Outdoor air pollution and the lungs

The average adult breathes over 15 cubic metres of air every day. Although pollutants in the air are often invisible, they can have serious effects on our health, including the lungs, the heart and other organ systems, and the developing foetus. This factsheet aims to provide you with the answers to many questions you may have about outdoor air pollution and your lungs.

What are the main air pollutants?

An air pollutant is "any substance in air that could, in high enough concentrations, harm humans, animals, vegetation or material". There are many pollutants in the air and the different items that make up air pollution vary from one area to another. However, some pollutants are more closely monitored than others as they are known to cause damage to the environment or health. The main pollutants include ozone, nitrogen dioxide, particulate matter and sulphur dioxide. Turn the page for a table describing all of these pollutants.

What are the health effects of air pollution on your lungs?

The respiratory effects of air pollution depend on the type and mix of pollutants, the concentration in the air, the amount of time that you are exposed to the pollutant, how much of the pollutant you breathe in and how much of the pollutant penetrates your lungs.

Lung health symptoms that can be seen straight after exposure to high pollution levels include irritation of the airways, dyspnoea (difficulty breathing) and an increased chance of having an asthma attack. Being exposed to air pollutants for a long period of time has been shown to increase the occurrence of lung diseases, including cancer, and deaths from these diseases. Turn the page for details on how each pollutant can affect your lungs.

Who is most at risk from air pollution exposure and how might it effect them?

Air pollution is especially harmful to people who already suffer from lung diseases such as asthma and chronic obstructive pulmonary disease (COPD - which includes chronic bronchitis and emphysema). However, the elderly, children and developing babies are also at an increased risk of experiencing harmful effects from exposure to air pollution.

If you have a chronic respiratory condition or are elderly, then you are most at risk of air pollution's harmful effects such as premature death from lung or heart disease. If you have sensitive airways, exposure to air pollution can trigger asthma attacks and cause wheezing, coughing and respiratory irritation.

Healthy people who work or exercise outdoors are also vulnerable to the adverse effects of air pollution, particularly during high concentrations of ground-level ozone.

How can you reduce your exposure to air pollution?

Exposure to air pollutants can be avoided in several ways according to the kind of air pollutant and the setting. Turn the page for details of how you should deal with each air pollutant.

In general, you should, first of all, check the air pollution alert for the day. In winter, avoid walking along busy streets with lots of traffic fumes. In summer, air pollution levels are generally higher on hot sunny days. So try to avoid energetic outdoor activities or do them in the morning when pollution levels are usually lower.

What can I do to reduce pollution levels?

As well as industrial processes, one of the major sources of air pollution is cars and other vehicles. Therefore, as an individual there are many things you can do to reduce pollution levels.

1. Think seriously before using your car for a journey. Consider the benefits offered by other modes of transport, like cycling, walking or using public transport (for example: increased safety, particularly for children; reduced congestion; better health by ensuring you meet the World Health Organization (WHO) recommended 20 minutes of exercise every day; saved time, it can be much quicker to travel by other forms of transport than by car; saved money).
2. When doing the school run, shopping or going to work, think about car sharing, turn off your engine while stationary, maintain your car properly and reduce your speed.
3. Buy 'green' and 'efficient' (for example, when buying your next car look at the vehicle that uses the least fuel and is the least polluting).
4. Look at reducing your energy consumption at home or switching to clean renewable energy sources, don't breathe in hazardous materials (read hazard labels) and stop burning solid fuels, particularly rubbish or treated woods.
5. Get involved with citizens in Europe to ensure your lungs are protected. Go to www.environment.european-lung-foundation.org for links and information about how to get involved in activities such as making the air in your city cleaner or helping to improve public transport facilities.

