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Article · May 2022

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AIR POLLUTION AND HUMAN HEALTH IN THE INDUSTRIAL AREAS OF ILORIN, KWARA STATE, NIGERIA

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ABSTRACT

Air is an important and vital requirement for life. Air sustains life, but it can also snuff out life. With air, one survives and lives; with air, one could also die. So it all boils down to the quality of that air. The role air plays in human life cannot be overemphasized because it is the main reason for life, but due to industrialisation the air gradually becomes polluted, making it unsafe for inhaling or breathing. Indoor or outdoor, one is at the risk of this polluted and unhealthy air because almost every breath taken here in Nigeria is like the breath of death. This study therefore, examines harmful effects of air pollution on human health residents in the industrial areas of Ilorin, Kwara state, Nigeria. The human forcings theory of climate change provided the conceptual framework. The design was survey. A two-stage sampling consisting of purposive and simple random techniques were used to select 135 respondents. A semi-structured questionnaire was used to elicit information on socio-demographic characteristics, how air pollution has affected the health status of the respondents, the health challenges faced by respondents, assess the coping mechanism used by respondents and measures that has been taken by Kwara state government in curbing the effects of air pollution in the study areas. Quantitative data were analysed using descriptive and chi-square test statistics at 5% level of significance. Using 0.05 level of significance, the null hypothesis was rejected since the chi-square tabulated is lesser than the chi-square calculated, meaning that “there is no relationship between air pollution and the health status of residents around the industrial area in Ilorin, Kwara State”. The study recommended that in order to minimize the harmful effect of air pollution, the Government has to embark on the following actions: Formulation of regulations/statutes, setting up of monitoring network for assessment of ambient air quality, as well as draft rules for handling and management of municipal waste.

Key words: Health, Diseases, Air pollution, Respiratory System, Biomass combustion

1.0 Introduction

The procedure of urbanization is mostly associated with many environmental challenges with adverse effects on the living standard of people. Urban areas of the world are often confronted with the challenge of the population due to unceasing migration of people from rural areas to urban areas to enhance their living standards through job seeking, businesses and trading. Most times the aspirations states, the environmental impacts of urbanization are enormous; the most common of these being air pollution (Michael, 2015). The subject of air pollution and its effects on the environment is referred to as one of the Universal Commons that many countries and local governments are seeking to address.

The epoch of the industrial revolution in the 18th century brought a new face of survival and socio-economic challenges. This is the period where human existence was beginning to completely tie to the machine. The function and utilization capacity of machines necessitated the invention of a turbine which became inevitable to the survival evolution of man. This indeed marked the beginning of environmental pollution, with serious consequences on human health (David, 2003). Air pollution is now a common term that our ears are attuned to. We hear about the various forms of pollution and read about it through the mass media. It occurs when any harmful gases, dust or smoke enters the atmosphere, thus, makes it difficult for plants, animals, and humans to survive as the air becomes heavily contaminated (Adel, Bamdad & Mahdi, 2016).

Normally, any substance that is being introduced into the atmosphere that has damaging effects on the environment is considered air pollution. The World Health Organization defines air pollution as 'the disequilibrium of air caused due to the introduction of foreign elements to humans' natural and man-made sources to the air so that it becomes injurious to biological communities'. It has also been defined as the contamination of air by discharge of harmful substances, which can cause health problems including burning eyes and nose, itchy irritated throat and breathing problems (United state environmental protection agency (USEPA:1994). Air pollution is also the introduction of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, or damages the natural environment, into the atmosphere. It is also defined as the presence of chemicals in the atmosphere in quantities and duration that are harmful to human health and the environment.

It can be defined as the presence in the outdoor or indoor atmosphere of one or more gaseous or particulate contaminants in quantities, characteristics and of duration such as to be injurious to human, plant or animal life or to property, or which unreasonably interferes with the comfortable enjoyment of life and property (Ukemenam, 2014). Shola (2018) asserts greenhouse gasses of the environment are one of the most horrible ecological crises the world is subjected today. Nigeria has the highest mortality in the world. It's the country with the highest number of extremely poor people in the world and now, it has the highest burden of death from air. This study, therefore, tends to examine the effect of air pollution on human health with particular reference to the residence in Ilorin Kwara state.

2. Problems

The burning up of energy in urban areas through transport or heating and our conditioning system resulting in the emission of gases that are injurious to human health is becoming a serious menace in Nigeria. This study, therefore, tends to examine the effects of air pollution on human health with particular reference to residents in Kwara state, particularly in the metropolitan areas. Inefficient energy combustion in the transportation

system generates high levels of localized air pollution (Ukemenam, 2014). The recent increase in the importation of second-hand cars and the common adoption of the single-engine, "Okada" motor-cycles for ferrying passengers all over most Nigeria cities have accentuated the general level of air pollution.

Nearly 50 percent of global carbon monoxide, hydrocarbon, and nitrogen oxide emissions from fossil fuel combustion come from gasoline – and diesel powered engines. In cities like Lagos and Abuja, especially on highly congested streets, traffic can be responsible for as much as 90 to 95% of the ambient carbon monoxide levels, 80 to 90% of the nitrogen oxides and hydrocarbons, and a large portion of the particulates, posing a significant threat to human health and natural resources (Ukemenam, 2014).

Our environment must be friendly if we must have good health. Good health although promoted by nutrition, physical exercises, etc., can hardly be attainable if, environmental problems like air pollution are not addressed. The environmental degradation occasioned by fumes from industrial, commercial, domestic and transportation activities affects health tremendously. For instance, carbon iv oxide is known to have a negative effect on the ozone layer and consequently cause severe heat to a human being.

However, air pollution following human activities in Ilorin constitutes a source of ailment to humanity. This is because carbon monoxide when released to air or inhaled can combine readily with hemoglobin and posed a threat to human health. Sometimes, in high concentrations, it (carbon monoxide) causes dizziness, headache, nausea, tiredness, and even brain damage when inhaled for a long period. In fact, the alarming rate of health problems and issues in the society are to a large extent traceable to environmental health hazards mostly air pollution. Based on the above assertion, therefore, this study tends to fill the gap in knowledge by examining the effects of air pollution on the health of the residents in Ilorin Kwara state Nigeria.

