



An Overview of the Effects of Polluted Outdoor Air on Human Health

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ABSTRACT

Air pollution is a major concern in third-world countries as a result of industrialization, modernization, and population growth. In addition, hazardous gases from automobile and industrial exhaust continue to be added to the atmosphere, making the overall concentration of pollutants worse every day. People have come to understand that breathing filthy air might be detrimental to their health. Public health risks like cardiovascular illness, respiratory disorders, chronic obstructive pulmonary disease (COPD), and asthma are on the rise all over the world, and outdoor air pollution is a major contributor. Sources, contaminants, exposures, and health impacts of outdoor air pollution are reviewed, along with the current state of the problem and projected future developments. The purpose of this review was to compile data from various studies to paint a picture of where we stand in terms of understanding the connection between outdoor air pollution and health; to educate the public on the risks associated with prolonged exposure to such pollution, and to suggest strategies for counseling at-risk populations to lessen their exposure.

KEY WORDS

Pollution, Health, Industrialization.

INTRODUCTION

Any atmospheric state in which certain compounds are present in such amounts that may have adverse effects on man and its surroundings is referred to as "air pollution." Air pollution is a threat to health on a global scale and has major implications for public health, particularly for the health of children and the elderly. The term "air pollution" refers to any contaminants that can be found in the atmosphere in

the form of gases or particulate matter, as well as biologically derived particles. The characteristics of populations in terms of their demographics and epidemiology in ways that are likely to determine how vulnerable they are to air pollution. The growth in the number of automobiles, machines, factories, and other sources of oxides contributes to the pollution of the environment. There are serious issues with outdoor air pollution in emerging countries, particularly in large cities like Beijing, Shanghai, Bombay, Karachi, Cairo, Sao Paulo, and Mexico City (Mage, 1996; Akimoto, 2003). These cities are located in developing countries. It is a well-established truth that wealthy nations are responsible for a greater amount of air pollution than emerging nations. Developed countries have robust economies, and their lifestyles differ significantly from those of emerging and under-developing countries; as a result, developed countries utilize their natural resources to a greater extent. However, there are still a lot of issues with the quality of the air outside in the industrialized world, and some of these can be made more unpleasant by the growing use of motor vehicles and industrial pollutants. Air pollution has been closely linked to the spread of human civilization ever since humans first discovered how to use fire. According to Menon et al. (2002), when industrialization became a primary driver of development, the urban climate and air quality underwent dramatic shifts, which in turn caused significant shifts in the hydrological cycle, agriculture, and the distribution of rainfall, as well as an increase in the frequency and severity of droughts and floods.

According to Munn's research from 1981, the levels of air pollution that are present in metropolitan areas change over time and move about. Human actions have a significant impact on the passage of time and its various manifestations. Several activities take place repeatedly at regular intervals, which produces cycles in the changes that occur in air pollution. These cycles include daily variations in CO₂ concentration as a result of the change in traffic density or seasonal variations in air pollution, for example, from heating systems that in moderate climates operate primarily in the cold months (Fugas et al., 1991). According to O'Neill et al. (2012), the genetic profile, race and ethnicity, lifestyle, behaviours, socioeconomic position, and location of the home or daily activities can all be associated with a human's vulnerability to developing unfavorable health impacts as a result of being exposed to air pollution.

The quality of the air in cities is very important and has significantly improved the lives of all living things. According to research that was conducted not too long ago in a variety of locations throughout the world, there has been an increase in the levels of ozone (O₃) and particulate matter (PM), which has resulted in an increase in the number of people suffering from respiratory and cardiovascular disorders (Garrett and Casimiro, 2011). The chemical reaction of several different contaminants coming from a number of different sources led to the contamination of the outside air. This is analogous to a massive amount of smog, which contributes to a variety of health problems. The impact of outdoor air pollution is greatest during the warmer months of the year relative to the cooler months. The emission of methane following digestion by cattle is one of the natural factors that contribute to outdoor air pollution. Other natural factors include radioactive decay, emissions from wildfires, and deposits of sulphur and chlorine following volcanic eruptions; however, these factors contribute very little to the problem and can be managed. Outdoor air pollution contributes to a number of significant environmental problems, including the greenhouse effect, ozone depletion, and acid rain.

