Petroleum and Coal

**Review** **Open Access**

# Urban Air Pollution and its Effects on Health, Safety and the Environment in Nigeria: A Concise Review

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Received October 18, 2021; Accepted March 16, 2021

**Abstract**

Clean air is an important requirement for human health and wellbeing. In this paper, the impact of urban air pollution on human health, safety and the environment in Nigeria was critically examined. It was observed that most cities and metropolises in Nigeria are characterized by high levels of air pollutants particularly when compared to European Union (EU) standards for air quality. The findings are largely ascribed to various natural or anthropogenic activities such as open-air burning of wastes, combustion of fossil and solid fuels, car exhaust fumes, land clearing, mining, agriculture, cement production and utilization, among others. The long- and short-term exposure to the high levels of air pollutants emitted from such activities pose significant risks to human health, safety and the environment in Nigeria. The review of the literature revealed that air pollutant largely accounts for the exacerbated or soaring cases of asthma, cancer, lung/respiratory diseases, other cardiovascular diseases, and eventually premature death in Nigeria. Therefore, there is an urgent need to develop a critical plan of action for the promotion of clean air and sustainable utilization of fuel and energy materials that cause air pollution, which severely impacts air quality and human health, safety and the environment.

***Keywords***: *Air pollution; Human health; Exposure; ambient air quality; Nigeria, $PM_{2.5}$.*

## 1. Introduction

Humans are inseparable from the environment due to the various interactions with nature and other pertinent components of the earth including the atmosphere. Therefore, the occurrence of foreign or extraneous materials such as toxic gases and particles generated by anthropogenic activities could consequently impact human health, safety and the surroundings. For instance, the high rates of rural-urban migration in recent times have significantly impacted every facet of human society. This unpredicted surge in population due to migration has caused numerous environmental problems such as air pollution [1]. According to the World

Health Organization (WHO), air pollution is one of the most significant risks to human health, safety and the environment [2]. It is known to be the cause of numerous cases of premature deaths, which the Organisation for Economic Co-operation and Development, OECD [3] predicts will double soon. Due to its effect on human health and safety, air quality is considered the prerequisite for measuring the state of the environment in any region [4].

Nigeria is ranked the fourth most air polluted country across the globe. In addition, the nation also has the highest recorded fatalities due to poor air quality arising from high levels of air pollution. According to World Bank's "Little Green Data Book 2015" the air pollution arising from particulate matter ($PM_{2.5}$) levels in Nigeria is 94%, which is above the WHO guidelines of 72% for Sub-Saharan African. The poor and worsening levels of urban air pollution in Nigeria is typically ascribed to the burning of fossil-fuels [5]. Other pertinent anthropogenic based activities such as rapid industrialization, economic growth and urbanization are also responsible for air pollution [6-7]. However, the burning of fossil fuels and solid biomass fuels such as sawmill dust in engines and automobiles emit toxic and pungent gases and particulate materials (PM) [8]. According to analysts, the burning of solid fuels accounts for over 50% of all sources of air pollution in various cities in Nigeria. This view is corroborated by Osuntogun and Koku [9], whose study examined the levels of air pollution in the key metropolises in the South-Western part of Nigeria.

Numerous studies have reported that long- and short-term exposure to air pollutants cause a broad range of health-related illnesses. For example, exposure to toxic pollutants causes asthma, respiratory and cardiovascular diseases, exacerbation, decreased lungs functions and early death [10-11]. Similarly, the effects of urban air population on human health and safety in Nigeria have been investigated in the literature. Oguntoke and Adeyemi [5] explored the effect of burning fossil fuels using generators and health effects on the inhabitants of the Abeokuta metropolis. Okobia [12] examined the impact of carbon monoxide (CO) on human health in the city of Abuja. Adedeji *et al.,* [4] examined the effects of traffic-linked air pollution in Ijebu-Ode using GIS (Geographic Information System). Olalekan *et al.,* [13] surveyed the quality of air and its health implications on the inhabitants of the Ilorin metropolis. Yakubu [14] investigated the effects of soot air pollutants on public health-related issues in Port Harcourt, whereas Raimi *et al.,* [15] investigated the impact of sawdust on air quality in Ilorin, Kwara state. Afolabi *et al.,* [16] reviewed the responsiveness of indoor air pollution and the pervasiveness of respiratory signs in South-western cities in Nigeria.

