International Journal of Pulmonary & Respiratory Sciences
ISSN: 2573-2234

Juniper Publishers
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Commentary Article
Volume 7 Issue 2 - April 2024
DOI: 10.19080/IJOPRS.2024.07.555710

Int J Pul & Res Sci

Air Pollution and Related Disorders

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Submission: March 21, 2024; **Published:** April 30, 2024

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Abstract

Air pollution is a man-made hazard and the effect of industrialization and civilization across the globe. Air pollution occupies center stage as contaminated air affects the lungs and other body organs causing fatal consequences. Air pollution is of two types indoor air pollution and outdoor air pollution. Outdoor air pollution is due to combustion of fossil fuels in home or in the industry and vehicular exhaust. Biological agents, formaldehyde, VOC and radon along with environmental tobacco smoke (ETS) are important indoor pollutants. Health effects of air pollution on the lung are multifactorial in nature. Air quality index is an important parameter to report and forecast air quality daily.

Keywords: Air pollution disorders; Air toxics; Particles and fibers; Sick building Syndrome; Respiratory symptoms

Abbreviations: ETS: Environmental Tobacco Smoke; PAH: Polycyclic Aromatic Hydrocarbons; BRI: Building Related Illness; SBS: Sick Building Syndrome; TBS: Tight Building Syndrome; HP: Hypersensitivity Pneumonitis

Introduction

Air pollution is a serious issue with the major sources being fuelwood and biomass burning, fuel adulteration, vehicle emission and traffic congestion. In winter months, large scale crop residue (stubble) burning in agriculture fields is a major source of smoke, smog and particulate pollution. "Pollution is defined as making the environment foul or impure". In recent times man has made a serious attempt to protect his environment. Both developing and developed countries have agreed to co-operate in clearing the ecological mess [1,2]. Air pollution is of two types indoor air pollution and outdoor air pollution.

Types of Pollutants

Various types of pollutants may be present in the air both outdoor and indoor. These are:

i. Biological agents such as viruses, bacteria fungi, protozoa, insect, mite, pollen.

ii. Gases and fumes such as nitrogen dioxide (NO_2), sulphur dioxide (SO_2), ozone, polycyclic aromatic hydrocarbons (PAH).

iii. Particles and fibres such as grain dusts, sand dust, coal dust and wood dust, silica, and beryllium, are examples of particles, asbestos of fibre.

iv. Radioactive substances such as radon and radon daughters.

Certain pollutants are used to determine the quality of ambient air. These are called criteria pollutants. These are NO_2, SO_2, CO, ozone; lead and particulate matter (PM10- less than 10 microns and PM 2.5 less than 2.5 microns). Fine particulates PM2.5 can be a matter of more serious health concern than PM10.

Sources of Outdoor Air Pollution (Criteria Pollutants) [1,2]

Two sources of criteria pollutants are most important, oxidant pollution and reduction pollutants. Oxidant pollution also called smog is due to photo-chemical oxidation of hydrocarbons and nitrogen oxides released from vehicle exhaust. This results in SO_2, NO_2, CO and ozone. SO_2 particulate pollution or reduction pollutant is due to fossil fuel combustion in industry, homes and power plants, which release SO_2 and nitrogen oxides. CO is also released from the environment tobacco smoke (ETS), and fires. Vehicle exhaust is also the source of lead whereas PM is released from fossil fuel combustion.

i. **Air Toxics:** These are potential hazardous air pollutants other than criteria pollutants. 200 air toxics are included in the Clean Air Act amendment 1990. The sources are localized, usually industries and population at risk are restricted e.g. MIC exposure in Bhopal. There is currently a limited health database on air toxics.

Sources of Indoor Air Pollution

With increasing awareness of outdoor air pollution, indoor pollution as a source of ill health and disease is becoming important. The sources of indoor pollutants include sources within homes and office and indoor concentration of outdoor pollutants, which is determined by rate of air filtration, the reactivity of the contaminants and efficacy of the mechanical filtration systems. Personal exposure to pollutants further depends on the concentration of the pollutants and the time spent in the location. Biological agents, formaldehyde, VOC and Radon along with environmental tobacco smoke (ETS) are important indoor pollutants.

