

AIR POLLUTION AND CHEST DISEASES – A REVIEW

TASKINA ALI¹, MD. ALI HOSSAIN², KAZI SAIFUDDIN BENNOOR³

Assistant Professor, Department of Physiology, Comilla Medical College¹, Associate Professor of Respiratory Medicine, National Institute of Diseases of the Chest & Hospital, Mohakhali, Dhaka-1212², Registrar (Medicine), National Institute of Diseases of the Chest & Hospital, Mohakhali, Dhaka-1212³

ABSTRACT

Ambient (outdoor) air pollution is now recognized as an important problem, both nationally and worldwide. Our scientific understanding of the spectrum of health effects of air pollution has increased, and numerous studies are discovering important health effects from air pollution at levels once considered safe. Elderly, children and infants are among the most susceptible to many of the air pollutants. In addition to associations between air pollution and respiratory symptoms, asthma exacerbations, and asthma hospitalizations, recent studies have found links between air pollution and preterm birth, infant mortality, deficits in lung growth, and possibly, development of asthma. This paper summarizes the recent literature linking ambient air pollution to adverse health outcomes in population and includes a perspective on the current regulatory process. The review provides advice to pediatricians on how to integrate issues regarding air quality and health into patient education and patients' environmental health advocacy and concludes with recommendations to the government on promotion of effective air-pollution policies to ensure protection of our health.

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INTRODUCTION

Fresh air is a precious and indispensable gift of the nature. Major air pollution episodes earlier this century provided clear evidence of the adverse human health consequences of elevated outdoor pollutants level in air. This striking increase in daily mortality and hospitalizations were observed in London during and following the famous fog episode of December 1952, which especially affected the old and the sick people.¹ Table 1 denotes the notable air pollution episodes of last two centuries worldwide.

Notable air pollution episodes of last two centuries.¹

Location	Date	Pollutants	Death
London, England	Dec. 9-11, 1873	SO ₂	650
Meuse Valley, Belgium	Dec. 1-5, 1930	SO ₂	1176
Donora PA, USA	Oct. 26-31, 1948	SO ₂	700
Poza Rica, Mexico	Nov. 24, 1950	H ₂ S	22
London, England	Dec. 5-9, 1952	SO ₂	4000
London, England	Jan. 3-6, 1966	SO ₂	1000
New York, USA	Nov. 24-30, 1966	SO ₂	168

Public concern regarding the human health effects of outdoor air pollution, motivated by episodes like these and causes the development of air quality regulations. In

the United States, the federal Clean Air Act of 1970 created the U.S. Environmental Protection Agency (U.S. EPA) and established for the first time nationwide standards for outdoor air quality. The following table shows the National Ambient Air Quality Standards (NAAQS) for "criteria pollutants,"

National Ambient Air Quality Standards for Criteria Air Pollutants, 1997,²

Pollutant	Primary Standards*
Ozone	
1-h average	0.12 ppm (235 µg/m ³)
8-h average	0.08 ppm (157 µg/m ³)
Carbon monoxide	
8-h average	9 ppm (10 µg/m ³)
1-h average	35 ppm (40 µg/m ³)
Sulfur dioxide	
Annual arithmetic mean	0.03 ppm (80 µg/m ³)
24-h average	0.14 ppm (365 µg/m ³)
PM ₁₀	
Annual arithmetic mean	50 µg/m ³
24-h average	150 µg/m ³
PM _{2.5}	
Annual arithmetic mean	15 µg/m ³
24-h average	65 µg/m ³
Nitrogen dioxide	
Annual arithmetic mean	0.053 ppm (100 µg/m ³)
Lead	
Quarterly average	1.5 µg/m ³

* People residing in regions with pollutant concentrations above the primary standard may experience adverse health effects from poor air quality.

Address of Correspondence: : Dr. Taskina Ali, Assistant Professor, Department of Physiology, Comilla Medical College, Comilla

But, in comparison to the NAQSS the ambient air quality standards for different pollutants are much higher under the Bangladesh Environment Conservation Rules, 1997, which are denoted in the following table:

Ambient Air Quality Standards (Concentration in $\mu\text{g}/\text{m}^3$).³

Area Category	SPM	SO ₂	CO	NO ₂
Industrial	500	120	5000	100
Commercial	400	100	5000	100
Residential & Rural	200	80	2000	80
Sensitive	100	30	1000	30

The major source of air pollution in developing countries like Bangladesh is traffic vehicles of 2 stroke 3 wheelers. However, industries, small manufacturing units, construction works, earth digging, open burning (cooking etc.), brick fields, aerosols, machineries (generators, photocopiers), open drainage and waste disposal, cigarette smoking, insecticides are also the culprits of air pollution.

