e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:01/January-2023 Impact Factor- 6.752 www.irjmets.com

EFFECTS OF AIR POLLUTION ON HUMAN HEALTH: A REVIEW

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DOI : https://www.doi.org/10.56726/IRJMETS33055

ABSTRACT

Air pollution is a major concern of developed and developing countries, which has a serious toxicological impact on human health and the environment. Air pollution has a number of different emission sources, but motor vehicles, solid fuel burning and industrial processes contribute the major part of outdoor air pollution, while the main contributors of indoor air pollution is biomass smoke, tobacco smoke, allergens, bacteria and viruses. The major air pollutants include gaseous pollutants, persistent pollutants, particulate matter, biological organisms and other organic pollutants. Long and short term exposure to air suspended toxicants has a different toxicological impact on human including respiratory and cardiovascular diseases, skin diseases, irritation of the eyes and nose, and long-term chronic diseases such as cancer. Several reports have revealed the direct association between exposure to the poor air quality and increasing rate of morbidity and mortality mostly due to cardiovascular and respiratory diseases. It is considered as the major environmental risk factor in the incidence and progression of some diseases such as lung cancer, asthma, psychological complications, kidney damage, renal cancer and fetal growth. The route of exposure is primarily via inhalation and ingestion while dermal contact represents minor routes of exposure.

Keywords: Air, Pollution, Health.

I. INTRODUCTION

Pollution is defined as contamination of the earth's environment with materials which interfere with human health, quality of life or the natural functioning of the ecosystem. The major types of pollution are water pollution, soil pollution, noise pollution, light pollution, and air pollution. (WHO,2005)

Air pollution is defined by the world health organization as the contamination of the indoor or outdoor environment by any chemical, physical, or biological agent that modifies the natural characteristics of the atmosphere. (WHO, 2005) The sources of air pollution could be natural sources such as volcanic eruptions, forest fires, biological decay, pollen grains, marches and radioactive materials or human-made sources such as thermal power plants, industries, vehicular emission, household combustion devices, fossils fuel burning and agricultural activities. Pollutants of the major public health concern include particulate matter, carbon monoxide, ozone, nitrogen dioxide and sulfur oxide. (WHO, 2005)

Although a number of physical activities such as volcanoes, fire and so on, may release different pollutants in the environment, anthropogenic activities are the major cause of environmental air pollution. Hazardous chemicals can escape to the environment by accident, but a number of air pollutants are released from industrial facilities and other activities and may cause adverse effects on human health and the environment. An air pollutant is defined as any substance which may harm humans, animals, vegetation or material. As far as humans are concerned an air pollutant may cause or contribute to an increase in mortality or serious illness or may pose a present of potential hazard to human health. The determination of whether or not a substance poses a health risk to humans is based on clinical, epidemiological, and/ or animal studies which demonstrate that exposure to a substance is associated with health effects. In the context of human health, "risk" is the probability that noxious health effects may occur.

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Air pollution is responsible for a large proportion of health- related problems. (Rizwan et al;2013) it occurs when harmful or excessive quantities of substances including gases, particulates, and biological molecules are introduced into Earth's atmosphere. It may cause diseases, allergies and even death to humans; it may also cause harm to other living organisms such as animals and food crops and may damage the natural and built environment. (Worstpolluted .org, 2010) High air pollution levels can cause immediate health problems including aggravated cardiovascular and respiratory illness, added stress to heart and lungs which must work harder to supply the body with oxygen, damage cells in the respiratory system. Long-term effects of air pollution on the onset of diseases such as respiratory infections and inflammations, cardiovascular dysfunction and cancer is widely accepted; (Rumana et al., 2014; Bricker et al., 2014; Yamamoto et al., 2014; Zhang et al., 2014); hence, air pollution is linked with millions of death globally each year. (Biggeri et al.,2004; Vermaelen et al., 2013; Kan et al., 2010)

Those most susceptible to severe health problems from air pollution are individuals with heart disease, coronary artery disease or congestive heart failure; individual with lung disease such as asthma; pregnant women; older adults and the elderly; children under age 14, e.t.c. People in these groups may experience health impacts at lower air pollution exposure levels.

