

Effect of pollution on Health

Blythe Mansfield, MD, FACOEM
Occupational Medicine



What is Air Pollution?

- Complex mixture of gas and particles (PM)
 - – SO₂
 - – CO
 - – NO₂
 - – Ozone
 - – Lead
 - – PM_{2.5} and PM₁₀
 - – Toxics (mainly related to specific sources ex) methane, smog
- Important sources include:
 - Natural: wildfires, volcanoes, methane, etc
 - Manmade: cars, trucks, industrial processes, wood heaters and ships
- Inevitably, in urban areas exposure to pollutants often come from multiple sources

Air pollution

The Clean Air Act requires EPA to set National Ambient Air Quality Standards (NAAQS) for six common air pollutants (also known as "criteria air pollutants").

These pollutants are found all over the U.S., some from natural sources and some from man-made sources.

They can harm your health and the environment, and cause property damage

Air pollution is a significant contributor to illness and increased mortality rates and can be measured by the air quality index



Health Effects

- Exposure to high levels of air pollution (short and long term) can cause a variety of adverse health outcomes
 - respiratory diseases and infections
 - heart disease
 - lung cancer
- Children, elderly, people with existing diseases, and minority communities are more susceptible

Exposure to Air Pollution

Acute or Immediate

- Air Pollution Episode – short-term increase concentrations
- Bronchitis

Chronic or delayed

- chronic bronchitis, lung cancer, asthma and respiratory allergies

Dependent on local conditions

- Sunshine can **cause** some **pollutants** to undergo chemical reactions, resulting in the development of smog.
- Higher **air** temperatures can speed up chemical reactions in the **air**.

Epidemiological

- Relationship between environmental factors and human disease
- Population susceptibility
- Latency period
 - Lung cancer – up to 30 years

Pollutant interactions

- acute and cumulative effects of combinations of pollutants is not well understood

EPA Administrator Announces Agency Actions to Advance Environmental Justice

Administrator Regan Directs Agency to Take Steps to Better Serve Historically Marginalized Communities

04/07/2021

•“Too many communities whose residents are predominantly of color, Indigenous, or low-income continue to suffer from disproportionately high pollution levels and the resulting adverse health and environmental impacts,” **said EPA Administrator Michael S. Regan in a message to all agency staff.** “We must do better. This will be one of my top priorities as Administrator, and I expect it to be one of yours as well.”



EPA proposes to:

1. Strengthen enforcement of violations of environmental statutes and civil rights laws in communities overburdened by pollution
2. Take immediate steps to incorporate environmental justice considerations while assessing impacts to pollution-burdened, underserved, and Tribal communities
3. Take immediate steps to improve early and more frequent engagement with pollution-burdened and underserved communities affected by agency rulemakings, permitting and enforcement decisions, and policies.
4. Prioritize direct and indirect benefits to underserved communities in the development of requests for grant applications and in making grant award decisions

The major historic air pollution problem has typically been high levels of **smoke** and **sulfur dioxide** arising from the combustion of sulfur-containing fossil fuels such as coal.

The major threat to clean air is now posed by traffic emissions. Gasoline and diesel-powered motor vehicles emit a wide variety of pollutants, principally carbon monoxide (CO), oxides of nitrogen (NO_x), volatile organic compounds (VOCs) and particulates (PM_{10}), which have an increasing impact on urban air quality.

In addition, photochemical reactions resulting from the action of sunlight on nitrogen dioxide (NO_2) and VOCs from vehicles leads to the formation of ozone, a secondary long-range pollutant, which impacts in rural areas often far from the original emission site.

Acid rain is another long-range pollutant influenced by vehicle NO_x emissions. In all except worst-case situations, industrial and domestic pollutant sources, together with their impact on air quality, tend to be steady-state or improving over time. However, traffic pollution problems are worsening world-wide.

What does air
pollution
include?

carbon monoxide

lead

ground-level ozone

particulate matter

nitrogen dioxide

sulfur dioxide

Carbon monoxide

Incomplete oxidation of carbon results in the production of carbon monoxide.