3. Methodology

The research designs for the study were both survey and exploratory and the study was descriptive in nature, combining both quantitative and qualitative techniques. The primary data was information gathered directly from respondents and for this study the Researcher used a questionnaire. The secondary data involved the collection and analysis of published materials and information from other sources, such as annual reports and published data. The data collected from the field were analysed using a triangulation of quantitative and qualitative methods. In analysing the quantitative data, the Statistical Package for Social Sciences (SPSS) was used. This involved the use of descriptive statistical tools, such as frequency counts, percentages and chi-square test.

In other words, the analysis involved univariate and bivariate analysis. While the former is mainly descriptive, the latter involves cross-tabulation to establish association between variables. Data from the in-depth interview were transcribed and analysed using content analysis with appropriate computer application software. Some aspects of the in-depth interviews were quoted verbatim to bring out the essential points. To address the specific objectives of the study, copies of the questionnaire were administered to 150 households in the study area out of which 148 were returned, which translate to 92.5% response rate. Out of which 135 copies returned 13 copies were not duly completed and so could not be used for analysis. A total of 135 copies which were duly completed, were analyzed.

4. Brief review of literature

This section of the paper reviews some literature that is relevant to the subject matter.

4.1 Major concepts in the paper

Health

Health is a very elusive concept to define and ways of thinking about it have evolved over the years, based on this, three approaches have been given to defining health. The first of such approaches is the medical model which views the body as a machine to be fixed when broken. Following this approach to defining health; health is defined as the absence of diseases and the presence of a high level of function. The second approach is the holistic model this model broadens the medical perspective of health. It is exemplified by the definition of health given by the WHO (2016) where health is defined as a state of complete physical, mental, and social well-being and not merely the absence of diseases or infirmity.

The last approach of defining health is the wellness model; the wellness model was developed by the WHO (2016) which proposed a movement away from viewing health as a state to a dynamic model that presented health as a process or a force (World Health Organization, 2016). This approach to defining health was amplified by the Ottawa Charter for Health Promotion (2016) which defined health as the extent to which an individual or group is able to realize aspirations and satisfy needs and to change or cope with the environment.

Some scholars viewed health in terms of resiliency thus health was defined by them as the capability of individuals, families, groups, and communities to cope successfully in the face of significant adversity or risk. Relating this definition to the entire population this definition of health might include elements such as the success with which the population adapts to change such as shifting economic realities or natural disasters. Another definition under the wellness approach is an ecological definition of health, he defines health as a state in which humans and other living creatures with which they interact and coexist indefinitely.

Air pollution

Air pollution is one of the environmental problems confronting growing cities and is currently the challenge faced by many developed and developing countries; its effects on human lives are enormous as it causes disease and can result in chronic illness. Apart from the health risk, it contributes to our changing climatic conditions, which are potential sources of threats to local and international communities. The current global changes caused by the changing climate have been attributed to human activities through civilization and industrialization and it is interesting to know that the urban settlements where most industrial activities occur in the world are also direct and indirect sources of global challenges.

Our atmospheric environment is very sensitive to various types of pollution resulting from three phenomena: Global warming, ozone layer depletion and, above all, local air pollution. The latter, which is mostly anthropogenic in nature, results from industrial activities, fossil fuel generator fumes, chemical exposures and so on. The pollutant molecules such as Sulphur Oxides (SO_x), Nitrogen Oxides (NO_x) Lead, Ozone, Benzene, Carbon Oxides (CO_x) Arsenic, Cd, Hg, and Particulate Matters have negative effect on the human health, which can rapidly spread abroad causing health instability in the system (Akinola, 2014). When the concentrations of these molecules/particles in the air exceed the international standard, the air is considered polluted.

The concentration of these pollutants, carbon dioxide, and nitrogen oxides, directly contributes to climate change which has become one of the world's challenges today. High concentrations of carbon in the atmosphere increase the climatic temperatures, causes greenhouse warming which often results in the heat generated from the sun being trapped close to the surface of the Earth. Increased concentrations of heat in the atmosphere over the years lead to precipitation rise in sea level and subsequent unusual rainfall that cause flooding in most vulnerable areas.

4.2 Common Causes of Air Pollution

Biomass combustion

In Ilorin, biomass in the form of firewood, coal, bamboo trunks and dead leaves are commonly used sources of cooking fuel, especially in the rural areas. Of all these the most frequently used is firewood. This fuel woods are usually logged from nearby bushes and forests or are collected as dead branches within the residential vicinities by the women and at times children and are used to generate energy for cooking. The combustion of firewood releases gaseous pollutants and particulate matter. From literature, the gaseous pollutants from cooking emissions are carbon monoxide CO, carbon dioxide CO₂, sulfur dioxide SO₂, nitrogen dioxide NO₂, volatile organic compounds VOCs and particulate matter. The particulate matter generated is in the form of carbon black, soot and fly ash which are major components of smoke and is most often within the 10µm size range (Ukemenam, 2014).

Refuse Burning:

Refuse disposal is a major environmental problem in Ilorin particularly in the urban areas. The refuse is usually from multiple sources including domestic, municipal, agricultural and industrial sources. One of the environmentally unfriendly methods of managing the waste is by open burning either on nearby lands or open dumps within the residential vicinities. The composition of the refuse, age of the dump and intensity of the flame usually determines the nature of the air pollutants. Often times the air within refuse burning sites is inundated with VOCs, CO, SO, NO, Total Hydrocarbons (THCs), as well as various classes of toxic and hazardous compounds via Polycyclic Aromatic Hydrocarbons (PAHs), dioxins, PCBs (Polychloro Biphenyls) and heavy metals such as lead, nickel and mercury. Refuse to burn is the most common refuse disposable method in Nigeria and it constitutes a major cause of air pollution (Ukemenam, 2014)

Traffic Emissions:

Over 600 million people globally are exposed to hazardous levels of traffic-generated pollutants (United Nation, 1998). Human exposure to these air pollutants is believed to have posed severe health problems especially in urban areas where pollution levels are on the increase. Pollution due to traffic constitutes up to 90- 95% of the ambient CO levels, 80-90% of NO, hydrocarbon and particulate matter in the world, posing a serious threat to human health.

