Chapter

Environmental Media and Associated Respiratory Defects

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Abstract

Environmental media majorly connotes abiotic components of the natural environment, namely, air, water and soil. Pollution to these media has resulted to a great deal of respiratory defects. Epidemiologic studies conducted in the U.S. and abroad provide evidence of associations between short and long-term exposure to fine particles in the air and both decrements in lung function growth in children and increased respiratory symptoms. Particles deposited in the respiratory tract in sufficient amounts induce lung inflammation, which has been demonstrated in both animal and controlled human exposure studies. More recently, the International Agency for Research on Cancer (IARC) also conducted an evaluation on the carcinogenicity of outdoor air pollution in the respiratory tract, including particle pollution, and concluded that both are Group I agents (carcinogenic to humans). Air pollution has been given great priority as a causal factor for respiratory defects; meanwhile dust particles from contaminated soil could also cause a great havoc. Moreover polluted water is also a major causal pathway. According to world health organization (WHO) 80% diseases are waterborne. Though water is an important natural resource used for drinking and other developmental purposes in our lives but health risk associated with polluted water includes different diseases in which respiratory diseases are the major ones. Bacterial, viral and parasitic diseases are spreading through polluted water and affecting human health. Poliomyelitis virus is responsible for poliomyelitis, sore throat, fever, nausea, which are all due to polluted water.

Keywords: air, water, soil, lung inflammation, cancer, nausea

1. Introduction

Defect is any abnormality or imperfection that is capable of impairing quality, function or utility [1]. A respiratory defect is therefore any impairment in the vital function or utility of the respiratory system caused by abnormalities (congenital or induced) in one or more of the respiratory organs. The major organs of the respiratory system are the nose and nasal cavity, larynx, pharynx, bronchi, alveoli, trachea and the lungs. They function primarily to provide oxygen to body tissues for cellular respiration, remove the waste product carbon dioxide, and help to maintain acid-base balance [2]. Due to the anatomy of the respiratory tract, it is constantly exposed to microbes, which is why the respiratory system includes many mechanisms to defend itself and prevent pathogens from entering the body.

Lungs are the powerhouse of the respiratory system. Through inhalation oxygen is brought into the body with and exhalation rids the body of carbon dioxide. Harm to the lungs can result from presentation to numerous things noticeable all around,

for example, allergens, lethal substances, metals, and molds. Research has indicated that long term introduction to air contaminations can influence the development and improvement of the lungs, and increment the danger of creating asthma, emphysema, and other lung illnesses.

The NIEHS-sponsored Harvard Six Cities Study found a significant relationship between introduction to fine particle air pollution and early deaths. Likewise, perhaps the greatest risk to lung wellbeing is tobacco smoke, containing many poisons, for example, nicotine carbon monooxide, tar, arsenic, cadmium, methane, etc. [3]. Respiratory disease is a common and significant cause of illness and death around the world. The most common cause of illness in children in developed countries and a leading cause of death in children in developing areas are diseases of the lung and airways. According to the Centers for Disease Control and Prevention (CDC), chronic obstructive pulmonary disorder (COPD) is the fourth leading cause of death in the United States. Its prevalence increases with age. Men are more likely to have the disease, but the death rate for men and women is about the same. In another research conducted in the United States in 2010, it was discovered about 6.8 million visits to the emergency division were for respiratory issues from patients younger than 18. About one-seventh of the United Kingdom population is affected by some type of persistent lung disease, most commonly COPD, which incorporates asthma, persistent bronchitis, and emphysema. There are various ways by which respiratory disorders can be classified: it could be based on

1. The organ or tissue involved

2. Pattern of signs and symptoms associated with the disease

3. Causal factor of the disease

Generally, respiratory disorders can be classified into these areas;

- Obstructive respiratory conditions are usually characterized by obstructed airflow inflamed and easily collapsible airways. Examples are asthma, bronchitis, emphysema, bronchiectasis, etc.

- Restrictive respiratory conditions these disease restrict lung expansion resulting in reduced lung volumes, either because of an alteration in lung parenchyma or because of a disease of the pleura (e.g., fibrosis, sarcoidosis, alveolar damage, pleural effusion).

- Vascular diseases. They are diseases that affect the blood vessels from the heart to the lungs. They are of two major types: pulmonary embolism and pulmonary hypertension.