	Ozone or O_3	Nitrogen dioxide or NO_2
What is it?	Ozone is a gas composed of three atoms of oxygen. It can be good or bad according to where it is found.	Nitrogen oxides are gases that contain nitrogen and oxygen. Nitrogen dioxide (NO_2 – one of the main nitrogen oxides present in the air) is a red–brown gas with a sharp, biting odour, and is a major source of smog.
Where does it come from?	In the stratosphere (the "ozone layer", 15–40 km above the earth's surface), ozone is good, as it is needed for absorbing harmful ultraviolet radiation and preventing it from reaching the earth. Near the ground, ozone is bad, as it is made by chemical reactions between the sun's rays and organic gases and oxides of nitrogen emitted by cars, power plants, industrial boilers, refineries, chemical plants and other sources.	The main man-made sources of nitrogen oxides include motor vehicles, power plants and other sources that burn fossil fuels. Nitrogen oxides and the pollutants formed from them can be transported over long distances, by the wind and weather.
What effects does it have on the lungs?	• Irritates the nose and throat • Causes wheezing, coughing, pain when taking a deep breath • Causes breathing difficulties during exercise or outdoor activities • Reduces lung capacity (amount of air that your lungs can hold) • Aggravates asthma • Causes rises in bronchodilator usage (treatment used to open the airways in asthma) • Increases vulnerability to respiratory illnesses like pneumonia and bronchitis • Increases the risk of dying from lung and heart diseases • Increases hospital admissions for lung diseases	• Increases incidence of asthma • Increases the risk of dying from lung diseases • Increases hospital admissions for lung conditions
What actions should be taken if you are exposed to high levels?	• People with asthma, the elderly and infants should avoid exercising outdoors • Individuals with symptoms of asthma, shortness of breath or cough should go and see their doctor, or rest and use reliever medicine if previously prescribed • If symptoms persist individuals should go and see their doctor	• People with symptoms of asthma, shortness of breath or cough should go and see their doctor, or rest and use reliever medicine if previously prescribed • If symptoms persist individuals should go and see their doctor

Particulate matter or PM	Sulphur dioxide or SO_2
Particulate matter (PM) is a mixture of solid and liquid particles of different sizes. • Coarse particles: 2.5–40 µm diameter (typical hair thickness 75 µm) • PM10: 2.5–10 µm. • Fine particles: (also known as known as PM2.5) <2.5 µm. • Ultrafine particles: diameter <0.1 µm.	Sulphur dioxide is a colourless gas, with a pungent, suffocating odour, produced by the burning of sulphur.
Natural sources of particulate matter include volcanoes, sea spray, pollens, fungal spores and soil particles. Man-made particles mainly result from industrial processes, construction work or friction from motor vehicles on road surfaces. Particulate matter is also formed in the atmosphere when gases are changed in the air by chemical reactions. Large particles usually settle out of the air quickly, while smaller particles may remain in the air for days or months. Rainfall helps to remove particulate matter from the air.	Most sulphur dioxide comes from electric industries that burn fossil fuels. Other sources of sulphur dioxide are industries that produce products from raw materials such as coal and crude oil, or that burn coal or oil to produce process heat (petroleum refineries, cement manufacturing and metal processing). Sulphur dioxide and the pollutants formed from sulphur dioxide, such as sulphate particles, can be transported over long distances.
• Irritates the nose and throat • Increases hospital admissions for lung conditions • Causes early deaths from heart and lung diseases • Possible association with asthma	• Contributes to respiratory illness, particularly in children and the elderly • Aggravates existing heart and lung diseases, particularly in people with asthma • Sulphate particles (formed when SO_2 reacts with other chemicals in the air) gather in the lungs and cause increased respiratory symptoms and disease, difficulty in breathing and even increased risk of premature death
• People with heart or lung disease should avoid heavy exercise • Individuals who experience chest pain, shortness of breath or cough should go and see their doctor, or take their reliever medicines if previously prescribed • If symptoms persist, individuals should go and see their doctor	• People with asthma, the elderly and infants should avoid excessive exposure • Individuals who experience symptoms should go and see their doctor or take their reliever medication if previously prescribed

How can I interpret air pollution levels?