According to the 2014 world health organization report, air pollution in 2012 caused the deaths of around 7 million people worldwide, (WHO,2014) an estimate roughly echoed by one from international energy agency. A recent study has revealed the association between male infertility and air pollution. (Zhou et al, 2014). Air pollution has now emerged in developing countries as a result of industrial activities and also increase the quantity of emission sources such as inappropriate vehicles. (Chen et al,2008; Molina et al,2004; Chi,1994) About 4.3 million people die from household air pollution and 3.7 million from ambient air pollution, most of whom (3.3 and 2.6 million, respectively) live in Asia. (Lancet, 2016)

II. POLLUTION AND HUMAN HEALTH

a. Health

Health is the ability to adapt and manage physical, mental and social challenges throughout life. (Huber et al, 2011) Whereas Health is defined by the world health organization “as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. (WHO ,2006) This definition of WHO has been subject to controversy as it may have limited value for implementation. (Jadad et al, 2008; Callahan, 1973 and Taylor et al, 2008)

The meaning of health has evolved overtime. In keeping with the biomedical perspective, early definitions of health focused on the theme of the body’s ability to function; health was seen as a state of normal function that could be disrupted from time to time by disease. An example of such a definition of health is “A state characterized by anatomic physiologic and psychological integrity, ability to perform personally valued family, work and community roles, ability to deal with physical, biological, psychological and social stress”. (Stokes, 1982)

b. Health effects

Health effects are changes in health resulting from exposure to a source. Health effects are an important consideration in many areas such as pollution studies, hygiene, occupational safety and health etc. Some of the major environmental sources of health effects are air pollution, water pollution, soil contamination, noise pollution and over-illumination. (NRC, 2017)

c. Adverse health effect

Adverse health effect is defined as the causation, promotion, facilitation and/or exacerbation of a structural and/or functional abnormality, with the implication that the abnormality produced has the potential of lowering the quality of life, contributing to a disabling illness or leading to a premature death.

Health effects caused by air pollution

The health effects caused by air pollution may include difficulty in breathing, wheezing, coughing, asthma and worsening of existing respiratory and cardiac conditions. These effects can result in increased medication use, increased doctor or emergency department visits, more hospital admissions and premature death. The human health effects of poor air quality are far reaching, but principally affect the body's respiratory system and the

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cardiovascular system. Individual reactions to air pollutants depend on the type of pollutant a person is exposed to, the degree of exposure, and the individual's health status and genetics. (Daniel,2018) Children aged less than five years that live in developing countries are the most vulnerable population in terms of total deaths attributable to indoor and outdoor air pollution.

Sporadic air pollution events, like the historic London fog in 1952 and a number of short and long term epidemiological studies investigated the effects of air quality changes on human health. A constant finding is that air pollutants contribute to increased mortality and hospital admissions. The different composition of air pollutants, the dose and time of exposure and the fact that humans are usually exposed to pollutant mixtures than to single substances, can lead to diverse impacts on human health. Human health effects can range from nausea and difficulty in breathing or skin irritation, to cancer. They also include birth defects, serious developmental delays in children, and reduced activity of the immune system, leading to a number of diseases. More-over, there exist several susceptibility factors such as age, nutritional status and predisposing conditions. Health effects can be distinguished to acute, chronic not including cancer and cancerous. Epidemiological and animal model data indicate that primarily affected systems are the cardiovascular and the respiratory system. However, the function of several other organs can be also influenced (Cohen et al., 2005; Huang and Ghio, 2006; Kunzli and Tager, 2005; Sharma and Agrawal,2005).

Exposure during pregnancy

It is rather important to mention that air pollutants can also affect the developing foetus (Schell et al.,2006). Maternal exposure to heavy metals and especially to lead, increases the risks of spontaneous abortion and reduced fetal growth (pre-term delivery, low birth weight). There are also evidences suggesting that parental lead exposure is also responsible for congenital malformations (Bellinger,2005), and lesions of the developing nervous system, causing important impairment in newborn's motor and cognitive abilities (Garza et al., 2006). Similarly, dioxins were found to be transferred from the mother to the fetus via the placenta. They act as endocrine disruptors and affect growth and development of the central nervous system of the foetus (Wang et al., 2004).