- Environmental and occupational respiratory "diseases." These respiratory defects are caused by harmful particles, mists, vapors, or gases that are inhaled, in the surroundings where people live and usually while people work. Various sorts of particles elicit various reactions in the body. For instance, particles like animal dander could cause unfavorably susceptible responses, like hay fever-like symptoms or a kind of asthma. Different particles cause hurt not by activating hypersensitive responses, however by being harmful to the cells of the aviation routes and air sacs in the lung. A few particles, for example, quartz residue and asbestos, may cause incessant aggravation that can prompt scarring of lung tissue (aspiratory fibrosis). Certain lethal particles, for

example, asbestos, can cause lung malignant growth, especially in people who smoke, or cancer of the lining of the chest and lung (mesothelioma), (e.g., pneumonia, tuberculosis, asbestosis, particulate pollutants) [4, 5].

2. Overview of the environment and its various components (media)

The environment can be defined as all that which is external to the individual host. It can be divided into physical, biological, social, and cultural factors, any or all of which can influence health status in populations [6]. In other words environment refers to those things that surrounds living beings and affect their lives. The environment is man's basic life support system. It provides the air we breathe, the water we drink, the food we eat and the land where we live.

The four major components of environment include lithosphere, hydrosphere, atmosphere and biosphere, corresponding to rocks, water, air and life respectively.

Lithosphere is the outermost layer of earth called crust, consisting of various minerals, it is where we have the rocks and soil. It is about 100 km in depth, and is found on both land and seas. The principal component of lithosphere is earth's tectonic plates.

Hydrosphere, covering 70% of earth's surface, involves all the varieties of water bodies on earth such as seas, oceans, rivers, lakes, lakes, streams, etc. 97.5% of water found on earth is in the seas as salt water. Just 2.5% of water on earth is freshwater. Out of this, 30.8% makes up the rivers, repositories, and lakes and is easily accessible to man.

Atmosphere is the gaseous, envelope-like material encasing the earth. It is unique to the earth because its abundance of oxygen (20.95%) which is vital in supporting life on earth. other constituents of the atmosphere includes 78.08% nitrogen, 0.93% argon, 0.038% carbon dioxide, and trace elements like, hydrogen, helium, noble gases and water vapor.

Biosphere refers to all the regions on Earth where life exists. The ecosystems that support life could be in soil, air, water, or land.

3. The environment and health

The environment we live in is a major determinant of our state of health, from the rural zones to thick urban communities, the sort meals we eat and water we drink, places we live to the spots we work, and hence harm to our indigenous habitat, likewise brings about harm to human wellbeing. Factors, like inaccessible, safe drinking water and sanitation, air pollution and changes in climatic conditions contribute to 23% of all deaths globally and 36% of all deaths among youngsters between the ages of 0 and 14. It is estimated that 1.8 billion individuals get drinking water from fecally contaminated water sources and 2.5 billion individuals live without essential sanitation facilities, increasing the rate of diarrheal infections, malnutrition and deaths. Insufficient water for hygienic purposes, consumption of unsafe water and absence of access to sanitation together makes up about 88% of deaths from diarrheal diseases, resulting in 11% of mortality of kids younger than 5 [7].

Health impacts associated with damage to our environment are numerous and diverse ranging from diarrheal and vector-borne diseases to respiratory diseases, ischemic heart disease and stroke to mental health impacts of extreme weather events, failing livelihoods, conflict and displacement [8]. This therefore implies that in order to reduce the incidence of disease more attention needs to be paid to reducing the environmental causes such as:

Poor air quality: about 3 billion people depend on wood, charcoal, animal compost, and crop waste as fuel for the supply of energy in households. Fifty to seventy percent of Africa's populace cooks with solid fuel, majorly exposing women and children to massive quantities of pollutants, in various concentrations, posing considerable health risks to humans, hence increasing the risk of diseases like pneumonia and chronic respiratory disorders on such exposures.

Poor sanitation diseases such as diarrhea result from poor sanitary conditions and unsafe water and are responsible for the deaths of 1.8 million people every year amounting to an estimated 4.1% of the total DALY global burden of disease. 88% of this disease burden is attributable to unsafe water supply, poor sanitation and poor hygiene practices. Provision of safe drinking water and sanitation are important measures of improvement.

