedia.org/wiki/Explosives), and natural processes such as the [radioactive decay](https://en.wikipedia.org/wiki/Radioactive_decay) of [radon](https://en.wikipedia.org/wiki/Radon).

Secondary pollutants include:

* Particulates created from gaseous primary pollutants and compounds in photochemical smog. [Smog](https://en.wikipedia.org/wiki/Smog) is a kind of air pollution. Classic smog results from large amounts of coal burning in an area caused by a mixture of smoke and sulfur dioxide. Modern smog does not usually come from coal but from vehicular and industrial emissions that are acted on in the atmosphere by [ultraviolet](https://en.wikipedia.org/wiki/Ultraviolet) light from the sun to form secondary pollutants that also combine with the primary emissions to form photochemical smog.
* [Ground level ozone](https://en.wikipedia.org/wiki/Ground_level_ozone) (O3) formed from NOx and VOCs. Ozone (O3) is a key constituent of the troposphere. It is also an important constituent of certain regions of the stratosphere commonly known as the Ozone layer. Photochemical and chemical reactions involving it drive many of the chemical processes that occur in the atmosphere by day and by night. At abnormally high concentrations brought about by human activities (largely the combustion of fossil fuel), it is a pollutant, and a constituent of smog.
* [Peroxyacetyl nitrate](https://en.wikipedia.org/wiki/Peroxyacetyl_nitrate) (PAN) - similarly formed from NOx and VOCs.

Minor air pollutants include:

* A large number of minor [hazardous air pollutants](https://en.wikipedia.org/wiki/Category:Hazardous_air_pollutants). Some of these are regulated in USA under the [Clean Air Act](https://en.wikipedia.org/wiki/Clean_Air_Act_%28United_States%29) and in Europe under the Air Framework Directive
* A variety of [persistent organic pollutants](https://en.wikipedia.org/wiki/Persistent_organic_pollutant), which can attach to particulates

Persistent organic pollutants (POPs) are organic compounds that are resistant to environmental degradation through chemical, biological, and photolytic processes. Because of this, they have been observed to persist in the environment, to be capable of long-range transport, bio accumulate in human and animal tissue, bio magnify in food chains, and to have potentially significant impacts on human health and the environment.

# Hazardous Air Pollutants

Hazardous air pollutants are those known to cause cancer and other serious health impacts.  The Clean Air Act requires the EPA to regulate toxic air pollutants, also known as air toxics, from categories of industrial facilities in two phases. The first phase is “technology‑based,” where the EPA develops standards for controlling the emissions of air toxics from sources in an industry group (or “source category”). These technology standards are based on emissions levels that are already being achieved by the best‑controlled and lower‑emitting sources in an industry.  Within eight years of setting the technology standards, the Clean Air Act directs the EPA to assess the remaining health risks from each source category to determine whether the standards protect public health with an ample margin of safety, and protect against adverse environmental effects.

### Sources

[](https://en.wikipedia.org/wiki/File:Dust_Storm_Texas_1935.jpg)

Dust storm approaching [Stratford, Texas](https://en.wikipedia.org/wiki/Stratford,_Texas).

[](https://en.wikipedia.org/wiki/File:BurningOffFieldsInTheEveningInSouthGeorgia.jpg)

[Controlled burning](https://en.wikipedia.org/wiki/Controlled_burning) of a field outside of [Statesboro](https://en.wikipedia.org/wiki/Statesboro,_Georgia), [Georgia](https://en.wikipedia.org/wiki/Georgia_%28U.S._state%29) in preparation for spring planting.

There are various locations, activities or factors which are responsible for releasing pollutants into the atmosphere. These sources can be classified into two major categories.

**Anthropogenic (man-made) sources:**

These are mostly related to the burning of multiple types of fuel.

* **Stationary sources** include smoke stacks of [power plants](https://en.wikipedia.org/wiki/Power_plant), manufacturing facilities (factories) and waste incinerators, as well as furnaces and other types of fuel-burning heating devices. In developing and poor countries, traditional biomass burning is the major source of air pollutants; traditional biomass includes wood, crop waste and dung.[[10]](https://en.wikipedia.org/wiki/Air_pollution#cite_note-10)[[11]](https://en.wikipedia.org/wiki/Air_pollution#cite_note-11)
* **Mobile sources** include [motor vehicles](https://en.wikipedia.org/wiki/Roadway_air_dispersion_modeling), marine vessels, and aircraft.
* [**Controlled burn**](https://en.wikipedia.org/wiki/Controlled_burn) practices in agriculture and forest management. Controlled or prescribed burning is a technique sometimes used in forest management, farming, prairie restoration or greenhouse gas abatement. Fire is a natural part of both forest and grassland ecology and controlled fire can be a tool for foresters. Controlled burning stimulates the germination of some desirable forest trees, thus renewing the forest.
* **Fumes** from [paint](https://en.wikipedia.org/wiki/Paint), [hair spray](https://en.wikipedia.org/wiki/Hair_spray), [varnish](https://en.wikipedia.org/wiki/Varnish), [aerosol sprays](https://en.wikipedia.org/wiki/Aerosol_spray) and other solvents
* **Waste deposition** in [landfills](https://en.wikipedia.org/wiki/Landfill), which generate [methane](https://en.wikipedia.org/wiki/Methane). Methane is highly flammable and may form explosive mixtures with air. Methane is also an [asphyxiant](https://en.wikipedia.org/wiki/Asphyxiant) and may displace oxygen in an enclosed space. Asphyxia or suffocation may result if the oxygen concentration is reduced to below 19.5% by displacement.
* **Military resources**, such as [nuclear weapons](https://en.wikipedia.org/wiki/Nuclear_weapon), [toxic gases](https://en.wikipedia.org/wiki/Toxic_gas), [germ warfare](https://en.wikipedia.org/wiki/Germ_warfare) and [rocketry](https://en.wikipedia.org/wiki/Rocket)