In Nigeria, much attention is focused on general industrial pollution and pollution from the oil industries, with little attention on the effects of air pollution from mobile transportation sources (Faboya, 1997). Increased pollution from mobile sources is on the increase with per capita increase in vehicle ownership. The consequence of this is the congestion of most Nigeria city roads and a corresponding increase in the burden of air pollutants and their associated effects. Studies conducted in Northern Nigeria show higher values of CO₂ concentration (1780-1840 ppm) in heavily congested areas in Kaduna and

(1160-1530 ppm) in Abuja. A study of the impacts of urban road transportation on the ambient air was conducted in three cities in southwestern Nigeria.

Bush Burning:

Bush burning is a common phenomenon in Nigeria. Most times the burning of the bush is done prior to land cultivation as one of the initial steps of land preparation. This constitutes part of the pre-planting preparation. The process of bush burning leads to the release of various types of gaseous pollutants and particulate matter. Very often the gas stream is inundated with volatile organics and oxides of carbon (CO), sulfur (SO) and nitrogen (NO) depending on the fuel composition and intensity of the flame. Particulate matter usually within the 10 μ m size range is also produced in the course of the combustion process.

Chemical Fertilizer Industry:

The chemical fertilizer industry in Nigeria is still in its infant stage. It utilizes a variety of raw materials such as natural or synthetic gas (methane), atmospheric nitrogen, steam, and sand as filler material in the production of various formulations.

Gas Flaring:

According to literature, Nigeria holds the highest record (19.79%) of natural gas flaring globally and is responsible for about 46% of Africa's total gas flared per tonne of oil produced. Until present, there are not less than 123 flaring sites in the region making Nigeria one of the highest emitters of greenhouse gases in Africa. Similarly, analytical assessment of the statistical bulletin of the Central Bank of Nigeria (2004) showed that the average rate of gas flaring in Nigeria during the period 1970-1979 stood at 97%, while 97 and 95% were flared between 1980, 1989 and 1990 to 1999, respectively. Between 2000 and 2004, 51% was flared.

In the same vein, between 1970 and 2004 Nigeria has flared an average of 76% of the total gas produced. Much of the natural gas extracted in oil wells in the Niger Delta is immediately flared into the environment at a rate that approximates 70 million/m³/day. This is equivalent to 40% of African natural gas consumption and forms the single largest source of greenhouse gas emissions on the planet (Wikipedia, 2007).

4.3 Effects of Air pollution on Humans' Health

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 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 (Grossni, 2008). The most common sources of air pollution include particulates, ozone, nitrogen dioxide, and sulfur dioxide. 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 (Törnqvist, Mills, Gonzalez, Miller, Robinson, Megson, MacNee, Donaldson, Söderberg, Newby, Sandström, and Bloomberg, 2007).

Mortality

The World Health Organization (2016) estimated that air pollution causes the premature death of some 7 million people worldwide (World Energy Outlook, 2016). India has the

highest death rate due to air pollution (Pope, 2003). India also has more deaths from asthma than any other nation according to the World Health Organization. In December 2013 air pollution was estimated to kill 500,000 people in China each year (Mateen, Brook, 2011). There is a positive correlation between pneumonia-related deaths and air pollution from motor vehicle emissions.

Urban outdoor air pollution is estimated to cause 1.3 million deaths worldwide per year. Children are particularly at risk due to the immaturity of their respiratory organ systems (Louwies, Int Panis, Kicinski, De Boever, Nawrot, Tim 2013). The US EPA estimated in 2004 that a proposed set of changes in diesel engine technology (Tier 2) could result in 12,000 fewer premature mortalities, 15,000 fewer heart attacks, 6,000 fewer emergency department visits by children with asthma, and 8,900 fewer respiratory-related hospital admissions each year in the United States (Gehring, Wijga, Brauer, Fischer, de Jongste, Kerkhof, Brunekreef, 2010).

Cardiovascular disease

A 2007 review of evidence found ambient air pollution exposure is a risk factor correlating with increased total mortality from cardiovascular events (range: 12% to 14% per 10 microg/m³ increase) (Chen, Goldberg, Villeneuve, 2008). Air pollution is also emerging as a risk factor for stroke, particularly in developing countries where pollutant levels are highest (Saber & Heydari, 2012). A 2007 study found that in women, air pollution is not associated with hemorrhagic but with ischemic stroke.

Air pollution was also found to be associated with increased incidence and mortality from coronary stroke in a cohort study in 2011. Associations are believed to be causal and effects may be mediated by vasoconstriction, low-grade inflammation, and atherosclerosis (Committee on Environmental Health, 2004). Other mechanisms such as autonomic nervous system imbalance have also been suggested (Pieters; Koppen; Van Poppel; De Prins; Cox; Dons; Nelen; Int Panis; Plusquin; Schoeters; Nawrot, 2015).

Lung disease

Research has demonstrated an increased risk of developing asthma and COPD from increased exposure to traffic-related air pollution (Fleischer; Merialdi, van Donkelaar, Vadillo-Ortega, Martin, Betran, Souza, João Paulo, 2014). Additionally, air pollution has been associated with increased hospitalization and mortality from asthma and COPD (Malley, Kuylensstierna, Vallack, Henze, Blencowe, Ashmore, 2017, Wang, Ding, Ryan, Xu, 1997). Chronic obstructive pulmonary disease (COPD) includes diseases such as chronic bronchitis and emphysema (Brauer, Lencar, Tamburic, Koehoorn, Demers, Karr, 2008).