Poor landscape and urban land management poor landscaping and lack of urban and regional planning contribute to overpopulation and overcrowding. This will increase the spread of infectious diseases, favor the proliferation of pest, poses a lot of pressure on the basic amenities and infrastructure, increased areas of stagnant water and thereby increasing the risk of malaria. Across the globe, about 30 million cases of malaria are being recorded yearly, leading to over a million deaths, with approximately 90% of these deaths occurring majorly among young children in Africa. Malaria makes up 10% of Africa's overall disease burden and is the main cause of death among children under the age of five. Africa bears over us$ 12 billion in lost GDP yearly due to malaria.

Overexploitation and degradation of natural resources: a major factor contributing to food insecurity is over exploitation and degradation of natural resources, it reduces the capacity of the land to produce crops and sustain livestock. The resultant effect of food shortage is malnutrition and in worst cases, starvation. Asides reducing immunity to other diseases, severe cases of malnutrition also causes stunting in children and hinders healthy development. According to World Health Organization, across the globe, one in seven people are affected by hunger. Also, of the 10.9 million child deaths each year, half is attributable to malnutrition+ [7].

4. Air-induced respiratory disorders

Air is a mixture of gases comprising the atmosphere, living things requires air for their existence. Thus the quality of air we breathe in is a vital indicator of our state of health. When we breathe in polluted air, the pollutants get inhaled deep into the lungs, resulting in serious harm to the respiratory tract. Polluted air can set off new cases of asthma, worsen existing cases of respiratory diseases and trigger the development or advancement of chronic illness including lung cancer, chronic obstructive pulmonary disease, and emphysema. Air pollutants also have a considerably adverse effect on lung development, thus, increasing the vulnerability for developing lung diseases in the long run [9]. Burning of wood, animal waste, and crops (biomass fuel) is an important source of particulate matter indoors in developing countries, Secondhand smoke is also an important source of indoor air pollution [10]. Air pollution-related lung disease increases the risk of heart and blood vessel disorders and may increase the risk of lung cancer. Long-term exposure to air pollution may increase respiratory infections and symptoms of respiratory disorders (such as cough and difficulty breathing) and decrease lung function.

Ozone, a primary air pollutant and basic constituent of smog, is a strong lung irritant. During the year, levels are noticeably higher during summer likewise in contrast with other period of the day, ozone levels tend to be higher, late in the morning and early in the afternoon. Short-term exposures can cause breathing

difficulties, chest pain, and airway hyperactivity. Participating in outdoor activities on days when ozone pollution is high can increase the risk of developing asthma among children. Long-term exposure to ozone causes a small, permanent decrease in lung function. When fossil fuel that are high in sulfur content are burnt, they acidic particles called sulfur oxides, which are deposited in the upper respiratory tract and can cause constriction and irritation resulting in increased risk of chronic bronchitis and symptoms like breathing difficulty. Particles affect the lung in various ways, depending on their primary material. Particles of the same material also may have different effects depending on their size and shape. Variation in environmental conditions and location affects the level of pollutants in the air. For instance, on warm and humid days, ozone tends to remain in the air. Carbon monoxide levels also tend to be high during peak periods when many commuters drive to or from work. The Air Quality Index is utilized to convey how polluted the air is at a given point in time. Individuals, particularly those with heart or lung disorders, can utilize the Air Quality Index to manage their choice of outdoor activities on days when pollution levels are high [10].

AQI values	Air quality condition
0–50	Good
51–100	Moderate
101–150	Unhealthy for members of sensitive groups
151–200	Unhealthy
201–300	Very unhealthy
301–500	Hazardous

Source: msdmanuals.com.
Adapted from US Environmental Protection Agency: Air Quality Index: A guide to air quality and your health. Research Triangle Park, NC, 2009.

Air Quality Index.

Children are more vulnerable to the impacts of air pollution. They inhale through their mouths, bypassing the sifting impacts of the nasal entries and permitting pollutants to travel further into the lungs. They have a larger lung surface area comparative with their weight and breathe in generally more air, compared to grown-ups. Children also spend more time outdoors especially in the afternoon and throughout the summer months when ozone and other pollutant levels are at their peak and may disregard early indications of impact of air pollution such as, an asthma exacerbation leading to severe attacks. A combination of these with the adverse impact of some pollutants on lung development and the immaturity of children's enzyme and immune systems that detoxify pollutants, results in series of factors that contribute to children's increased sensitivity to air pollutants [9].