Indoor atmosphere provides adequate humidity and heat for growth of biological agents such as humidifiers, air conditioning systems, moist surfaces, decorative plants, refrigeration evaporation pans and shower heads. Several VOC are found in home and office environments, of which formaldehyde, a colorless, volatile gas with a characteristic odor is most important. Carpets, new furnishings and urea formaldehyde foam insulation) are ready sources of formaldehyde. Radon daughters are short-lived products of radon found indoors. Radon, which is present in soil beneath homes, may occasionally reach levels close to those permitted in uranium and other underground mines. Radon daughters dissolve in water and form inert radon. However, they are highly carcinogenic particularly with other risk factors like smoking.

Principles of Lung Injury

Several factors are crucial in determining the effects of pollutants. These are factors related to the agent, host and exposure and dose [2,3].

Agent

Gases

Factors such as solubility, concentration, rate, depth of respiration, and reactivity of gases are very important in determining the effect of the gas. Gases that are highly water soluble, such as SO_2 or formaldehyde are completely extracted by the nose and pharynx during brief periods of exposures and hence result in upper airway irritation. Less water-soluble gases such as NO_2 and ozone reach the lower respiratory tract. On the other hand, CO, which is the least water- soluble, is in effect absorbed by hemoglobin and causes non-respiratory symptoms such as headache, chest pain or confusion. Increased rate and depth of respiration allows higher doses of pollutants into the respiratory tract. During exercise this factor along with mouth breathing results in loss of protective nasal route and increases the effects of the pollutants. eg inhalation of ambient levels of ozone or NO_2 results in bronchoconstriction only with moderate exercise.

Particles and fibres

Size, dimensions, and rate of clearing determine health effects of particles and fibres. Particles sizes greater than 10u are trapped by the nose and naso pharynx and cleared in the nasal secretions cough or are swallowed. Particles of less than 10 and 2.5u are deposited in the tracheobronchial tree with those of 1-2u reach the alveoli, while those less than 0.5 are impacted in the alveolar wall e g viral particles. In the conducting airways is rapid by mucociliary clearance however clearance by the alveoli is by alveolar macrophages, rather slow and taking days to months. Fibres are particles that are at least 2 times longer than they are broad e g asbestos. Amphibole asbestos are straight fibres and tend to align with the flow axis and reach the alveoli whereas chrysotile serpentine fibres impact sideways in the airways.

Host

Host factors of increased susceptibility and synergism are important for determining health effects of pollutants to individuals. Cases with asthma and COPD are more susceptible to health effects of air pollutants. Similarly, smoking with exposure to certain factors like asbestos or radons increases the susceptibility to lung cancer.

Exposure and dose

The disorders due to air pollution finally depend on exposure and the dose of the pollutant. “Exposure” refers to the amount of environmental agent that is inhaled and this is determined by the concentration of the agent in the inhaled air and duration of inhalation of the contaminated air. “Dose” on the other hand refers to the quantity of agent delivered to the target site. Dose and exposure may not always be the same, the dose depending on the ventilation and nasal oral route of breathing.

Health Effects of Air Pollution

The health effects of air pollutants may be by direct toxicity, infection or immunological mechanisms. In industrial workplaces several different pollutants are likely to be responsible for various health hazards particularly if their levels are not monitored and adequate ventilation and protection for the work force is not provided. However, often small-scale industry is carried out in small and poorly ventilated makeshift premises particularly in large cities with shortage of space. Some of them include soapstone cutting or crushing to make talc (talcosis), making of decorative tiles like granite and pseudo-marbles (silicosis), slate pencil making (silicosis) and dental technicians developing pneumoconiosis due to exposure to silica and other dust. Even in non-industrial workplaces or homes exposure can occur to unusual pollutants causing serious health effects e.g. Transkei silicosis due to small levels of silica and nuisance dust during hand grinding maize on high silica content stones. As these situations are not typical occupational exposures and often workers are

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unaware of the exposures a high level of clinical suspicion is required to diagnose these conditions [2].