Effects of air pollutants on different organs and body systems

Respiratory system

Numerous studies describe that all types of air pollution, at high concentration, can affect the airways. Nevertheless, similar effects are also observed with long-term exposure to lower pollutant concentrations. Symptoms such as nose and throat irritation, followed by bronchoconstriction and dyspnoea, especially in asthmatic individuals, are usually experienced after exposure to increased levels of sulphur dioxide (Balmes et al., 1987), nitrogen oxides (Kagawa, 1985), and certain heavy metals such as arsenic, nickel or vanadium. In addition, particulate matter that penetrates the alveolar epithelium (Ghio and Huang, 2004) and ozone initiate lung inflammation (Uysaland Schapira, 2003). In patients with lung lesions or lung diseases, pollutant-initiated inflammation will worsen their condition. More over air pollutants such as nitrogen oxides increase the susceptibility to respiratory infections (Chauhan et al.,1998). Finally, chronic exposure to ozone and certain heavy metals reduces lung function (Rastogi et al., 1991; Tager et al., 2005), while the later are also responsible for asthma, emphysema, and even lung cancer (Kuo et al., 2006; Nawrot et al., 2006).

Digestive system

The digestive system is affect by metals and dioxins. Dioxins induce liver cell damage (Kimbrough et al.,1977), as indicated by an increase in levels of certain enzymes in the blood as well as gastrointestinal and liver cancer (Mandal, 2005).

Nervous system

The nervous system is mainly affected by heavy metals (lead, mercury and arsenic) and dioxins. Neurotoxicity leading to neuropathies, with symptoms such as memory disturbances, sleep disorders, anger, fatigue, hand tremors, blurred vision, and slurred speech, have been observed after arsenic, lead and mercury exposure (Ewan and Pamphlett,1996; Ratnaike,2003). Especially, lead exposure causes injury to the dopamine system, glutamate system, and Nmetyl-D-Aspartate (NMDA) receptor complex, which play an important role in memory functions (Lasley and Gilbert, 2000; Lasley et al., 2001). Mercury is also responsible for certain cases of

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neurological cancer. Dioxins decrease nerve conduction velocity and impaired mental development of children (Thomke et al., 1999; Walkowiak et al., 2001).

Cardiovascular system

Carbon monoxide binds to hemoglobin modifying its conformation and reduces its capacity to transfer oxygen (Badmanand Jaffe, 1996). This reduced oxygen availability can affect the function of different organs (and especially high oxygen-consuming organs such as the brain and the heart), resulting in impaired concentration, slow reflexes, and confusion. Apart from lung inflammation, systemic inflammatory changes are induced by particulate matter, affecting equally blood coagulation (Riediker et al., 2004). Air pollution that induces lung irritation

and changes in blood clotting can obstruct (cardiac) blood vessels, leading to angina or even to myocardial infraction (Vermylen et al., 2005). Symptoms such as tachycardia, increased blood pressure and anemia due to an inhibitory effect on hematopoiesis have been observed as a consequence of heavy metal pollution (specifically mercury, nickel and arsenic) (Huang and Ghio,2006). Finally, epidemiologic studies have linked dioxin exposure to increased mortality caused by ischemic heart disease.

Urinary system

Heavy metals can induce kidney damage such as an initial tubular dysfunction evidenced by an increased excretion of low molecular weight proteins, which progresses to decreased glomerular filtration rate (GFR). In addition they increase the risk of stone formation or nephrocalcinosis (Damek-Poprawa and Sawicka-Kapusta, 2003; Jarup, 2003; Loghman-Adham,1997) and renal cancer (Boffettaetal.,1993;Vamvakasetal.,1993).

Skin

Skin is the largest organ of human body, and any factor affecting skin health will impact the body as a whole. Major air pollutants having detrimental effects on the skin include solar ultraviolet radiation, polycyclic aromatic hydrocarbons, volatile organic compounds, nitrogen oxides, particulate matter, ozone and cigarette smoke. Particulate matter penetrates skin either through hair follicles or transdermal, and exerts its detrimental effects through the generation of oxidative stress, which contributes to extrinsic skin aging, characterized particularly by pigment spots on the face and nasolabial folds, and less so by coarse wrinkles, solar elastosis and telangiectasia. (Lademann et al, 2004); (Vierkotter et al, 2010); (Mills et al ,2011)