Asthma is a chronic disease which affects the bronchi and bronchioles of the lungs characterized by inflammation and narrowing of the airways, it causes a sensation of tightness in the chest, shortness of breath, wheezing, and coughing. Over 20 million people in the U.S., including six million children now gasp for breath due to asthma [9]. Asthma triggers are numerous and vary; dust, smoke, pollen, and volatile organic compounds are examples of asthma triggers. Primary pollutants such as ozone, carbon monoxide, sulfur dioxide, and nitrogen oxides are also outdoor triggers.

Chronic Obstructive Pulmonary Disease (COPD), chronic bronchitis and emphysema. Chronic Obstructive Pulmonary Disease (COPD) is an irreversible condition caused by exposure to pollutants that produce inflammation, and

immunological response. It is characterized by narrowing of the airways. In larger airways, the inflammatory response is referred to as chronic bronchitis. It leads to tissue damage or emphysema in the tiny air cells at the end of the lung's smallest passageways [9]. Emphysema is a chronic disease that causes reduction of the respiratory surface due to the damage to the lung alveolar walls. It is caused mainly by cigarette smoking, dust, chemicals and exposure to passive cigarette smoking. The main symptoms of emphysema include shortness of breath and cough. Emphysema might lead to a loss of elasticity of the lungs.

Lung cancer in the U.S, the main cancer killer in both men and women is lung cancer, is frequently (and precisely) related with smoking tobacco. While that is valid, there are also other risk factors associated with lung cancer, along with air pollution. Particulate issue and ozone are also implicated in mortality due to lung cancer [9].

5. Occupational respiratory disorders

Occupational respiratory disorders are defined as any disorder which affects the respiratory system by long-term inhalation of chemicals, proteins, and dust. Occupational respiratory disorders might happen due to the inhalation of the following substances fumes from metals, smoke from burning organic materials, sprays of varnishes, paint, acids, and pesticides, dust from cotton, silica, coal, drug powders and pesticides and gases from industries. The type of occupational respiratory disorder depends on the environment to which the person is exposed: people, particularly those with other lung disorders, are at risk when they are exposed to air pollution in the environment or to contaminants in indoor environments. Some many more people are at risk of occupational asthma as a result of exposure in the workplace. Exposure to asbestos can cause asbestosis, mesothelioma, and asbestos-related pleural disease. People who work with beryllium, such as aerospace workers, are at risk of beryllium disease. Byssinosis is prevalent among people who work with cotton, flax, or hemp. Coal workers and graphite workers are at risk of coal workers' pneumoconiosis. Prolonged exposure to silica would result in silicosis [5].

6. Soil-related respiratory defects

Soil is a complex system of air, water, minerals, natural matter and biota that covers the terrestrial earth in layers over the underlying bedrock. Endogenous segments of soil incorporate minerogenic colloidal clay and trace elements, biogenic organic materials, and biota, any of which might be advantageous, impeding or harmful, contingent upon their relative concentrations and the exposure pathway. Soils are also significant source of supplements, and they go about as common channels to expel contaminants from water [11]. Notwithstanding, soils may contain heavy metals, chemicals, or pathogens that can adversely affect human wellbeing. As soil is persistently being made airborne and afterward dispersed through the air by the global components of climate and weather. Soil, in dust forms, can sometime be dispersed to great distances therefore, increasing the exposure levels of humans to soil particles throughout their evolutionary history, from both local and regional sources and potentially from almost anywhere on the planet [12].

The NIH National Institute of Allergy and Infectious Diseases also reported that airborne residue is the main source of environmental agents that encourage human allergic disorders [13]. The basis of reactions of the human immune system to airborne dusts has created an outcome of long term exposures, on a developmental

time scale to minerogenic, biogenic and anthropogenic parts that are pervasive segments of the natural history of people. The manner in which the respiratory system reacts to inhaled particles depends on where the molecule settles. For instance, irritant dust that settles in the nose may prompt rhinitis, an irritation of the mucous layer. Peradventure the molecules attacks the larger airways, irritation of the trachea (tracheitis) or the bronchi (bronchitis) might be seen (**Figure 1**).