The combustion of fossil fuels, which are utilized for the generation of energy and transportation, is the primary and most significant cause of air pollution. The majority of less developed countries' rising reliance on fossil fuels drives up industrial emission levels, which in turn drives up the overall rate of air pollution in such countries. The expanding human population is one of the primary contributors to the problems of pollution and overcrowding in urban areas. The effects of pollution in the air can vary greatly depending on factors such as latitude, altitude, temperature, wind, and other elements of the environment.

Table 1: Different air pollutants and their effects

Pollutant	Sources	Health Effects	References
Particulate Matter	Automobile, bus and truck exhaust, fuel burning (wood stoves, fireplaces), industry, construction.	- Infant respiratory mortality. - Lung function decreases. - Lung growth decreases. - Symptoms in asthmatics.	Muneeswaran et al., 2012; Poschl, 2005
Ozone	Formed when nitrogen oxides (vehicle emissions) and volatile organic compounds (VOC) chemically react under sunlight.	- Decreases lung growth. - Asthma exacerbations. - All respiratory hospitalization. - Asthma hospitalization. - School absence for respiratory illness.	Krupa and Manning, 1988; Amato et al., 2002; Akimoto, 2003
Gaseous pollutants	Nitrogen dioxide (NO ₂)	- Symptoms in asthmatics. - Nitrogen dioxide can irritate the lungs and lower resistance to respiratory infections such as influenza.	Ackermann-Liebrich and Rapp, 1999
	Carbon Monoxide (CO)	- Exposure to elevated CO levels is associated with visual impairment, reduced work capacity, and reduced manual dexterity.	Baldauf, 2009; Brook et al., 2004
Sulphur Dioxide (SO ₂)	Industrial sites such as smelters, paper mills, power plants, and steel manufacturing plants are the main sources.	- Irritates the nose, throat, and airways, causing coughing, wheezing, shortness of breath, or a tight feeling around the chest.	Amato et al., 2002; Akimoto, 2003
Persistent Organic Pollutants	Pesticides, industrial chemicals, and unintentional by-products of chemical and/or combustion processes.	- Effects on the reproductive potential of fish-eating birds. - Organochlorines such as DDT affect birds' eggshell thickness.	N/A
Heavy Metals	Natural sources (volcanoes, degradation of minerals, forest fires, evaporation from soil and water surfaces).	- Short-term exposure to high levels of dioxins may result in skin lesions (chloracne), patchy darkening of the skin, and altered liver function.	Schechter et al., 2006; Hu and Shy, 2001; Lee et al., 2002; Godish, 2003; Wu et al., 2006

According to research conducted by the World Health Organisation (WHO), the air quality in large cities in many developing countries is shockingly bad. WHO also discovered that very large numbers of people in these countries are exposed to ambient concentrations of air pollutants that are well above the WHO's guidelines for air quality (Ambient Air Pollution: Health Hazards to Children, 2004, A Guide to Children's Health).

Different Kinds of Pollutants in the Air

Air pollutants are distinguished from one another by their chemical make-up, reactive qualities, capacity to emit into the environment, length of time they remain there, their ability to be carried over long or short distances, and the eventual effects they have on the health of animals and/or humans. On the other hand, they have some things in common with one another, and this allows us to classify them according to the categories in Table 1 and the causes of air pollution according to Table 2.