The review studies have demonstrated that Nigeria lacks a designed strategy and ecologically defined guidelines or principles to check, organize, endorse, and monitor air pollution as obtained in many developed countries. Hence, there is an urgent need for robust strategies in addition to well designed and developed monitoring systems for tracking air pollution across various cities. It is envisaged that such approaches will assist policymakers, engineers and scientists to effectively examine and maximally comprehend the scale of air pollution in Nigeria. Hence, this review intends to focus mainly on assembling and exploring recent studies concerning the effect of urban air pollution in Nigeria and thus focusing on its damaging consequences on human health and safety. Furthermore, the different categories of foremost air pollutants and their various sources would be identified and highlighted in detail.

## 2. Study area

Nigeria is an African country located in the Western part of the continent. The nation is bordered to the North by Niger; Northeast by Chad; East by Cameroon; West by the Republic of Benin and the South by the Atlantic Ocean as shown in Figure 1 [17]. The country is located in the tropics on longitude 9.0820° N and latitude 8.6753° E. Nigeria has four climates Alpine, Savannah, Tropical, and the Sahel with varying temperatures between 25ºC along the Cameroonian border and 44ºC during the dry season [18]. The rainy season has an average fall between 2000 mm (118.1 inches) and 4000 mm (157.5 inches) per year in the Southern parts, which adds up to 1100 mm (43.3 inches) in the central region of the country. Nigeria has a total of 36 states and 774 council areas, with an estimated population of 210 million, although this is projected to exceed the population of the United States by 2050 [19]. The population distribution indicates that 51.2%, which falls within the age of 18 years resides in urban areas [20]. The nation has a population growth rate of 2.62% but is likely to drop to 2.04% by the year 2050. However, the towns and cities have witnessed an influx of people from all over its rural areas.