Particulate matter (PM)

PM₁₀ is a heterogeneous mixture of small solid or liquid particles of varying composition found in the atmosphere. Fine particles (PM_{2.5}) are emitted from combustion processes (especially diesel-powered engines, power generation, and wood burning) and from some industrial activities. Coarse particles (diameter between 2.5 and 10 micron m) include windblown dust from dirt roads or soil and dust particles created by crushing and grinding operations. Toxicity of particles may vary with composition.⁴

PM_{2.5} represents the mass concentration of air-borne particles with aerodynamic diameters smaller than 2.5 micro m. PM_{2.5} particles vary widely in size, composition, and origin. Some are emitted directly by fossil fuel combustion, such as fly ash and soot from coal and diesel fuel combustion. Other forms as secondary pollutants by chemical reactions in the atmosphere that convert gases emitted by fossil fuel combustion, such as sulfur dioxide, to particles, such as acid sulfates. Although all particles less than 2.5 μm diameter are capable upon inhalation of reaching the deepest portions of the lung, particles less than 0.1 mm diameter have a higher likelihood of depositing in the deep lung, because of their high diffusion coefficients⁵. However, because particle mass increases as the third power of diameter, large-diameter particles tend to dominate measurements of PM_{2.5}, which are reported in units of micrograms of particles per cubic meter of air.

Important chemical components of PM_{2.5} include sulfates, nitrates, elemental carbon, organic molecules, and a variety of trace elements⁵.

Outdoor PM_{2.5} particles penetrate readily to the indoor environment⁶. Unlike ozone, significant indoor sources of PM_{2.5} exist, the most prominent being smoking and cooking⁶.

Ozone

Ozone is a natural constituent of air, existing in equilibrium with oxygen. In the stratosphere, it filters out ultraviolet light and therefore from the human point of view serves a useful function. In the lower atmosphere it exists in lower concentrations by the photochemical reactions on volatile organic compounds produced by plants together with intrusion of gas from thunderstorms. The photochemical reductions of nitrogen dioxide produces nitric oxide and an oxygen radical; the combination of this oxygen radical with oxygen causes ozone formation; the reductions of ozone by nitric oxide to reform nitrogen dioxide and oxygen. Thus, in a steady state condition, there is always equilibrium between oxygen, ozone and nitrogen dioxide. Introduction of large quantities of nitrogen dioxide or volatile organic compounds into this system moves the equilibrium towards the greater production of ozone⁷.

These photochemical reactions are dependent on presence and intensity of sunlight. So ozone is a more important pollutant in sunnier climate, that is, in southern than northern climates. Again, these photochemical reactions takes some time to occur and for that reason is higher in distant from site of production of primary pollutant. It pollutes the downhill urban area, countryside and sunburn areas⁷.

Sulphur dioxide

Sulphur dioxide is produced by, combustion of fossil fuel, coal and oil and naturally by volcanic activity⁷. Sulphur dioxide in atmosphere is oxidized to Sulphur trioxide and then hydrolyzed to sulphuric acid. It is important in the place of coal burning, larger rural plants and countryside downwind of the source⁷.

Nitrogen dioxide

Nitrogen dioxide is a gaseous pollutant, produced by, high temperature combustions, volcano, and thunderstorm, fuel combustion in vehicle and industrial process and bacteria. It is the main gaseous pollutant of indoor⁷.

Effects of Air Pollution

As children spend more time in outdoors than do adults, they have increased exposure to outdoor air pollution and are more vulnerable to the adverse effects

of air pollution than adults. Different studies showed that, 80% of alveoli are formed postnatally and changes in the lung continue through adolescence and the developing lung is highly susceptible to damage after exposure to environmental toxicants during this early childhood⁸. In adults, air pollution is associated with respiratory and cardiovascular hospitalization, cardiovascular mortality and lung cancer⁹.

Particulate matter

Particle pollution contributes to excess mortality and hospitalizations for cardiac and respiratory tract disease⁹. The mechanism for particulate matter-associated cardiac effects may be related to disturbances in the cardiac autonomic nervous system, cardiac arrhythmias, or increased blood concentrations of markers of cardiovascular risk (eg, fibrinogen)⁹. In children, they are also associated with deficits in lung growth (as measured by lung function tests)¹⁰. Recent studies in different countries have also found associations between ambient particulate pollution and post neonatal infant mortality, low birth weight and preterm birth¹¹.

