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PM2.5: A Major Concern in Air Pollution Studies around the World

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Abstract

Human activities are generating huge amount of harmful gases, particulates, and biological molecules. PM2.5 is an atmospheric particulate matter of diameter of fewer than 2.5 micrometres which is around 3 percent the diameter of a human hair. PM2.5 causes a number of severe respiratory problems asit can penetrate deeply into the lung, deposit in the alveoli, and consequently impair lung function. The present paper emphasizes the effects of PM2.5 on human health and recommends some precautionary measures.

Keywords: PM2.5; Air pollution; Particulate matter; Health; Air pollutants; Climate; Environmental pollution

Introduction

Human activities and natural processes are generating a huge amount of harmful substances including gases, particulates and biological molecules that are introduced into Earth's atmosphere. These additions in large amounts may cause various health related problems including diseases, allergies and also deaths of humans. It may also cause harm to other living organisms such as animals and food crops. This may damage the natural or man-made environment. Hazardous air pollutants, also known as toxic air pollutants or air toxics, are those pollutants that cause or may cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental and ecological effects.

The Sources of Air Toxics

Most air toxics originate from human-made sources, including mobile sources (e.g., cars, trucks, buses) and stationary sources (e.g., factories, refineries, power plants), as well as indoor sources (e.g., building materials and activities such as cleaning). There are two types of stationary sources that generate routine emissions of air toxics. First are the major sources which are defined as sources that emit 10 tons per year of any of the listed toxic air pollutants, or 25 tons per year of a mixture of air toxics. These sources may release air toxics from equipment leaks, when materials are transferred from one location to another, or during discharge through emission stacks or vents. Second are the Area sources consisting of smaller-size facilities that release lesser quantities of toxic pollutants into the air. Area sources are defined as sources that emit less than 10 tons per year of a single air toxic, or less than 25 tons per year of a combination of air toxics. Though emissions from individual area sources are often relatively small, collectively their emissions can be of concern - particularly where large numbers of sources are located in heavily populated areas [1].

Recently a number of researches indicated the rise in PM2.5 levels in major cities of the world [2-5]. Continued development of personal air pollution monitors is rapidly improving government and research capabilities for data collection. PM2.5 is an atmospheric particulate matter of diameter of fewer than 2.5 micrometres which is around 3 percent the diameter of a human hair. It causes various respiratory problems and also reduces visibility. Fine Particulate Matter (PM2.5-particles with an aerodynamic diameter </=2.5μm) can penetrate deeply into the lung, deposit in the alveoli, and consequently impair lung function [6]. In a number of studies PM2.5 has been reported to cause premature death from heart and lung disease. Due to their very small sizes the PM2.5 particles easily bypass the nose and throat and enter into the circulatory system. Long term exposure to these particles may also lead to chronic diseases including heart attack, bronchitis and other respiratory problems. PM2.5 may contribute to an abnormality in the human respiratory system through EGFR, MAP kinase, NF-kappaB, and IL-8 induced toxicity signaling [7]. Short and long-term exposure to PM2.5 also instigates adverse health effect upon the cardiovascular (CV) system [8].

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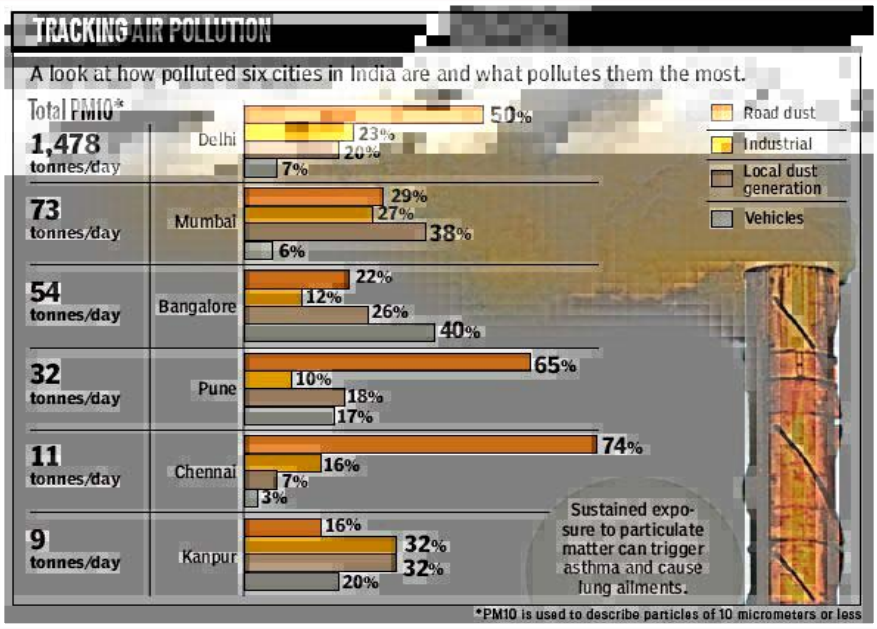