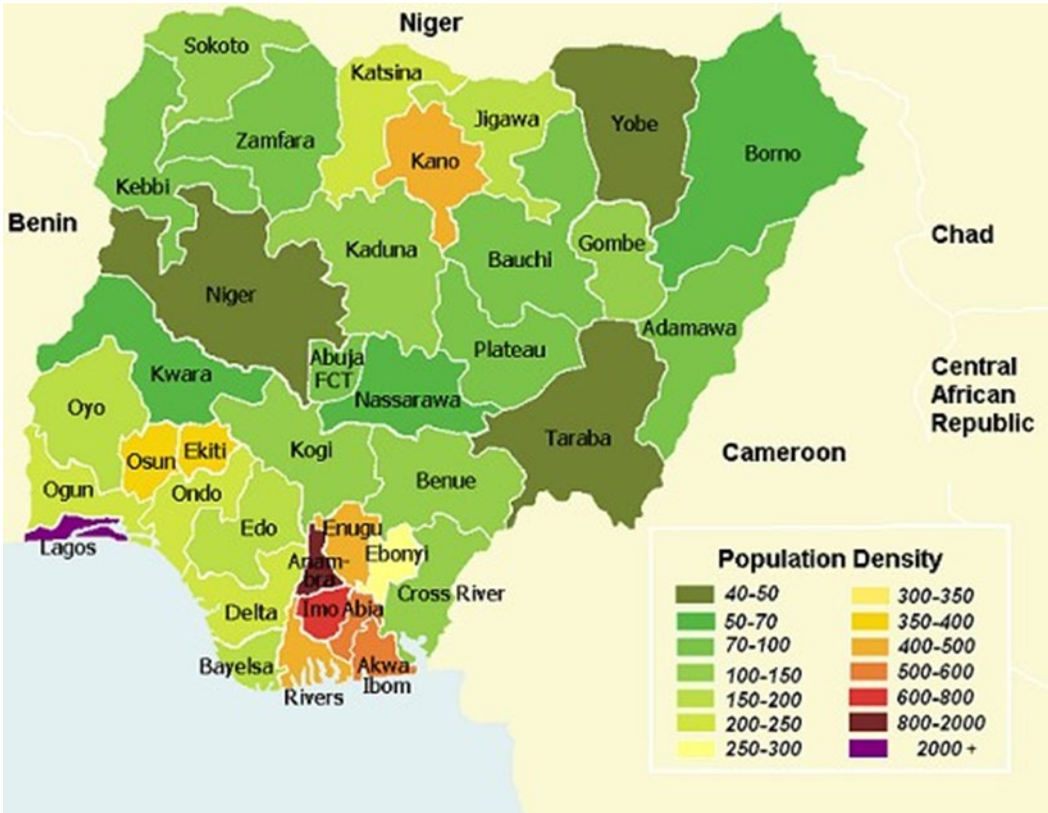


Figure 1. Population distribution density

Lagos state has the largest population density of Nigeria. As a result, its ambient air quality has declined over the years, largely due to the flagrant disregard for public facilities. Over the years, this scenario has taken an aggressive dimension due to rising population and pressure on social amenities. Other factors such as hasty and unstructured urbanization, also due to increased population growth, have exacerbated the challenges of the urban population in the state. Furthermore, the extensive use of fossil fuel generators due to lack of electricity supply, and fumes from old vehicles that periodically break down have worsened air quality. Another critical factor in the deterioration of air quality and rising air pollution in the city is the unrestrained transportation density, undisciplined drivers, and poor infrastructure. Lastly, the poor inner-city air quality is also a deep consequence of poor social amenities.

Anambra state also experiences high levels of ambient air pollution particularly at the famed Onitsha market located in Onitsha town, which is the commercial metropolis of Anambra [21-22]. The state has one of the largest markets in West Africa based on geographical size and the volume of goods traded annually. Hence, merchants from all over the ECOWAS sub-region are known to massively patronize the market, which severely affects the air quality in the city [23-24]. The pollution level recorded in the market is 30 times higher than the WHO guidelines [14]. Similarly, the Niger Delta producing region of the country generates large quantities of pollutant emissions annually. This observation is ascribed to the large concentration of petroleum refineries and petrochemical plants in the region particularly Port Harcourt (Rivers State), Warri (Delta State), Ogbelle (River state), Eleme (River State). Due to the volume of crude oil refined and chemicals produced in the region, the companies operating in the region emit pollutant gases such as CO, carbon dioxide ($CO_2$), sulphur dioxide ($SO_2$), and methane ($CH_4$).

Other toxic emissions include hydrogen fluoride (HF), benzene, polyaromatic hydrocarbons (PAHs) and chlorine which pollute the entire atmosphere of cities located close to such industries [25-27].

Natural gas also emits nitrogen oxides ($NO_x$), which is deemed deadly due to several respiratory problems associated with its emission into the atmosphere. It is widely reported that $NO_x$ reacts with extra substances in the air to yield ozone and particulate matter (PM), which causes various health problems such as heart attack, shortness of breath, and premature death, among others. Furthermore, natural gas emits a total of over 100 tons of $NO_x$ per year, which could increase over time [28]. In Nigeria, the following power stations largely utilize natural gas as shown in Table 1.

Tables 1. Geographical distribution of fossil fuel power plants across Nigeria

| Power station | Community | Type | Capacity |
|---|---|---|---|
| Aba power station | Aba (Abia State) | Simple cycle gas turbine | 140 MW |
| Okpai power Station | Okpai (Delta State) | Combined cycle gas turbine | 480 MW |
| Omoku Power station | Omoku (Rivers State) | Simple cycle gas turbine | 150 MW |
| Ibom power plant | Ikot Abasi (Akwa Ibom State) | Combined cycle gas turbine | 191 MW |
| Azura Power Station | Benin City (Edo State) | Simple cycle gas turbine | 450 MW |

Other states such as Imo, Kano, River, Enugu, Abia, Akwa Ibom, Osun, and Ekiti have also experienced a relative increase in pollutant emissions in major cities over the years. This could be due to the daily increase in businesses, industrialization, and transportation among other anthropogenic activities. According to Ferguson [29], automobile exhaust accounts for about 70% of the entire pollution weight of a city. It has been reported that the unstructured increase in motor vehicles particularly two-stroke engines exacerbates the levels of air pollution.

## 3. Concept and classification of air pollution

Air pollution is conceptualized as the presence of redundant particles in the air typically generated by various anthropogenic activities [30-31]. The phenomenon is also defined as the presence of high concentrations of tiny particles caused by anthropogenic activities and harmful to human health, vegetation, properties and yield of crops. According to Ghorani-Azam *et al.,* [32], air pollution is described as an unhelpful consequence of deteriorating substances that contributes to the contamination of the atmosphere [33]. These substances that contaminate the environment are generally called pollutants [34]. Examples of the pollutants include carbon monoxide (CO), nitrogen oxides ($NO_x$), particulate matter (PM), sulphur dioxide ($SO_2$), among other pollutants [35].

