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Review Paper

Review on effects of Particulates; Sulfur Dioxide and Nitrogen Dioxide on Human Health

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Abstract

High concentration of air pollutants can cause different adverse health effects. This study aim to overview the hazardous effect of air pollutants like particulate, sulfur dioxide and nitrogen dioxide on human health.

Keywords: Air pollution, air pollutants, adverse health outcome.

Introduction

Studies showed that the chronic exposure to air aollution leads to shortening of life. Toxicological and epidemiological studies had shown that air pollution is responsible for a wide range of adverse health effects, ranging from mortality to sub clinical respiratory symptoms. Air pollution is a combination of particulate and some other co-pollutants for this reason it is necessary to consider the relative contributions of all pollutants to pollution-related mortality. Epidemiological studies have established a close relationship between chronic exposure to ambient air pollution and mortality resulting from cardio-pulmonary diseases[1-3]. Air pollution is a complex mixture of particulates, different gases, hydrocarbons, and transition metals. Among all the pollutants, the association between air pollution and adverse health conditions was the strongest and consistent for respirable suspended particulate matters (RSPM) having an aerodynamic diameter less than 10 micrometer (PM_{10}). Since 1960s studies on health effects caused due to air pollution had shifted attention from mortality to morbidity as more and more emphasis were given to the effects of chronic, low level of air pollution exposure that the people experience normally in their real life. Other studies have confirmed the importance of the association between particulates and occurrence of respiratory symptoms in children[4,5].

Studies have also revealed that diminished growth of airways in childhood increases the probability of subnormal lung function and risk of cardio-pulmonary diseases in adulthood[6,7].

Gaseous co-pollutants such as sulfur dioxide, nitrogen dioxide, ozone and carbon dioxide found to be associated with increased mortality due to short-term exposure to ambient air pollutants[8]. Urban air is also contaminated with a number of toxic substances such as benzene[9] and manganese[10]. A number of studies had shown that acute and chronic morbidity related health effects are due to particles and gaseous air pollutants. Recent study showed health impacts of air pollution visible in early development period of human[11]. A study also showed adverse pregnancy results like low birth weight, intrauterine growth retardation and preterm birth are due to low level of ambient air pollution[12].

Air Pollutants and Adverse Health outcome

Particulate Pollutant: Particulate is a combination of large and small particles of varying origin and chemical composition, particulates are finely divided solid or liquid particles. Particulates can be composed of inert or very reactive materials of size 0.0002 to 500 microns. Particulate matters are deposited in the different regions of the respiratory system depending on their sizes. The particles greater than 10 microns are retained by the cilia of the nose. If the particle is between 2 to 10 microns, they can enter the upper region of respiratory tract which consist of nasal cavity, nasal pharynx, larynx and trachea. Particles of size less than 2 microns are deposited in bronchioles and few reaches the Alveolar ducts which is a part of lower region of Respiratory tract. Particles of size less than 0.25 microns to 1 microns enter Alveoli of lungs which reduces the volume of the alveoli there by causing damage to the lungs by minimizing the Oxygen exchange from air to blood. Number of hospital admission increased for a range of respiratory diagnoses and events due to exposure to particulate air pollution[13]. It has been found out that particles are responsible for increase in cardiac and respiratory problems and admission in 168 acute care hospitals in Ontario, Canada[14], for cardiac and pulmonary cases in Los Angeles[15] and for severe respiratory cases[16] and also for admissions diagnosed in the cases of cardiac, respiratory and for cerebral and peripheral vascular diseases[17]. Among different pollutants Particulates is most responsible for shortening of life. The effects of PM on health occur at levels of exposure which is being experienced by most urban and rural mass of population in both developed and developing countries. Chronic exposure to particles leads to the risk of generating cardiovascular and respiratory diseases, as well as it can also cause lung cancer. In developing countries, Indoor air pollution like combustion of

solid fuels on open fires or traditional stoves increases the risk of acute lower respiratory infections and mortality among children, indoor air pollution from use of solid fuel is a major risk factor for creating chronic obstructive pulmonary disease and also lung cancer among adults.

Sulfur Dioxide: Sulfur dioxide is a colorless gas released from burning of coal, high Sulfur coal and diesel fuel. So_2 and particulates together forms a major portion of the pollutant load in many cities. It can cause irritation, reduction of visibility and some respiratory diseases. Healthy person experience brancho-construction at 1.6 ppm of so_2, for a very few minutes exposure at 8-12 ppm level throat irritation occurs. At 20 ppm, immediate cough and eye irritation results. Even for exposure of $S0_2$ at 400-500 ppm is dangerous for life. Sulfur dioxide (SO_2) harms human health by reacting with the moisture in the nose, nasal cavity and throat and this is the way in which it destroys the nerves in the respiratory system present[18]. When the concentration of SO_2 is higher than the prescribed standards of World Health Organization (WHO), it effects especially those suffering from asthma, bronchitis, lung and cardiac problems[19]. SO_2 can be dangerous to the respiratory system and the functions of the lungs and can also leads to irritation of eyes. Respiratory tract inflammation causes coughing, mucus secretion, chronic bronchitis and aggravation of asthma it makes people more and more prone to respiratory tract infection. Hospital admissions for cardiac problem and mortality increase on the days with higher SO_2 concentration. When SO_2 combines with water, it forms sulphuric acid; this is the main component of acid rain and is also a cause of deforestation.