Ozone

Ozone is a powerful oxidant and respiratory tract irritant in adults and children, causing shortness of breath, wheezing, cough and chest pain when inhaling deeply¹². By experimental study, it has been shown that ozone is a pulmonary irritant causing increase in bronchial resistance and reactivity in relation to the dose inhaled¹³. Children have decrease in lung function, increase in respiratory tract symptoms, and asthma exacerbations with emergency department visits for asthma and school absences on days with higher levels of ambient ozone¹⁰. In healthy adults, ozone causes airway inflammation and hyper reactivity, decrements in pulmonary function, and increased respiratory tract symptoms¹¹. Ozone inhalation also decreases the allergen conc. at which sensitized people react¹¹.

Sulphur dioxide

By an experimental study, it has been shown that the ventilatory function of healthy volunteers falls after inhalation of concentration around 5000 ppb, while asthmatic individuals may respond at about 200 ppb or lower, depending on severity¹³. There is also evidence of increasing the risk of exacerbation of chronic lung diseases also¹³.

Nitrogen dioxide

A controlled-exposure study in asthmatic people showed that short-term exposures (30 minutes) to nitrogen dioxide at concentrations as low as 0.26 ppm can enhance the allergic response¹³. Different epidemiological studies have reported relationships

between increased ambient nitrogen dioxide and risks of respiratory tract symptoms^{14,15}.

Prevention

To improve air quality public health interventions is necessary. A decrease in levels of air pollutant in former East Germany after reunification was associated with a decrease in bronchitis and improved lung function^{16,17}. During the 1996 Summer Olympics in Atlanta, Georgia, extensive programs were implemented to improve mass transportation and also to decrease anticipated downtown traffic congestion. These programs were successful and were associated with a prolonged decrease in ozone pollution and significantly lower rates of childhood asthma attacks during this period¹⁸. Lung function improved in children who moved away from communities with high particulate air pollution, compared with those who remained or moved to communities with comparable particulate air pollution¹⁹. These studies provide support for continued efforts to decrease air pollution and improve health. Dietary factors may play a role in modulating the effects of air pollution in children. A recent study in Mexico City showed that children with asthma given antioxidant supplements were less affected by pollutant air than those of without supplementation²⁰. In USA, for the protection of public health, the EPA (Environmental Protection Agency) established the National Ambient Air Quality Standards (NAQQS) (Table 1), which are reviewed every five years and set to protect public health. These standards are set on the basis of numerous scientific studies showing that the previous standards were not adequate to ensure health protection. There is also an air quality index (AQI), which provides the local information on air quality and levels of different air pollutants². The AQI is reported daily in metropolitan areas, often as part of local weather forecasts on television or radio or in newspapers. In the developing countries like Bangladesh these types of measures can be useful as a preventive measure for pollutant caused disease exacerbation.

Strategies for control of air pollution

Total elimination of air pollution is an unrealistic or impossible goal. So measures needed to identify the nature and source of the specific pollutants responsible and also to reduce their production and dispersal. The environmental pollution can be controlled by primary, secondary and tertiary prevention.

Primary Prevention:

Primary prevention means abrogating the risk factor before illness strikes. It includes banning of certain hazards, for example, two stroke scooters, unplanned industrialization, etc.

Secondary Prevention:

Secondary prevention means the identification of the people at risk and the diseased and also the avoidance of further deterioration of their illness. The pulmonary

clinicians have more opportunities for secondary than primary preventive interventions.

Tertiary Prevention:

Tertiary prevention means the activities to slow the progression of complications of previous exposure or of disease that is already established, e.g. smoking cessation among asbestos workers, Tuberculosis prophylaxis among the silicotics.

CONCLUSION

Environmental pollution comprises an important and challenging topic in respiratory medicine. Their diagnosis, treatment and most prominently their prevention have major public health implications. The present day environment crisis demands a change in public attitude to rescue the environment from destruction. Industrialized nations have a big share in the present day environment problems.

In developing countries like Bangladesh, environmental protection is still a luxury and hard to afford. Some are finally becoming aware of the environment abuse, but a large part of population, foreign debts and unplanned industrialization have kept them off the environment conservation process.

The situation may improve only when people realize that there are certain rules that they must go by to protect the environment. In Bangladesh, we should strictly abide by the "Environment Conservation Act 1995" and the "Environment Conservation Rules 1997". Side by side, awareness programs should be taken up by the Government and non-government organizations through mass media, especially Radio and Television. Concerted efforts like epidemiological and experimental studies should be organized involving multi-discipline peoples like Scientists, Doctors, Engineers, Lawyers and Journalists etc.

Without control of environmental pollution, present situation will be worse in near future and will push the world towards a corner, making the proposition uncertain whether or not it will remain habitable for coming generations.

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