The global consensus is that air pollution is an environmental problem that targets everyone. Hence, if there is little or no collectively effort to fight or reduce air pollution, the entire world will be at the mercy of this disastrous occurrence [36]. The study by Enger *et al.,* [37] showed the correlation between air pollution, population size and developmental technologies that emit pollution during utilization. For air pollution to occur, pollutants must first and foremost be released from different pollutant sources (Figure 2) into the atmosphere and mixed chemically. According to Alexis *et al.,* [38], air pollution can be categorized into various types based on the origin, source, size, chemical composition and form of release into the environment. For instance, air pollution is divided into natural or man-made and stationary or mobile pollution based on sources [39].

The pollutants from natural sources include volcanic eruptions, forest fires, pollen grain, dust storms, and radon gas. However, man-made pollution, which in other words are referred to as anthropogenic pollution, occurs due to human actions in their surroundings. Such pollution sources are further classified into point, area and line sources. The point sources are local, stationary and large industrial facilities such as power plants, paper mills, and oil refineries, among others [40]. Nearly all man-made point sources deliver pollutants into the air through the chimney at a stature to enable pollutants to undergo dilution before travelling down to the ground surface. On the other hand, area sources of pollution are small but when abundant eries, gasoline stations, dry cleaners, service station operations and agricultural burning [41].

According to Fujita *et al.,* [42], mobile sources are air pollution from movable machines. These typically include automobiles such as buses, boats, planes, cars, and trucks. However, the non-mobile or stationary pollution are air pollution from non-movable machinery, which includes machines that operate standing in one position. Examples of such machinery include power plants, chemical plants, oil refineries, among others. Abou Rafee *et al.,* [43] observed that non-mobile sources emit the highest concentration of air pollution not including CO from automobile exhaust of mobile sources.

