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Review on Role of Biomedical Instrumentation on Environment Monitoring And Its Needs

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Abstract

In this chapter various aspects related to particulate dust pollution and their consequences on health of human are discussed. Various studies have been described the burden of pollution in air on physiological parameters of human subjects here still there is a lack of information focusing on Agriculture Crop Residue Burning (ACRB) practices and their effects on lung functions of school going children. Human physiology such as Body Mass Indices (BMI) is an integral part in exposure assessment. The assessment of ACRB on lung function parameters of children are focused in this chapter.

Keywords: Biomedical instruments, Survey on health, Ecology

Introduction

Clean air is a fundamental right of each living being for its survival on the earth. This is the most essential element like food and water. A human body consists of several complex and integrated systems comprising of skeletal system, muscular system, respiration system, digestive system and nervous system that are constantly working while coordinating with each other to maintain the health status [1,2]. Among these systems, respiratory system has a key role in the life of a human being. Human body organs need oxygen and release carbon dioxide in a cyclic manner because of their natural biological process. This process is called pulmonary functioning of lungs. Through nose, respiratory mechanism takes O_2 through inhalation from ambient environment and transport to different parts of the body by cardiopulmonary organs and exhale CO_2 from the body parts [2]. Respiratory system is too critical to immediate survival [3]. This mechanism regularly comes in close contact with the ambient environment for exchange of gases [4]. Any kind of impurity in ambient air reduces working capacity of organs and may cause damage to this system. Body needs only hygienic food, dustless shelter, clean air and water for their healthy life. But because of

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exponential growth in population, living standards, technology, need of food and socioeconomic security, a rapid growth has been observed in manufacturing units, factories and chimneys, use of fuel for transport by personal or public vehicle, burning of coal furnaces, construction and cement plants, use of artificial fertilizers and pesticides, washing through chemicals. Hence, the environment is getting polluted. These activities are polluting all sources of basic amenities needed by a living being for its survival. Pollution is a collective term for the substances that are responsible for disturbance of biological and physiochemical compositions of ambient environment. Pollution is identified as the key marker behind the growth of these diseases like cancer, heart attacks, asthma. There are several kinds of pollutions who are polluting water, soil and air, but pollution in air is always an important dust of debate because of its direct effects on lungs and cardiopulmonary system of human subjects [4,5]. More than 2.4 million people lose their life because of exposure to the polluted air. The count of morbidity and mortality of human subjects has been rapidly increasing from 2000 by 19% to 67% in 2016 because of ambient air pollution. Figure 1.1 shows worldwide growth of mortality of human subjects because of cause of air pollution in different continents.

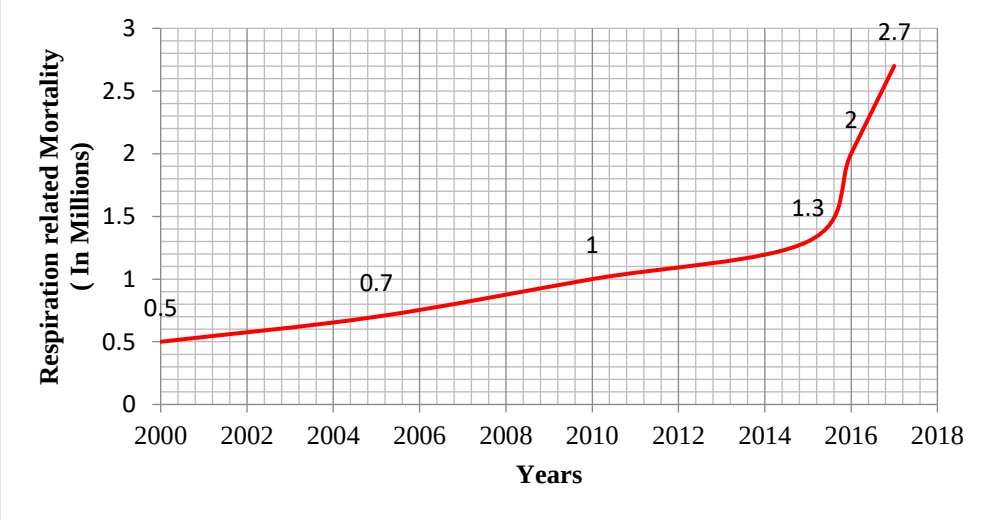

Figure 1.1: Rapid growth in disorders and mortality rate in human subjects by air pollution