The most prominent responses of the lung happen in the core of the organ. Particles that avoid being eliminated in the nose or throat in turn settles in the sacs or near the distal part of the airways. Be that as it may, if the dust quantity is enormous, the macrophage system can fail. Dust particles and residue containing macrophages accumulate in the lung tissues, causing damage to the lungs. The amount of dust and the types of particles involved is proportional to how severe the lung damage will be. For instance, after the macrophages swallow silica particles, they undergo apoptosis and emit harmful substances. These substances cause sinewy or scar tissue to form. This tissue is simply the body's typical means of fixing itself. However, on account of crystalline silica so much stringy tissue and scarring structures accumulate so much that the lung capacity can be debilitated. The general name for this condition for sinewy tissue arrangement and scarring is fibrosis. The particles which cause fibrosis or scarring are called fibrogenic. At the point when fibrosis is brought about by crystalline silica, the condition is called silicosis. Once deposited in the pulmonary alveoli, these quartz-based minerogenic silica particles start a fibrotic wound reaction that can in the long run lead to silicosis, a debilitating pneumonic condition. Extreme silicosis can additionally harm the immune system by impeding the ability of macrophages in the lungs to distort the growth of pathogenic organisms found in airborne dust, prompting a variety of bacterial infections [14].

An inherited hypersensitivity of the immune system to react to a specific ubiquitous airborne antigen or the presentation to a new aerosoled soil material

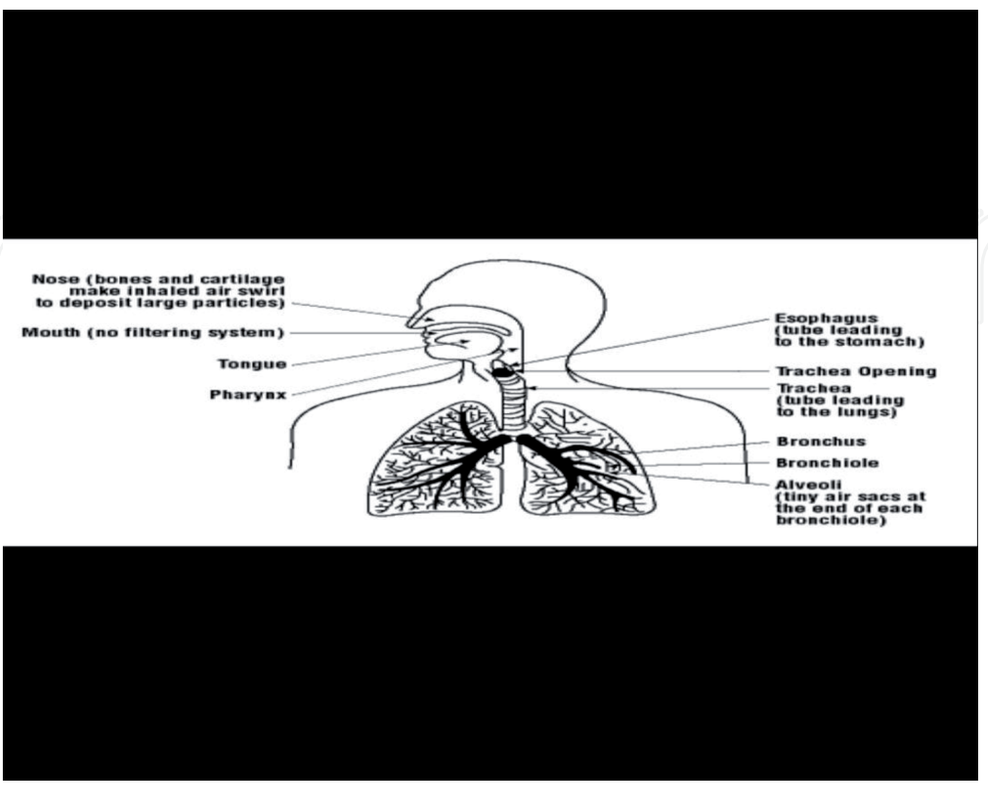

Figure 1.
The human respiratory tract (source: Pinterest.com).

may trigger reactions of the immune system that can bring about asthma and other related conditions. The scarring effect of inhaling minerogenic dust upon the nasopharyngeal mucosa creates an ideal environment for contamination of *N. meningitis*. Studies have shown that samples of aerosoled materials collected during dust events on the African continent have a host of human pathogens, including *Actinobacter calcoaceticus*, *Kocuria rosea* and others [15].

7. Water-related respiratory defects

Varieties of water sources can become repositories and vectors for contaminants related with intense and chronic lung infection. Improper sewage sanitation is an issue for about 40% of the world's population, and a millions of individuals die every year from waterborne illnesses [16]. Polluted and filthy water is exceptionally harmful for living organism particularly for wellbeing of humans. It causes numerous health issues which can eventually lead to death if not treated on time. Inhalation of contaminated aerosols is the most important route of exposure leading to water-related lung disease. Nonetheless, dermal assimilation, dispersed marine-acquired wound infections, and ingestion or aspiration of water containing harmful contaminants have been related with pneumonic sickness also. Upper respiratory side effects are common after water exercises, with over 40% of recreational swimmers reporting sinus symptoms. Hyperemia is the suspected etiology, and indication of prolonged water exposure [17].