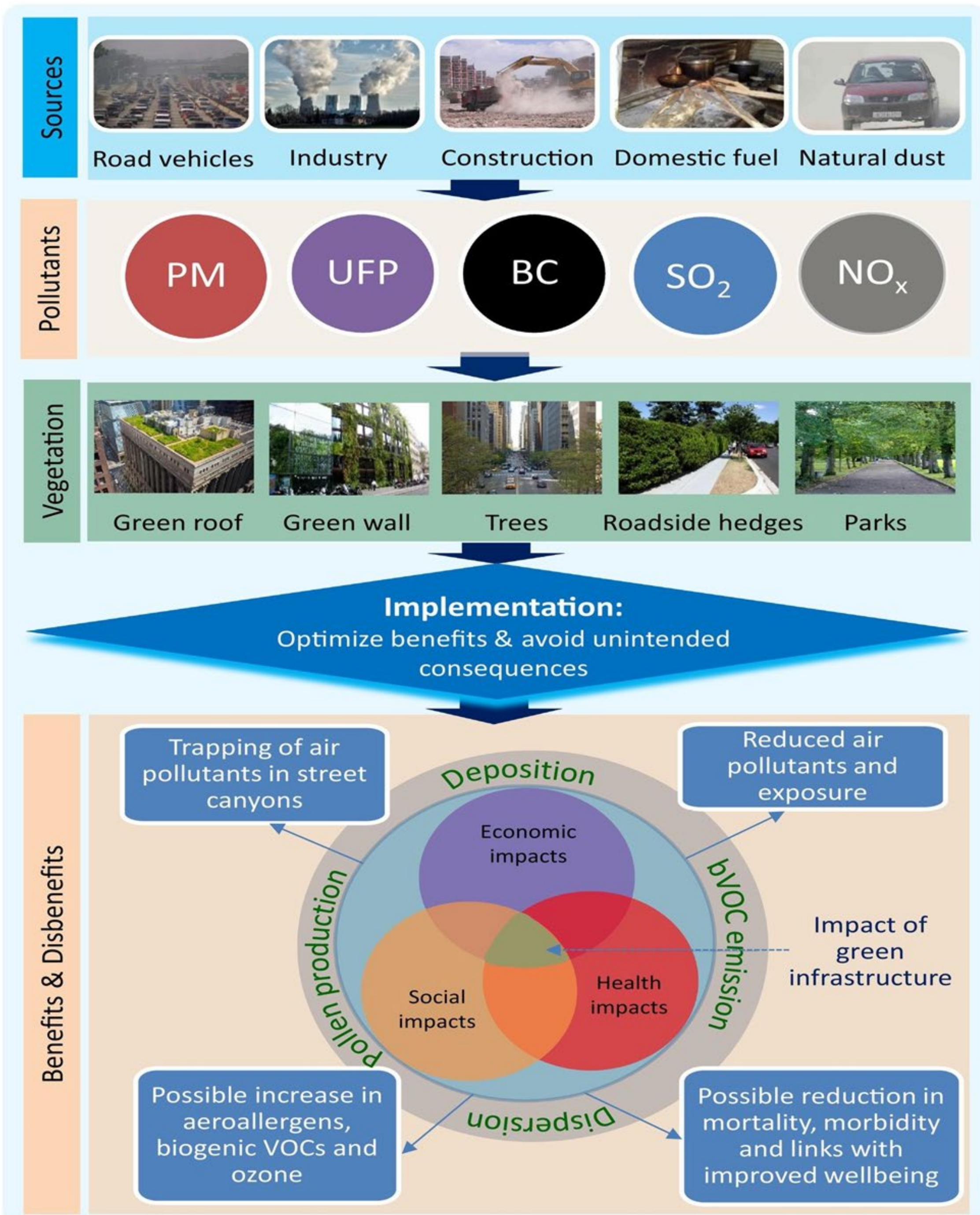


Figure 2. Theoretical illustration showing the relationship between air pollution sources, greening options, optimized benefits and its costs [37]

Based on origin, air pollution is divided into primary and secondary pollutants. The primary pollutants are emitted from sources such as human activities or natural proceedings emitted into the air that remain in their original form. Such pollutants include CO, NOx, hydrocarbons, as well as compounds of lead, sulphur, and volatile organics. The secondary pollutants transpire due to either interaction between primary pollutants or atmospheric constituents. The processes that generate these contaminants are photochemical oxidation, oxidation and/or hydrolysis in the atmosphere or primary pollutant and chemical constituents. Examples of secondary pollutants include nitric acids, Sulphurous acid ($H_2SO_3$), which causes acidic rain, ketones, ozone, smog and carbonic acid [44]. Based on the size, air pollution is further divided into gaseous or airborne particles termed particulate matter (PM) pollutants. The PMs may be organic or inorganic materials with a diameter below 2.5 μm.

## 4. Major air pollutants and their impact on health

Numerous air pollutants have adverse impacts on human health and the environment. However, the damaging consequences of these pollutants on humans depends on the class of pollutant concentration, and exposure time. The various types of pollutants include nitrogen oxides ($NO_X$), sulphur oxides ($SO_X$), carbon monoxide (CO), lead (Pb), volatile air compounds (VOCs) and particulate matter (PM).

### 4.1. Nitrogen dioxide ($NO_X$)

Almetwally *et al.,* [45] describe $NO_x$ as a group of gas pollutants generated from the chemical reaction between nitrogen (N) and oxygen (O). Rosa (2015) listed about seven (7) likely by-products from this reaction namely, NO, $NO_2$, $N_2O$, $NO_3$, $N_2O_3$, $N_2O_4$, and $N_2O_5$. $NO_2$ is the key forerunner of ozone and as such, it is a foremost constituent of oxidant air pollution. In general, $NO_X$ compounds are naturally shaped using soil emissions [46]. However, other sources include thunderstorm lightning, excessive use of chemical fertilizer and volcanic eruptions [47]. Conversely, nitrogen oxides are emitted from anthropogenic activities as NO, which rapidly reacts with ozone to yield nitrogen dioxide ($NO_2$) [1]. The major mobile sources include cars, trains, and trucks, whereas the point or stationary sources are generators, plants, heating as illustrated in Figure 1. Typically, exposure to high levels of $NO_2$ can stimulate unceasing and sharp changes in lung functions which includes asthma, bronchial neutrophilic infiltration, and pro-inflammatory cytokine production and finally death [48, 49]. $NO_2$ is also associated with the formation of acidic rain which is deadly to humans and the environment [50-51].

### 4.2. Sulphur oxides ($SO_X$)

These are colourless, acidic, and choking odour gases typically emitted from the combustion of fossil fuels, volcanic eruptions, and power plant generators (Figure 1). According to Macdonald *et al.,* [52], an unstable form of organic Sulphur is also obtained from soil, oceans and vegetation. $SO_2$ is the most common sulphur-based air pollutant. $SO_X$ exist in two forms namely sulphur dioxides ($SO_2$) and trioxides ($SO_3$). These sulphur compounds have been reported by Almetwally *et al.,* [45] and Komarnisky *et al.,* [53] to be amongst the pollutants that play a major role in altering the chemistry of the earth atmosphere when emitted. For example, $SO_X$ manipulates the weather and climate. It is also known to be corrosive amidst other pollutants [2]. Historically, concerns about $SO_2$ based contaminants became heightened around the middle of the 20$^{th}$ century by the London fogs. Exposure to high levels of $SO_X$ in the short term may cause respiratory diseases [45]. However, long term exposure causes asthma, heart diseases, lung diseases and premature death [54]. Further studies reveal that exposure to $SO_X$ above 0.5 ppm increases airway resistance, which is due to reflex bronchoconstriction [55].

