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Review Article

Effects of Air Pollution on Respiratory System (Lungs) and Modern Techniques to Control Pollution

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Abstract

Air pollution is a significant health risk factor all over the world. A global study of diseases showed that air pollution is one of the top ten global health risk factors. Approximately 7 million people in the world and 40, 0000 people experience early death due to air pollution. The most common pollutants include particulate matter, carbon monoxide, ozone, nitrogen oxide, and sulfur dioxide. The two types of air pollution, indoor and ambient, both contribute to a host of cardiac and respiratory illnesses. General ambient air pollution, chiefly due to the incomplete combustion of fossil fuels, may be responsible for increased rates of lung cancer. Exposure to excess levels of air pollution is significantly associated with a variety of acute and chronic respiratory illnesses, such as chronic obstructive pulmonary disease, asthma, respiratory allergies, and lung cancer. The effects of air pollution disproportionately impact the extremes of the age distribution, perhaps due to altered immune responses. The presence of one or more contaminants in the atmosphere, such as dust, fumes, gases, gas, 'fog', odour or vapour in quantities or with characteristics, and of a duration that may be detrimental to human, animal or plant. Combustion-source air pollution contributes to the occurrence of lung cancer among the general population. By using modern techniques to control pollution Multi-vortex wet air scrubber's technology, nano technology, recycle reuse techniques is very helpful to control pollution.

Keywords: Air pollution, environment, human health, respiratory tract diseases, modern techniques.

INTRODUCTION

Air pollution is a significant health risk factor all over the world. A global study of diseases showed that air pollution is one of the top ten global health risk factors. Approximately 7 million people in the world and 40, 0000 people experience early death due to air pollution [1]. Exposure to outdoor air pollution is associated with acute and chronic health problems that range from minor irritation to death [2]. According to the World Health Organisation (WHO), air pollution is defined as 'The presence of one or more contaminants in the atmosphere, such as dust, fumes, gases, gas, 'fog', odour or vapour in quantities or with characteristics, and of a duration that may be detrimental to human, animal or plant life, to property or that interferes unfavorably in the comfortable enjoyment of life or property' [3]. Generally, a very large group of pollutants in the air are grouped together under the designation of particles and may originate from such sources as cars, steelworks, thermal power plants, heating systems, cement plants, volcanoes, deserts, and oceans [4]. Pollution, also called environmental pollution, the addition of any substance (solid, liquid, or gas) or any form of energy (such as heat, sound, or radioactivity) to the environment at a rate faster than it can be dispersed, diluted, decomposed, recycled, or stored in some harmless form.

"Environmental pollution is the contamination of the environment with unwanted, hazardous substances that adversely affect the biological as well as physical constituents of the atmosphere or environment". With an increase in the industrial revolution, we unknowingly contaminated our

surroundings [5]. Pollution of all kinds can have negative effects on the environment and wildlife and often impacts human health, animal's health and also impact of wildlife flora and fauna. Animals, or wildlife, are vulnerable to harm from air pollution. Pollutant issues of concern include acid rain, heavy metals, persistent organic pollutants (POPs) and other toxic substances [6].

Persistent organic pollutants (POPs) are regarded as very harmful compounds because they are resistant to various factors of biochemical and photolytic degradation. POPs are persistent to soils, sediments, and air for several decades [7]. Cars spew pollutants from their exhaust pipes. Burning coal to create electricity pollutes the air. Industries and homes generate garbage and sewage that can pollute the land and water. Pesticides-chemical poisons used to kill weeds and insects seep into waterways and harm wildlife. The major kinds of pollution, usually classified by environment, are air pollution, water pollution, and land pollution [8].

Fig-01: Main source of air pollution [9]

Air pollution composition

Air pollution is a complex mixture of thousands of pollutants. This mixture may consist of solid and liquid particles suspended in air (particulate matter – PM), and different type of gases such as ozone (O3), nitrogen oxides (NO2 or NOx), volatile organic carbons (VOCs), and carbon monoxide (CO). While particles vary in number, size, shape, surface area and chemical composition, both particles and gases may vary in solubility and toxicity [10]. The most important processes causing air pollution relate to the combustion of fossil fuels used in cars and trucks, aircraft, marine vessels or other engines, as well as in industry, power plants, or household heating systems. Due to the close proximity between people and emissions, transport-related activities, in particular involving cars and trucks, are an important source of air pollutants [11]. Traditionally, health studies have used markers of air pollution to study its effects, e.g. the mass of size specific PM fractions – such as PM10 or PM2.5 – NO2, or distance to main roads [12].