**Natural sources:**

* [Dust](https://en.wikipedia.org/wiki/Dust) from natural sources, usually large areas of land with little or no vegetation
* [Methane](https://en.wikipedia.org/wiki/Methane), [emitted](https://en.wikipedia.org/wiki/Flatulence) by the [digestion](https://en.wikipedia.org/wiki/Digestion) of food by [animals](https://en.wikipedia.org/wiki/Animal), for example [cattle](https://en.wikipedia.org/wiki/Cattle)
* [Radon](https://en.wikipedia.org/wiki/Radon) gas from [radioactive decay](https://en.wikipedia.org/wiki/Radioactive_decay) within the [Earth's crust](https://en.wikipedia.org/wiki/Earth%27s_crust). Radon is a colorless, odorless, naturally occurring, radioactive [noble gas](https://en.wikipedia.org/wiki/Noble_gas) that is formed from the decay of radium. It is considered to be a health hazard. Radon gas from natural sources can accumulate in buildings, especially in confined areas such as the basement and it is the second most frequent cause of lung cancer, after [cigarette](https://en.wikipedia.org/wiki/Cigarette) smoking.
* [Smoke](https://en.wikipedia.org/wiki/Smoke) and [carbon monoxide](https://en.wikipedia.org/wiki/Carbon_monoxide) from [wildfires](https://en.wikipedia.org/wiki/Wildfires)
* Vegetation, in some regions, emits environmentally significant amounts of [Volatile organic compounds](https://en.wikipedia.org/wiki/Volatile_organic_compounds) (VOCs) on warmer days. These VOCs react with primary anthropogenic pollutants—specifically, NOx, SO2, and anthropogenic organic carbon compounds — to produce a seasonal haze of secondary pollutants. Black gum, poplar, oak and willow are some examples of vegetation that can produce abundant VOCs. The VOC production from these species result in ozone levels up to eight times higher than the low-impact tree species.
* [Volcanic](https://en.wikipedia.org/wiki/Volcano) activity, which produces [sulfur](https://en.wikipedia.org/wiki/Sulfur), [chlorine](https://en.wikipedia.org/wiki/Chlorine), and ash particulates

### Emission factors

[](https://en.wikipedia.org/wiki/File:Beijing_smog_comparison_August_2005.png)

[Beijing](https://en.wikipedia.org/wiki/Beijing) air on a 2005-day after rain (left) and a smoggy day (right)

Air pollutant emission factors are reported representative values that attempt to relate the quantity of a pollutant released to the ambient air with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e.g., kilograms of particulate emitted per [tons](https://en.wikipedia.org/wiki/Tonne) of coal burned). Such factors facilitate estimation of emissions from various sources of air pollution. In most cases, these factors are simply averages of all available data of acceptable quality, and are generally assumed to be representative of long-term averages.

There are 12 compounds in the list of [Persistent organic pollutants](https://en.wikipedia.org/wiki/Persistent_organic_pollutant). Dioxins and furans are two of them and intentionally created by combustion of organics, like open burning of plastics. These compounds are also endocrine disruptors and can mutate the human genes.

The [United States Environmental Protection Agency](https://en.wikipedia.org/wiki/United_States_Environmental_Protection_Agency) has published a compilation of air pollutant emission factors for a multitude of industrial sources. The [United Kingdom](https://en.wikipedia.org/wiki/United_Kingdom), [Australia](https://en.wikipedia.org/wiki/Australia), [Canada](https://en.wikipedia.org/wiki/Canada) and many other countries have published similar compilations, as well as the [European Environment Agency](https://en.wikipedia.org/wiki/European_Environment_Agency).

## Air pollution exposure

Air pollution risk is a function of the hazard of the pollutant and the exposure to that pollutant. Air pollution exposure can be expressed for an individual, for certain groups (e.g. neighborhoods or children living in a county), or for entire populations. For example, one may want to calculate the exposure to a hazardous air pollutant for a geographic area, which includes the various microenvironments and age groups. This can be calculated as an inhalation exposure. This would account for daily exposure in various settings (e.g. different indoor micro-environments and outdoor locations). The exposure needs to include different age and other demographic groups, especially infants, children, pregnant women and other sensitive subpopulations. The exposure to an air pollutant must integrate the concentrations of the air pollutant with respect to the time spent in each setting and the respective inhalation rates for each subgroup for each specific time that the subgroup is in the setting and engaged in particular activities (playing, cooking, reading, working, etc.). For example, a small child's inhalation rate will be less than that of an adult. A child engaged in vigorous exercise will have a higher respiration rate than the same child in a sedentary activity. The daily exposure, then, needs to reflect the time spent in each micro-environmental setting and the type of activities in these settings. The air pollutant concentration in each micro activity/micro environmental setting is summed to indicate the exposure.[[](https://en.wikipedia.org/wiki/Air_pollution#cite_note-Daniel_A._Vallero-19)

## Indoor air quality (IAQ)

A lack of ventilation indoors concentrates air pollution where people often spend the majority of their time. Radon (Rn) gas, a [carcinogen](https://en.wikipedia.org/wiki/Carcinogen), is exuded from the Earth in certain locations and trapped inside houses. Building materials including [carpeting](https://en.wikipedia.org/wiki/Carpet) and [plywood](https://en.wikipedia.org/wiki/Plywood) emit [formaldehyde](https://en.wikipedia.org/wiki/Formaldehyde) (H2CO) gas. Paint and solvents give off [volatile organic compounds](https://en.wikipedia.org/wiki/Volatile_organic_compounds) (VOCs) as they dry. [Lead](https://en.wikipedia.org/wiki/Lead) paint can degenerate into [dust](https://en.wikipedia.org/wiki/Dust) and be inhaled. Intentional air pollution is introduced with the use of [air fresheners](https://en.wikipedia.org/wiki/Air_freshener), [incense](https://en.wikipedia.org/wiki/Incense), and other scented items. Controlled wood fires in stoves and [fireplaces](https://en.wikipedia.org/wiki/Fireplace) can add significant amounts of smoke particulates into the air, inside and out. Indoor pollution fatalities may be caused by using [pesticides](https://en.wikipedia.org/wiki/Pesticide) and other chemical sprays indoors without proper ventilation.