### 4.3. Carbon monoxide (CO)

It is a colourless, tasteless, and odourless gas that is soluble in water and less dense than air. This is an especially important air pollutant generated from the incomplete combustion of fossil fuels. CO is mostly emitted into the atmosphere from man-made activities (incomplete combustion of carbonaceous materials) and other natural sources. Examples include the incomplete combustion of petrol engines, open waste incineration, burning of bush, volcanoes, natural gas emission and seed germination [56]. When inhaled, it interferes with haemoglobin (Hb) in the blood to yield carboxyhaemoglobin (COHb) [57]. It is very poisonous when present in high concentrations as it limits the amount of oxygen carried by tissues in the human body. Cases of accidental death have been reported from exposure to towering levels of smoke during combustion dating back to the Roman civilization.

### 4.4. Particulate matter (PMs)

PMs are considered the most omnipresent pollutants present in the atmosphere. PMs are a mixture of solid, liquid, and very tiny particles present in the atmosphere [58]. Typically, PMs have been classified as coarse particles with a diameter ≤of 10 μm - PM10, fine particles diameter ≤ 2.5 μm or ultrafine with diameter < 0.1 [59], as depicted in Figure 3.


Figure 3. Various sizes of PM [59]

The PMs are typically emitted into the atmosphere either naturally or through human activities (anthropogenic). However, the inhalation of PMs by humans could result in high mortality or morbidity. Ware *et al.,* [60] confirm that the prevalence of bronchitis and coughing can be linked to the ambient concentrations of PM, as corroborated by Pope *et al.,* [61]. Numerous studies have also demonstrated that fine particles are more noxious and destructive to the human body when compared to coarse particles and thus, participate in a critical role in climate change [62-63]. The findings of Ezeh *et al.,* [64] and Moses and Orok [65] demonstrated that inhaling $PM_{2.5}$ and $PM_{10}$ causes chronic issues such as damage to the reparative organs in the human body.

## 5. Air pollutants in selected Nigerian cities

Figure 4 presents the various sources, levels, and distribution of air pollutants in the various towns and cities in Nigeria. Recent results from numerous researchers carried out in different cities in Nigeria confirms the presence of an extensive range of air pollutants with risks to human health, safety and the environment. For example, the city of Jos located in the Middle Belt region of Nigeria has numerous air pollutants categorised according to point source and varying degrees. On several busy roads within Jos town, the following data on urban air pollution are presented in Table 3 [66].

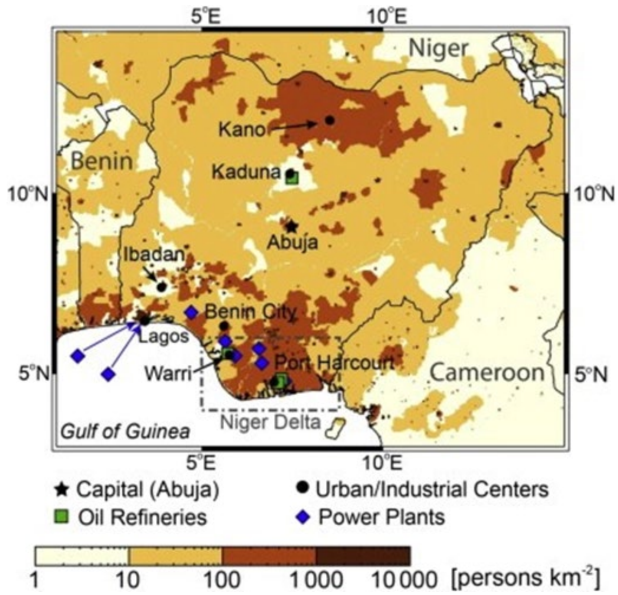


Figure 4. Map of Nigeria showing highlighting major areas of air pollution

Table 2. Point source air pollutants pollutant in Jos metropolis

| No/s | Pollutant/s | Mg/M$^3$ (μg/m$^3$) | Type of pollution | City | Source |
|---|---|---|---|---|---|
| 1. | $NO_X$ | 0.73 (730) | Point source | Jos | (Dibofori-Orji and Braide 2013) [37] |
| 2. | $SO_X$ | 0.11 (110) | Point source | Jos | |
| 3. | CO | 0.67 | Point source | Jos | |

