

THE CONTRIBUTION OF AIR POLLUTION TO HEALTH AND ENVIRONMENT

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ABSTRACT

Air pollution is a major concern of innovative civilized world, which has a serious toxicological effect on human health and the environment. It has a number of different emission sources, but motor vehicles and industrial processes contribute the major part of air pollution.

The contribution of air pollutants on living organism will not only be limited to the human and animal health but also include the whole environment. Different geographical conditions, global climate changes, and the environmental variations affect the human health and the environment.

People exposed to high concentrations of air pollutants contribute disease symptoms. These contributions are grouped into short- and long-term effects affecting health. Long- and short-term exposure to air suspended toxicants has a different toxicological effect on human including respiratory and cardiovascular diseases, neuropsychiatric complications, the eyes irritation, skin diseases, and cancer.

According to the World Health Organization, six major air pollutants include particle pollution, ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead.

In this review article, we aimed to discuss toxicology of major air pollutants, sources of emission, and their effect on human health.

Keywords: Air pollution, cardiovascular diseases, environment, human health, respiratory tract diseases, toxicology.

INTRODUCTION

Air pollution is a major problem of recent decades, which has a serious toxicological effect on human health and the environment. The sources of pollution vary from minor unit of cigarettes and natural sources such as volcanic activities to large volume of emission from motor engines of automobiles and industrial activities. A long-term effect of air pollution on the onset of diseases such as respiratory infections and inflammations, cardiovascular disfunctions, and cancer is extensively accepted; hence, air pollution is linked with millions of deaths globally each year.

A recent study has revealed the association between male infertility and air pollution. Therefore, it is of great importance to describe the problem, particularly its toxic effects on human health and provide recommendations as a basis for environmental guidelines and standard protocols in the field of air pollution.

In the present article, we have tried to summarize the toxicology of air pollutants and related diseases with a possible mechanism of action and suitable management of the patients. Therefore, it shall be useful for the environmental and health particularly air pollution and related diseases.

Effects of Air Pollution on Human Health

Air pollution associates the respiratory system; however, air pollution is also affecting the circulatory system and the nervous system. When particular matter enters the nasal cavity, the lining gets irritated and the body may mistake it for an infection.

Every material in the air, which can affect human health or have an extremely effect on the environment. According to the World Health Organization (WHO), Particle pollutants (PM), ground-level Ozone (O₃), Carbon Monoxide (CO), Nitrogen Oxide (NO₂), Sulfur dioxide (SO₂), and lead (Pb) are the six major air pollutants which harm human health and also

the ecosystem. There are many pollutants of suspended materials such as dust, fumes, smokes, mists, gaseous pollutants, hydrocarbons, volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and halogen derivatives in the air which at the high concentrations cause susceptibility to many diseases including different types of cancers. The most important air pollutants and their toxic effects on different human body organs and related diseases have been briefly described below:

1. Particle pollutants (PM)

Particle pollutants (PM) are major parts of air pollutants. In a simple definition, they are a mixture of particles found in the air. Particle pollution (PM) is linked with most of respiratory and cardiac-associated morbidity and mortality. The size of particle pollutants is ranging mostly from 2.5 to 10 μm . Particles of smaller size reach the lower respiratory tract and thus have greater potential for causing the lungs and heart diseases.

Long-term exposure to current ambient PM concentrations may lead to a marked reduction in life expectancy. The increase of cardiopulmonary and lung cancer mortality are the main reasons for the reduction in life expectancy. Reduced lung functions in children and adults leading to asthmatic bronchitis.

2. Ozone (O_3)

Ozone (O_3) is a colorless gas which is the major constituent of the atmosphere. It is found both at the ground level and in the upper regions of the atmosphere which is called troposphere. Ground-level ozone (GLO) is produced as a result of chemical reaction between oxides of nitrogen and volatile organic compounds (VOCs) emitted from natural sources and/or due to human activities. GLO is believed to have a reasonable association with increased risk of respiratory diseases, particularly asthma.