Carbon monoxide poisoning and fatalities are often caused by faulty vents and chimneys, or by the burning of [charcoal](https://en.wikipedia.org/wiki/Charcoal) indoors or in a confined space, such as a tent. Chronic [carbon monoxide poisoning](https://en.wikipedia.org/wiki/Carbon_monoxide_poisoning) can result even from poorly-adjusted [pilot lights](https://en.wikipedia.org/wiki/Pilot_light). Traps are built into all domestic [plumbing](https://en.wikipedia.org/wiki/Plumbing) to keep sewer gas and [hydrogen sulfide](https://en.wikipedia.org/wiki/Hydrogen_sulfide), out of interiors. Clothing emits [tetrachloroethylene](https://en.wikipedia.org/wiki/Tetrachloroethylene), or other dry cleaning fluids, for days after [dry cleaning](https://en.wikipedia.org/wiki/Dry_cleaning).

Though its use has now been banned in many countries, the extensive use of [asbestos](https://en.wikipedia.org/wiki/Asbestos) in industrial and domestic environments in the past has left a potentially very dangerous material in many localities. [Asbestosis](https://en.wikipedia.org/wiki/Asbestosis) is a chronic [inflammatory](https://en.wikipedia.org/wiki/Inflammation) medical condition affecting the tissue of the [lungs](https://en.wikipedia.org/wiki/Lung). It occurs after long-term, heavy exposure to asbestos from asbestos-containing materials in structures. Sufferers have severe [dyspnea](https://en.wikipedia.org/wiki/Dyspnea) (shortness of breath) and are at an increased risk regarding several different types of [lung cancer](https://en.wikipedia.org/wiki/Lung_cancer). As clear explanations are not always stressed in non-technical literature, care should be taken to distinguish between several forms of relevant diseases. According to the [World Health Organization (WHO)](http://www.euro.who.int/__data/assets/pdf_file/0015/123072/AQG2ndEd_6_2_asbestos.PDF), these may defined as; [asbestosis](https://en.wikipedia.org/wiki/Asbestosis), *lung cancer*, and [*Peritoneal Mesothelioma*](https://en.wikipedia.org/wiki/Peritoneal_Mesothelioma) (generally a very rare form of cancer, when more widespread it is almost always associated with prolonged exposure to asbestos).

Biological sources of air pollution are also found indoors, as gases and airborne particulates. [Pets](https://en.wikipedia.org/wiki/Pet) produce dander, people produce dust from minute skin flakes and decomposed hair, [dust mites](https://en.wikipedia.org/wiki/House_dust_mite) in bedding, carpeting and furniture produce enzymes and micrometer-sized fecal droppings, inhabitants emit methane, [mold](https://en.wikipedia.org/wiki/Mold) forms on walls and generates [mycotoxins](https://en.wikipedia.org/wiki/Mycotoxins) and spores, [air conditioning](https://en.wikipedia.org/wiki/Air_conditioning) systems can incubate [Legionnaires' disease](https://en.wikipedia.org/wiki/Legionellosis) and mold, and [houseplants](https://en.wikipedia.org/wiki/Houseplant), soil and surrounding [gardens](https://en.wikipedia.org/wiki/Gardens) can produce [pollen](https://en.wikipedia.org/wiki/Pollen), dust, and mold. Indoors, the lack of air circulation allows these airborne pollutants to accumulate more than they would otherwise occur in nature.

## Health effects

Air pollution is a significant risk factor for a number of health conditions including respiratory infections, heart disease, [COPD](https://en.wikipedia.org/wiki/Chronic_obstructive_pulmonary_disease), stroke and lung cancer. The health effects caused by air pollution may include difficulty in breathing, wheezing, coughing, [asthma](https://en.wikipedia.org/wiki/Asthma) and worsening of existing respiratory and cardiac conditions. These effects can result in increased medication use, increased doctor or emergency room visits, more hospital admissions and premature death. The human health effects of poor air quality are far reaching, but principally affect the body's respiratory system and the cardiovascular system. Individual reactions to air pollutants depend on the type of pollutant a person is exposed to, the degree of exposure, and the individual's health status and genetics. The most common sources of air pollution include particulates, ozone, nitrogen dioxide, and sulphur dioxide. Children aged less than five years that live in developing countries are the most vulnerable population in terms of total deaths attributable to indoor and outdoor air pollution.

### Mortality

It is estimated that some 7 million premature deaths may be attributed to air pollution. India has the highest death rate due to air pollution. India also has more deaths from asthma than any other nation according to the World Health Organization. In December 2013 air pollution was estimated to kill 500,000 people in China each year. There is a correlation between [pneumonia](https://en.wikipedia.org/wiki/Pneumonia)-related deaths and air pollution from motor vehicles.

Air pollution is estimated to reduce life expectancy by almost nine months across the European Union. Causes of deaths include [strokes](https://en.wikipedia.org/wiki/Stroke), [heart disease](https://en.wikipedia.org/wiki/Heart_disease), COPD, lung cancer, and lung infections.