A study conducted in 1960–1961 in the wake of the Great Smog of 1952 compared 293 London residents with 477 residents of Gloucester, Peterborough, and Norwich, three towns with low reported death rates from chronic bronchitis. All subjects were male postal truck drivers aged 40 to 59. Compared to the subjects from the outlying towns, the London subjects exhibited more severe respiratory symptoms (including cough, phlegm, and dyspnea), reduced lung function (FEV1 and peak flow rate), and increased sputum production and purulence.

The differences were more pronounced for subjects aged 50 to 59. The study controlled for age and smoking habits, so concluded that air pollution was the most likely cause of the observed differences (Qian, 2017). More recent studies have shown that air pollution exposure from traffic reduces lung function development in children and lung

function may be compromised by air pollution even at low concentrations (Bos, De Boever, Int Panis, Meeusen, 2014). Air pollution exposure also causes lung cancer in a non-smoker.

Cancer (lung cancer)

A review of evidence regarding whether ambient air pollution exposure is a risk factor for cancer in 2007 found solid data to conclude that long-term exposure to PM_{2.5} (fine particulates) increases the overall risk of non-accidental mortality by 6% per a 10 micron/m³ increase. Exposure to PM_{2.5} was also associated with an increased risk of mortality from lung cancer (range: 15% to 21% per 10 microg/m³ increase) and total cardiovascular mortality (range: 12% to 14% per a 10 microg/m³ increase).

The review further noted that living close to busy traffic appears to be associated with elevated risks of these three outcomes-increases in lung cancer deaths, cardiovascular deaths, and overall non-accidental deaths. The reviewers also found suggestive evidence that exposure to PM_{2.5} is positively associated with mortality from coronary heart diseases and exposure to SO₂ increases mortality from lung cancer, but the data was insufficient to provide solid conclusions (McEnaney, 2014). Another investigation showed that higher activity level increases deposition fraction of aerosol particles in human lung and recommended avoiding heavy activities like running in outdoor space at polluted areas (McEnaney, 2014).

4.3 Health Challenges of Air Pollution in Nigeria

Nigeria is located on the west coast of Africa between the Bight of Benin to the fringes of the Sahara Desert (between the Benin Republic and Cameroun). Nigeria is the most populous country in Africa accounting for approximately one-sixth of Africa's people (Wikipedia, 2013). Based on the 2006 National Population Census Nigeria has a population of 140, 431,790 people and the population is exploding with current estimates of over 170 million and a growth rate of more than 2% per annum (Wikipedia, 2013). Approximately 50% of Nigerians lived in urban centers and eight cities namely Lagos, Kano, Ibadan, Kaduna, Port Harcourt, Benin City, Maiduguri, and Zaria have a population of over 1 million people (Channels TV, 2012).

According to literature, Pollution kills 150 per 100,000 Nigerians. Nigeria has the highest burden of fatalities from air pollution in Africa and 4th globally. There is a silent rage of air pollution in Nigeria. These days, the air quality is so bad it kills. Almost every breath taken is like the breath of death. Literally, air pollution is choking the life out of Nigerians. Indoors and outdoors, air pollution is killing more urban residents today than ever before. The air people breathe in Nigeria is more likely to cause harm than the air in any other country in Africa because Nigeria currently has the highest burden of fatalities from air pollution in Africa and 4th highest in the world with 150 deaths per 100,000 people attributable to pollution

According to the Health Effects Institute (HEI, 2018), air quality in Nigeria and at least 10 other countries is among the deadliest anywhere on earth with higher than ambient air pollution death rates as a result of the environmental hazards combined with extreme pollution sources like generator fumes, vehicle emissions and crop burning among others. The HEI chart notes that there were 150 deaths per age-standardized deaths per 100,000 people attributable to air pollution in Nigeria in 2016 (the latest year of available data), compared to highly industrialized countries like China, 117 deaths per 100,000 people; Russia, 62 deaths per 100,000 people; Germany, 22 deaths per 100,000 people; United Kingdom, 21 deaths per 100,000 people; the United States, 21 deaths per 100,000 people;

Japan 13 deaths per 100,000 people and Canada, 12 deaths per 100,000 people. Only Afghanistan with 406; Pakistan, 207, and India, 195 deaths per 100,000 people per country, exceed the Nigerian figure. The chart showcases a striking gap between the most and least polluted air around the world.

In 1990, 3.5 billion people were exposed to it and that has now fallen to 2.4 billion despite an increase in the global population. The report notes that 95 percent of the world's population is breathing unhealthy air. It said long-term exposure to air pollution contributed to just over 6 million deaths in 2016 with strokes, lung disease, lung cancer and heart attacks linked to many of them. After smoking, high blood pressure and poor diet, air pollution is the fourth-highest cause of death worldwide with most deaths occurring in developing countries. Air sustains life, but air could also snuff out life. With air, you live, and with the air you could die.

In a number of the big Nigerian cities, when people present at the hospital with health problems including chest pain, dry throat, nausea, aggravated respiratory diseases such as emphysema, bronchitis, lung damage, and asthma among other respiratory problems, it often turns out that they've been exposed to the effects of poor air quality. Symptoms such as irritation to the eyes, nose, and throat, and upper respiratory infections such as bronchitis and pneumonia are also suspect. Air pollution increases the risk of cancer. There are two types of air pollutants – gas pollutants (e.g. carbon monoxide, sulfur dioxide, etc.) and particles in the air. Air particles can accumulate in the lungs. Air pollution is hardly listed among causes of death on death certificates in Nigeria, yet the health conditions linked to air pollution exposure, such as lung cancer and emphysema, are often fatal.

According to a 2016 World Health Organisation report, Onitsha, Kaduna, Aba, and Umuahia were among four of the 20 African cities with the worst air quality in the world. The WHO measured air quality by examining the annual mean concentration of particulate matter in nearly 3,000 cities across the world with populations of at least 100,000. Onitsha's average annual PM10 was 594 – nearly 30 times greater than the WHO-recommended annual level of 20.

