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REVIEW

Understanding the Status of Important Criteria Air Pollutants and its Health Effects − A Review

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Abstract

In India, airborne pollutant is serious, and a growing illness cause of concern, adding considerably to the country's disease burden. Atmospheric effects are generally known to have several harmful health implications. India's air pollution has risen significantly because of population expansion, rising vehicle numbers, fuel usage, inefficient transit networks, poor land use patterns, industrialisation, and most importantly, insufficient environmental legislation. Because air pollution is a major factor, this has an impact on human health. People gradually understood that contaminated outdoor air had detrimental consequences on human health. Hypercholesterolemia, breathing problems, chronic obstructive pulmonary disease (COPD), and asthma are all connected to ambient air pollution on a global scale. The purpose of this research is to review the literature on air quality and how it impacts population livelihoods.

Keywords: Air pollution, Diseases, Health impacts, Population growth

1. Introduction

Environmental pollution is a prevalent problem that will have a big influence on the population. Human actions and natural elements both contribute to pollution (WHO, 2016). Emission is one of the most serious problems of our life. Premature mortality and a decline in life expectancy are both linked to air pollution. In both rural and urban India, poor air quality is a problem. There are however, several sources and contamination profiles to consider. Construction, transportation, and manufacturing processes drain natural resources while also producing substantial amounts of rubbish, resulting in emission. Emission is described as the identification of excessive levels of toxins in the air over long periods of time. Particulates, hydrocarbons, CO, CO_2, NO, NO_2, and other air pollutants are examples of contaminants (see Table 1).

Toxic compounds often introduced into the atmosphere by a variety of biological or human made mechanism, so they can affect the ecosystem significantly. The relationship between air pollution and a range of negative health impacts is becoming clearer, but its negative financial ramifications are less well known [1]. According to research, both near and distant future exposure has been associated to disease burden and death in India. The welfare of elderly and sensitive persons may be impacted when emission is minimal [2]. Air pollution has a detrimental influence on economic productivity in addition to harming one's health and shortening one's life expectancy. According to the World Health Organization (WHO), emission is the reason for roughly a quarter of all diseases afflicting humanity today. Air pollution has both submicron and microeconomic on one's nutrition. Rapid economic expansion and urbanisation are a portion of the explanation for higher Particulate Matter (PM)

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exposures. The suspended particles are also related to a raised incidence of breathing, cardiac, neurological, and pulmonary ailments [3,16]. Around three million people die prematurely because of outdoor emission each year because aerosolized irritants and chemical contaminants are speed is generally in the ambience at the same time, an enhanced IgE-mediated response to aeroallergens and increased inflammatory processes could explain the rise in the incidence of respiratory allergic rhinitis in atopic people over the last five decades [4].

Death and sickness cost India nearly 8% of its GDP in reduced workdays in 2013, totalling $560 billion, according to a World Bank report. While this research is a solid start, it needs to account for the expenditures of disease treatment induced by air quality, **which, might lead in a far higher number of deaths** [5]. The Central Pollution Control Board (CPCB), constituted by the Air Act of 1981, sets or reviews the National Environmental Quality Standards (NAAQS) in India (MOEF, 1981) [6]. 13 Indian towns were amongst the top 20 most corrupt countries in the world, as shown in a recent WHO assessment.

2. Air pollution

Air pollution is no longer confined to metro cities only. Air pollution has come from the increased use of carbon energy in power stations, manufacturing, commerce, construction works, and stone crushers [7]. Poor air quality is defined as a state of the atmosphere in which certain substances are accumulated in such high quantities that they have harmful effects on man and his surroundings. Air pollution has always been rooted in human society that originated when humans invented fire [8]. The economic consequences of causes of morbidity and mortality owing to carbon emissions must be evaluated to assess the health costs exposure to environmental [5,9]. The predicted health consequences of exposure to ambient air are interpreted by the categorizations of present air quality [10]. **The higher the Air quality index, the more severe the air pollution and the more harmful the human health impacts.**