The [US EPA](https://en.wikipedia.org/wiki/United_States_Environmental_Protection_Agency) estimates that a proposed set of changes in [diesel engine](https://en.wikipedia.org/wiki/Diesel_engine) technology (*Tier 2*) could result in 12,000 fewer *premature mortalities*, 15,000 fewer [heart attacks](https://en.wikipedia.org/wiki/Myocardial_infarction), 6,000 fewer [emergency room](https://en.wikipedia.org/wiki/Emergency_room) visits by children with asthma, and 8,900 fewer respiratory-related hospital admissions each year in the United States.

The US EPA estimates allowing a ground-level ozone concentration of 65 parts per billion, would avert 1,700 to 5,100 premature deaths nationwide in 2020 compared with the current 75-ppb standard. The agency projects the stricter standard would also prevent an additional 26,000 cases of aggravated asthma, and more than a million cases of missed work or school.

A new economic study of the health impacts and associated costs of air pollution in the [Los Angeles Basin](https://en.wikipedia.org/wiki/Los_Angeles_Basin) and [San Joaquin Valley](https://en.wikipedia.org/wiki/San_Joaquin_Valley) of Southern California shows that more than 3,800 people die prematurely (approximately 14 years earlier than normal) each year because air pollution levels violate federal standards. The number of annual premature deaths is considerably higher than the fatalities related to auto collisions in the same area, which average fewer than 2,000 per year.

Diesel exhaust (DE) is a major contributor to combustion-derived particulate matter air pollution. In several human experimental studies, using a well-validated exposure chamber setup, DE has been linked to acute vascular dysfunction and increased thrombus formation. This serves as a plausible mechanistic link between the previously described association between particulates air pollution and increased cardiovascular morbidity and mortality.

### Cardiovascular disease

A 2007 review of evidence found ambient air pollution exposure is a risk factor correlating with increased total mortality from cardiovascular events (range: 12% to 14% per 10 microg/m3 increase).

Air pollution is also emerging as a risk factor for stroke, particularly in developing countries where pollutant levels are highest. A 2007 study found that in women, air pollution is not associated with hemorrhagic but with ischemic stroke. Air pollution was also found to be associated with increased incidence and mortality from coronary stroke in a cohort study in 2011. Associations are believed to be causal and effects may be mediated by vasoconstriction, low-grade inflammation and [atherosclerosis](https://en.wikipedia.org/wiki/Atherosclerosis) Other mechanisms such as autonomic nervous system imbalance have also been suggested.

### Lung disease

[Chronic obstructive pulmonary disease](https://en.wikipedia.org/wiki/Chronic_obstructive_pulmonary_disease) (COPD) includes diseases such as chronic bronchitis and emphysema.

Research has demonstrated increased risk of developing asthma and COPD from increased exposure to traffic-related air pollution. Additionally, air pollution has been associated with increased hospitalization and mortality from asthma and COPD.

A study conducted in 1960-1961 in the wake of the [Great Smog](https://en.wikipedia.org/wiki/Great_Smog) of 1952 compared 293 London residents with 477 residents of Gloucester, Peterborough, and Norwich, three towns with low reported death rates from chronic bronchitis. All subjects were male postal truck drivers aged 40 to 59. Compared to the subjects from the outlying towns, the London subjects exhibited more severe respiratory symptoms (including cough, phlegm, and dyspnea), reduced lung function ([FEV1](https://en.wikipedia.org/wiki/FEV1) and peak flow rate), and increased sputum production and purulence. The differences were more pronounced for subjects aged 50 to 59. The study controlled for age and smoking habits, so concluded that air pollution was the most likely cause of the observed differences.

It is believed that much like [cystic fibrosis](https://en.wikipedia.org/wiki/Cystic_fibrosis), by living in a more urban environment serious health hazards become more apparent. Studies have shown that in urban areas patients suffer [mucus](https://en.wikipedia.org/wiki/Mucus) hypersecretion, lower levels of lung function, and more self-diagnosis of chronic bronchitis and emphysema

### Cancer

A review of evidence regarding whether ambient air pollution exposure is a risk factor for cancer in 2007 found solid data to conclude that long-term exposure to PM2.5 (fine particulates) increases the overall risk of non-accidental mortality by 6% per a 10 microg/m3 increase. Exposure to PM2.5 was also associated with an increased risk of mortality from lung cancer (range: 15% to 21% per 10 microg/m3 increase) and total cardiovascular mortality (range: 12% to 14% per a 10 microg/m3 increase). The review further noted that living close to busy traffic appears to be associated with elevated risks of these three outcomes --- increase in lung cancer deaths, cardiovascular deaths, and overall non-accidental deaths. The reviewers also found suggestive evidence that exposure to PM2.5 is positively associated with mortality from coronary heart diseases and exposure to SO2 increases mortality from lung cancer, but the data was insufficient to provide solid conclusions. Another investigation showed that higher activity level increases deposition fraction of aerosol particles in human lung and recommended avoiding heavy activities like running in outdoor space at polluted areas.

In 2011, a large Danish epidemiological study found an increased risk of lung cancer for patients who lived in areas with high nitrogen oxide concentrations. In this study, the association was higher for non-smokers than smokers. An additional Danish study, also in 2011, likewise noted evidence of possible associations between air pollution and other forms of cancer, including cervical cancer and brain cancer.

In December 2015, medical scientists reported that [cancer](https://en.wikipedia.org/wiki/Cancer) is overwhelmingly a result of [environmental factors](https://en.wikipedia.org/wiki/Environmental_factor), and not largely down to bad luck. Maintaining a healthy weight, eating a healthy diet, minimizing alcohol and eliminating smoking reduces the risk of developing the disease, according to the researchers.