Kaduna, Aba, and Umuahia cities were ranked among the top 20 worst cities measured by PM10, ranking 8th, 9th, and 19th, respectively. Air pollution is now the fourth-highest cause of death worldwide, trailing smoking, high blood pressure, and diet, with the majority of deaths recorded in poorer nations with India and China leading the world in the total number of deaths attributable to air pollution in 2016 with 1.61 million and 1.58 million respectively. Data from the report show that ambient levels of unsafe air continue to exceed the Air Quality Guideline established by the World Health Organisation (WHO).

In a typical scenario thick clouds of blackened smoke usually envelope large areas within Nigerian city suburbs as many smoky and noisy generators run throughout the day and all night. Its routine residents are familiar with clouds of particulate-tinged smoke spreading, setting the pace for generator-induced illnesses and even death. Generator fumes comprise a lethal cocktail of poisonous and environmentally unfriendly gases, including carbon monoxide and other noxious products. Carbon monoxide could be a serious health hazard. Indoors or in close proximity, the gas quickly infiltrates living spaces and incapacitates occupants. All over town, worn out generators and vehicles with poorly-tuned engines are belching out the smoke of noxious emissions, making the air as toxic on the streets as it is unhealthy in the kitchen at home where a kerosene stove burns sooty flames almost around the clock.

A combination of incomplete combustion and lack of ventilation leads to high concentrations of particulate matter and other pollutants in the home and the resulting burden of household air pollution on human health. Rather than dispose refuse and some other wastes or unwanted materials some Nigerians burn them within their neighborhood. The problem is also manifesting in rural areas due to the burning of firewood and coal for cooking. Globally the estimated population relying on solid fuels has reduced but Nigeria remains among countries with populations exposed to household air pollution from dependence on solid fuel. Worse still, over 70 percent of the fuel in the country is generated from fossil fuel.

Most Nigerians are thus exposed to household air pollution with fine particulate matter levels exceeding air quality guidelines by as much as 20 times. Air pollution from indoor sources is recognized as the single largest contributor to the negative health effects of air pollution in Nigeria. While developed nations have been taking action to clean their air, Nigeria is still among the countries that have fallen behind as revealed in the death rate. Nigeria produces more than 3 million tons of waste annually, and uncontrolled waste burning is one of the practices that contribute to deteriorating air quality. Almost every Nigerian is exposed to air pollution levels exceeding WHO guidelines and inflicting significant air pollution damage costs.

In Lagos for instance, an estimated seven million people died from diseases related to indoor and outdoor air pollution in 2012 according to the WHO. Part of the problem is that environmental regulations and enforcement are lax; people are more exposed to air pollution but less able to protect themselves from exposure either in the open, in the workplace or at home. No doubt, Nigeria requires tougher pollution controls if it hopes to effectively combat indoor air pollution by producing safer and more environmentally friendly alternatives. How clean the air matters to your health? Increasing public awareness of air pollution and the burden of diseases that it imposes on individuals, families, and society is an essential step toward making the changes that will improve public health.

Meanwhile, there are two main types of air pollution: ambient air pollution (outdoor pollution) and household (or indoor) air pollution refers to pollution generated by household combustion of fuels (caused by burning fuel such as coal, wood or kerosene) using open fires or basic stoves in poorly ventilated spaces. Both indoor and outdoor air pollution can contribute to each other, as air moves from inside buildings to the outside, and vice versa. Household air pollution kills four million people a year and tends to affect countries in Africa and Asia, where polluting fuels and technologies are used every day particularly at home for cooking, heating, and lighting. Women and children, who tend to spend more time indoors, are affected the most.

The main pollutants: are (1) particulate matter, a mix of solid and liquid droplets arising mainly from fuel combustion and road traffic; (2) nitrogen dioxide from road traffic or indoor gas cookers; (3) sulphur dioxide from burning fossil fuels; and (4) ozone at ground level, caused by the reaction of sunlight with pollutants from vehicle emissions. The pollutant that affects people the most is particulate matter (often abbreviated to PM and used as a measure for air pollution).

4.5 Sources of Air Pollution in Nigeria

There are various sources of air pollution in the urban centers of Nigeria. The major sources are highlighted below:

a. Vehicle exhaust

The release of vehicle exhaust into the air is one of the major sources of air pollution in Nigeria especially in the urban centers where many people owned motor vehicles and move with them on urban roads. There is rapid urbanization in the major cities of Nigeria which is accompanied by the rising car population and hence increases in the release of vehicle exhaust which causes air pollution (Onokala, 2008). This is particularly the case during a period of heavy vehicular traffic that results in traffic congestion. Several studies conducted by experts on the environment has over the years shown that vehicle exhaust or smoke has caused air pollution which destroys the air quality in cities such as Lagos, Ibadan, Kano, Kaduna, and even Abuja the Federal Capital.

b. Use of gasoline generator

There is an inadequate electric power supply to households, businesses, and industries. The result is that many households, businesses, and even industries operate small, medium and large capacity fossil fuel electric power generators for electric power supply whose exhaust is a source of air pollution that releases poisonous carbon monoxide. A recent study conducted in 2010 showed that small household generators in Nigeria operate an average of six (6) hours daily, while the average distance of generator away from buildings was 5.6m. These alongside poor ventilation have negatively influenced the quality of indoor air in the households causing air pollution (Stanley, Mbamali and Dania, 2010).

c. Use of fuelwood

A large percentage of the people in urban centers use fuelwood for cooking and heating. Also, small scale industries such as bakeries and businesses such as restaurants use fuelwood during their production processes. The result is that the burning of the wood has become a major source of indoor air pollution in the urban centers both at home and elsewhere. More people are using fuelwood due to the absence of cheap and readily available sources of cooking and heating in the country.

d. Industrial Emissions

The distribution of industries in Nigeria is not uniform as they are concentrated in urban centers. Major industrial centers in the country include Lagos, Port Harcourt, Ibadan, Kano, and Kaduna. The industries range from oil and gas, chemicals, cement, textiles, iron and steel, plastics, etc. (Ibrahim and Abdullahi, 2004). Even though these industries are located in industrial estates, uncontrolled urban growth has resulted in the expansion of residential buildings very close to the industries. These industries release large quantities of gaseous wastes into the air which are sources of air pollution.

e. Domestic and industrial wastes

The improper disposal and ineffective management of municipal solid waste and industrial waste create major environmental and aesthetic problems in most of Nigeria's urban areas (Ibn Al-Gargani, 2012). Due to over-population and the creation of slums, most municipal areas generate more waste that can be disposed of which led to the accumulation of waste heaps that over time decomposes which becomes a source of air pollution. In addition, waste burning method of disposal as practiced by most residents of the urban centers results in air pollution due to the release of gases such as carbon monoxide, sulfur dioxide, oxides of nitrogen, halogenated carbon and other particulate matter (Ibn Al-Gargani, 2012).