Table 2: Sources of air pollution

Traffic	Janssen and coworkers recently demonstrated that health impact assessments of traffic-related pollutants based upon PM 2.5 seriously underestimated the health risks compared to an assessment based upon elemental carbon (Janssen NA et al., 2011). There is also growing evidence of health effects related to ultrafine particles (Rückerl R et al., 2011).
Bioaerosols: molds, bacteria, pollen and others	Bioaerosols are airborne particles (seeds, spores, dander etc.) produced by living organisms. Such bioaerosols include pollen, seeds, bacteria, gram negative bacterial endotoxins, molds (fungi), algae, protozoans, flour, latex and animal dander/waste products. Some bioaerosols are hazardous since they are infectious and/or produce allergens and toxins. Mold spores can travel thousands of miles across the Pacific and Atlantic Oceans and land on other continents (Shinn et al., 2003).
Chemicals	Major sources include petroleum refining, petrochemicals, vehicle exhaust, natural gas fields and distribution lines, storage of fuels and wastes, household products, pesticides, combustion, many industries and volatile emissions from coniferous forests (Breas O, 2003). The chemicals are very harmful and hazardous to human health.

Various Ways to Get Exposed

The major routes of exposure for humans to various air pollutants are inhalation and ingestion, while skin contact is considered a minor channel of exposure. Air pollution plays a significant role in the contamination of food and water, which makes ingestion the primary route of pollutant intake in many instances (Thron, 1996). Absorption of pollutants can take place via the gastrointestinal and respiratory tracts, while a number of toxic substances can be found in the general circulation and deposited in different tissues. Excretion is responsible for some of the elimination processes, according to Madden and Fowler (2000). According to Kampa et al. (2007), the composition of air pollutants, the amount of exposure, the length of time, and being exposed to pollutant mixes as opposed to single compounds can all contribute to a variety of effects on human health.

Health Hazards to Children

Because children spend more time outdoors than adults do, they have increased exposure to outdoor air pollution (Wiley et al., 1991). As a result, children are more susceptible to the negative effects of air pollution than adults. According to Ciccone et al. (1998), living in places with high traffic density, particularly truck traffic, is related to an increased risk of respiratory tract issues in children. These complications include wheezing, chronic productive cough, and hospitalizations due to asthma. Other researchers have found a connection between proximity to traffic and a variety of childhood malignancies (Raaschou-Nielsen et al., 2001). Children whose communities had higher levels of urban air pollution (acid vapour, nitrogen dioxide, particulate matter with a median aerodynamic diameter less than 2.5 µm [PM 2.5], and elemental carbon (a component of diesel exhaust)) had decreased lung function growth, and children who spent more time outdoors had larger deficits in the growth rate of lung function (Gauderman et al., 2002). These findings were published in the journal *Environmental Health Perspectives*. Asthma, a disease that can be persistent over time, is one of the health problems that can be attributed to exposure to air pollution. Asthma attacks can be triggered by a variety of environmental factors, including ozone, sulphur dioxide, particulate matter (dust, ash), and nitrogen oxide. According to Mission (2012), the primary factor in the development of asthma in children is exposure to pollutants in their environments, most notably in the air they breathe outside.

Hazards to the Elderly Person's Health

Even at levels from low to moderate, exposure to contaminants in the outdoor air can significantly exacerbate respiratory difficulties in the aged population. According to the findings of a study that was conducted between the years 1980 and 1995 on inhabitants of Tokyo who were over the age of 65, increased airborne outdoor PM10 concentrations were associated with substantially higher incidence of asthma and bronchitis (p < 0.001 in both cases). This research was published in Ye et al., 2001. According to research carried out by Chen et al. (2004) in Vancouver, Canada, higher levels of PM2.5 were found to be associated with considerably increased rates of hospitalization for chronic obstructive pulmonary disease in aged participants. (Moolgavkar et al., 1997) found that higher outdoor levels of O₃, PM₁₀, SO₂, and NO₂ were related to significantly higher rates of hospital admissions for chronic obstructive pulmonary disease in Minneapolis, Minnesota, but were not related to significantly higher rates of chronic obstructive pulmonary disease admissions in Birmingham, Alabama. The study was conducted in both cities.