3. Air pollutants

3.1. Sulphur dioxide (SO_2)

One sulphur atom and hydroxyl group make up each molecule oxide. Oxide represent chemical compound SO_2. It's a deadly gas that smells like smouldering matches [11]. SO_2 emissions can have an impact on the suitability of habitats for many plant and animal species. Suspended particles formed when SO_2 reacts with other pollutants to generate sulphate particles, are both hazardous [12]. Exposure to ambient SO_2 for a near of time has been related to a range of poor health consequences [13]. Numerous clinical studies investigations, epidemiological research, and phytochemical constituents have proven a causal relationship between short-term exposure to environmental SO_2 and respiratory illness. This causes adverse impacts on human health ranging from respiratory problems, bronchitis, asthma and cardiovascular problems [14].

Sources of SO_2: According to a recent analysis issued by Greenpeace on August 19, 2019, India is the world's greatest emitter of SO_2, accounting for more than 15% of worldwide anthropogenic emissions [40]. **It's a poisonous gas that gives off the odour of burned matches.** [15]. It is created as a by-product of copper extraction and is released naturally by volcanic activity. The combustion of sulphur-containing fossil fuels, such as coal or oil, in

Table 1. Concentration of CO in air.

Concentration of CO in Air	Effects, Inhalation Time and Toxic Symptoms Developed
1–2 ppm	It's possible that this is usual, given the presence of cooking burners, spills, and outside traffic.
>2 ppm	It begs the issue of why CO levels are so high. The source should be recognised; it might be something common (e.g., traffic, a cooking stove) (Energy Conservatory).
9 ppm	In any given year, the maximum permitted concentration for an 8-h period. Pollution levels in cities frequently surpass 9 parts per million, increasing the risk of congestive heart failure.
15 ppm	Residential detectors must not warn at 15 ppm until they have been exposed continuously for 30 days, according to U-L regulations. (The concentration of U-L is increasing.)
15–20 ppm	Time discrimination performance is impaired. Reduction in total exercise time (HbCO 2.5) Shortened time to angina response (HBCO 2.9) Vigilance decrement
50 ppm	Exposure to the workplace for a maximum of 8 h is permissible (OSHA). For exposures more than 50 parts per million, most fire departments demand the use of self-contained breathing gear. Chronic exposures in dogs were shown to cause severe morphologic alterations, including brain pathology, heart pathology, and abnormal EKGs.

power plants and other industrial facilities is the major producer of SO_2 in the atmosphere [16]. SO_2 in conjunction with other pollutants and moisture (e.g., humidity), causes high resistance, visible corrosion layers to develop on all but the most noble metals (e.g., silver and gold) and alloys. The amount of SO_2 in the atmosphere has an impact on the **relevance** of habitat for plant groups and animal life. SO_2 is utilised in a variety of industrial operations, including chemical processing, refining, pulping, and solvent extraction. In addition, because of its capacity to inhibit bacterial development and fruit browning, it is employed in the preparation and preservation of food. Many metals, including iron, copper, zinc, lead, mercury, molybdenum, arsenic, antimony, and gold, are found naturally as sulphide ores.

Existing short-term exposure guidelines: 10-min EEGL: 30 ppm, 30-min EEGL: 20 ppm, 60-min EEGL: 10 ppm and 24-h EEGL: 5 ppm according to the National Research Council (NRC 1984) Emergency Exposure Guidance Levels (EEGLs).

Health effects: When exposed to large quantity of SO_2 over a **nearby** of time, it may be lethal. SO_2 amounts of 100 parts per million (ppm) parts of air are considered life-threatening. In long-term research involving large numbers of children, SO_2 pollution (CPCB, 2010) has been related to respiratory symptoms or reduced breathing ability. Infants who have breathed SO_2 contamination are more prone than other toddlers to have breathing problems as they get older. Large amounts of SO_2, especially after severe physical activity, can agitate and stir up the circulatory tract [9,17]. Protracted presence of high SO_2 levels can result in serious breathing problems such bronchial cirrhosis and acute respiratory distress syndrome (ARDS). The dose, duration, and type of task done all contribute to the quantity of exposure [18]. In health control, non-asthmatic people, exposure to SO_2 at gusts of up to 1.0 ppm for up to 40 min was related with just a little increase in interpretive, moderate outer sensations such persistent cough and the ability to taste and smell SO_2 [19]. New research has found that chronic (long-term, recurring) susceptible to SO_2 concentrations nearing 5.0 ppm has virtually little influence on work individuals. Lung illness, youngsters, the aged, and those who are the most exposed to SO_2 are more likely to develop skin and lung problems [20].