The center for disease control (CDC) likewise detailed the peril in swimming; swimmers are said to be in danger of respiratory diseases if they take in steam or mist from a pool or hot tub that contains harmful germs. A respiratory sickness brought about by the germ Legionella is one of the most reoccurring waterborne ailments (drinking water and recreational water). If legionnaires' disease develops and is unrecognized, mortality might be as high as 10%. Untreated lakes and streams are said to have been the culprit, just as public pool or hot tub [14].

8. Food-related respiratory defects

Diet and nutrition might be significant modifiable risk factors for the improvement, movement and the management of obstructive lung infections, for example, asthma and incessant obstructive pneumonic ailment (COPD) [18]. Diet and nutrition are progressively becoming recognized as modifiable contributors to chronic disease development and progression. Significant proof has shown the essence of dietary intake in obstructive lung disease, for example, asthma and incessant obstructive pneumonic disease (COPD) in both early life and ailment advancement. This dietary example should comprise of a high admission of insignificantly handled plant nourishments, to be specific; organic product, vegetables, breads, grains, beans, nuts and seeds, low to direct intake of dairy nourishments, fish, poultry and wine and low intake of red meat. High intake of olive oil brings about a dietary synthesis that is low in soaked fat however still moderate in complete fat. Be that as it may, over sustenance and coming about weight are unmistakably connected with asthma; however the instruments included are still under scrutiny [19].

9. Recommendation and conclusion

The ability to survey the environment and exposure must be improved upon so as to comprehend the impact environmental factors have on disease and to decide if

new ecological variables may bring about illness. Assessment methods are required to screen an individual's absolute exposure to environmental factors over a lifetime as opposed to during a specific time span or in one circumstance. This evaluation could be accomplished at any rate halfway with the improvement of biomarkers that indicate exposure to precipitating factors from in utero to the end of life. Research surveys that address the multifaceted nature of the exposures are very likely to show the impact of environmental factors on lung infection [20].

So likewise, more discoveries should be made about the interaction between the individual and environment to have a better definition of at risk population. These efforts ought to not only distinguish most at risk population but to likewise consider how alterations of environmental factors could decrease the impact of disease. An integrative methodology will be required for these researches, alongside dependence on genetic technologies, bioinformatics, and complex biostatistical techniques. Likewise distinguishing hereditary components related with risk of exposure. This research could also recognize biomarkers of illness and characterize potential pathogenic pathways that might be focused to lessen or treat sickness [20].

Furthermore, the means by which environmental toxins influence disease development should be characterized. In spite of the fact that it is confirmed that indoor air pollution increases the danger of cardiovascular illness, so also indoor air contamination due to biomass smoke accumulation especially in children, the mechanisms by which these toxicants act are unknown [20].

Finally, to mitigate environmental lung disease, multidisciplinary research and public health programs are expected to decipher what is found about these toxicants and pathways for modifications in the environment in order to help individuals who are in danger of respiratory diseases. Presently, there are not too many researchers and clinicians who have the interest and capacity to lead environmental research. Hence, a significant step to improve in this field is to prepare more analysts. With these methodologies and the improvement of organizations among researchers and the general population everywhere, the role of environmental factors in lung disease will keep on being characterized and techniques to forestall must be implemented [20].

To avoid respiratory problems with other health issues especially in work areas caused by exposure to dust, controls must be implemented. According to the hierarchy of control, the main consideration should be hazardous substances substituted with non-hazardous substances. Where substitution is impossible, other engineering control methods could be introduced. which include: the use of wet processes for the enclosure of dust-producing processes under negative air pressure (slight vacuum compared to the air pressure outside the enclosure); exhausting air containing dust through a collection system before releasing to the atmosphere; use of vacuums instead of brooms good housekeeping efficient storage and transport controlled disposal of dangerous waste; use of personal protective equipment is also very important, but it should nevertheless be the last resort of protection. Personal protective equipment should not be a substitute for proper dust control and should be used only where dust control methods are not yet effective or are inadequate. Most importantly, workers, through education and proper orientation, must comprehend the need to avoid the risks of dust [18].

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