Table 3: National Ambient Air Quality Standards

Pollutant	Annual * µg/m ³	24 Hours ** µg/m ³	Area	Methods of Measurement
Sulphur Dioxide (SO ₂)	50	80	Industrial, Residential, Rural, and other Areas	- Improved West and Gaeke Method - Ultraviolet Fluorescence
Nitrogen Dioxide (NO ₂)	40	80	Industrial, Residential, Rural, and other Areas	- Jacob & Hochheiser modified (NaOH-NaAsO ₂) Method - Gas Phase Chemiluminescence - Gravimetric - TEOM - Beta Attenuation UV Photometric - Chemical Method AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper - ED-XRF using Teflon filter - Non-dispersive Infrared (NDIR) Spectroscopy - Chemiluminescence - Indophenol blue method - Gas Chromatography (GC) based continuous analyzer - Adsorption and desorption followed by GC analysis
Particulate Matter (=10µm)	20	-	Industrial, Residential, Rural, and other Areas	- Gravimetric
Benzene (C ₆ H ₆)	5	80	Sensitive Area (Notified by Central Government)	- Ultraviolet Fluorescence
Benzo(a)Pyrene (BaP)	5	1	Sensitive Area (Notified by Central Government)	- Solvent extraction followed by HPLC/GC analysis
Arsenic (As)	6	6	Annual * 24 Hours **	- AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper
Nickel (Ni)	20	20	Annual * 24 Hours **	- AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper

(Source: NAAQS Monitoring & Analysis Guidelines Volume-I, CPCB, MAY, 2011)

Hazards to Plants

Plants also exhibited responses to air pollution. In the case of SO₂ and NO₂, the visible injury typically occurs as a result of exposure to pollutant concentrations that are above a point that is approximately an order of magnitude bigger than the threshold for growth and yield decreases in the absence of visual, i.e., injury. According to Rai et al. (2011), chronic damage. According to Taylor et al. (1987), acute injuries caused by these pollutants can take the shape of a variety of necrotic lesions. These lesions can range in size from a small stipple to huge areas of dead tissue, and their coloration can go from white to brown to black.

Hazards for the Animals

In addition, excessive ultraviolet radiation coming from the sun through the ozone layer in the upper atmosphere, which is eroded by some air pollutants, may cause skin cancer in wildlife; ozone in the lower atmosphere may damage lung tissue in animals; and acid rain, which is formed in the air, kills fish life in lakes and streams, which disrupts the aquatic ecosystem.

Hazards Posed to the Materials

The corrosion of metals, the deterioration of materials and paints, and the fading of dyes are three of the many adverse impacts that can be caused by air pollution on materials. There have been a variety of attempts

made to calculate the economic losses that have been incurred as a direct result of the negative effects caused by air pollution. Calcareous building stores and ferrous metals are the materials that are most susceptible to being damaged by contaminants. Losses in mass as well as changes in porosity and discolouration, as well as increased fragility, are all manifestations of deterioration. In the case of stone, it is difficult to separate the impacts of historical concentrations of pollution from those of current ones and to establish background rates of erosion or decay in the absence of pollutants. This is because it is difficult to dissociate the effects of past concentrations of pollution from those of current ones.

Standards for the Quality of the Air

There are two different types of air quality standards that are considered: primary standards and secondary standards. Primary standards are those that set limitations to protect public health, particularly the health of “sensitive” populations such as asthmatics, children, and the elderly. Secondary standards set limits to safeguard the environment. According to Kelishadi et al. (2009), secondary standards are restrictions that are established to protect public welfare. This includes protection against diminished visibility as well as damage to animals, crops, plants, and structures. Table 3 outlines the National Air Quality Standards for the United States.

Index of the Air’s Quality

The level of pollution in the air is an important factor in one’s overall health. According to Senthilnathan (2007), ambient air quality is also referred to as the air pollution index. This index measures points to determine the variation in the quantity of pollutants from the standard level and assists in determining the consequences that a rise in pollution has on human health. The Air Quality Index is a tool that is used by the EPA (2000) and other agencies to offer the general people up-to-date information on the air quality in their area that is also easy to grasp. According to Shukla et al. (2010), a high degree of air pollution is indicated by a value of an index that is greater than or equal to 125.