There are large number of sources that pollute ambient air by releasing hazardous gases (SO_2, SO_x, NO_x and CO *etc.*) and Respirable Suspended Particulate Dust (RSPM) (having size PM_{10} and

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$PM_{2.5}$). Both gaseous and RSPM pollutants affect the respiratory system of human subjects with different intensities but RSPM has more statistically significant correlation coefficient value than gaseous pollutants (-0.78,p-value <0.05) [2,4,5].

Suspended Particulate dust and its Significance

Particulate Dust (PM) is a collection of dust particles, unburned particles of fuel (released during combustion process) and organic tarry dust that remains suspended in the ambient environment for different time slots from few days to months because of their aerodynamic nature.

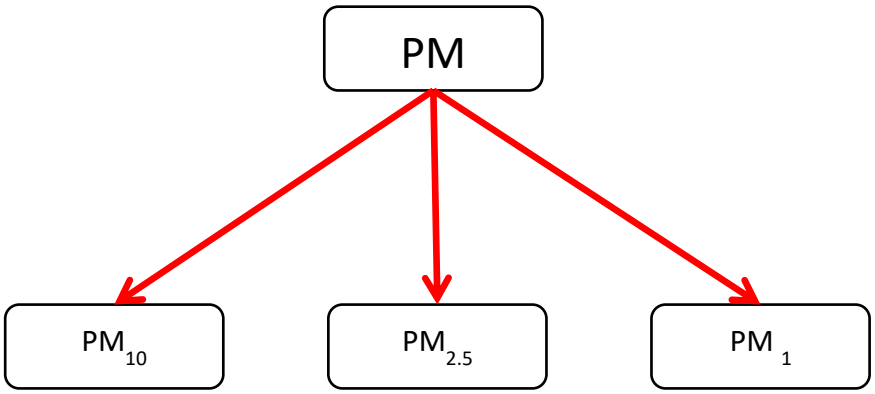

Figure 1.2: Classification of RSPM as per EPA and NAAQ standard

According to pollution control agencies, RSPM of different aerodynamic size are defined as:

PM_1 - is defined as ultrafine dust as they reside in the ambient environment for long time (from few weeks to months) and can travel several hundred Kilometers (Km) because of their aerodynamic nature. These particles are 97 times smaller than the thickness of single human hair. They investigations says that these particles are more harmful to human respiration health because of significant increment in Chronic Obstructive Pulmonary Diseases (COPD) cases and hospital admissions at various affected sites. These particles easily enter into blood vessels through alveolar sacs because of their nuclear size and cause cardiopulmonary complications.

$PM_{2.5}$ - composition is identified as fine dust. They reside in the ambient environment from few days to months because of their aerodynamic nature and travel several miles. These particles are 63 times smaller than a single human hair width. They study says that these particles are respirable and impacts on endothelial and alveolar sacs in respiration system. The nasal cavity is unable to

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trap them during inhalation process. They may affect the capacity of lungs because of restrictions in exhalation mechanism in lungs.

PM_{10} - composition is defined as coarse particles because they are heavier than $PM_{2.5}$ and PM_1 constituents. The residence time of PM_{10} is too less than fine and ultra fine particulate dusts because of unfavorable aerodynamic conditions. Their size is 27 times smaller than a human hair. They described PM_{10} as coarse particles that are emitted from diesel vehicles, biomass burning activities and by construction sites. PM_{10} is mostly responsible for smoke plumes in the urban and rural areas. During respiration, they are not able to reach deep into lungs, as they are trapped by mucus in the nasal cavity of larynx of wind pipe because of their size [6].