The cardiovascular system can be irritated and inflamed by high amounts of SO_2, especially after severe physical activity [21]. Chronic cough, throat soreness, and respiratory problems are just a few of the signs that this ailment can cause. Gas transmission into the deeper lung is improved by greater airflow during deep, rapid breathing. As a result, those who exercise in polluted air inhale more SO_2 and are more likely to feel ill [22].

3.2. Nitrogen oxide (NO)

Nitrogen oxide is one of the most frequent pollutants in the atmosphere [23]. Nitrogen oxide is a yellowish-brown liquid or a reddish-brown gas that is compressed. Its fumes are thicker than those of air [24]. The most apparent generators of NO_2 for the public are hydrocarbons that contain **and** use fossil fuels. Cigarette smoke, as well as butane and kerosene heaters and stoves, are sources of nitrogen oxide inside. NO_2 is formed when NO reacts with certain gases in the atmosphere [25].

Values suggested by the guidelines NO: To safeguard the population from the health impacts of gaseous NO, the current WHO guideline limit of 10 g/m^3 (annual mean) was set.

Sources of NO: NO is seldom discharged into the atmosphere. When nitrogen oxide (NO) and other nitrogen oxides (NO_x) mix with other compounds in the air, NO is produced. The burning of fossil fuels (coal, gas, and oil), particularly in automobiles, is the primary source of NO_2 produced by human activity [26]. **Making nitric acid, welding and employing explosives, refining fuel and metals, and food manufacture are all sources of nitrogen oxides**. As per the report, India's rapidly developing electricity sector has culminated in a 50% increase in NO emissions across South Asia [26,35]. **According** to the Occupational Safety and Health Administration (OSHA), the allowable NO_2 susceptible level in places and businesses should not exceed 5 ppm (9 mg/m3). This is **an** automobile contaminant since it is produced by mechanical equipment. NO is produced via slightly elevated combustion processes and meteorological reactions [27].

Health effects: The air is foggy and tough to **see** through because of the nitrogen nanoparticles created by NO_x. **When taken inside at high levels, it produces lung problems such as sneezing, dyspnoea, tachypnoea, bronchoconstriction, and embolism.** NO_x is a source of contamination that rises risk of breathing ailments (WHO 2016). Inhaling oxygen with a high concentration of NO_2 might irritate the human oxygen delivery. Relatively brief exposures can exacerbate respiratory illnesses, particularly asthma, related to respiratory symptoms (coughing, wheezing, or difficulty breathing), admissions, and emergency room visits. Quantities larger than 0.2 ppm appear to influence humans, whereas **those greater than** 2.0 ppm appear to have no effect.

Exposures of higher ppm will influence T-lymphocytes, particularly CD8+ cells and natural killer cells, which **play a** vital role in the host's viral attacks [21,28]. Considering the large concentrations, demographic studies reveal that NO_2 has an effect on T-lymphocytes, particularly CD8+ cells and NK cells, which are needed for our immune response.

3.3. Carbon monoxide (CO)

Carbon monoxide (CO) is a translucent, scentless, unpalatable, and lethal air pollution produced by partial oxidation of emissions from petroleum, fossil fuel, alcohol, lignite, and timber. This is created and released by a multitude of climate and physiological **sources. However** thermal combustion is the most common. CO has both positive and negative effects on humans [29].