a. Ozone: The effect of ozone is mediated by its ability to induce oxidative stress. It leads to the formation of peroxides, aldehydes and lipid ozonation products, as a result of unsaturated fatty acid oxidation and damages the barrier function of epidermis. Thiele et al. reported that ozone causes a reduction in the level of antioxidants such as tocopherol (vitamin E) and ascorbic acid (vitamin C) and increases malondialdehyde, a lipid peroxidation product in murine skin causing impairment of barrier function and inflammation. (Thiele et al, 1997); (Thiele et al, 1997) In human skin, exposure to ozone caused a 70% decrease in vitamin E concentration in stratum corneum, and 50% reduction in skin microflora. (He et al, 2006)

b. Smoking: Smoking has also been associated with skin cancer, psoriasis, acne and skin malignancy. Exposure to ozone has been associated with urticaria, eczema, contact dermatitis and other nonspecific eruptions. Polyaromatic hydrocarbons cause skin cancer, extrinsic skin aging, pigmentation and acneiform eruptions. Oxides have been associated with increased prevalence, as well as exacerbations of atopic dermatitis in children. Chemical substances from cigarette smoke increase transepidermal water loss, degeneration of connective tissue in the skin and upregulation of matrix metalloproteinases-1 and 3 which degrade collagen and elastic fibers. (Valacchi et al, 1998 ;Jorgensen et al, 1998; Just et al, 2007) Smoking causes premature aging which clinically manifests as deeper periorbital.wrinkling. (Solly ,1856; Daniell HW, 1971; Freiman et al, 2004) Premature facial skin aging in smokers, with a characteristic pattern of wrinkling and orange-purple skin discoloration, was defined as smoker's face. (Chaichalotornkul et al, 2015)

c. Ultraviolent Radiation: The effects of ultraviolet radiation on human skin differ depending on the wavelength. Ultraviolet A exposure results in extrinsic skin aging (photo aging) characterized by coarse wrinkles, solar elastosis and pigment irregularities. Aging results from the combined action of intrinsic and extrinsic factors. The general aging process which is genetically determined and occurs in all skin by passing time is called intrinsic aging whereas skin aging induced by environmental factors is termed as extrinsic aging.

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Ultraviolet B alone is responsible for sunburn. Ultraviolet A and B both have been implicated in cutaneous immunosuppression and skin cancers (photo carcinogenesis) such as malignant melanoma, basal cell carcinoma and squamous cell carcinoma. (Valacchi et al, 2012; Baudouin et al, 2002; Aubin, 2003)

d. Polycyclic Aromatic Hydrocarbons: are among the most widespread and dangerous organic pollutants. (English et al, 2003). Polycyclic aromatic hydrocarbons are absorbed on the surface of suspended particulate matter in the air in urban areas. (Menichini, 1992). They are converted into quinines, redox-cycling chemicals that produce reactive oxygen species. (penning, 1993), irrespective of the route of entry in the human body, they are found in almost all the internal organs especially in the lungs and digestive tract. The main source of atmospheric polycyclic aromatic hydrocarbons benzo (a) pyrene is residual wood burning the other sources being automobile exhaust, diesel fumes, metallurgical industry, production of plastic, pesticides, dyes, cigarette smoke and smoke resulting from the combustion of organic material. (Burke et al,2009) polycyclic aromatic hydrocarbons are associated with extrinsic skin aging, pigmentation, cancers, and acneiform eruption (krutman et al, 2008).

a. Health effects associated with air pollutants

Health effect of carbon monoxide(CO)

CO is a colorless and odorless gas, which is produced by fossil fuel, particularly when combustion is not appropriate, as in burning coal and wood. The affinity of CO to hemoglobin (as an oxygen carrier in the body) is about 250 times greater than that of oxygen. Depending on CO concentration and length of exposure, mild to severe poisoning may occur. Symptoms of CO poisoning may include headache, dizziness, weakness, nausea, vomiting, and finally loss of consciousness. The symptoms are very similar to those of other illnesses, such as food poisoning or viral infections. No human health effects have been showed for carboxyhemoglobin (COHb) levels lower than 2%, while levels above 40% may be fatal. Hypoxia, apoptosis, and ischemia are known mechanisms of underlying CO toxicity. [Akyol et al,2014] The mechanism of such toxicity is the loss of oxygen due to competitive binding of CO to the hemoglobin heme groups. Cardiovascular changes also may be observed by CO exposures that create COHb in excess of 5%.