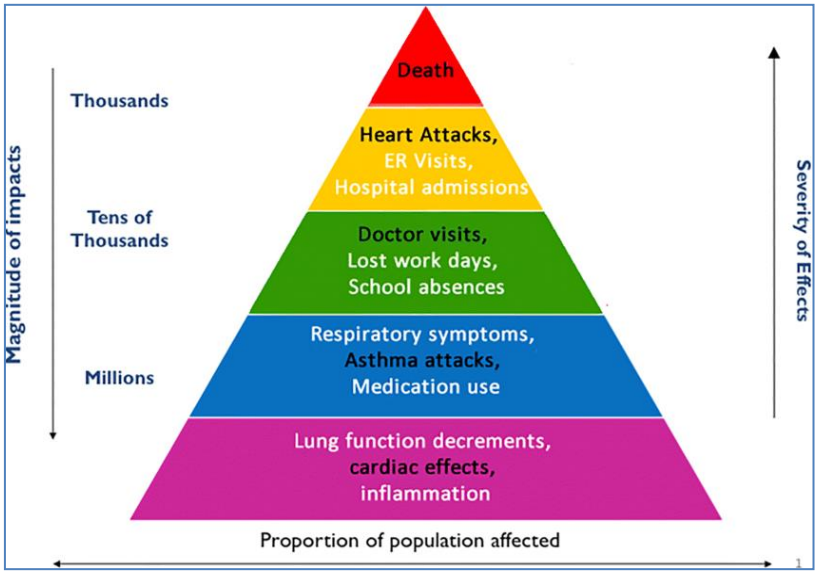

Fig-02: Pyramid of Ambient Air Pollution Adverse Human Health Effects [13].

Air pollution affects the respiratory system (Lungs)

The most consistent and most widely accepted explanation is that, once in contact with the respiratory epithelium, high concentrations of oxidants and pro-oxidants in environmental pollutants such as PM of various sizes and compositions and in gases such as O3 and nitrogen oxides cause the formation of oxygen and nitrogen free radicals, which in turn induce oxidative stress in the airways [14]. In other words, an increase in free radicals that are not neutralized by antioxidant defenses initiates an inflammatory response with release of inflammatory cells and mediators (cytokines, chemokines, and adhesion molecules) that reach the systemic circulation, leading to subclinical inflammation, which not only has a negative effect on the respiratory system but also causes systemic effects [7,15].

Table-1: List of the various air pollutants, properties, sources and their effects on lungs

Air Pollutants	Properties	Sources	Effects on Lungs	Vulnerable populations	References
CO2	Colorless, odorless gas	Burning of Fossil Fuels, Deforestation Crop Residue Burning	Shortness of breath. Lung function reduction.	People with respiratory diseases	[16]
CO	Colorless Odorless Toxic gas	Biomass and fossil fuels Combustion, Cigarette Smoke, vehicle exhaust	Reduce oxygen delivery. Bronchial hyper responsiveness. Lung diseases.	People with respiratory& cardiovascular diseases	[17]
NO2	Reddish Brown Gas, Strong Oxidizing Agent.	Vehicles, Power Plants, Industrial Emissions, Volcanoes, Fertilizers Lung tissue damage.	Bronchitis Destruction of cilia	People with heart diseases	[18]
SO2	Colorless, non-Flammable gas with irritating odor	Smelting, Paper Manufacture, Burning high sulfur coal or oil.	Breathing Difficulties Respiratory illness	Pregnant women and children	[19]
O3 Aerosols, Refrigerants, Air Conditioning, Cleaning Solvents.	Colorless, Unpleasant odor, Part of smog	Photocopiers, cars, industry, gas vapors, chemical solvents.	Reparatory tract irritation. Interference lungs functions. Asthma	People with heart diseases	[20]
Other Pollutants	**(CFC's)** From refrigerants, aerosol Styrofoam **Formaldehyde** colorless irritating gas	From building materials & household products (industrial glues)	Lung Cancer Throat Discomfort	Smokers, Asbestos workers. Adults and children with asthma	[21]