4.6 Theoretical Framework: Human Forcings Theory of Climate Change

This theory of climate change holds that mankind's greatest influence on climate is not its greenhouse gas emissions, but its transformation of Earth's surface by clearing forests, irrigating deserts, and building cities. Pielke, (2009) opines that "although the natural causes of climate variations and changes are undoubtedly important, the human influences are significant and involve a diverse range of first-order climate forcing, including, but not limited to, the human input of carbon dioxide (CO₂)".

Cities tend to be warmer than suburbs, and suburbs warmer than rural areas, because they have greater concentrations of energy-producing machines and vehicles and large amounts of concrete, asphalt, and other building and road materials that absorb solar energy and then re-emit thermal energy (Matsui and Pielke, 2006). Pielke and Matsui (2006) were of the opinion that with many surface-based temperature stations located in urban or near urban areas, it is likely they are registering the warming effects on the ozone.

Removing trees by burning, a common practice in developing countries releases CO₂ into the atmosphere and prevents forests from sequestering carbon in the future. The pasture or cropland that replaces the forest lacks the shade created by a forest canopy and tends to be warmer. The IPCC has estimated that between one-quarter and one-third of anthropogenic CO₂ emissions are due to deforestation, not the burning of fossil fuels (IPCC, 2007).

Anthropogenic activities in coastal areas such as logging, agriculture, construction, mining, drilling, dredging, and tourism all can increase or (more rarely) decrease surface temperatures of nearby bodies of water. For example, storm runoff from city streets following heavy rains can result in seawater dilution and temperature increases. Development can produce sediment that reduces stream flow and damages coral reefs by reducing the penetration of sunlight or by direct deposit on the coral, causing damage mistakenly attributed to global warming (Bast, 2010).

Anyone living in or near a large city knows that jets often leave trails behind them, called contrails (short for "condensation trails"). Composed of water vapor, they precipitate the creation of low clouds that have a net warming effect. According to Travis (2006) contrails "may cause net warming of the surface rivaling that of greenhouse gases" and "in certain regions, contrails already may contribute as much as the present anthropogenic CO₂ forcing on climate." Several of these "human forcings" have local effects on human health.

4.7 Data Presentation and Analysis

Section A

Table 1: Socio-economic and demographic characteristics of respondents

Variable	Frequency	Percentage
Gender		
Male	77	57.0
Female	58	43.0
Total	135	100.0
Age		
18-23	34	25.2
24-29	49	36.3
30-35	52	38.5
Total	135	100.0
Marital status		
Married	60	44.4
Single	75	55.6
Total	135	100.0
Level of Education		
Primary	23	17.1
Secondary	52	38.5
Tertiary	60	44.4
Total	135	100

Source: Field survey, 2021

The demographic information above shows that the sample had more males (57%) than females (43%). Respondents in this sample tend to be 30 years and above (38.3%). Although 49 respondents (36.3%) are between the ages of 24 and 29. Only 34 respondents (25.2%) are between the ages of 18 and 23. Majority of the respondents are single (55.6%). The level of education of the sample population is in the decreasing structure. Most represented in this research are the tertiary school students with 44.4%, slightly greater than the secondary school students (38.5%) which are greater than the primary school students (17.1%).

Section B

Table 2: Effects of Air Pollution on Residents' Health Status

Questions	Frequency	Percentage
Do you often fall sick?		
Yes	72	53.3
No	63	46.7
Total	135	100
Have you been admitted in the hospital on the reason of air		
Yes	62	45.9
No	73	54.1
Total	135	100.0
Do you think air pollution is the reason for your ill health		
Yes	85	63.0
No	50	37.0
Total	135	100.0
In all how will you evaluate the health challenges faced by resident of the areas?		
Poor	25	18.5
Fair	51	37.8
Good	36	26.7
Undecided	23	17.0
Total	135	100.0
The common and traceable effect of carbon monoxide when released to the air in this area is?		
Dizziness	20	14.8
Nausea	26	19.3
Tiredness	76	56.3
Brain damage	13	9.6
Total	135	100.0

Source: Field survey, 2021

Five (5) questions are included in the above table for the purpose of analyzing responses on the effects of air pollution on residents' health status. From the first question, 72 respondents (53.3%) fall sick regularly, while 62 respondents (45.9%) have been hospitalized on air pollution basis. 85 respondents (63%) from the entire sample size (those who fall sick often and those who don't) believe that their ill health condition is as a result of air pollution. Although numbers of air pollution related ill health is above average, it is believed that health challenge in this industrial resident is low. Only about 18.5% respondents experience poor health. Tiredness (56.3%) is the most pronounced effect of air pollution (carbon monoxide) in the industrial area.

