Air pollution is responsible for 6.7 million premature deaths every year

- **Around 2.4 billion people cook and heat their homes with polluting fuels and every year 3.2 million people die prematurely from household air pollution.**
- **More than 99% of the population live in areas where the air pollution is above WHO air quality guidelines and 4.2 million deaths are attributed to ambient air pollution each year.**

Ambient and household air pollution can come from similar processes such as incomplete combustion of fuels or chemical reactions between gases. However, the specific source of the combustion process can vary. For example, household activities such as cooking and heating with dirty technologies, and lighting with kerosene, emits a range of health harmful pollutants indoors, while activities such as high temperature combustion in vehicles, industries and power generating facilities contribute to ambient air pollution. Activities such as boiling water for bathing or cooking animal fodder can also add to household air pollution exposures.

Pollutants with the strongest evidence for public health concern include particulate matter (PM), carbon monoxide (CO), ozone (O_3), nitrogen dioxide (NO_2) and sulfur dioxide (SO_2). Health problems can occur as a result of both short- and long-term exposure to these various pollutants. For some pollutants, there are no thresholds below which adverse effects do not occur.

Pollutants which are included in the WHO global air quality guidelines are presented firstly followed by pollutants for which there are good practice statements but no quantitative values.

Particulate Matter

Particulate matter (PM) refers to inhalable particles, composed of sulphate, nitrates, ammonia, sodium chloride, black carbon, mineral dust or water. PM can be of different size and is generally defined by their aerodynamic diameter, with $PM_{2.5}$ and PM_{10} the most common in the regulatory framework and relevant for health.

Sources of the largest particles called coarse particles (particles with diameter between 2.5 μm and 10 μm) will mainly consist of pollen, sea spray and wind-blown dust from erosion, agricultural spaces, roadways and mining operations. The finer particles (i.e., $PM_{2.5}$) can be derived from primary sources (e.g., combustion of fuels in power generation facilities, industries or vehicles) and secondary sources (e.g., chemical reactions between gases). The greatest source of particulate matter around the home is generally the combustion of polluting fuels in open hearths or poorly vented, inefficient stoves or space heaters. In addition to household activities like cooking, space heating, and lighting, other activities can be important sources of particulate matter pollution in the home environment, such as preparing animal fodder, heating water for bathing and brewing beverages.

In outdoor environments, the main sources are location-specific and can be made up of different different origins but typically include traffic and transportation, industrial activities, power plants, construction sites, waste burning, fires or fields.

The health risks associated with particulate matter of less than 10 and 2.5 microns in diameter (PM_{10} and $PM_{2.5}$) are especially well documented. PM is capable of penetrating deep into the lung and enter the bloodstream causing cardiovascular (ischaemic heart disease), cerebrovascular (stroke) and respiratory impacts. Both long-term and short-term exposure to particulate matter is associated with morbidity and mortality from cardiovascular and respiratory diseases. Long-term exposure has been further linked to adverse perinatal outcomes and lung cancer. In 2013, it was classified as a cause of lung cancer by WHO's International Agency for Research on Cancer (IARC). It is also the most widely used indicator for assessing the health effects of exposure to air pollution.

Read more about particulate matter in the Air Quality Guidelines.

Nitrogen Dioxide

Nitrogen dioxide (NO_2) is a reddish-brown gas that is soluble in water, and a strong oxidant. Ambient sources of NO_2 results from high temperature combustion of fuels in processes such as those used for heating, transportation, industry and power generation. Household sources of nitrogen oxides (NOx) include equipment that burn fuels such as furnaces, fireplaces and gas stoves and ovens. Exposure to nitrogen dioxide can irritate airways and aggravate respiratory diseases.

NO_2 is an important ozone precursor, a pollutant closely linked to asthma and other respiratory conditions.

Read more about nitrogen dioxide here and here.

Ozone

Ground-level ozone (O_3) is a major component of smog. It is formed from photochemical reactions with pollutants such volatile organic compounds, carbon monoxide and nitrogen oxides (NOx) emitted from vehicles, and industry. Due to the photochemical nature, the highest levels of ozone are seen during periods of sunny weather. It is worth mentioning that ozone can also be generated by household equipment, such as portable air cleaners.

Exposure to excessive ozone can cause problems breathing, trigger asthma, reduce lung function and lead to lung disease.

Read more about ozone here and here.

Carbon monoxide

Carbon monoxide (CO) is a colourless, odourless gas produced by the incomplete combustion of carbonaceous fuels such as wood, petrol, coal, natural gas and kerosene in simple stoves, open fires, wick lamps, furnaces, fireplaces. The predominant source of carbon monoxide (CO) in ambient air is from motor vehicles.

Carbon monoxide diffuses across the lung tissues and into the bloodstream, making it difficult for the body's cells to bind to oxygen. This lack of oxygen damages tissues and cells. Exposure to carbon monoxide can cause difficulties breathing, exhaustion, dizziness, and other flu-like symptoms. Exposure to high levels of carbon monoxide can be deadly.

Read more about carbon monoxide here and here.