Building related illness

Building related illness (BRI) are epidemics of illnesses occurring in non-industrial workplaces. Often no specific aetiology is identified in such cases when the term sick building syndrome (SBS) or tight building syndrome (TBS) is used. Well -defined BRI such as asthma or hypersensitivity pneumonitis (HP) may occur due to specific causes such as moulds, spores or other agents in the indoor environment. Similarly, rhinitis, conjunctivitis or laryngopharyngitis may occur due to irritant exposure, while infections with Legionella, virus or TB may occur as BRI. Examples of diseases related to specific indoor pollutants are Japanese summer type HP occurring due to high indoor concentrations of mould Trichosporon cutaneum in Japanese homes during summer and increased incidence of adenocarcinoma in non-smoking Chinese women due to exposure cooking oil fumes containing high levels of PAH. Domestic gas appliances have also been found to cause increase in respiratory symptoms and reduced lung functions in young women who cook on gas stoves in unvented kitchens. The possible pollutant is thought to be NO_2 and the health effects were found to increase in presence of atopy.

SBS or TBS on the other hand are usually epidemics of non-specific complaints such as headache, fatigue, upper airway irritation, skin rash and are associated with a particular building, a temporal pattern of occurrence and occurrence amongst several inhabitants or colleagues at the same time. An increase in BRI particularly SBS is being reported with increasing use of energy efficient "airtight" buildings in place of well-ventilated ones. Additionally, ETS, use of carpets, furnishings, Xerox copiers and poorly maintained air-conditioning systems contribute to high levels of indoor air pollutants. Appropriate diagnosis and removal from the polluted area results in improvement in symptoms. Treatment consists of improving ventilation and reducing the source of pollutants [3].

Health effects of outdoor air pollution

Outdoor air pollution and its health effects are a challenge to the pulmonary physician, as we breathe 10,000 to 20,000 litres of air daily and expose ourselves to a range of air pollutants and related disorders. The disorders range from mild increase in respiratory symptoms to acute lung injury and death and the situations of exposure range from individual exposure to several thousands of people being exposed. Many health effects are controversial; however, some have been studied and documented. The health effects are worse during winters when the cold air fails to rise and traps pollutants resulting in choking smog that may linger from hours to days - this phenomenon is called inversion. There have been dramatic episodes of air pollution inversion in many industrialized countries in the past, eg the London fog of 1952 when 4000 excess deaths occurred over a period of 2 weeks.

The lung serves as a portal of entry for toxins, which may affect other organs eg benzene (bone marrow). Hence, in any disease of obscure aetiology an inhaled environmental agent should be suspected. The main effects of outdoor air pollution are an increase in cardiorespiratory morbidity and mortality. Increased health care utilization due to asthma exacerbations and respiratory symptoms are seen with increasing levels of pollutants. Various studies have shown reduced lung functions, increased lung inflammation (influx of inflammatory cells, mediators) and reduced host defence (mucociliary clearance, macrophage function, immune response) as a result of the criteria pollutants [4-7].

Control of Indoor Air Pollution

Control of indoor air pollution mainly consists of

a) Prevention: By avoiding tobacco smoke and moist areas. Use of phenol urea ply instead of formaldehyde and cleaning, adding bactericides to water in humidifiers and cooling towers.

b) Control: By reducing pollen by closing windows and use of AC. Proper ventilation and use of exhaust fans in kitchen. Sealing leaks in floors and around drainage systems help to reduce radon. Workplace toxic dust control is extremely important to reduce dust- related disorders.

Control of Outdoor Air Pollution

This entails the following measures

a) Containment: Prevention of escape of toxic gases into air and automobile engine maintenance.

b) Replacement: Replacing coal with electricity and compressed natural gas (CNG), use of lead-free petrol and CFC substitutes.

c) Dilution: Creation of green belts is an important way of diluting the effects of air pollutants.

d) Legislation: Strict legislation, monitoring air quality and penalties for defaulters are an equally important way to protect the environment.

Various measures have been implemented for control of air pollution. The acceptable levels of pollutants are as shown in box Increased maintenance of vehicles can reduce vehicular pollution by up to 20%. Discarding / scrapping old poorly maintained vehicles, use of lead-free petrol, control of ETS, by banning smoking in public places are other important measures. However recent work suggests that fine particulate matter PM may be a high health hazard in the previous permissible levels of 50-150ugms/m^2. New recommendations suggest 50ugms /m^2 for 24 hours. Fossil fuel combustion from stationary sources like power plants, mobile sources like vehicles and area sources such as fires

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or barbecues are important sources of PM. Despite the inability to explain biological mechanisms of PM effect, conflicting reports on health effects and differing opinions, one fact is certain that PM worsens asthma control along with ozone, NO_2 and SO_2. Reduction in power plants and better control of traffic is urgently required for this [1,8].