Section C

Table 3: Common Health challenge faced by residents around the Industrial Area

Questions	Frequency	Percentage
Which of the following waste materials do you think is the cause of illness in your area?		
Industrial waste gases	51	37.8
Industrial waste water	69	51.1
Industrial solid waste	12	8.9
Others	3	2.2
Total	135	100.0
Which air pollution diseases do you think often occur in your area?		
Respiratory diseases	34	25.2
Skin infection	38	28.1
Eye infection	52	38.5
Ear infection	7	5.2
Other	4	3.0
Total	135	100.0
What are the likely health challenges faced by residents of your area?		
Air-borne disease	5	3.7
Breathing problem	50	37.0
Cholera	1	0.7
Eye problem	18	13.3
Fever	9	6.8
Hearing problem	20	14.8
Lung disease	1	0.7
Malaria	3	2.2
Malaria and Typhoid	1	0.7
Skin irritation	12	8.9
Throat challenge	8	6.0
Typhoid	2	1.5
Water-borne diseases	5	3.7
Total	135	100.0
What is the common health problem faced by the resident of this area?		
Burning eyes and nose	13	9.6
Itchy irritated throat	54	40.0
Breathing problems	59	43.7
Others	9	6.7
Total	135	100.0
What is the common cause of air pollution in the area?		
Motor cycle (Okada)	19	14.1
Used cars	7	5.2
Used fire wood	32	23.7
Generator	77	57.0
Total	135	100.0

Source: Field survey, 2021

According to public responses there are about 13 health challenges that are likely to be faced by residents. Breathing related challenges (37%) is the most common health challenge of all. Next to breathing problem are hearing problem (14.8%), eye problem (13.3%), skin irritation (8.9%) and throat challenge (6.0%) among others. Industrial water

wastes (51.1%) contribute mostly to these health challenge, followed by industrial gas waste (37.8%). In actual fact, breathing problems are the common health problem faced by residents. Out of 135 responses, 50 (37%) identified breathing problems, 54 (40%) identified throat irritation, while only 13 (9.6%) identified burning eyes and nose as the health problem faced by the residents.

Section D

Table 4: Coping Mechanism put in Place by Residents

Questions	Agree(A)		Strongly Agree (SA)		Disagree (D)		Strongly Disagree (SD)		Undecided (D)		Total	
	F	%	F	%	F	%	F	%	F	%	F	%
One way by which I cope with air pollution is reducing the numbers of trip I take in my car around the industrial area	69	51.1	31	23.0	25	18.5	3	2.2	7	5.2	135	100
I reduce or totally eliminate fire place or use of wood stone	28	20.7	88	65.2	15	11.1	1	.7	3	2.2	135	100
I avoid burning of trash and other materials in the area	61	45.2	57	42.2	11	8.1	2	1.5	4	3.0	135	100
I avoid use of gas power and garden equipment	31	23.0	62	46.0	33	24.4	3	2.2	6	4.4	135	100
I try as much as I can to increase the greenery	59	43.7	53	39.3	18	13.3	3	2.2	2	1.5	135	100

Source: Field survey, 2021

From the above table, majority of the residents reduce coming in contact with industrial area. This is believed to be a viable coping strategy has 23% of the respondents take this very seriously and 51.1% takes it slightly serious, giving a total of 74.1% residents adopting this strategy. While 85.9% of the residents also reduces or eliminate fire place or use of wood stone that are liable to cause air pollution. Gas power and garden equipment are avoided by majority (68.9%). Only 26.6% respondent disagree (24.4% strongly disagree) with the strategy. 43.7% of the residents agree to the increasing of the greenery, 39.3% strongly agree, leaving only 13.3% who disagree to the strategy. 1.5% did not decide.

Section D

Table 5: Measures taken by the Kwara State Government in Addressing Air Pollution

Questions	Agree(A)		Strongly Agree (SA)		Disagree (D)		Strongly Disagree (SD)		Undecided (D)		Total	
	F	%	F	%	F	%	F	%	F	%	F	%
The government of Kwara state has put in place vehicle inspection agency	95	70.4	15	11.1	22	16.3	2	1.5	1	.7	135	100
The government has provided alternative means of cooking and heating both for homes and small scale industrial use, in order to reduce the use of fuel wood	20	14.8	78	57.8	24	17.8	10	7.4	3	2.2	135	100
Government has brought about improvement in electricity power supply in order to reduce the use of gasoline generator in homes, business premises, offices and institutions	62	45.9	32	23.7	33	24.4	6	4.4	2	1.5	135	100
Government has made provision of effective refuse collection in the area in order to ensure that there is no time for waste decompose and generate bad odor which pollutes the air	49	36.3	61	45.2	21	15.6	3	2.2	1	.7	135	100
Government has ensure the enforcement of air pollution legislations across the state which has help to reduce air pollution	57	42.2	53	39.3	18	13.3	4	3.0	3	2.2	135	100

Source: Field survey, 2021

From the table above, 81.5% (with 11.1% strongly agree) agree that the Kwara state government has put in place an agency in charge of vehicle inspections. According to the responses, the Kwara state government has a policy on the provision of alternative means of cooking for both homes and small scale industries. While 14.8% agree, 57.8 strongly agree, 17.8% disagree, 7.4% strongly disagree and 2.2% undecided.

Majority (45.9%) of the respondents agree that the government has brought about improvement in power supply, 23.7% strongly agree to this fact. However, 28.8% disagree (4.4% strongly disagree) with this fact. The enforcement of air pollution legislation, for

example refuse collection policy by the Kwara state government is effective according to 81.5% of the respondents.

Testing of Hypothesis

Ho: There is no relationship between air pollution and the health status of residents around the industrial area in Ilorin, Kwara State.

To test the hypothesis two items from section B of the questionnaire were considered. “Do you often fall sick?” and “Have you been admitted in the hospital on the reason of air pollution?”

Table 6

Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Do you often fall sick? *	130	96.3%	5	3.7%	135	100.0%
Have you been admitted in the hospital on the reason of air pollution?						

Do you often fall sick? * Have you been admitted in the hospital on the reason of air pollution? Cross tabulation

			Have you been admitted in the hospital on the reason of air pollution?		
			Yes	No	Total
Do you often fall sick?	Yes	Count	47	21	68
		Residual	17.2	-17.2	
	No	Count	10	52	62
		Residual	-17.2	17.2	
Total		Count	57	73	130

Table 6.1: Analysis

Chi-Square Tests				
	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	36.984 ^a	1	.000	
Continuity Correction ^b	34.863	1	.000	
Likelihood Ratio	39.391	1	.000	
Fisher's Exact Test				.000
Linear-by-Linear Association	36.699	1	.000	
N of Valid Cases	130			

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 27.18.

b. Computed only for a 2x2 table

Decision Rule:

Level of Significance = 0.05

$\chi^2 T = 27.18$

$\chi^2 C = 36.984$

$\chi^2 T < \chi^2 C$

H_0 is rejected.