Environmental and Health Effects of PM

According to aerodynamic size of SPM, PM with small structure is danger to environmental ecology and human health. Broadly, Figure 1.3 shows different aspects of PM.

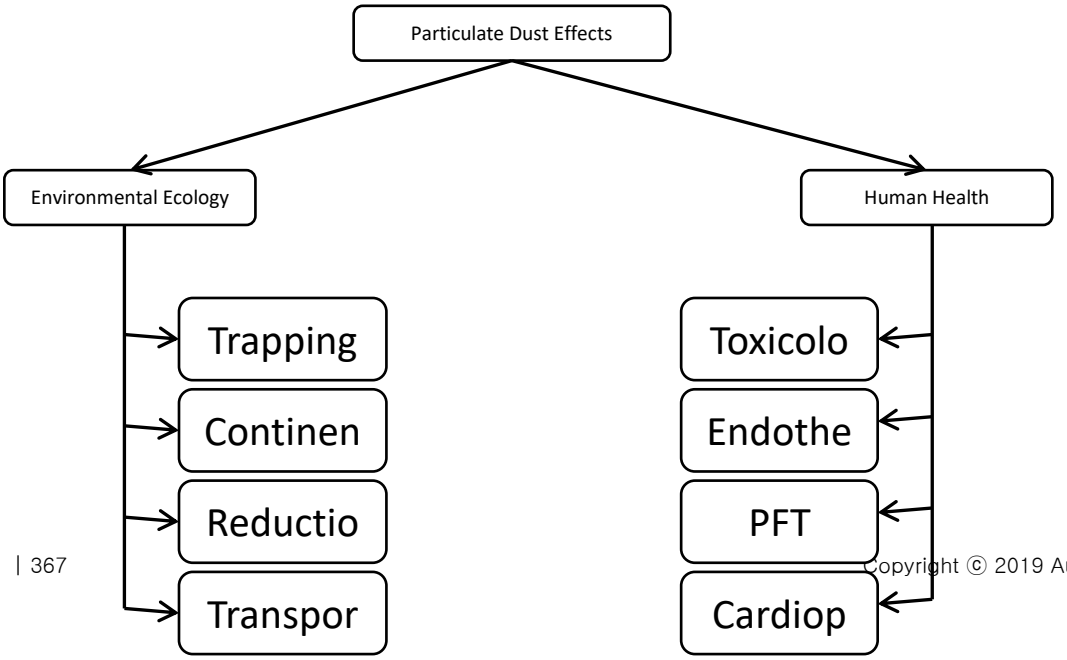

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Figure 1.3: Ecological and Health effects of PM

Effects on Environmental ecology - In ambient environment, trace elements of PM absorb the UV (Ultra violet) rays from sun and trap them in the troposphere. Because of trapping of UV rays, the temperature of continent has increased from their existing levels of 9% to 15%. So, they are directly or indirectly responsible for global warming. they investigated that the emission of PM affects visibility of the areas. The investigation of him reveals the toxicological aspects of SPM as these are responsible for transport of hazardous toxins and pollens from one place to several miles because of their favorable biochemical and physiological compositions.

Effects on Human Health – PM having smaller size affects ambient environmental parameters as well as human health. Respiration and cardiopulmonary organs is the prime target of PM [7]. Through breathing, PM enters into lungs of human subjects and stresses the endothelial walls. Toxicologically, PM having oxidative nature damages tissues of respiration mechanism [8]. SPM having size $PM_{2.5}$ and PM_1 are more harmful to chest compliances as they do affect recoilless of lung wall.

Because of slow cleaning mechanism of lungs, PM affects the capacity and flow of Pulmonary Function Test (PFTs) parameters by deposition on alveolar sacs.