Health effect of nitrogen oxides(NO)

Nitrogen oxides are important ambient air pollutants which may increase the risk of respiratory infections. (Chen et al,2001) They are mainly emitted from motor engines and thus are traffic-related air pollutants. They are deep lung irritants that can induce pulmonary edema if been inhaled at high levels. They are generally less toxic than O, but NO can pose clear toxicological problems. Exposures at 2.0–5.0 ppm have been shown to affect T-lymphocytes, particularly CD8 cells and natural killer cells that play an important role in host defenses against viruses. Although these levels may be high, epidemiologic studies demonstrate effects of NO on respiratory infection rates in children. Coughing and wheezing are the most common complication of nitrogen oxides toxicity, but the eyes, nose or throat irritations, headache, dyspnea, chest pain, diaphoresis, fever, bronchospasm, and pulmonary edema may also occur. In another report, it is suggested that the level of nitrogen oxide between 0.2 and 0.6 ppm is harmless for the human population. (Westerners et al,2009)

Health effect of sulfur dioxide (SO_2)

SO_2 is a colorless, highly reactive gas, which is considered as an important air pollutant. It is mostly emitted from fossil fuel consumption, natural volcanic activities, and industrial processes. SO_2 is very harmful for plant life, animal, and human health. People with lung disease, children, older people, and those who are more exposed to SO_2 are at higher risk of the skin and lung diseases. The major health concerns associated with exposure to high concentrations of SO_2 include respiratory irritation and dysfunction, and also aggravation of existing cardiovascular disease. SO_2 is predominantly absorbed in the upper airways. As a sensory irritant, it can cause bronchospasm and mucus secretion in humans. Residents of industrialized regions encountered with SO_2 even at lower concentrations (<1 ppm) in the polluted ambient air might experience a high level of bronchitis. The penetration of SO_2 into the lungs is greater during mouth breathing compared to nose breathing. An increase in the airflow in deep, rapid breathing enhances penetration of the gas into the deeper lung. Therefore, people who exercise in the polluted air would inhale more SO_2 and are likely to suffer from greater irritation. When SO_2 deposits along the airway, it dissolves into surface lining fluid as sulfite or bisulfite and is easily distributed throughout the body. It seems that the sulfite interacts with sensory receptors in the

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airways to cause local and centrally mediated bronchoconstriction. According to the Environmental Protection Agency (EPA) of the USA, the level of annual standard for SO_2 is 0.03 ppm. Due to its solubility in water, SO_2 is responsible for acid rain formation and acidification of soils. SO_2 reduces the amount of oxygen in the water causing the death of marine species including both animals and plants. Exposure to SO_2 can cause damages to the eyes (lacrimation and corneal opacity), mucous membranes, the skin (redness, and blisters), and respiratory tracts. Bronchospasm, pulmonary edema, pneumonitis, and acute airway obstruction are the most common clinical findings associated with exposure to SO_2. (Chen et al,2007)

Health effect of particulate matter

Particulate matter are major parts of air pollutants. In a simple definition, they are a mixture of particles found in the air. Particle pollution which is more known as PM is linked with most of pulmonary and cardiac-associated morbidity and mortality. (Sadeghi et al, 2015; Sahuetal et al, 2014) They have varied in size ranging mostly from 2.5 to 10μm (PM to PM). The size of particle pollutants is directly associated with the onset and progression of the lungs and heart diseases. Particles of smaller size reach the lower respiratory tract and thus have greater potential for causing the lungs and heart diseases. Moreover, numerous scientific data have demonstrated that fine particle pollutants cause premature death in people with heart and/or lung disease including cardiac dysrhythmias, nonfatal heart attacks, aggravated asthma, and decreased lung functions. Depending on the level of exposure, particulate pollutants may cause mild to severe illnesses. Wheezing, cough, dry mouth, and limitation in activities due to breathing problems are the most prevalent clinical symptoms of respiratory disease resulted from air pollution. (Bentayeb et al, 2013; Guillam et al, 2013; Goa et al, 2014) Long-term exposure to current ambient PM concentrations may lead to a marked reduction in life expectancy. The increase of cardiopulmonary and lung cancer mortality are the main reasons for the reduction in life expectancy. Reduced lung functions in children and adults leading to asthmatic bronchitis and chronic obstructive pulmonary disease (COPD) are also serious diseases which induce lower quality of life and reduced life expectancy. Strong evidence on the effect of long-term exposure to PM on cardiovascular and cardiopulmonary mortality come from cohort studies. (Zhou al et, 2014; Pelucchi et al, 2009; Jarrett et al, 2009)