Table 1: Sources of Outdoor Air Pollutants.

Criteria Pollutants	SO_2, NO_2, CO, ozone, lead and suspended particulate matter less than 10 microns (SPM).
Oxidant pollution (smog)	due to photo -chemical oxidation of hydrocarbons and nitrogen oxides released from vehicle exhaust releases SO_2, NO_2, CO and ozone.
SO2 particulate pollution (reduction pollutant)	due to fossil fuel combustion in industry, homes and power plants, which release SO_2, nitrogen oxides and SPM.
Environment tobacco smoke (ETS) and fires	CO
Vehicle exhaust	lead
Air Toxics	Potential hazardous air pollutants other than criteria pollutants.

Table 2: Acceptable levels of various pollutants.

Mean Concentration in ugms/cumm				
	Low	**Moderate**	**High**	**Critical**
SO_2	0-30	30-60	60-90	>90
NO_2	0-30	30-60	60-90	>90
SPM	0-70	70-140	140-210	>210

Air Quality Index

The Air Quality Index, or AQI, is a nationally uniform index for reporting and forecasting daily air quality. It is used to report the five most common ambient air pollutants that are regulated under the Clean Air Act: ground-level ozone, particle pollution (or particulate matter), carbon monoxide, sulfur dioxide, and nitrogen dioxide. The AQI tells the public how clean or polluted the air is and how to avoid potential associated health effects. The AQI uses a normalized scale from 0 to 500. The higher the AQI value, the greater the level of pollution and the greater the health concern. An AQI value of 100 generally corresponds to the level of the National Ambient Air Quality Standard for the pollutant. AQI values below 100 are generally considered to be satisfactory. When AQI values are above 100, air quality is considered to be unhealthy, at first for members of susceptible populations, then for everyone as AQI values get higher.

The AQI is divided into six categories that correspond to different levels of health concern. For ozone, the breakpoints between these categories were selected based on a review of the health effects evidence. The six categories are as follows:

i. "Good" (0-50): Air quality is excellent and poses little or no risk.

ii. "Moderate" (51-100): Air quality is acceptable; however, there may be some health concern for a small number of unusually sensitive individuals.

iii. "Unhealthy for Sensitive Groups" (101-150): When air quality is in this range, people that are included in a sensitive group, whether the sensitivity is due to medical conditions, exposure conditions, or inherent susceptibility, may experience the effects described above when engaged in outdoor activities. However, exposures to ambient concentrations in this range are not likely to result in effects in the general population.

iv. "Unhealthy" (151-200): When air quality is in this range, any individual who is active outdoors may experience the respiratory effects described above. Members of sensitive groups are likely to experience more severe effects.

v. "Very Unhealthy" (201-300): When air quality is in this range, it is expected that there will be widespread effects among the general population and more serious effects in members of sensitive groups.

"Hazardous" (301-500): If air quality gets in this range, it will trigger health warnings of emergency conditions and there will be widespread coverage in the media [8].

References

1. Utell MJ, Samef JM (1990) Environmentally mediated disorders of the respiratory tract. Med Clin North Am 74(2): 291-306.
2. (1996) Health effects of outdoor air pollution. Committee of the Environmental and Occupational Health Assembly of the American Thoracic Society. Am J Respirat Critical Care Med 153(1): 3-50.
3. Redlich CA, Sparer J, Cullen MR (1997) Sick building syndromes. Lancet 349(9057): 1013-1016.

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4. SM Kennedy, M Brauer (1996) Gas stoves and respiratory health. Commentary. Lancet 347(8999): 412.

5. Choulet D (1994) Occupational lung diseases among dental technicians. Tuber Lung Dis 75(2): 99-105.

6. Shuguang Li, Dinhua P, Guoxang W (1994) Analysis of poly aromatic hydrocarbons in cooking oil fumes. Arch Environ Health 49(2): 119-122.

7. Ando M, Arima K, Yoneda R, Tamura M (1991) Japanese summer type hypersensitivity pneumonitis. Geographic distribution, home environment, and clinical characteristics of 621 cases. Am Rev Respir Dis 144(4): 765-769.

8. Suman (2021) Air quality indices: A review of methods to interpret air quality status. Materialstoday: Proceedings 34(3): 863-868.

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