The following equation was utilized in order to determine the air quality index (AQI). The Air Quality Index (AQI) is equal to 100 times the observed mean concentration of a pollutant. According to Baldauf et al. (2009), determining the quality of the air requires not only knowing the types of pollutants that are being measured but also the precise location of those measurements.

Studies of Specific Instances of Outdoor air Pollution

Within the framework of the European Aphekom project, Pascal. In 2013, M et al. conducted a study in which they investigated the impact of ozone and particulate matter in 25 cities across Europe. The health dangers, rates of death, and the number of hospitalizations that can be attributed to urban air pollution are the focus of this investigation. They studied 39 million people living in 25 cities and found that cardiovascular mortality is highest in people aged 30 to over 60 years old in Budapest and Bucharest. This was the case across all of the cities. There were 2997 documented cases of cardiac hospitalization, which is a significant number in comparison to comparable cities. The city’s respiratory difficulties are also contributing to an increase in the number of reported cases. Multiple health impact analyses found that particulate matter (PM) and ozone were the root cause of many health problems in Europe. despite the fact that the concentrations of PM and ozone continue to be higher than what is recommended by the World Health Organisation Air Quality Guidelines (WHO-AQG). In Europe, the annual mean concentration of PM10 shouldn’t be more than 40 micrograms per cubic metre (the limit number was established in 2005), and Member States are asked to reduce exposure to PM2.5 in urban areas to below 20 micrograms per cubic metre by the year 2015.

The greatest developed country, like China, the economic standards lead to greater utilization of fossil fuel, which results in air pollution. China is also one of the world’s most polluted countries. According to the Chinese Ministry of Environmental Protection’s monitoring of 621 cities, there are 107 cities that do not fulfill the country’s national ambient air quality standards (NAAQS) (Chinese Ministry of Environmental Protection, 2010). Many health problems were reported in China’s cities in the previous year as a result of the grey sky

development. The death rate among the Chinese people is significantly lower when compared to that of Europe due to air pollution. It is advised that we use less fossil fuel in order to enhance air quality, which will also have the additional benefit of slowing climate change. The infant population in China is affected by outdoor pollution, which is a major cause for concern. Infants in homes close to main roads are more likely to suffer from asthma, persistent cough, and wheeze, while infants living in homes close to factories and chimneys are more likely to suffer from asthma, persistent cough, and wheeze (Guowei Pan et al.). Outdoor pollution affects the infant population in China, which is a significant cause for concern. (Guowei Pan et

As a result of a growth in population and the construction of unplanned roadways in Pakistan, an excessive amount of fuel has been burned, which has caused a number of issues for the environment. In a country that relies heavily on agriculture like Pakistan, the developmental activities lead to the conversion of many landmasses that were formerly used for agriculture into industrial zones. The primary contributors to air pollution are the exhaust fumes from motor vehicles and the waste products of industrial processes that are released into the atmosphere. According to research carried out by Syed Zafar Ilyas et al. (2009) in the most polluted city in Pakistan, Quetta, deteriorating air quality has detrimental effects on the human race.

According to the latest statistics from the Global Burden of Disease Report (The Centre for Science and Environment (CSE)), outdoor air pollution has surpassed high blood pressure, smoking tobacco, and inadequate nutrition to become the fifth leading cause of death in India. (Anjali et al., 2004) Research investigations in the city of Mumbai seek to discover volatile organic compounds (VOCs) in both the outdoor and indoor air. Analyzing the air quality state of Visakhapatnam based on indices requires the use of a non-linear equation for variable factors, such as suspended particle matter (SPM), oxides of nitrogen (NO_x), and sulphur dioxide (SO₂), which are the primary criterion pollutants in India. The current investigation makes use of data on seasonal air quality, which reveals that the SPM values during the winter at the majority of the locations and during the summer at only a handful of the sites exceed the mandated levels. According to the results of calculated indices, the majority of the areas had poor or bad air quality both during the winter and during the summer. This is primarily because of higher concentrations of suspended particulate matter and to a certain extent, values of sulphur dioxide (Reddy MK et al., 2004). According to Renu et al.'s 2004 research, the "Air Quality Index" in Jaipur is highest for PM₁₀, followed by CO.