Health effect of ozone (O)

Ground-level ozone with the chemical formula of O is a colorless gas which is the major constituent of the atmosphere. It is found both at the ground level and in the upper regions of the atmosphere which is called troposphere. Ground- level ozone (GLO) is produced as a result of chemical reaction between oxides of nitrogen and VOCs emitted from natural sources and/or due to human activities. GLO is believed to have a plausible association with increased risk of respiratory diseases, particularly asthma. (Gorai et al, 2014) As a powerful oxidant, O accepts electrons from other molecules. There is a high level of polyunsaturated fatty acids in the surface fluid lining of the respiratory tract and cell membranes that underlie the lining fluid. The double bonds available in these fatty acids are unstable. O attacks unpaired electron to form ozonides and progress through an unstable zwitterion or trioxolane (depending on the presence of water). These ultimately recombine or decompose to lipohydroperoxides, aldehydes, and hydrogen peroxide. These pathways are thought to initiate propagation of lipid radicals and auto-oxidation of cell membranes and macromolecules. It also increases the risk of DNA damage in epidermal keratinocytes, which leads to impaired cellular function. (McCarthy et al, 2013) Ozone induces a variety of toxic effects in humans and experimental animals at concentrations that occur in many urban areas. (Lippmann, 1989) These effects include morphologic, functional, immunologic, and biochemical alterations. Because of its low water solubility, a substantial portion of inhaled O penetrates deep into the lungs but its reactivity is scrubbed by the nasopharynx of resting rats and humans in around 17% and 40%, respectively. (Hatch et al, 1994; Gerrity et al, 1985)

Health effect of lead (Pb)

Pb or plumb is a toxic heavy metal that is widely used in different industries. (Balali-Mood et al, 2010) Pb pollution may result from both indoor and outdoor sources. It is emitted from motor engines, particularly with those using petrol containing Pb tetraethyl. Smelters and battery plants, as well as irrigation water wells and wastewaters, are other emission sources of the Pb into the environment. (Balali-Mood et al, 2010; Mousavi et al, 2013) Evaluation of the blood Pb level in traffic police officers shows that environmental pollution may be considered as a source of Pb exposure. (Manuela et al, 2012) Fetuses and children are highly susceptible to

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even low doses of Pb. (Farhat et al, 2013) Pb accumulates in the body in blood, bone, and soft tissue. Because it is not readily excreted, Pb can also affect the kidneys, liver, nervous system, and the other organs.

(Farhat et al, 2005) Pb absorption by the lungs depends on the particle size and concentration. Around 90% of Pb particles in the ambient air that are inhaled are small enough to be retained. Retained Pb absorption through alveoli is absorbed and induces toxicity. Pb is a powerful neurotoxicant, especially for infants and children as the high-risk groups. Mental retardation, learning disabilities, impairment of memory, hyperactivity, and antisocial behaviors are of adverse effects of Pb in childhood. (Lidsky et al, 2006; Lidsky and Schneider, 2003) Therefore, it is very important to reduce the Pb level ofambient air. (AAPC,2005) Pb exposure is often chronic, without obvious symptoms. (Kianoush et al, 2012) It can affect the different parts of the body including cardiovascular, renal, and reproductive systems, but the main target for Pb toxicity is the nervous system. (Kianoush et al, 2013) Pb disrupts the normal function of intracellular second messenger systems through the inhibition of N-Methyl-D-aspartate receptors. Pb may also replace calcium as a second messenger resulting in protein modification through various cellular processes including protein kinase activation or deactivation. Abdominal pain, anemia, aggression, constipation, headaches, irritability, loss of concentration and memory, reduced sensations, and sleep disorders are the most common symptoms of Pb poisoning. Exposure to Pb is manifested with numerous problems, such as high blood pressure, infertility, digestive and renal dysfunctions, and muscle and joint pain.