Table 3. Area source air pollutants pollutant in Jos metropolitan (Ola *et al.* 2013, [66])

| No/s | Pollutant/s | Ppm (mg/m$^3$) | Type of pollution | City |
|---|---|---|---|---|
| 1. | CO | 6 - 110 (7.40 -136) | Area source | Jos |
| 2. | $H_2S$ | 1.0 – 0.6 | Area source | Jos |
| 3. | PM | (0.1 – 0.6) | Area source | Jos |

Okobia and Hassan [67] found that the emission of CO was higher than 40 ppm (49.3mg/m$^3$) based on the analysis of a selected location in the capital of Nigeria. In Calabar and Port Harcourt, the levels of pollutants present in the air in the two south-south cities of Nigeria are tabulated in Table 4 [68-69].

Table 4. Area and mobile sources of air pollutants in Calabar and Port Harcourt metropolis

| No/s | Pollutant/s | unit | Type of pollution | City | Source |
|---|---|---|---|---|---|
| 1. | CO | 3.3 – 8.7 Ppm 4.07 -10.7 mg/m$^3$ | Area source | Calabar | |
| 2. | $NO_2$ | 0.02 – 0.09 ppm 4.07 -10.7 μg/m$^3$ | Area source | Calabar | Abam and Unachukwu (2009) [69] |
| 3. | $SO_2$ | 0.04– 0.15 ppm 113–423 μg/m$^3$ | Area source | Calabar | |
| 4. | PM | 170– 260 μg/m$^3$ | Area source | Calabar | |
| 5. | CO | 0–60.24 ppm 0–74.30 mg/m$^3$ | Mobile source | Port Harcourt | |
| 6. | $NO_x$ | 0–1.5 ppm 0–3,040 μg /m$^3$ | Mobile source | Port Harcourt | Zagha and Nwaogazie (2015) [70] |
| 7. | $SO_x$ | 0–0.75 ppm 0–2,120 μg/m$^3$ | Mobile source | Port Harcourt | |
| 8. | PM | 26–199 μg/m$^3$ | Mobile source | Port Harcourt | |

In the south-western states, analyses were carried out in Lagos and Abeokuta metropolitan areas of the Lagos and Ogun states, respectively. With certainty, out of the 17 cities in Nigeria, around 10 metropolises experience air pollutants of mean/yearly PM concentration of about 120 μg/m$^3$, while around 7 cities experience their PM concentration above 119.2 μg/m$^3$. Though, air standard quality acceptable by the EU (European Union) is presented in Table 6. Nevertheless, some $CO_X$ levels reported in different locations in Nigeria go far above the EU recommend standard. While SOX reported levels seems to be within EU acceptable limits, thus some exceed the required level. $NO_X$ and PM follow the same drift. Consequently, measures must be taken both locally and globally to safeguard the quality of air to improve the wellbeing of the earth inhabitants.

Table 5. Area and Mobile source air pollutants in Lagos and Abeokuta metropolise

| No/s | Pollutant/s | unit | Type of pollution | City | Source |
|---|---|---|---|---|---|
| 1. | CO | 289.64 ppm 357.2 mg/m$^3$ | Mobile source (trucks) | Lagos | Akinyemi and Usikalu (2013) [71] |
| 2. | | 116.23 ppm 143.3 mg/m$^3$ | point source (generators) | Lagos | |
| 3. | | 5.75 ppm 7.092 mg/m$^3$ | Point source (Firewood) | Lagos | |
| 4. | CO | 45 - 835 ppm 55.5–1,030 mg/m$^3$ | Area source (high traffic) | Lagos | |
| 5. | $CO_2$ | 4.5–10.9% | point source (generators) | Abeokuta | Oguntoke and Adeyemi (2017) [5] |
| 6. | CH | 0.0–1.2 ppm | point source (generators) | Abeokuta | |
| 7. | CO | 141.1–4167.0 ppm | point source (generators) | Abeokuta | |
| 8. | $NO_X$ | 4.0–85.7 ppm | point source (generators) | Abeokuta | |
| 9. | $H_2S$ | 0.0–0.7 ppm | point source (generators) | Abeokuta | |
| 10. | $NO_2$ | 100-662 ppb | Area source (high traffic) | Ijebu-Ode | Adedeji, Oluwafunmilayo, and Oluwaseun (2016) [4] |
| 11. | CO | 4.8 – 137 ppm | Area source (high traffic) | Ijebu-Ode | |
| 12. | NO | 67-302 ppb | Area source (high traffic) | Ijebu-Ode | |
| 13. | $SO_2$ | 38-245 ppb | Area source (high traffic) | Ijebu-Ode | |