SO_2 (ppm)	Duration of Exposure	Effects
0,037-0,092	Annual Average	With 185 µg $^{m-3}$ smoke concentration, increase in lung disease and respiratory track problem.
0,007	Annual Average	With high concentration of particulate matter, progression in the respiratory track and diseases in children.
0,11-0,19	24 hours	In low concentration of particle, increase in the respiratory track diseases in the elderly
0,19	24 hours	Progression in severe respiratory track diseases in the grown-ups
0,19	24 hours	In low concentration of particle, an increase can be observed in mortality.
0,25	24 hours	With 750 µg $^{m-3}$ smoke concentration, an increase in daily mortality rates may be observed (UK) and Sudden increase in morbidity.
0,5	10 mins	In asthma patients, increase in breathing resistance during exercise (mobility).
5	24 hours	In healthy people, increase in breathing resistance.
10	10 mins	Bronchospasm
20		Coughing, Eye irritation

Effect on human health due to SO_2 [19]

Nitrogen Dioxide: Nitrogen dioxide is the primary pollutant released by petroleum operation, industrial and automobile combustion. Direct acute effects of Nitrogen Dioxide includes damage of the cell membranes in the lung tissues and causes constriction of the Lung way passages. The indirect effects include edema or filling of the inter cellular spaces with the fluid. Between concentrations of 15 to 25 ppm eye and nasal irritation and pulmonary discomfort is common.

Air Pollution and Health Effects: Modifying Factors

Indoor air pollution: Environmental tobacco smoke (ETS) i. e. passive smoking, nitrogen dioxide from cooking by gas / heating and smoke from biomass fuels are the three main indoor air pollution sources that may modify health effects . Environmental tobacco smoke (ETS) is associated with increased risk of respiratory disorders in children with decrease lung function[20]. Exposure to nitrogen dioxide gas by family members increased by Natural gas cooking and heating by stove[21].

Housing and family size: Respiratory illnesses due to respiratory infections are contagious diseases. Their propagation is favored by overcrowding. In 1927, Woods showed a strong significant correlation between pneumonia mortality and houses which are overcrowded in England and Wales.

Nutrition: Malnutrition is considered to be a risk factor for respiratory infection. Malnutrition has an strong correlation with poverty, poor education level, crowding and poor housing facilities in developed countries. It has been reported that malnourished children experiences 2.7 times more bronchitis and 19 times more pneumonia in comparison to properly nourished children with normal weights[22]. Studies shown strong significant relation between malnutrition and pneumonia but with bronchitis has not been reported[23].

Psychosocial factor: Earlier cross sectional studies showed that correlation exist between anxiety and upper respiratory illness[24] and between life changes, maladaptive coping, social isolation, unresolved role crises with respiratory infections[25]. Earlier cross sectional studies also showed relations between maternal stress and problem of bronchitis in children[26] and poor functioning of family with doctor visits for respiratory infection in children[27]. It has been observed that stressful events of life in families are four times more likely to cause an episode of streptococcal pharyngitis[28].

Low birth weight: It has been found that low birth weight is responsible for high respiratory infections[29]. Low birth weight (< 2 kg) is responsible for chronic cough but not wheeze[30]. A study in India showed that low weighted infants at the time of birth (<2.5 kg) experiences the same respiratory problems occurrence as normal weighted infants in the first year of their life (4.65 vs. 4.56 episodes), but had a much higher death rate

(24.6 vs. 3.2 per 100 episodes of moderate to severe respiratory illness)[31] . Confounding factors for low birth weight such as poverty, overcrowding and poor nutrition provided make it difficult to ascertain whether the association is causal or not.

Conclusion

Numerous scientific investigation established relationship between air pollutants like Particulate, Sulphur dioxide Nitrogen dioxide and the health risk associated with them. It is characterized by diverse effects on human health like asthma, bronchitis, chronic obstructive pulmonary disease, pneumonia, lung cancer etc. These associated health effects have been reviewed in this paper. Studies shows that even at relatively low concentration the effects of pollutants on human health is significant , among the pollutants like Particulate, Sulphur dioxide and Nitrogen dioxide the RSPM with an aerodynamic diameter of less than 10 micrometer (PM 10) cause severe health effects than any other air pollutants. Careful monitoring of air pollution is necessary to reduce health risk, air pollution can be reduced by limiting emissions of pollutants from various sources such as changing modes of transport, reducing energy consumption especially which are based on combustion sources.

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