Ozone (O_3) is a gas formed from oxygen under high voltage electric discharge. It is a strong oxidant, 52% stronger than chlorine. It arises in the stratosphere, but it could also arise following chain reactions of photochemical smog in the troposphere.

Ozone (O_3) induces a variety of toxic effects in humans and animals at concentrations that occur in many urban areas. These effects include morphologic, functional, immunologic,

and biochemical alteration. Because of its low water solubility, a substantial portion of inhaled O₃ penetrates into the lungs but its reactivity is scrubbed by the nasopharynx of latent rats and humans in around 17% and 40%, respectively. On ecological feature, O₃ can reduce carbon absorption in trees leading to deforestation which may affect global food security in long-term exposure.

Ozone uptake usually occurs by inhalation. Ozone affects the upper layers of the skin and the tear ducts. A study of short-term exposure to high levels of ozone showed malondialdehyde formation in the upper skin but also reduction in vitamins C and E. It is expected that ozone levels are not interfering with the skin barrier function and influence to skin disease. Due to the low water-solubility of ozone, inhaled ozone has the capacity to penetrate deeply into the lungs.

Ozone concentrations compared to the daily number of deaths were reported from different European cities. During the warm period of the year, an observed increase in ozone concentration was associated with an increase in the daily number of deaths (0.33%), in the number of respiratory deaths (1.13%), and in the number of cardiovascular deaths (0.45%).

3. Carbon Monoxide (CO)

Carbon Monoxide (CO) is a colorless and odorless gas, which is produced by fossil fuel, particularly when combustion is incomplete, as in burning coal and wood. The affinity of CO to hemoglobin (as an oxygen carrier in the body) is about 250 times greater than that of oxygen. Depending on CO concentration and length of exposure, mild to severe poisoning may occur. The symptoms of poisoning due to inhaling carbon monoxide include headache, dizziness, weakness, nausea, vomiting, and, finally, loss of consciousness.

Carbon monoxide affects the greenhouses gases that are closely connected to global warming and climate. This should lead to an increase in soil and water temperatures, and extreme weather conditions or storms may occur.

4. Nitrogen Oxide (NO₂)

Nitrogen oxides (NO₂) are important ambient air pollutants which may increase the risk of respiratory infections. Nitrogen oxide is a traffic-related pollutant, as it is emitted from

automobile motor engines. It is an irritant of the respiratory system as it penetrates deep in the lung, inducing respiratory diseases, coughing, wheezing, dyspnea, bronchospasm, and even pulmonary edema when inhaled at high levels.

It is reported that long-term exposure to high levels of nitrogen dioxide can be responsible for chronic lung disease. Long-term exposure to NO₂ can damage the sense of smell. Coughing and wheezing are the most common complication of nitrogen oxides toxicity, but the eyes, nose or throat irritations, headache, dyspnea, chest pain, diaphoresis, fever, bronchospasm, and pulmonary edema may also occur. It is suggested that the level of nitrogen oxide between 0.2 and 0.6 ppm is harmless for the human population.

High levels of nitrogen dioxide are harmful to crops and vegetation, as they have been observed to reduce crop yield and plant growth efficiency. Moreover, NO₂ can reduce visibility and discolor fabrics.

5. Sulfur dioxide (SO₂)

Sulfur dioxide (SO₂) is a colorless, highly reactive gas, which is considered as an important air pollutant. Sulfur dioxide is a harmful gas that is emitted mainly from fossil fuel consumption, natural volcanic activities, and industrial processes. SO₂ is very harmful for plant life, animal, and human health. People with lung disease, children, older people, and those who are more exposed to SO₂ are at higher risk of the skin and lung diseases.

According to the Environmental Protection Agency (EPA) of the USA, the level of annual standard for SO₂ is 0.03 ppm. Due to its solubility in water, SO₂ is responsible for acid rain formation and acidification of soils. SO₂ reduces the amount of oxygen in the water causing the death of marine species including both animals and plants. Exposure to SO₂ can cause damages to the eyes (lacrimation and corneal opacity), mucous membranes, the skin (redness, and blisters), and respiratory tracts.