Table 6. European Union (EU) accepted limits of air quality

| NO/s | Pollutant/s | μg/m$^3$ | Source |
|---|---|---|---|
| 1. | CO | 10 | European Commission (2016) [72] |
| 2. | $SO_2$ | 350 | |
| 3. | $PM_{10}$ | 50 | |
| 4. | $PM_{2.5}$ | 25 | |
| 5. | $NO_2$ | 200 | |

## 6. Impact of air pollution on human health in Nigeria

Typically, air pollutants enter the human body through ingestion and inhalation. Various studies have demonstrated that long exposure to pollutants poses severe risks to human health and safety. However, studies on the impacts of air pollutants on human health and safety in Nigeria reveals that these pollutants could result in severe consequences and even unexpected death. For instance, Oguntoke and Adeyemi [5] evaluated the consequence of fumes from generator sets on air quality and the health of inhabitants in Abeokuta. The air pollutants monitored from the generator set were extremely high, while a few distances from the set recorded a variation pollutant figure between 14% and 66%. Nevertheless, illnesses regularly experienced by the exposed populace include headache (24%), nasal congestion (66%), fever (12%) and cough (33%). Bashiru and Ebede [73] evaluated the impact of air pollution in some selected states in Nigeria between 2012 and 2014. The findings revealed that Abuja and Lagos witnessed patients with high levels of airborne diseases such as Pneumonia, Asthma, Bronchitis, Upper respiratory tract infection (URTI), Pulmonary Tuberculosis (PTB), and Tuberculosis. The authors also revealed that about 30% of the total patients in Kano died of pneumonia, while 9% of patients survived Asthma in Port-Harcourt. In a separate study in Lagos State, Croitoru *et al.,* [74] found that ambient fine PM2.5 caused the premature deaths of about 11,200 patients, which generated health costs equivalent to 2.1 % of the GDP of Lagos in 2018. Raimi *et al.,* [15] evaluated the ambient air quality of key sawmill locations in Ilorin. The analysis revealed that high levels of Combustible (LEL), Volatile Organic Compounds (VOCs), PM10 and PM2.5 could cause unexpected health effects and subsequently death. Nwachukwu *et al.,* [75] analysed the consequence of air pollution on Rivers State inhabitants between 2003 and 2008. The findings revealed dangerously high levels of Pb ($1 \times 10^{-6}$ ppm/year), PM (105 ppm/year), NO (2.55 ppm/year), VOC (82.78 ppm/year) and $SO_2$ (1 ppm/year). The occurrence and exposure to these pollutants were attributed to 30,435 cases of pulmonary tuberculosis, pertussis, cerebrospinal meningitis (CSM), measles, pneumonia, upper respiratory tract infection (URT), chronic bronchitis, and 61 deaths.

## 7. Conclusion

The effects of urban air pollution on human health, safety and the environment in Nigeria were reviewed in this paper. The reviewed literature showed that urban air pollution is primarily caused by anthropogenic activities ranging from open-air burning to transportation and agriculture. Other pertinent factors include the rapidly growing urban population arising from rural-urban migration, which greatly constrains the already fragile infrastructure or dilapidated social amenities in many cities and towns in Nigeria. Due to the high levels of air pollutants in urban areas, numerous cases of illnesses and mortality have been reported among inhabitants in Nigeria. The review of the literature revealed that air pollutants largely account for the exacerbated or soaring cases of asthma, cancer, lung/respiratory diseases, other cardiovascular diseases, and eventually premature death in Nigeria. With the nation's population projected to soar significantly by the year 2050, there could be even more severe consequences of air pollution on health. Therefore, there is an urgent need to develop a critical plan of action for the promotion of clean air and sustainable utilization of fuel and energy materials that cause air pollution, which severely impacts air quality and human health, safety and the environment.

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