### Children

In the United States, despite the passage of the [Clean Air Act](https://en.wikipedia.org/wiki/Clean_Air_Act_%28United_States%29) in 1970, in 2002 at least 146 million Americans were living in [non-attainment areas](https://en.wikipedia.org/wiki/Non-Attainment_Area)—regions in which the concentration of certain air pollutants exceeded federal standards. These dangerous pollutants are known as the [criteria pollutants](https://en.wikipedia.org/wiki/Criteria_pollutant), and include ozone, [particulate matter](https://en.wikipedia.org/wiki/Particulate_matter), sulfur dioxide, nitrogen dioxide, carbon monoxide, and lead. Protective measures to ensure children's health are being taken in cities such as [New Delhi](https://en.wikipedia.org/wiki/New_Delhi), India where buses now use [compressed natural gas](https://en.wikipedia.org/wiki/Compressed_natural_gas) to help eliminate the "pea-soup" smog. A recent study in Europe has found that exposure to [ultrafine](https://en.wikipedia.org/wiki/Ultrafine_particle) particles can increase [blood pressure](https://en.wikipedia.org/wiki/Blood_pressure) in children.

Even in the areas with relatively low levels of air pollution, public health effects can be significant and costly, since a large number of people breathe in such pollutants. A 2005 scientific study for the British Columbia Lung Association showed that a small improvement in air quality (1% reduction of ambient PM2.5 and ozone concentrations) would produce $29 million in annual savings in the [Metro Vancouver](https://en.wikipedia.org/wiki/Metro_Vancouver) region in 2010. This finding is based on health valuation of lethal (death) and sub-lethal (illness) affects.

### Central nervous system

Data is accumulating that air pollution exposure also affects the [central nervous system](https://en.wikipedia.org/wiki/Central_nervous_system).

In a June 2014 study conducted by researchers at the [University of Rochester](https://en.wikipedia.org/wiki/University_of_Rochester) Medical Center, published in the journal [Environmental Health Perspectives](https://en.wikipedia.org/wiki/Environmental_Health_Perspectives), it was discovered that early exposure to air pollution causes the same damaging changes in the brain as [autism](https://en.wikipedia.org/wiki/Autism) and [schizophrenia](https://en.wikipedia.org/wiki/Schizophrenia). The study also shows that air pollution also affected short-term memory, learning ability, and impulsivity. Lead researcher Professor Deborah Cory-Slechta said that "When we looked closely at the ventricles, we could see that the white matter that normally surrounds them hadn't fully developed. It appears that inflammation had damaged those brain cells and prevented that region of the brain from developing, and the ventricles simply expanded to fill the space. Our findings add to the growing body of evidence that air pollution may play a role in autism, as well as in other neurodevelopmental disorders." Air pollution has a more significant negative effect of males than on females.

In 2015, experimental studies reported the detection of significant episodic (situational) cognitive impairment from impurities in indoor air breathed by test subjects who were not informed about changes in the air quality. Researchers at the Harvard University and SUNY Upstate Medical University and Syracuse University measured the cognitive performance of 24 participants in three different controlled laboratory atmospheres that simulated those found in "conventional" and "green" buildings, as well as green buildings with enhanced ventilation. Performance was evaluated objectively using the widely used Strategic Management Simulation software simulation tool, which is a well-validated assessment test for executive decision-making in an unconstrained situation allowing initiative and improvisation. Significant deficits were observed in the performance scores achieved in increasing concentrations of either [volatile organic compounds](https://en.wikipedia.org/wiki/Volatile_organic_compound) (VOCs) or [carbon dioxide](https://en.wikipedia.org/wiki/Carbon_dioxide), while keeping other factors constant. The highest impurity levels reached are not uncommon in some classroom or office environments.

## Agricultural effects

In India in 2014, it was reported that air pollution by black carbon and ground level ozone had cut crop yields in the most affected areas by almost half in 2010 when compared to 1980 levels.

## Historical disasters

The world's worst short-term civilian pollution crisis was the 1984 [Bhopal Disaster](https://en.wikipedia.org/wiki/Bhopal_Disaster) in [India](https://en.wikipedia.org/wiki/India) Leaked industrial vapours from the Union Carbide factory, belonging to Union Carbide, Inc., U.S.A. (later bought by [Dow Chemical Company](https://en.wikipedia.org/wiki/Dow_Chemical_Company)), killed at least 3787 people and injured anywhere from 150,000 to 600,000. The United Kingdom suffered its worst air pollution event when the December 4 [Great Smog](https://en.wikipedia.org/wiki/Great_Smog) of 1952 formed over [London](https://en.wikipedia.org/wiki/London). In six days more than 4,000 died and more recent estimates put the figure at nearer 12,000. An [accidental leak](https://en.wikipedia.org/wiki/Sverdlovsk_anthrax_leak) of [anthrax](https://en.wikipedia.org/wiki/Anthrax) spores from a [biological warfare](https://en.wikipedia.org/wiki/Biological_warfare) laboratory in the former [USSR](https://en.wikipedia.org/wiki/USSR) in 1979 near [Sverdlovsk](https://en.wikipedia.org/wiki/Yekaterinburg) is believed to have caused at least 64 deaths.[[67]](https://en.wikipedia.org/wiki/Air_pollution#cite_note-67) The worst single incident of air pollution to occur in the US occurred in [Donora, Pennsylvania](https://en.wikipedia.org/wiki/Donora,_Pennsylvania) in late October, 1948, when 20 people died and over 7,000 were injured.