Many countries and international agencies have developed systems to show the different levels of air pollution in different areas each day and this alerts the population when levels are excessive. One of these, from the UK Department of Health, is shown below. This system works by grading each concentration of pollutant, and ranking it at a level between 1 and 10. These levels are then split into four categories: low; moderate; high; and very high.

Band	Index	O_3 µg/m^3	NO_2 µg/m^3	PM µg/m^3	SO_2 µg/m^3
Low	1	0–32	0–95	0–16	0–88
	2	33–66	96–190	17–32	89–176
	3	67–99	191–286	33–49	177–265
Moderate	4	100–126	287–381	50–57	266–354
	5	127–152	382–476	58–66	355–442
	6	153–179	477–572	67–74	443–531
High	7	180–239	573–635	75–82	532–708
	8	240–299	636–700	83–91	709–886
	9	300–359	701–763	92–99	887–1063
Very high	10	≥360	≥764	≥100	≥1064

Who is controlling our air pollution levels?

Air quality standards are set by the European Union to protect our health. For more information, please go to http://ec.europa.eu/environment/air. They vary from country to country depending on risks to health, how easy the levels are to achieve, cost and other considerations.

The WHO regularly reviews the evidence on health effects of air pollutants, and then writes guidelines. These guidelines help support actions worldwide to get air quality to the best level to protect health. The table below shows the air quality levels that are recommended by the WHO and that all countries should aim for.

For particulate matter, average levels are recommended over 1 year and for 24 hours, because both short- and long-term effects occur. It is thought that no guideline will ever provide complete protection, but health effects can be reduced.

For ozone, a level is given that should not be exceeded in 8 hours, as the effects of ozone can be seen very quickly. Ozone may have long-term effects, but there is not, at present, enough evidence to suggest a guideline.

Evidence has shown that nitrogen dioxide has long-term health effects and that its levels match with other pollutants. Therefore, the long-term levels given for nitrogen dioxide will offer protection to the public.

A 10-minute sulphur dioxide level has been proposed, as its effects on exercising asthmatics can be seen in this time. The 24-hour levels of sulphur dioxide have been proposed because studies have shown that lowering levels reduces health effects, although it is difficult to separate these effects from other pollutants.

Pollutant	Averaging time	Air quality guidelines
PM		
$PM_{2.5}$	1 year	10 µg/m^3
	24 hours	25 µg/m^3
PM_{10}	1 year	20 µg/m^3
	24 hours	50 µg/m^3
O_3	8 hours (daily)	100 µg/m^3
NO_2	1 year	40 µg/m^3
	1 hour	200 µg/m^3
SO_2	24 hour	20 µg/m^3
	10 minutes	500 µg/m^3

Other pollutants

Volatile organic compounds or VOCs are any compounds that are made from carbon and are involved in chemical reactions with the sun's rays in the air. As it says in the name, these compounds are volatile (gaseous) and they can also be called organic gases. Outdoors, the main sources of VOCs are road traffic and industrial use of paint, varnish or glue. It has already been shown that VOCs irritate the nose and throat, cause allergic skin reactions and dyspnoea (difficulty breathing), and aggravate asthma.

Carbon monoxide or CO is a colourless and odourless gas, which comes from incomplete combustion of carbon in fuel. Outdoors, carbon monoxide emissions are generated by road traffic, manufacturing industries and housing. Heating our houses produces the main part of this pollutant in towns and cities. CO reduces the amount of oxygen the blood can carry around the body, causing temporary or permanent damage to different parts of the body.

- For more information and links go to www.environment.european-lung-foundation.org http://ec.europa.eu/environment/air/links.htm
- This information was written and compiled by the European Respiratory Society (www.ersnet.org) Environment and Health Committee. Other sources include the WHO Air Quality Guidelines - Global Update 2005 (www.euro.who.int/Document/E87950.pdf) and the UK National Air Quality Information Archive (www.airquality.co.uk/archive/index.php).
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