Health effect of volatile organic compounds (VOC)

They are categorized as either methane (CH_4) or non-methane (NMVOCs). Methane is an extremely efficient greenhouse gas which contributes to enhanced global warming. Other hydrocarbon VOCs are also significant greenhouse gases because of their role in creating ozone and prolonging the life of methane in the atmosphere. This effect varies depending on local air quality. The aromatic NMVOCs benzene, toluene and xylene are suspected carcinogens and may lead to leukemia with prolonged exposure.

Emission of volatile organic compounds occurs from the use of organic solvents in paints, varnishes (aliphatic hydrocarbons, ethyl acetate, glycol ethers, methylene chloride and acetone) vehicle refinishing products in repairing car paint, environmental tobacco smoke, stored fuels, exhaust from cars (benzene) and from emissions from industrial facilities (tetrachloroethylene). (Kampa and Castanas, 2008; Dales et al, 2008; Okada et al, 2012) It is an important indoor source of air pollutants. A longitudinal study has shown that symptoms of atopic dermatitis increase in children shifted to a new building due to an increase in exposure to volatile organic compounds. (Kim et al, 2015)

Volatile compounds can cause irritation of the eye, nose and throat. In severe cases there may be headaches, nausea, and loss of coordination. In the longer run, some of them are suspected to cause damage to the liver and other parts of the body.

b. Cellular mechanisms involved in air pollutants actions

Common cellular mechanism by which most air pollutants exert their adverse effects is their ability to act directly as pro oxidants of lipids and proteins or as free radical's generators, promoting oxidative stress and the induction of inflammatory responses (Menzel, 1994; Rahman and MacNee, 2000). Free radicals (reactive oxygen and nitrogen species) are harmful to cellular lipids, proteins, and nuclear- or mitochondrial DNA, inhibiting their normal function (Valko et al., 2006). In addition, they can interfere with signaling pathways within cells (Valko et al., 2006). In eukaryotic aerobic organisms including humans, free radicals are continuously generated during normal metabolism and in response to exogenous environmental exposures (e.g. irradiation, cigarette smoke, metals and ozone). When free radical concentration increases, due to an overwhelming of organism's defense, a state of oxidative stress occurs. This oxidative state has been implicated in a wide variety of degenerative diseases such as atherosclerosis, heart attacks, stoke, chronic inflammatory diseases (rheumatoid arthritis), cataract, central nervous system disorders (Parkinson's, and Alzheimer's disease), age related disorders and finally cancer. Furthermore, the toxic effects of heavy metals, apart from inducing oxidative stress, can be also attributed to their ability to substitute diverse polyvalent cations (calcium, zinc, and magnesium) that function as charge carriers, intermediaries in catalyzed reactions, or as structural elements in the maintenance of protein conformation. Indeed, metals accumulate in cellular organelles and interfere with their function. For example, it has been observed that lead accumulation in

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mitochondria induces several changes such as inhibition of Ca2þ uptake, reduction of the transmembrane potential, oxidation of pyridine nucleotides, and a fast release of accumulated Ca2þ (Chavez et al.,1987). Moreover, metals bind to proteins (Goering, 1993) and inhibit a large number of enzymes, including the mitochondrial ones (Rossi et al., 1993). Nucleic acid binding proteins are also involved, while it has been shown that metals can also bind to DNA, affecting the expression of genes. For example, nickel enters the nucleus, interacts with chromatin and silences the expression of genes such as tumor suppressor genes, inducing carcinogenesis (Costa et al., 2003). Finally, some metals interfere with various voltage- and ligand-gated ionic channels exerting neurotoxic effects. For instance, lead affects the N-Methyl-D-aspartic acid (NMDA) receptor, subtypes of voltage- and calcium-gated potassium channels, cholinergic receptors and voltage-gated calcium channels (Garza et al., 2006; Toscano and Guilarte, 2005). Dioxin causes abroad range of adverse effects (Birnbaum, 1994): they alter metabolism by inducing a number of metabolic enzymes (e.g. CYPs, glutathione-transferase, tyrosine kinase etc.), homeostasis, through hormone modulation (e.g. estrogens, androgens glucocorticoids, insulin, thyroid hormones) and their receptors, and growth and differentiation by interfering with growth factors (e.g. EGF, TGFa, TNFa) and their receptors. At the cellular level, dioxins interact with the aryl hydrocarbon receptor (AhR) (Schwarz et al., 2000) which has a basic helix-loop-helix domain, acting as a transcription factor after nuclear translocation, allowing interaction of dioxins with DNA. The receptor-ligand complex binds to specific sites on DNA, altering the expression of a number of genes.