## Alternatives to creating air pollution

There are now practical alternatives to the three principal causes of air pollution. Combustion of fossil fuels for space heating can be replaced by using [ground source heat pumps](https://en.wikipedia.org/wiki/Ground_source_heat_pumps) and [seasonal thermal energy storage](https://en.wikipedia.org/wiki/Seasonal_thermal_energy_storage). Electric power generation from burning fossil fuels can be replaced by power generation from nuclear and renewables. Motor vehicles driven by fossil fuels, a key factor in urban air pollution, can be replaced by electric vehicles.

## Reduction efforts

There are various air pollution control technologies and [land-use planning](https://en.wikipedia.org/wiki/Land-use_planning) strategies available to reduce air pollution. At its most basic level, land-use planning is likely to involve zoning and transport infrastructure planning. In most developed countries, land-use planning is an important part of social policy, ensuring that land is used efficiently for the benefit of the wider economy and population, as well as to protect the environment.

Because a large share of air pollution is caused by combustion of [fossil fuels](https://en.wikipedia.org/wiki/Fossil_fuels) such as [coal](https://en.wikipedia.org/wiki/Coal) and [oil](https://en.wikipedia.org/wiki/Oil), the reduction of these fuels can reduce air pollution drastically. Most effective is the switch to clean power sources such as [wind power](https://en.wikipedia.org/wiki/Wind_power), [solar power](https://en.wikipedia.org/wiki/Solar_power), [hydro power](https://en.wikipedia.org/wiki/Hydro_power) which don't cause air pollution. Efforts to reduce pollution from mobile sources includes primary regulation (many developing countries have permissive regulations), expanding regulation to new sources (such as cruise and transport ships, farm equipment, and small gas-powered equipment such as [string trimmers](https://en.wikipedia.org/wiki/String_trimmer), [chainsaws](https://en.wikipedia.org/wiki/Chainsaw), and [snowmobiles](https://en.wikipedia.org/wiki/Snowmobiles)), increased fuel efficiency (such as through the use of [hybrid vehicles](https://en.wikipedia.org/wiki/Hybrid_vehicle)), conversion to cleaner fuels or conversion to [electric vehicles](https://en.wikipedia.org/wiki/Electric_vehicle).

[Titanium dioxide](https://en.wikipedia.org/wiki/Titanium_dioxide) has been researched for its ability to reduce air pollution. [Ultraviolet](https://en.wikipedia.org/wiki/Ultraviolet) light will release free electrons from material, thereby creating free radicals, which break up VOCs and NOx gases. One form is [superhydrophilic](https://en.wikipedia.org/wiki/Superhydrophilicity).

In 2014, [Prof. Tony Ryan](https://en.wikipedia.org/wiki/Tony_Ryan_%28scientist%29) and [Prof. Simon Armitage](https://en.wikipedia.org/wiki/Simon_Armitage) of [University of Sheffield](https://en.wikipedia.org/wiki/University_of_Sheffield) prepared a 10 meter by 20 meter-sized poster coated with microscopic, pollution-eating nanoparticles of titanium dioxide. Placed on a building, this giant poster can absorb the toxic emission from around 20 cars each day.

A very effective means to reduce air pollution is the [transition](https://en.wikipedia.org/wiki/Energy_transition) to [renewable energy](https://en.wikipedia.org/wiki/Renewable_energy). According to a study published in [Energy and Environmental Science](https://en.wikipedia.org/wiki/Energy_and_Environmental_Science) in 2015 the switch to [100% renewable energy](https://en.wikipedia.org/wiki/100%25_renewable_energy) in the United States would eliminate about 62,000 premature mortalities per year and about 42,000 in 2050, if no biomass were used. This would save about $600 billion in [health costs](https://en.wikipedia.org/wiki/Health_costs) a year due to reduced air pollution in 2050, or about 3.6% of the 2014 U.S. gross domestic product.

# Health Hazards of Air Pollution

In Singapore, the air quality is generally good due to the strict pollution standards. Yet doctors still see many patients whose lives and health are directly affected by the global phenomenon of air pollution.   
  
The common effects of air pollution include irritation to the eyes, nose and throat, and upper respiratory infections such as bronchitis and pneumonia. Poor air quality can also exacerbate underlying lung problems, such as bronchial [asthma](http://www.healthxchange.com.sg/healthyliving/ManagingChronicIllnesses/Pages/5-Things-You-Should-Know-About-Asthma-Slideshow.aspx), [chronic obstructive pulmonary disease](http://www.healthxchange.com.sg/healthyliving/ManagingChronicIllnesses/Pages/maintaining-healthy-body-weight-a-must-for-people-with-copd.aspx) (COPD), or [allergic rhinitis](http://www.healthxchange.com.sg/healthyliving/childrenhealth/Pages/allergic-rhinitis-common-in-children-in-singapore.aspx). Some patients may even need to be hospitalized.

### Fine air particles can accumulate in the lungs

We can divide pollutants into two types:

1. gas pollutants (e.g. carbon monoxide, sulphur dioxide, etc.) and
2. particles in the air

Broadly speaking, gas pollutants can be detrimental to our health as they take part in gas exchange during each breath we take. However, they are not retained in the body and are excreted.  
  
Particles in the air are another story. While the bigger particles are filtered by the respiratory tract (which includes our nostrils, airways and lungs), the finer particles are deposited in our lungs and may build up over a prolonged period. Such prolonged exposure to pollution can lead to the onset of [chronic lung diseases](http://www.healthxchange.com.sg/healthyliving/SpecialFocus/Pages/Cigarette-Smoking-Is-the-Main-Cause-of-Lung-Cancer.aspx).