Exposure Effectiveness of Particulate Dust

Particulate dust is emitted in ambient environment by a number of processes, activities and sources. Figure 1.5 describes different aspects related to exposure effectiveness of PM in the ambient environment.

Typographical aspects: On earth, various geographical grids are identified as permanent sources of PM**.** There are various sites in different continents where unpredictable amount of SPM have been released by particular sources because of geo-typographical reasons like volcanoes in east Australia and forest fires of Indonesia. The findings found a permanent releasing of trace gases and alkali metals from Mt. Etna Volcano in Sicity and Soufriere Hills Volcano, Montserrat, West

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Indies as these sites are famous for volcanic activities. The evidences of trace pollutants were even observed several miles far from active sites because of travel of PM with wind directions. This activity is natural and cannot be interrupted to stop releasing of pollutants. There are various manmade sites that are influenced by uncontrolled release of pollutants because of weak and ineffective policies of control agencies. These sites have the constraints of large population, manufacturing units, millions of on road vehicles in cities like Tokyo (Japan), China, New Delhi and Hyderabad of India. Figure 1.5 shows the effectiveness of various factors on PM compositions.

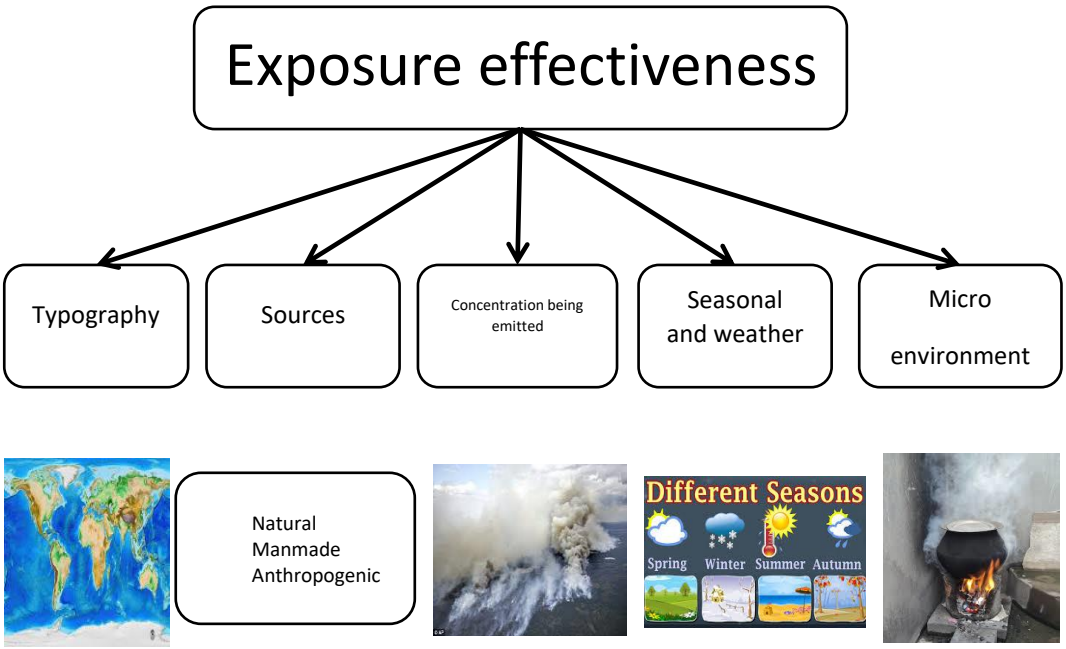

Figure 1.5: Exposure effectiveness of PM depending on various factors

Sources of PM: There are various natural and manmade activities that are polluting the environment in an unabated manner (Figure 1.5). These activities are constantly releasing coarse and fine PM. Worldwide, these practices are the main sources of pollution in each area of continents. Regular use of fuel in daily activities by inhabitants is observed as the main sources of SPM in the respective areas. It has been found from the Badarinath and groups in 2003 studies that there are various anthropogenic activities (construction of buildings, biomass burning and fuel burning) observed as prime source of PM pollution in areas.