Sources of CO: Respiration is the primary source, with roots in **faunal** and flora respiration as well as anaerobic condition decomposition processes. Oceans, which contain a lot of hydroxides, might absorb **them** and then release **them**. Although coal combustion has received the most attention, a tiny mismatch in the methane gas cycle is generating a slow rise in levels in the atmosphere. Whenever you inhale oxygen with a high CO level, the amount of oxygen that can be delivered to important parts such as **the** lungs and brain is damaged. When carbon is not fully metabolized, CO is formed. The amount of oxygen transported by haemoglobin decreases when CO levels rise in red blood cells. CO is produced by photochemical reactions in the troposphere, volcanoes, forest fires, and other natural phenomena.

Health effects: CO affects cell metabolism in both hypoxic and non-hypoxic conditions. The ability of CO to generate both types of effects is thought to be the cause of both (but not entirely) [30]. Because of its ability to murder individuals quickly and quietly while they are unaware that they are in danger, CO is known as the "Silent Killer. It has no taste or odour, but in high enough concentrations, **it can kill within minutes** [24,31]. **At high concentrations, CO kills in less than five minutes**. Low concentrations have a longer time to influence the body. There are no clinical signs or symptoms after an 8-h exposure to an ambient CO concentration of 100 ppm (0.01 percent).

CO binds to haemoglobin much more tightly than oxygen. CO poisoning may occur when people are **exposed to a** large quantity of the gas over a lengthy period of time. Nitrogen narcosis, infarction, and hypertension are all acknowledged as functions of carboxyl component binding against air [32]. Haemoglobin (the body's oxygen transporter) has a 250-fold greater affinity for CO. The different effects according to the concentration of CO **vary as** mentioned in the table. At extremely high concentrations, CO **causes** vertigo, unconsciousness, and demise, **which** might happen inside or in other enclosed spaces [33].

Greenhouse gases, which are connected to greenhouse effect and weather change, are affected by CO. As a result of the rise in ground and sea level, storms may arise. In humans, levels of carboxyhaemoglobin (COHb) less than 2% have no known health implications, while levels more than 40% can be disaster. Extremely high CO levels are rare to occur outside. When CO levels rises, they may be especially deadly for people who have certain types of cardiac problems. These persons already have a reduced capacity to transmit oxygenated blood to their hearts in situations where the heart requires more oxygen than usual.

3.4. Particulate matter (PM)

Two of the most frequent pollutants are PM_{10} and PM_2. A mixture of diverse chemicals **that may pass through** 10 m (PM_{10}) or 2.5 m ($PM_{2.5}$) screen with 50% of the solid material going through is referred to as a 5 particle [34]. PM_{10} and PM_2 contain chemical molecules such as benzene, 1-1-3 butadiene, polycyclic aromatic hydrocarbons, dioxins, and other organic compounds, as well as inorganic components such as carbon, sulphates, nitrates, chlorides, and even some **metals, for a total** of five elements. **Despite their small size, PM10 and PM2.5 particles have a long half-life in the atmosphere because they do not settle to the ground and can travel a long distance** [35]. Hydrophobic interaction between pollutants produces particulate matter (PM) in the atmosphere.

3.5. Guideline values

Fine particulate matter ($PM_{2.5}$): 5 $\mu g/m^3$ annual mean and 15 $\mu g/m^3$ 24-h mean.

Coarse particulate matter (PM_{10}): 15 $\mu g/m^3$ annual mean and 45 $\mu g/m^3$ 24-h mean.

Two of the most frequent pollutants are PM_{10} and $PM_{2.5}$. The number of deaths associated with ambient PM2.5 rose from 35 million in 1990 (95 percent UI 30 million to 40 million) to 42 million in 2015 (37 million to 48 million). In 2015, O3 exposure resulted in an additional 254 000 deaths (95 percent UI 97 000−422000) and a loss of 41 percent (16 million to 68 million) DALYs due to chronic obstructive pulmonary disease.