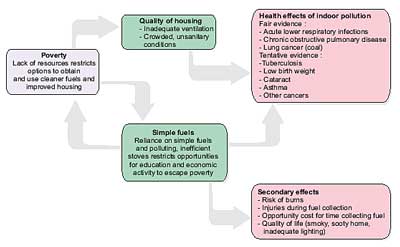
### Dangerous haze

In Singapore, the most preoccupying source of air pollution is the haze attributable to forest fires in Indonesia. This typically happens around October, when farmers carry out their slash and burn method of cultivation.

The haze can be exacerbated depending on the prevailing wind direction which carries the smoke particles. Air pollution may then reach the moderate to unhealthy range.  
  
During the smoke haze pollution of 1997, there was an immediate 30 per cent increase in outpatient attendance and increased accident and emergency attendance for haze-related conditions. Measurements showed that 94 per cent of haze particles were smaller than 2.5 microns in diametre, which is the size that bypasses our filtering system and gets deposited in our lung tissues.

### Ways to protect yourself from air pollution

Should you want a face mask to protect yourself against the haze and air pollution, make sure you get one that can catch the smallest particles? Look for filters that contain an electro-static charge, which can trap fine dust and particles below 0.3 microns.  
  
As for inside your home, using an air conditioner may help remove air pollutants. Why? Air conditioning makes the air drier, effectively removing many water-soluble pollutants.  
  
Stand-alone HEPA air cleaners can also be considered. The best ones are those equipped with True HEPA filters, which can capture high proportions of very small particles.



Air pollution is a major environment-related health threat to children and a risk factor for both acute and chronic respiratory disease. While second-hand tobacco smoke and certain outdoor pollutants are known risk factors for respiratory infections, indoor air pollution from solid fuels is one of the major contributors to the global burden of disease. In poorly ventilated dwellings, indoor smoke can be 100 times higher than acceptable levels for small particles. Exposure is particularly high among women and young children, who spend the most time near the domestic hearth.

WHO is providing technical support to countries in their own evaluations and scale up of promoting safer stove technologies, as well as air quality guidelines to offer global guidance on reducing the health impacts of air pollution?

#### Outdoor air pollution

Outdoor air pollution is large and increasing a consequence of the inefficient combustion of fuels for transport, power generation and other human activities like home heating and cooking. Combustion processes produce a complex mixture of pollutants that comprises of both primary emissions, such as diesel soot particles and lead, and the products of atmospheric transformation, such as ozone and sulfate particles.

Urban outdoor air pollution is estimated to cause 1.3 million deaths worldwide per year. Children are particularly at risk due to the immaturity of their respiratory organ systems. Those living in middle-income countries disproportionately experience this burden. Exposure to air pollutants is largely beyond the control of individuals and requires action by public authorities at the national, regional and even international levels.

Indoor air pollution

Indoor cooking and heating with biomass fuels (agricultural residues, dung, straw, wood) or coal produces high levels of indoor smoke that contains a variety of health-damaging pollutants. There is consistent evidence that exposure to indoor air pollution can lead to acute lower respiratory infections in children under age five, and chronic obstructive pulmonary disease and lung cancer in adults.

Indoor air pollution is responsible for 2 million deaths annually. Acute lower respiratory infections, in particular pneumonia, continue to be the biggest killer of young children and this toll almost exclusively falls on children in developing countries.

**Impact of air pollution on health**

The magnitude of the London fog of 1952, which affected such a large number of people, was the first incident that made people aware of the damage done to the atmosphere due to industrialization. The SPM levels increased manifold and resulted in over 4000 deaths.

Indoor air pollution can be particularly hazardous to health as it is released in close proximity to people. It is stated that a pollutant released indoors is many times more likely to reach the lung than that released outdoors. In the developing countries a fairly large portion of the population is dependent on biomass for their energy requirements. These include wood, charcoal, agricultural residue, and animal waste. Open fires used for cooking and heating are commonly found in the household both in the rural and the urban areas. The stove is often at floor level, adding to the risk of accident and the hygiene factor. In addition, they are often not fitted with a chimney to remove the pollutants. In such households the children and women are most likely to be affected, as they are the group that spends more time indoors. The main pollutant in this environment is the SPM. In fact, death due to indoor air pollution, mainly particulate matters, in the rural areas of India are one of the highest in the world. Many of the deaths are due to acute respiratory infections in children; others are due to cardiovascular diseases, lung cancer, and chronic respiratory diseases in adults. If emissions are high and ventilation is poor, household use of coal and biomass can severely affect the indoor air quality.

Pollutant emissions per meal are also very high compared to those of other fuels. Household use of fossil fuel is also fairly common in the developing countries, particularly coal—both bituminous and lignite. These are particularly damaging as they burn inefficiently and emit considerable quantities of air pollutants. If emissions are high and ventilation poor, then the exposure levels to the gases emitted are far higher. The most harmful of the gases and agents that are emitted are particulate matter, carbon dioxide, polycyclic organic matter, and formaldehyde. The indoor concentrations of these are far higher than the acceptable levels and is cause for concern in rural areas.

**Health impact of specific air pollutants**

Some of these gases can seriously and adversely affect the health of the population and should be given due attention by the concerned authority. The gases mentioned below are mainly outdoor air pollutants but some of them can and do occur indoor depending on the source and the circumstances.