Figure 1: Air pollution levels in six major cities in India [10].

Table 1: Health messages for 'at risk' individuals and the general public for each of the AQHI Health Risk Categories in Canada [9].

Health Risk	Air Quality Health Index	Health Messages for	
		At Risk population	General Population
Low	1–3	Enjoy your usual outdoor activities.	Ideal air quality for outdoor activities
Moderate	4–6	Consider reducing or rescheduling strenuous activities outdoors if you are experiencing symptoms.	No need to modify your usual outdoor activities unless you experience symptoms such as coughing and throat irritation.
High	7–10	Reduce or reschedule strenuous activities outdoors. Children and the elderly should also take it easy.	Consider reducing or rescheduling strenuous activities outdoors if you experience symptoms such as coughing and throat irritation.
Very high	Above 10	Avoid strenuous activities outdoors. Children and the elderly should also avoid outdoor physical exertion.	Reduce or reschedule strenuous activities outdoors, especially if you experience symptoms such as coughing and throat irritation.

An air quality index (AQI) is a number measure used by different agencies to communicate to the public how polluted the air is.

In India, Delhi's name is at the top of the list of the 6 most polluted cities. Delhi's air pollution levels are by far the highest with 1,478 tonnes a day, followed by Mumbai, Bangalore, Pune, Chennai and Kanpur.

Studies on Pm2.5

Daily PM2.5 samples were collected at an urban site in Beijing during four one-month periods in 2009-2010, with each period in a different season. The six major source factors of PM2.5 included secondary inorganic aerosol, industrial pollution, soil dust, biomass burning, traffic emission, and coal burning [11]. In another study, outdoor and indoor (subway) samples were collected by passive sampling in urban Seoul (Korea) and analysed with computer-controlled scanning electron microscopy coupled with energy dispersive x-ray spectroscopy (CCSEM-EDX). Soil/road dust particles accounted for 42%-60% (by weight) of fine particulate matter larger than 1μm (PM(2.5-1.0)) in outdoor samples and 18% of PM2.5-1.0 in subway samples [12].

A study assessed the effects of PM2.5 on miRNA and target gene expression. Integrated analyses of miRNA and mRNA expression profiles identified negative correlations between miRNA and mRNA in both W-PM2.5 and O-PM2.5 exposure groups. The study suggested that target genes may play important roles in PM2.5 -induced respiratory toxicity by miRNA regulation [13]. Another study found the differences in PM2.5 exposure level in the context of four commuting modes (by walk, bicycle, bus and subway) in Guangzhou. The PM2.5 exposure assessment was carried out from January to December 2015 in Guangzhou. PM2.5 was measured by using SidePak individual dust meter (AM510, TSI Inc. USA) with time interval of 1 minute. A total of 284 air samples during walking, 281 air samples during bicycle riding, 278 air samples in bus, and 280 air samples in subway were collected. The median PM2.5 concentrations exposed during walking, during bicycle riding, in bus and in subway were 38.4, 38.6, 23.3 and 24.1μg/m^3, respectively, which was positive correlated with exposure concentration in fixed surveillance sites [14].

Safety Measures to be Taken

1. Try to stay indoor if PM 2.5 levels are at hazardous levels.

2. Close all windows to stop the entry of polluted air and use a room air filter.

3. Avoid burning candles or other flammable things which can emit smoke when you stay indoors.

4. Use air purifier equipped with a High-Efficiency Particulate Air filter (HEPA) while travelling.

5. Use car for transportation. Eat antioxidant rich food that can increase your body's resistance against PM 2.5.

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