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Concentration of PM being emitted: The level of pollutants released by the sources is totally different at various sites during different time slots. The emission is not constant throughout the years. There are a number of activities such as use of fireworks during festivals or carnivals celebrated worldwide that suddenly increases the level of SPM to a hazardous level in the respective areas.

Season and weather constraints: Spatial and temporal parameters (speed of blowing air, direction of air, ambient humidity, level of precipitation and temperature) has an important role in the settlement [8]. It has been observed in literature that the areas having low temperature, low precipitation and low wind speed are more prone to PM pollutants than other places having relatively high values. The PM trends are even too sensitive to seasonal variations because of variations in meteorological parameters in the areas.

Rice crop has two residues forms (straw and husk). Straw is a main part of rice crop residue and it is used as fodder by inhabitants of southern and eastern parts of India. Husk is a waste that is produced by rice mills during separation of cereal from raw form. Although, husk of rice is not found appropriate as fodder for lactic animals because of presence of silica in the waste. A large portion of husk is used as fuel in energy production units of mills and a small portion is consumed in domestic stoves as fuel, bedding for poultry products and oil extraction. The use of combine harvesters and threshers scatter the straw and husk in the open fields that are subjected to burning in the open fields. Waste of Wheat is also generated in large scale and the major portion is used as cattle field because of favorable and hygienic content, domestic fuel, raw material in paperboard making and oil extraction. Rice and wheat (Table 1.1) are the two major crops responsible for residue generation in India, especially in Punjab Rice and wheat crops contribute main role in agricultural biomass burning-related emissions of pollutants in ambient environment. Rice and wheat are grown widely in India and referred to as Cyclic Rice Wheat System (CRWS), because both of these crops are grown one after then other in a cyclic manner. Most of the land is under CRWS practice. This system is also adopted by various regions in Indo Gangetic belt.

Table 1.1: Agriculture crop residue generation in Mt/yr in Indo Gangetic plains

Crop	Annual crop waste production in Mt/yr	Dry residue Generation in Mt/yr

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Rice	192.8	153.4
Wheat	120.7	80.7
Maize	26.75	19.7
Cotton	90.9	37.9
Sugarcane	18.6	16.8

Agriculture crop residue disposal is a labor intensive and tedious task of this practice, thus burning is adopted to be an easy, convenient, economical method by the local farmers. ACRB being less time consuming, is widely used practice for preparing a farm land for next seasonal crops. Moreover, ACRB does not require any extra labor to take care of it. Sometimes, farmers are supposed to use this practice as pest and weeds control method in the fields for the coming crops. For the personal and short term benefits, farmers used the practice of ACRB but it poses a serious, long term hazardous effect on environmental ecology and society. Because of lack of proper combustion environment, ACRB practice produces hazardous gases and fine PM in the affected areas. The plumes of dense smoke are visible in the areas that cause ill effects on ecological system (Ribeiro *et al.* 2008). ACRB practice contaminates ecological system that directly affects global and regional ambient air, visibility, climate, soil, weather and seasonal cycles [6,7,8].

Conclusions

Pulmonary Function Test (PFTs) is a valuable method for evaluation of respiratory system of human subjects. Respiration volume and flow are the two main components that are further categorized by spirometer. Breathing tests measure the functioning of the lungs performed to assess lung function. These parameters can help to find disease in respiratory system through PFT practice. PFTs are a set of processes that measures the lungs functioning [8]. Pulmonary function test helps doctors and researchers to identify respiratory disorders such as bronchitis, cardiopulmonary ailments, Chronic Obstructive Pulmonary Disease (COPD), mechanical injury by measuring degree of lung impairment.

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