Health effects: Particulate matter is a mixture of soot, smoke, metals, nitrates, sulphates, dust, water, and tyre rubber that can include soot, smoke, metals, nitrates, sulphates, dust, and water [36]. It can be intentionally emitted, such as in fire smoke, or it can come from gas processes in the atmosphere, such as nitrogen oxides. Small particles smaller than 10 μm inflict the most injury since they may go deeply into the lungs and even into your bloodstream. Reduced lung function in children and adults' **is caused by** asthmatic bronchitis and chronic obstructive pulmonary disease (COPD), both of which are serious illnesses that have a negative impact on quality of life and shorten life expectancy [12,37]. Long-term exposure to particle pollution can cause serious health issues such as:

Increased respiratory symptoms, such as airway inflammation, coughing, or breathing difficulties.

1. A deterioration in lung function
2. Asthma attacks
3. Respiratory disease in children.
4. Chronic bronchitis in children or COPD (chronic obstructive pulmonary disease)
5. Number five is an irregular heartbeat.
6. Heart attacks that aren't life threatening
7. Deaths due to heart or lung disease, notably lung cancer, among the young.

3.6. Ozone (O_3)

One of the main ingredients of atmospheric pollution is O_3 at ground level, which is not to be mistaken with the stratospheric O_3 in the higher atmosphere. It is generated when pollutants such as nitrogen oxides (NOx) from car and commercial fumes, as well as polycyclic aromatic hydrocarbons (VOCs) released by automobiles, chemicals, and manufacturing, combine with sunlight (photochemical reaction) [38]. As a result, the highest amounts of O_3 pollution occur when the weather is sunny.

O_3 guideline values:

* 100 g/m3, maximum 8-h.
* Peak season*, 60 g/m3 8-h mean.
* Ninety-ninth percentile (i.e., 3–4 exceedance days per year).
* The aggregate of suggested amount 8-h mean O_3 pressure for the 60 days before the highest seven different running standard O_3 concentration is regarded as peak tourist season (WHO 2020).

Health effects: Excess O_3 in the air has a significant impact on human health. It has the potential to induce breathing issues, asthma, reduced lung function, and lung illnesses (WHO 2019) [39]. Everyone with allergies, children, the aged, and individuals who work abroad, especially agricultural craftsmen, are all at risk of inhaling aerosol air. Individuals with relevant inherited characteristics, but also those who take **fewer** nutrients like vitamin C, are more susceptible to oxidative stress.

Children are especially sensitive to oxidative stress since **their** bodies are still developing, but they're more likely to take actions outside while O_3 levels are high, increasing their exposure. Children suffer from asthma at a considerably higher rate than adults.

- Coughing and a scratchy or sore throat are common side effects.
- Making deep and powerful breathing more difficult, as well as generating pain when doing so.
- Inflammation and destruction to the bronchi occur.
- Improve the airway vulnerability to inflammation.
- Lung illnesses such as asthma, emphysema, and chronic bronchitis are worse.
- Asthma episodes will become more frequent.

4. Conclusion

The worsening of air pollution has become one of India's most pressing challenges in recent years. Those who reside in urban **areas**, where transportation emissions contribute the most to air pollution, are most affected. Increased urbanisation, expanding industry, and related human activities are the main drivers' emissions and low air quality. One of the biggest causes of illness in the world's environment is air pollution, which is well known. There is a considerable amount of scientific research demonstrating detrimental health effects even in countries with relatively low levels of emissions. The earth gets hotter and more congested. Our engines continue to spew dangerous gases. Air pollution has a number of detrimental effects on our lives. **Prolonged** exposure to the environment can lead to permanent ailments, including respiratory and cardiovascular disorders, as well as lung cancer, which can lower one's life expectancy. Ambient (outdoor) air pollution was estimated to have caused 4.2 million premature deaths worldwide in both urban and rural areas in 2016. Regional and national policymakers can use population attributable fraction and burden of sickness tools to make decisions about how to avoid and control air pollution, as well as assess the cost-effectiveness of different approaches. Techniques for reducing air pollution must be ecologically sustainable.

Conflict of interest

No conflict of interest.

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