Air Legislation in India

There are various air acts adopted in India which are as follows:

- 1948: The Factories Act and Amendment in 1987 was the first to express concern for the working environment of the workers. The amendment of 1987 has sharpened its environmental focus and expanded its application to hazardous processes.
- 1981: The Air (Prevention and Control of Pollution) Act provides for the control and abatement of air pollution. It entrusts the power of enforcing this act to the CPCB.
- 1982: The Air (Prevention and Control of Pollution) Rules define the procedures of the meetings of the Boards and the powers entrusted to them.
- 1982: The Atomic Energy Act deals with the radioactive waste.
- 1987: The Air (Prevention and Control of Pollution) Amendment Act empowers the central and state pollution control boards to meet with grave emergencies of air pollution.
- 1988: The Motor Vehicles Act states that all hazardous waste is to be properly packaged, labeled, and transported (<http://edugreen.teri.res.in/explore/laws.htm#air>).

The Adverse Consequences of Polluted Air on the Economy

According to Levy (2003), it is difficult to precisely assess the financial consequences of pollution in the air. Because of the higher rates of death and morbidity, as well as increased absenteeism and lost productivity, prolonged exposure to a variety of air pollutants and combinations of air pollutants results in significant economic

consequences. People are experiencing detrimental repercussions to their health as a direct result of air pollution, which is difficult to quantify financially. In addition, air pollution results in a significant increase in the number of economic expenses that are not directly related to human health. These costs include a decrease in visibility, an increase in the rate of global warming, damage to buildings and vehicles, and harm to a wide variety of plant and animal species (Curtis et al., 2006).

CONCLUSIONS

This review was conducted for the purpose of gaining a grasp of the current state of outdoor pollution in India as well as in other countries around the world. This will provide an overview of all of the health risks that are posed to the human race as a result of pollution in the environment. A review from different regions of the world makes primary knowledge data for the better conservation and well-being of life on the earth. The effects of polluted outdoor air on one's health are the topic of discussion in this study. Urbanization, with its high levels of vehicle emissions and a westernized lifestyle, is linked to the rising frequency of outdoor pollution-related diseases seen in both developed and developing countries, although the role played by outdoor pollutants in the health of human beings has yet to be clarified. A body of evidence suggests that urbanization, with its high levels of vehicle emissions and a westernized lifestyle. The improvement of the quality of the air that people breathe outside should be one of the environment's highest priorities. Therefore, the use of industries and cars as part of an effective strategy to combat outdoor air pollution is beneficial in terms of lowering the risk to one's health. The transition of industries to greener fuels should be supported and encouraged. Options for reducing energy use are also strongly recommended. In addition, governments all over the world have an immediate responsibility to make significant choices regarding the air pollution caused by motor vehicles to reduce the potential consequences of long-term effects on both human health and the natural environment. In addition to the need for additional studies on the health impacts of air pollution, there is also a requirement for the development of medicinal and nutritional treatments in order to mitigate the negative effects of pollutants.

Recommendations

Though studies have been conducted on outdoor air pollution, the issue remains unresolved; hence, we must implement the following recommendations:

- Reduced energy waste.
- Switching to cleaner burning fossil fuels.

Use of renewable energy sources to rise:

- The transition to cleaner combustion technology.

Air pollution must be strictly regulated:

- Should actively stimulate internationally coordinated research and development targeted at developing technology for fossil fuel combustion and control of pollutant emission, and at better understanding atmospheric processes and the impacts of air pollution on man and the environment.
- Should work together to increase the quantity and quality of information about the emissions of various sources of air pollution.

The principles, which are incorporated into the recommendation, should be used as a foundation for expanding air pollution management measures.

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