6. Lead (Pb)

Lead (Pb) or plumb is a toxic heavy metal that is widely used in different industries. Pb pollution may result from both indoor and outdoor sources. It is emitted from motor engines, particularly with those using petrol containing lead tetraethyl. Smelters and battery plants, as

well as irrigation water wells and wastewaters, are other emission sources of the Pb into the environment. Moreover, major sources of lead pollution in the air are metals, ore, and piston-engine aircraft. Lead poisoning is a risk to public health due to its harmful effects upon humans, animals, and the environment.

Lead toxicity affects the fetal nervous system; edema or swelling of the brain is observed. Lead, when inhaled, accumulates in the blood, soft tissue, liver, lung, bones, and cardiovascular, nervous, and reproductive systems. Moreover, loss of concentration and memory, as well as muscle and joint pain, were observed in adults.

Elevated amounts of lead in the environment are harmful to plants and crop growth. Neurological effects are observed in vertebrates and animals in association with high lead levels.

7. Polycyclic Aromatic Hydrocarbons (PAHs)

The contribution of Polycyclic Aromatic Hydrocarbons (PAHs) is global in the environment, as the atmosphere is the most important means of their dispersion. They are found in coal and in tar residues. Moreover, they are generated through incomplete combustion of organic matter as in the cases of forest fires, ignition, and engines. PAH compounds, such as benzopyrene, acenaphthylene, anthracene, and fluoranthene are recognized as toxic, mutagenic, and carcinogenic substances. They are as significant risk factor for lung cancer.

8. Volatile Organic Compounds (VOCs)

Volatile organic compounds (VOCs), such as toluene, benzene, ethylbenzene, and xylene, have been found to be associated with cancer in humans. The use of new products and materials has actually resulted in increased concentrations of VOCs.

Volatile organic compounds (VOCs) pollute indoor air and may have adverse effects on human health. Short-term and long-term adverse effects on human health are observed. VOCs are responsible for indoor air smells. Short-term exposure is found to cause irritation of eyes, nose, throat, and mucosal membranes, while those of long duration exposure include toxic reactions. Predictable assessment of the toxic effects of complex VOC mixtures is difficult to estimate, as these pollutants can have synergic, antagonistic, or indifferent effects.

9. Dioxins

Dioxins originate from industrial processes but also come from natural processes, such as forest fires and volcanic eruptions. They accumulate in foods such as meat and dairy products, fish and shellfish, and especially in the fatty tissue of animals.

Short-period exhibition to high dioxin concentrations may result in dark spots and lesions on the skin. Long-term exposure to dioxins can cause developmental problems, loss of the immune, endocrine and nervous systems, reproductive infertility, and cancer.

Other air pollutants

Other major air pollutants that are classified as carcinogen and mutagen compounds and are thought to be responsible for incidence and progression of cancer in human include VOCs such as benzene, toluene, ethylbenzene, and xylene, PAHs such as acenaphthene, acenaphthylene, anthracene, and benzopyrene, and other organic pollutants such as dioxins, which are unwanted chemical pollutants that almost totally produced by industrial processes and human activity.

CONCLUSION

Air pollution is defined as all critical effects of any sources which contribute to the pollution of the atmosphere and/or deterioration of the ecosystem. Air pollution is caused by both human interventions and/or natural phenomena. It is made up of many kinds of pollutants including materials in solid, liquid, and gas phases

When the industry doesn't follow the government regulations to curb air pollution, several pollutants get released into the air. From nitrogen oxide to carbon monoxide, these gases are harmful to human health. It can lead to irritation in the eyes, throat, breathing and more.

When we burn fossil fuels, such as coal or oil, carbon monoxide gets released into the air and pollutes the air we breathe. When we inhale the toxic air, it deteriorates our heart's ability to pump the oxygen and leads to various respiratory illnesses

Use of chemical infused products and vehicle pollution can cause the release of harmful pollutants into the air. When vehicle pollution becomes excessive, it can create a hole in the ozone layer, which leads to smog and other various health issues.

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