Air pollution in Nigeria

The World Health Organization mentioned Nigeria as a country with several worst polluted towns. That list included Onitsha, Aba, Kaduna, and Umuahia. But these are not the only areas with extreme PM10 levels (particulate matter concentration) used to measure air pollution across the planet. The effects and consequences of polluted air in Nigeria is investigated by Environmental Protection Agency. Unfortunately, when foreigners talk about African countries, including Nigeria, they mention the garbage, smog, loud traffic, and severe pollution.

The consequences of air pollution in Nigeria Just as it happens in most other countries worldwide, the biggest pollutants in Nigeria are: Old vehicles and other types of transportation. Industrial waste disposals from big companies, Fires in the woods, Fuel burning. Air pollution can happen anywhere you are:

•**Indoors**: at school, home and office (gas stoves, air conditioners, etc.)

•**Outdoors**: on the streets (cars, industrial production, etc.)

The biggest changes and effects Nigerians and all humans can experience from air pollution are not only real damage to the environment but also bad changes in the quality of life and severe issues to human health.

c. Practical measures to reduce air pollution in Nigeria

The natural sources of pollution are difficult to predict and prevent such as volcano eruptions or forest fires. However, human-made sources can be controlled. Some strategies include less use of personal vehicles, increase in the use of car pools and public modes of transport, supply of low Sulphur petrol, shifting of industries to areas away from the cities, development and usage of industrial machines and methods which are eco-friendly, avoiding burning of garbage in the open, avoidance of smoking and no use of wood and crop residues as fuel for the purpose of household cooking and heating.

III. RESEARCH SUMMARY AND RECOMMENDATIONS

The term pollution refers to any substance that negatively impacts the environment or organism that live within the affected environment. The five major types of pollution include water pollution, soil pollution, house pollution, light pollution and air pollution.

Air pollution could be of natural sources or human made sources. Air pollution as the main contaminants of the indoor and outdoor environment by chemicals, physical or biological gent resulted in adverse health effects. The health effect caused by air coughing, asthma and worsening of existing respiratory and cardiac conditions.

The health effect cued by air pollution is as a result of different types of pollutants, heavy metals, particulate matter, biological organisms and other organic pollutants. These affect different organs and system of the human body which include lungs, skin, digestive system, nervous system, cardiovascular system etc. the natural

sources of pollution are difficult to predict and prevent such as volcano eruptions or forest fires, flowerer, human – made sources can be controlled.

Some strategies include less use of personal vehicles, increase in the use of car pools and public modes of transport, supply of low-sulphur petrol, shifting of industries to areas away from the cities, development and usage of industrial machines and methods which are eco-friendly, avoiding burning of garbage in the open, avoidance of smoking and no use of wood and crop residues as fuel for the purpose of household cooking and heating.

Another way for reducing the air pollution is to make an emphasis on the green job and green economy in general so as to substitute fossil fuel in energy generation, and these will lead to prevention of air and environmental pollution, decreasing of CO_2 emission in the global warming, sustainable growth, and exhaustion of natural resource.

IV. CONCLUSION

Air pollutions have major impacts on human health, triggering, and inducing many diseases leading to high morbidities and mortalities, particularly in the developing countries.

The effects of air pollution on health are very complex as there are many different sources and their individual effects vary from one to the other.

Air pollutants that are inhaled have serious impact on human health affecting the lungs and the respiratory system; they are also taken up by the blood and pumped all-round the body. These pollutants are also deposited on soil, plants, and in the water, further contributing to human exposure.

Therefore, air pollutions control is vital and should be on the top of priority list of the governments.

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