*http://edugreen.teri.res.in/explore/air/sqb.gifTobacco smoke*. Tobacco smoke generates a wide range of harmful chemicals and is a major cause of ill health, as it is known to cause cancer, not only to the smoker but affecting passive smokers too. It is well-known that smoking affects the passive smoker (the person who is in the vicinity of a smoker and is not himself/herself a smoker) ranging from burning sensation in the eyes or nose, and throat irritation, to cancer, bronchitis, severe asthma, and a decrease in lung function.  
*http://edugreen.teri.res.in/explore/air/sqb.gifBiological pollutants*. These are mostly allergens that can cause asthma, hay fever, and other allergic diseases.   
*http://edugreen.teri.res.in/explore/air/sqb.gifVolatile organic compounds*. Volatile compounds can cause irritation of the eye, nose and throat. In severe cases there may be headaches, nausea, and loss of coordination. In the longer run, some of them are suspected to cause damage to the liver and other parts of the body.  
*http://edugreen.teri.res.in/explore/air/sqb.gifFormaldehyde*. Exposure causes irritation to the eyes, nose and may cause allergies in some people.  
http://edugreen.teri.res.in/explore/air/sqb.gif*Lead*. Prolonged exposure can cause damage to the nervous system, digestive problems, and in some cases cause cancer. It is especially hazardous to small children.  
http://edugreen.teri.res.in/explore/air/sqb.gif*Radon*. A radioactive gas that can accumulate inside the house, it originates from the rocks and soil under the house and its level is dominated by the outdoor air and also to some extent the other gases being emitted indoors. Exposure to this gas increases the risk of lung cancer.  
http://edugreen.teri.res.in/explore/air/sqb.gif*Ozone*. Exposure to this gas makes our eyes itch, burn, and water and it has also been associated with increase in respiratory disorders such as asthma. It lowers our resistance to colds and pneumonia.  
http://edugreen.teri.res.in/explore/air/sqb.gif*Oxides of nitrogen*. This gas can make children susceptible to respiratory diseases in the winters.  
http://edugreen.teri.res.in/explore/air/sqb.gif*Sulphur dioxide*. SO2 (sulphur dioxide) in the air is caused due to the rise in combustion of fossil fuels. It can oxidize and form sulphuric acid mist. SO2 in the air leads to diseases of the lung and other lung disorders such as wheezing and shortness of breath. Long-term effects are more difficult to ascertain as SO2 exposure is often combined with that of SPM.  
http://edugreen.teri.res.in/explore/air/sqb.gif*SPM (suspended particulate matter)*. Suspended matter consists of dust, fumes, mist and smoke. The main chemical component of SPM that is of major concern is lead, others being nickel, arsenic, and those present in diesel exhaust. These particles when breathed in, lodge in our lung tissues and cause lung damage and respiratory problems. The importance of SPM as a major pollutant needs special emphasis as a) it affects more people globally than any other pollutant on a continuing basis; b) there is more monitoring data available on this than any other pollutant; and c) more epidemiological evidence has been collected on the exposure to this than to any other pollutant.

## Regulations

## In general, there are two types of air quality standards. The first class of standards (such as the U.S. [National Ambient Air Quality Standards](https://en.wikipedia.org/wiki/National_Ambient_Air_Quality_Standards) and E.U. [Air Quality Directive](http://ec.europa.eu/environment/air/quality/legislation/directive.htm)) set maximum atmospheric concentrations for specific pollutants. Environmental agencies enact regulations which are intended to result in attainment of these target levels. The second class (such as the North American [Air Quality Index](https://en.wikipedia.org/wiki/Air_Quality_Index)) take the form of a scale with various thresholds, which is used to communicate to the public the relative risk of outdoor activity. The scale may or may not distinguish between different pollutants.

### Canada

In Canada, air pollution and associated health risks are measured with the [Air Quality Health Index](https://en.wikipedia.org/wiki/Air_Quality_Health_Index_%28Canada%29) or (AQHI). It is a health protection tool used to make decisions to reduce short-term exposure to air pollution by adjusting activity levels during increased levels of air pollution.

The Air Quality Health Index or "AQHI" is a federal program jointly coordinated by [Health Canada](https://en.wikipedia.org/wiki/Health_Canada) and [Environment Canada](https://en.wikipedia.org/wiki/Environment_Canada). However, the AQHI program would not be possible without the commitment and support of the provinces, municipalities and NGOs. From air quality monitoring to health risk communication and community engagement, local partners are responsible for the vast majority of work related to AQHI implementation. The AQHI provides a number from 1 to 10+ to indicate the level of health risk associated with local air quality. Occasionally, when the amount of air pollution is abnormally high, the number may exceed 10. The AQHI provides a local air quality current value as well as a local air quality maximums forecast for today, tonight and tomorrow and provides associated health advice.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **+** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Risk:** | Low **(1-3)** | Moderate **(4-6)** | High **(7-10)** | Very high **(above 10)** |

As it is now known that even low levels of air pollution can trigger discomfort for the sensitive population, the index has been developed as a continuum: The higher the number, the greater the health risk and need to take precautions. The index describes the level of health risk associated with this number as 'low', 'moderate', 'high' or 'very high', and suggests steps that can be taken to reduce exposure.

The measurement is based on the observed relationship of Nitrogen Dioxide (NO2), ground-level Ozone (O3) and particulates (PM2.5) with mortality, from an analysis of several Canadian cities. Significantly, all three of these pollutants can pose health risks, even at low levels of exposure, especially among those with pre-existing health problems.

When developing the AQHI, Health Canada's original analysis of health effects included five major air pollutants: particulates, [ozone](https://en.wikipedia.org/wiki/Ozone), and [nitrogen dioxide](https://en.wikipedia.org/wiki/Nitrogen_dioxide) (NO2), as well as [sulfur dioxide](https://en.wikipedia.org/wiki/Sulfur_dioxide) (SO2), and [carbon monoxide](https://en.wikipedia.org/wiki/Carbon_monoxide) (CO). The latter two pollutants provided little information in predicting health effects and were removed from the AQHI formulation.

The AQHI does not measure the effects of odour, [pollen](https://en.wikipedia.org/wiki/Pollen), dust, heat or humidity.

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