Air pollution and lung cancer

The World Health Organization estimates that, in 2008, there were 12.7 million new cases of cancer that caused 7.6 million deaths worldwide, the number of new cases of lung cancer and the number of deaths from lung cancer being 1.61 million and 1.18 million, respectively [22]. The effects of exposure to pollutants and the development of lung cancer, which is attributed to the direct action of carcinogens present in pollution and to the chronic inflammation induced by such carcinogens [23]. Lung cancer was associated with a 10-µg/m3 in PM2.5 concentration. In a study conducted in European countries, 5% and 7% of the various types of lung cancer in nonsmokers and former smokers, respectively, were attributed to the effects of pollution [24]. Air pollution increases the risk of lung cancer incidence by 20-30% [25].

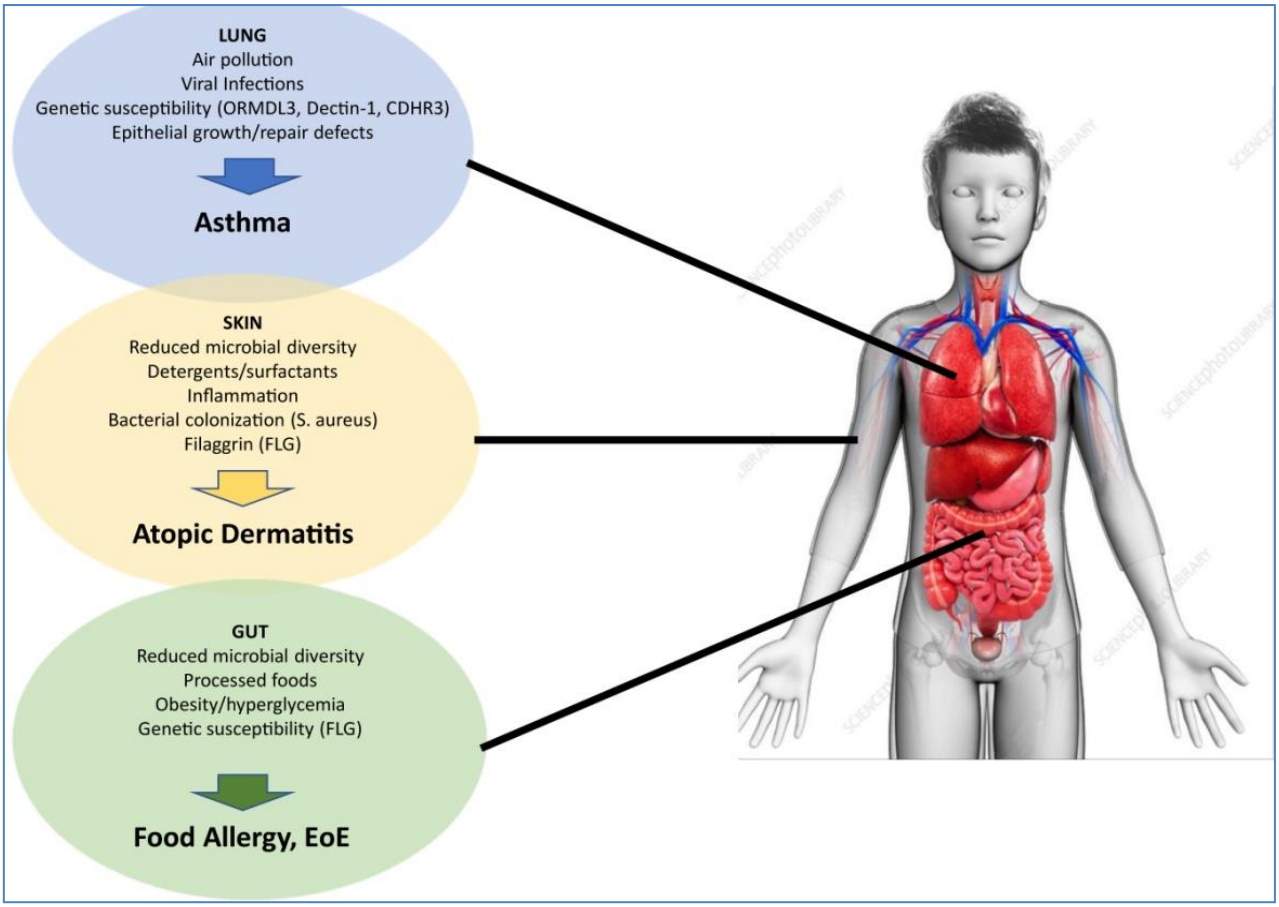

Fig-03: Effect of pollution on lungs and skin [26]

Oxidative stress and inflammation

High concentrations of oxidants and pro-oxidants contained in ambient air pollution, such as particulate components of various sizes and compositions (eg ultrafine PM, transition metals, reactive organic compounds), and gases such as ozone (O3) or nitrogen oxides (NO, NO2) promote oxidative stress and respiratory inflammatory responses [27]. Mediated through cytokines and chemokines, the pulmonary responses also lead to sub-clinical systemic inflammation with alterations in the vascular system. Moreover, inflammation itself is a potent source of oxidant stress which leads to DNA damage [28].

Respiratory disorders

Most of the pollutants enter the body through the airways, the respiratory system is in the first line of battle in the onset and progression of diseases resulted from air pollutants. Depending on the dose of inhaled pollutants, and deposition in target cells, they cause a different level of damages in the respiratory system [29]. In the upper respiratory tract, the first effect is irritation, especially in trachea which induces voice disturbances. Air pollution is also considered as the major environmental risk factor for some respiratory diseases such as asthma and lung cancer [30]. Air pollutants, especially PMs and other respirable chemicals such as dust, O_3, and benzene cause serious