Sulfur Dioxide

Sulfur dioxide (SO_2) is a colourless gas that is readily soluble in water. It is predominantly derived from the combustion of fossil fuels for domestic heating, industries and power generation.

Exposure to SO_2 is associated with asthma hospital admissions and emergency room visits.

Read more about sulfur dioxide here and here.

Lead

Lead (Pb) and lead particulate compounds can be found in the home in contaminated dust from products such as paints, ceramics, pipes and plumbing materials, solders, gasoline, batteries, ammunition, and cosmetics. Lead can also be found in ambient air from vehicle exhaust of fuel with lead.

Lead poses health risks of particular concern for children and pregnant women. The health impacts for children exposed to lead include behaviour and learning problems, lower IQ and hyperactivity, slowed growth, hearing problems, and anemia. In rare cases, ingestion of lead can cause seizures, coma and even death. For pregnant women, health risks include reduced growth of the fetus and premature birth. Adults exposed to lead also have a higher risk of cardiovascular effects increased blood pressure, the incidence of hypertension, decreased kidney function and risk of reproductive problems in both men and women.

Read more about lead poisoning here and here.

Polycyclic aromatic hydrocarbons

Polycyclic aromatic hydrocarbons (PAH) are present in the atmosphere in particulate form. They are a group of chemicals formed primarily from incomplete combustion of organic matter (e.g. cooking of meat) as well as fossil fuels in coke ovens, diesel engines and wood-burning stoves. They are also emitted from tobacco smoke. Short-term exposure can irritate eyes and breathing passages. Long-term exposure to PAH has been linked to lung cancer.

Read more about polycyclic aromatic hydrocarbons here.

Formaldehyde

Formaldehyde is a colourless gas with a pungent smell. It is one of the most common volatile organic compounds (VOCs) found indoors. Formaldehyde is emitted from building materials (e.g. particleboard, plywood, glue, paints) as well as household and personal care products (e.g. drapes, carpets, cleaning products, hair sprays). Additional indoor sources may be combustion processes such as smoking, heating, cooking, or candle or incense burning.

Short-term exposure to formaldehyde can lead to eye, nose and throat irritation as well as increased allergic sensitization. However, long-term exposure to formaldehyde has been associated with nasopharyngeal cancer.

Read more about formaldehyde here.

Radon: Radon (Rn) is a radioactive gas that emanates from certain rock and soil formations, concentrating in the basement or ground levels of homes, in the absence of inadequate ventilation or evacuation systems.

Recent studies on indoor radon in Europe, North America and Asia indicate that lung cancers attributable to radon may range from 3% to 14%, making radon the leading cause of lung cancer among non-smokers.

Read more about radon here.

The table below highlights the recommended guideline value for each pollutant.

Pollutant	Guideline value	Averaging time	Guideline reference
$PM_{2.5}$	5 µg/m^3 15 µg/m^3	Annual 24-hour	World Health Organization, 2021
PM_{10}	15 µg/m^3 45 µg/m^3	Annual 24-hour	World Health Organization, 2021
Carbon monoxide	4 mg/m^3	24-hour	World Health Organization, 2021
Nitrogen dioxide	10 µg/m^3 25 µg/m^3	Annual 24-hour	World Health Organization, 2021
Sulfur dioxide	40 mg/m^3	24-hour	World Health Organization, 2021
Formaldehyde	0.1 mg/m^3	30-minute	World Health Organization, 2010
Polycyclic aromatic hydrocarbons	8.7 × 10–5 per ng/m^3		World Health Organization, 2010
Radon	100 Bq/m^3		World Health Organization, 2010

Lead	0.5 µg/m^3	Annual	World Health Organization. Regional Office for Europe, 2000

The pollutants highlighted below do not have quantitative guideline limits, but they are included in the WHO Global Air Quality Guidelines due to their potential health impacts.

Black carbon

Black carbon is a major component of $PM_{2.5}$ and it is sometimes referred to as soot and its main sources are from incomplete combustion of fossil fuels, biofuels and biomass. It can be emitted both from anthropogenic (e.g. diesel vehicles, biomass cookstoves) and natural (e.g. wildfires) sources. It is also a potent warming agent in the atmosphere and contributes to regional environmental disruption and accelerates glacier melting.

Short- and long-term exposure to black carbon has been associated with cardiovascular health effects and premature mortality.

Read more about the health effects of black carbon here and here.

Ultrafine Particles

Ultrafine particles (UFP) are particulate matter with a diameter less than or equal to 0.1 micrometer. The main source of UFP is combustion processes in transportation (e.g. vehicles, aviation, shipping), industrial and power plants and residential heating.

Exposure to UFP can increase the likelihood of pulmonary, cardiovascular and ischaemic heart diseases.

Read more ultrafine particles here or here.

Mould

Moisture build-up, mould and bacterial growth can occur as a result of structural building faults, inadequate heating and insulation, or inadequate ventilation.

These produce allergens and irritants that can cause asthma attacks among those allergic to mould. They also irritate the eyes, skin, nose, throat, and lungs of both mould-allergic and non-allergic people.