Natural CO formation occurs from photochemical reactions in the troposphere, volcanoes, forest fires, etc.

Breathing air with a high concentration of CO reduces the amount of oxygen that can be transported in the blood stream to critical organs like the heart and brain.

At very high levels, which are possible indoors or in other enclosed environments, CO can cause dizziness, confusion, unconsciousness and death.

CARBON MONOXIDE (CO) POISONING



**CAN'T BE
SEEN**

**CAN'T BE
SMELLED**

**CAN'T BE
HEARD**

**CAN BE
STOPPED**

This Photo by Unknown Author is licensed under [CC BY](#)

Lead poisoning

Sources of lead emissions vary from one area to another.

At the national level, major sources of lead in the air are ore and metals processing and piston-engine aircraft operating on leaded aviation fuel.

Other sources are waste incinerators, utilities, and lead-acid battery manufacturers. The highest air concentrations of lead are usually found near lead smelters.

Volcanic activity and airborne soil are the primary natural sources of atmospheric lead.

Lead:

As a result of EPA's regulatory efforts including the removal of lead from motor vehicle gasoline, levels of lead in the air decreased by **98** percent between 1980 and 2014.

Once taken into the body, lead distributes throughout the body in the blood and is accumulated in the bones.

Depending on the level of exposure, lead can adversely affect the nervous system, kidney function, immune system, reproductive and developmental systems and the cardiovascular system.

Lead exposure also affects the oxygen carrying capacity of the blood.



Ground Level Ozone

Ozone is formed in the atmosphere when energetic ultraviolet (UV) radiation dissociates molecules of oxygen, O_2 , into separate oxygen atoms.

Free oxygen atoms can recombine to form oxygen molecules but if a free oxygen atom (O^{-2}) collides with an oxygen molecule (O_2), it joins up, forming ozone (O_3).

Ozone

Breathing ozone can trigger a variety of health problems, particularly for children, the elderly, and people of all ages who have lung diseases such as asthma.

Ground level ozone can also have harmful effects on sensitive vegetation and ecosystems.

Particulate matter;
PM; of aerodynamic
diameters 10
microns or less
[PM10] and very fine
particles with
aerodynamic
diameter of 2.5
microns or less
[PM2.5]

Sea salt, soil dust, volcanic particles, smoke from forest fires account for particulate emissions each year.

Small particles are removed from the atmosphere by accretion to water droplets, which grow in size until they are large enough to precipitate.

Larger particles are removed by direct washout by falling raindrops.

Particulate matter

EPA groups particle pollution into two categories:

"Fine particles," such as those found in smoke and haze, are 2.5 micrometers in diameter and smaller. These particles can be directly emitted from sources such as forest fires, or they can form when gases emitted from power plants, industries and automobiles react in the air.

"Inhalable coarse particles," such as those found near roadways and dusty industries, are larger than 2.5 micrometers and smaller than 10 micrometers in diameter.

Nitrous Oxides

- Nitrogen Dioxide (NO_2) is one of a group of highly reactive gases known as oxides of nitrogen or nitrogen oxides (NO_x).
- Although some is naturally occurring, NO_2 primarily gets in the air from the burning of fuel.
- NO_2 forms from emissions from cars, trucks and buses, power plants, and off-road equipment.
- Breathing air with a high concentration of NO_2 can irritate airways in the human respiratory system.
- Such exposures over short periods can aggravate respiratory diseases, particularly asthma, leading to respiratory symptoms (such as coughing, wheezing or difficulty breathing), hospital admissions and visits to emergency rooms.

Sulfur Oxides

-
- The largest source of SO_2 in the atmosphere is the burning of fossil fuels by power plants and other industrial facilities.
 - Smaller sources of SO_2 emissions include:
 - industrial processes such as extracting metal from ore
 - natural sources such as volcanoes
 - and locomotives, ships and other vehicles and heavy equipment that burn fuel with a high sulfur content.
 - Short-term exposures to SO_2 can harm the human respiratory system and make breathing difficult. Children, the elderly, and those who suffer from asthma are particularly sensitive to effects of SO_2 .