Using 0.05 level of significance, the hypothesis (null hypothesis) “There is no relationship between air pollution and the health status of residents around the industrial area in Ilorin, Kwara State” is rejected since the chi-square tabulated is lesser than the chi-square calculated. Thus, from the above analysis, it is deduced that there is a relationship between air pollution and the health status of the residents around the industrial area in Ilorin, Kwara state.

4.8 Conclusion

Air pollution has adverse effects on the health of individuals but its effects can be controlled if the right checks and policies are put in place by the relevant bodies. Awareness of pollution laws is an important tool in reducing diseases caused by the illicit emission of pollutants by factories. In our society today, various forms of pollution exist which are consequentially hazardous to the health of human beings, animals and even plants either directly or indirectly. Air, which normally consists of nitrogen, oxygen, argon, carbon dioxide, neon, helium, krypton, xenon, hydrogen, methane, and nitrous oxide, is being interfered with by activities from land, seas and even the atmosphere itself, through man. The activities of man which pollute the air, their effects on human health are the core of this study.

This study examines how air pollution has affected the health status of the residents around the industrial areas in Ilorin, Kwara State. From the findings, it shows that 63% of the residents in the area were of the opinion that they fall sick often and that their ill health condition is as a result of air pollution. There are about 13 health challenges according to the finding from the study that the residents in the study area are likely to face, most common among are breathing related challenges. In order to reduce the harmful effects of air pollution on the residents, the majority of them adopted a common strategy by avoiding pollutants around the industrial area.

In order to curb the effects of air pollution on the residents, the Kwara state government has put in place various kinds of measures such as establishing an agency in charge of vehicle inspections; a policy on the provision of alternative means of cooking for both homes and small scale industries; has brought about improvement in power supply and enforcement of air pollution legislation.

4.9 Recommendations

Findings from the study show that air pollution causes respiratory diseases in humans. Air Pollution in general causes respiratory ailments and also may affect lung function. Asthma, Chronic Obstructive Pulmonary Disease, chronic bronchitis, etc. are the diseases caused by exposure to increasing air pollution. Air pollution is known to be one of the aggravating factors for many respiratory ailments and cardiovascular diseases.

In our society today, various forms of pollution exist which are consequentially hazardous to the health of human beings, animals and even plants either directly or indirectly. Air, which normally consists of nitrogen, oxygen, argon, carbon dioxide, neon, helium,

krypton, xenon, hydrogen, methane, and nitrous oxide, is being interfered with by activities from land, seas and even the atmosphere itself, through man. The activities of man which pollute the air, their effects on human health are the core of this study.

This study examines how air pollution has affected the health status of the residents around the industrial areas in Ilorin, Kwara State. From the findings, it shows that 63% of the residents in the area were of the opinion that they fall sick often and that their ill health condition is as a result of air pollution.

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In order to curb the effects of air pollution on the residents, the Kwara state government has put in place various kinds of measures such as establishing an agency in charge of vehicle inspections; a policy on the provision of alternative means of cooking for both homes and small scale industries; has brought about improvement in power supply and enforcement of air pollution legislation.

4.9.1 Recommendation to Government

To minimize the harmful effect of air pollution, the Government has to embark on the following actions:

- i. Formulation of regulations/statutes
- ii. Setting up of monitoring network for assessment of ambient air quality
- iii. Introduction of cleaner/alternate fuel like CNG, LPG, etc. and promotion of public transport network including Metro
- iv. Creation of infrastructure for industrial pollution control incorporating cleaner production processes, setting up of common pollution control facilities
- v. Draft Rules for handling and management of municipal waste
- vi. Banning of burning of leaves/ biomass
- vii. Relevant draft rules, including those pertaining to construction and demolition waste
- viii. Stringent industrial standards must be formulated
- ix. The government should give high priority to public partnership in the area of lane discipline, carpooling, vehicle maintenance, pollution under control certification, etc.
- x. increasing green cover alongside roads
- xi. sprinkle water on trees nearby the roads
- xii. strict instructions to construction companies regarding pollution
- xiii. reducing carbon emissions by focusing on renewable energy generation
- xiv. ban on the sale of firecrackers
- xv. crackdown on the burning of solid waste and agricultural waste
- xvi. urging businesses to invest in solutions related to environmental sustainability
- xvii. strengthening the public transport system

These are some of the steps that respective governments at their own capacities can take to reduce the harmful effect of air pollution on human health. However, when it comes to environmental pollution, there is still a lot of work that needs to be done for ensuring that future generations get to live in much better conditions.

4.9.2 Recommendation to individual residents

Every time we drive to school, use our heater or air conditioner, clean our windows, or even style our hair, we make choices that affect air pollution. These steps, as well as many others, are things we all can do to help reduce air pollution.

- a) Conserve energy-remember to turn off lights, computers, and electric appliances when not in use.
- b) Use energy efficient light bulbs and appliances.
- c) Participate in your local utility's energy conservation programs.
- d) Limit driving by carpooling, using public transportation, biking and walking.
- e) Combine errands for fewer trips.
- f) Keep your automobile well-tuned and maintained. Follow the manufacturer's instructions on routine maintenance, such as changing the oil and filters, and checking tire pressure and wheel alignment.
- g) Avoid excessive idling of your automobile.
- h) Use electric or hand-powered lawn care equipment.
- i) Be careful not to spill gasoline when filling up your car or gasoline-powered lawn and garden equipment.
- j) Run dishwashers and clothes washers only when full.
- k) Choose environmentally friendly cleaners.
- l) Seal containers of household cleaners, workshop chemicals, and solvents, and garden chemicals to prevent volatile organic compounds from evaporating into the air.
- m) Purchase and use low-polluting outboard marine engines and personal watercraft (4-stroke and direct fuel injection 2-stroke outboard marine engines).
- n) Advocate for emission reductions from power plants and more stringent national vehicle emission standards.

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