damage to the respiratory tract. Asthma is a respiratory disease which may be developed as a result of exposure to air toxicants [31,32].Some studies have validated associations between both traffic-related and/or industrial air pollution and increasing the risk of COPD [33, 34]. Treatment of respiratory diseases due to air pollution is similar to the other toxic chemical induce respiratory disorders [35, 36].

Modern techniques to control pollution

The construction of modern landfills with well-engineered and managed disposal facilities can significantly lessen the impacts of landfill on soil, air, and water. Landfills that are well-designed and operated ensure compliance with environmental preservation requirements and it ultimately ensures that the environment is free from contaminants [37]. While a landfill is also an excavated piece of land for waste storage but it is regulated by the government. A landfill has a liner at the bottom to catch the liquid produced by solid waste while a dump does not have a liner [38].

Design and implementation of integrated waste management technique:

The construction of modern landfills with well-engineered and managed disposal facilities can significantly lessen the impacts of landfill on soil, air, and water. Landfills that are well-designed and operated

ensure compliance with environmental preservation requirements and it ultimately ensures that the environment is free from contaminants [39].

Recycle, Re-use, and reduce

Landfill management will always remain a major environmental if communities don't embrace the need of recycling, reducing and reuse. The increased demand of manufactured products is what increases the final waste products that end up in the landfill. In this view, the use of recycling systems for electronic wastes, plastics, paper, metal, glass and other non-biodegradable materials can provide an effective means of reducing the landfill effects. Reusing the products that we have already bought keeps them away from the landfill [40].We can buy used items from internet sites like E-bay, second-hand stores, garage sales, or otherwise donate the items that we don't use. Recycling is one of the best solutions for landfill management. Materials such as plastics, cans, paper and glass can be recycled [41].