Benzene

COLORLESS, FLAMMABLE LIQUID THAT HAS A SWEET SMELL AND EVAPORATES QUICKLY WHEN EXPOSED TO THE AIR

KNOWN CARCINOGEN, AND IT IS ONE OF THE 20 MOST WIDELY USED CHEMICALS IN PRODUCTION IN THE US AND PRESENT IN TWO MAJOR AREAS OF EXPOSURE TO THE POPULATION: *AUTO EXHAUST AND CIGARETTE SMOKE*

LONG TERM EFFECTS: RISK FOR APLASTIC ANEMIA; EXCESSIVE BLEEDING; LEUKEMIA; NON-HODGKIN'S LYMPHOMA AND MULTIPLE MYELOMA

SHORT TERM EFFECTS: LARGE DOSES OF BENZENE EXPOSURE IS RARE BUT CAN CAUSE SEVERE EFFECTS INCLUDING PARALYSIS, COMA, CONVULSIONS, DIZZINESS, SLEEPINESS, RAPID HEART RATE, CHEST TIGHTNESS, TREMORS, AND RAPID BREATHING

Butadiene

Acute low exposures may cause irritation to the eyes, throat, nose, and lungs. Frostbite may also occur with skin exposure

Acute high exposures may cause damage to the central nervous system or cause symptoms such as distorted blurred vision, vertigo, general tiredness, decreased blood pressure, headache, nausea, decreased pulse rate, and fainting

Chronic effects: potential increased risk in cardiovascular diseases and cancer

Environmental and occupational causes of health problems: Immediate or short-term effects

Immediate or short-term effects	Agent	Potential exposures
Dermatoses (allergic or irritant)	Metals (chromium, nickel), fibrous glass, epoxy resin, cutting oils, solvents, caustic alkali, soaps	Electroplating, metal cleaning, plastics, machining, leather tanning, housekeeping
Headache	Carbon monoxide, solvents	Firefighting, automobile exhaust, foundry, wood finishing, dry cleaning
Behavioral changes	Lead (especially organic), mercury, carbon disulfide, manganese	Handling gasoline, fungicide, wood preserving, viscose, rayon industry, mining
Asthma or dry cough	Formaldehyde, toluene diisocyanate, animal dander, latex, chemical irritants	Textiles, plastics, polyurethane kits, car painting, lacquer use, animal handling, latex glove use
Pulmonary edema, pneumonitis	Nitrogen oxides, phosgene, halogen gases, cadmium	Welding, farming ("silo filler's disease"), chemical operations, smelting
Cardiac arrhythmias	Solvents, fluorocarbons, carbon monoxide	Metal cleaning, solvent use, refrigerator maintenance, automobile exhaust
Angina	Carbon monoxide	Car repair, traffic exhaust, foundry, wood finishing
Abdominal pain	Lead	Battery making, enameling, smelting, painting, welding, ceramics, plumbing, radiator repair
Hepatitis (may become a long-term effect)	Halogenated hydrocarbons (eg, carbon tetrachloride), dimethylformamide, viral infection	Solvent use, lacquer use, hospital work, electroplating, plastic manufacturing
Tendonitis, carpal tunnel syndrome, "repetitive strain disorder" (may become a long-term effect)	Repetitive motions, awkward postures, pinching motions, wrist flexion	Assembly work, keyboarding, data entry, material handling

What can citizens do to protect themselves?

- Fighting air pollution is everybody's responsibility
 - government, business, and individual – we are all accountable
- **national governments:** reduce emissions and set national standards that meet air quality guidelines. Invest in research and education around clean air and pollution
- **cities and local communities:** Public policies across sectors must factor in public health from the beginning, followed up with sufficient data and tools to assess them
- **individuals:** Continue to stand up for your right to healthy and sustainable environments. Hold your governments accountable

Questions?