Using nanotechnology for smart packaging

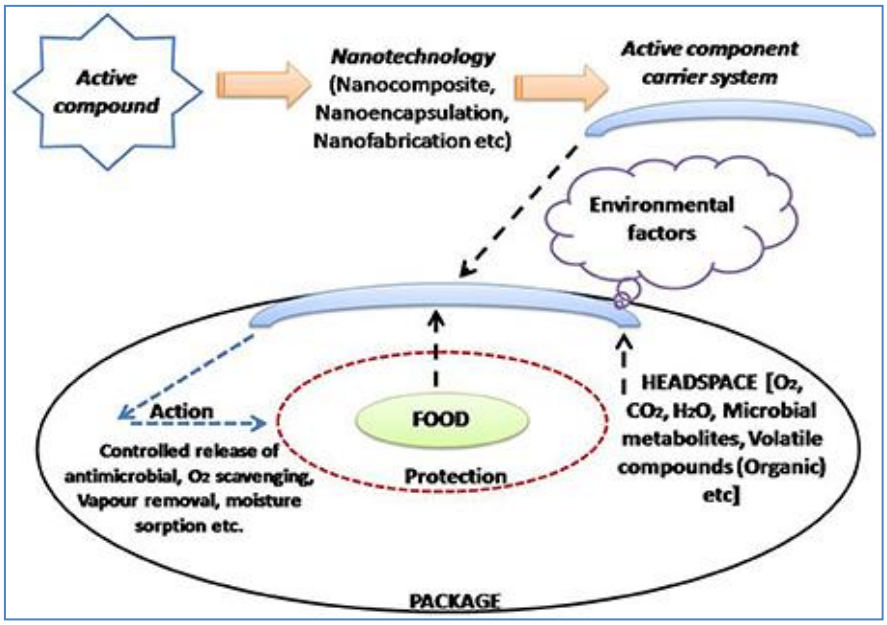

Fig-04 Active packaging and its association with nanotechnology [42]

Nano-composites, a fusion of traditional food packaging material with nano-particles are gaining active interest in food packaging sector. In addition to its remarkable antimicrobial spectrum, it displays great mechanical performance and tough resistant. Nan composites are usually made up of a polymer matrix in a continuous or discontinuous phase [43].

Multi-vortex wet air scrubbers technology

Multi-vortex wet air scrubbers wash dust, flue gases, and vapors from a gas stream. The multi-vortex scrubber is very customizable. Its design allows the manufacturing of 2,100 – 25,000 cfm gas cleaning system for the removal of a wide variety of pollutants. Multi-vortex wet air scrubber removes coal dust from the air at loading facilities [44, 45].

Fig-05: Modern air pollution control technologies – Multi-vortex Wet Air Scrubber [46]

Different ways to reduce Air pollution [47, 48, 49, 50]

Use filters for chimneys: The gas that is emitted from fireplaces in homes and factories are extremely dangerous for air pollution and harms the air quality severely. The use of filters should be used at least if the consumption couldn't be lessened, this will help to reduce the effect of harmful gases absorbing in the air.
Avoid usage of crackers The use of crackers during festivals and weddings is sadly one of the biggest contributors to air pollution, leading to a layer of smog which is extremely harmful for health. So, practice of no crackers should be implemented.
Avoid using of products with chemicals Products that use the chemicals in their usage or smell strongly, like paints or perfumes should be used less or outside the house. There can also be an alternative to use products with low chemical content and organic properties.
Reduction of forest fires and smoking The collecting of garbage and getting it on fire in dry seasons or dry leaves catching fires is a huge factor for causing air pollution, moreover smoking also causes air pollution and causes the air quality to worsen along with obviously damaging one's health.

CONCLUSION

Air pollutions have major impacts on human health, triggering, and inducing many diseases leading, lungs disease, and respiratory disease. Air pollution is a complex mixture of thousands of pollutants. This mixture may consist of solid and liquid particles suspended in air (particulate matter – PM), and different type of gases such as ozone (O3), nitrogen oxides (NO2 or NOx), volatile organic carbons (VOCs), and carbon monoxide (CO). Air pollutions control is vital and should be on the top of priority list of the governments. Different techniques used to control pollution such as Multi-vortex Wet Air Scrubber very helpful technology, nano technologies, recycle and reuse technology, cyclons. Use different ways to reduce pollution combustion-source air pollution contributes to the occurrence of lung cancer among the general population.

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