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*Original Paper*

# Prevalence of Pollutant Gases and the Occurrence of Associated Diseases in Asaba Metropolis, Delta State, Nigeria

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***Abstract***

*The study examined the prevalence of pollutant gases and occurrence of associated diseases in Asaba Metropolis, Delta State, Nigeria. The study adopted a retrospective cohort and survey research design. The cohort study analyzed the reported air pollution medical cases in Federal Medical Center in Asaba such as respiratory diseases, Asthma, Pneumonia, Tuberculosis, Meningitis and Measles. The survey involved measurement of air pollutant such as* $NO_2$*,* $SO_2$*,* $H_2S$*, CO and VOC to compare with the National Ambient Air Quality Standard (NAAQS) data and the World Health Organization Air Quality Guideline (WHOAQG) in order to ascertain the level of air pollution. As part of the study, a total of two hundred (200) copies of questionnaires were administered in two major communities representing the two LGAs that make up Asaba Metropolis serving as study sites (Asaba and Okpanam). The data were analyzed using simple percentage and frequency distribution method, averaging model and standard deviation, measure of central tendency/dispersion (Mean±SD), Pearson Product Moment Correlation Coefficient (PPMC) and analysis of variance (ANOVA). The results of the study revealed that the highest recorded gas emitted in the area include Volatile and Organic Compounds (VOCs) with 96.4%, Carbon monoxide (CO) was 0.8%, Hydrogen sulfide (*$H_2S$*) was 0.4% while Sulfur dioxide (*$SO_2$*) and Nitrogen oxide (*$NO_2$*) were 1.2% respectively.* $NO_2$ *exceeded the WHO and NAQS thresholds. The most prevalent air pollution related diseases reported were respiratory diseases which were above 50% of the yearly prevalence and Tuberculosis which was over 30% each year followed closely by Asthma and Pneumonia. The least diseases in terms of prevalence in the study area were Meningitis and Measles. Based on the findings, it was recommended that routine measurements should be made on a continuous basis to ascertain the volume of gaseous pollutants in the urban and rural environments of the study area.*

***Keywords***

*prevalence, pollutant gases, occurrence, associated Disdases, asaba metropolis*

## 1. Introduction

Air pollution can be defined as the introduction of harmful substances including particulates and biological molecules into earth atmosphere in such capacity and for such duration as they can produce undesirable effect, or tending to be injurious to human health or welfare or to other living organisms such as animal and plant life (Katulski, Namiessnik, Sadowski, Stefannski, & Wardencki, 2011). It can be categorized into natural and anthropogenic sources of air pollution. The natural air pollution includes forest fire, volcanic activity such as ash and gases, smoke, organic decay or soil dispersion by wind-blown dust while the anthropogenic sources of air pollution includes human activities as transportation, combustion of fossil fuel and burning of coal for energy demands (Akinsanmi, Olusegun, & Clement, 2018). The contamination of air arises from the natural and anthropogenic activities has been on increase due to urbanization and industrialization. These activities release some gaseous emissions ($SO_2$, $NO_2$, CO, $H_2S$ and VOCs) that contaminate air, and when in high concentrations could threaten the wellbeing of living organisms or interrupt the function of the atmosphere leading to injuries of human health in various ways (Rai, Rajput, & Agrawa, 2011; Abu-Allaban & Abu-Qudais, 2011; Hassan & Abdullahi, 2012; Mohammed & Caleb, 2014; Nitasha & Sanjiv, 2015).

According to World Health Organization (WHO, 2014), 10% of global mortality, amounting to 7 million people are estimated resulted from air pollution in 2014. **Meanwhile, i**n the 2016 annual report, 2.9 million annual deaths were reported, of which more than 85% occurred in the third world countries, Eddie, (2017). However, in 2017, it was revealed that air pollution constitutes the highest environmental risks among all in which 3 million deaths are associated annually with exposure of outdoor air pollution related, Olufemi, Mji, and Mukhola (2019). Approximately, 94% of air pollution-related deaths occurring in low and middle-income countries are as a result of non-communicable diseases, including Chronic Obstructive Pulmonary Disease (COPD), Cardiovascular Diseases (CVDs) as well as lung cancer (WHO, 2017).

The major sources of air pollutants in the environment include vehicular emission which constitute the main source of fine and ultrafine particles and have a serious impact on urban air quality and public health, combustion of fossil fuel, emission released from industrial processes which contributed significantly to high ground level concentration of air pollutants in the surrounding and distant residential areas, construction of road and building activities, as well as mining (Ogunyemi, Oguntoke, & Adeofun, 2019). Approximately 3 billion people worldwide cook with biomass in form of firewood, coal, and residues agricultural activities (Smith, Bruce, Balakrishnan, Adair-Rohani, Balmes, Chafe, Dherani, Hosgood, Mehta, Pope, & Rehfuess, 2014; Edwards, Princevac,Weltman, Ghasemian Arora, & Bond, 2017). Such biomass are often combusted in ineffective devices, carbonaceous emissions production. (Rooney, Zhao, Wang, Bates, Pillarisetti, Sharma, Kundu, Bond, Lam, Ozaltun, Xu, Goel, Fleming, Weltman, Meinardi, Blake, Nizkorodov, Edwards, Yadav, Arora, Smith, & Seinfeld, 2019). As a result of exposure to fine Particulate Matter (PM), 2.6 and 3.8 million premature deaths occur resulting from household air pollution (Osimobi, Yorkor, & Nwankwo, 2019). Household air pollution contributes to ambient air pollution and are often moreworse than outdoor pollution. Adaji, Ekezie, Clifford, and Phalkey (2019) ascertain that exposure to this indoor air pollution increases the risk of pneumonia in children, accounting for about a million deaths globally.

On the other hand, rapid growth in motor vehicular traffic and rapid industrialization constitute higher levels of urban air pollution. According to Roychowdhury, Nasim, and Chandola (2016), Nigerian cities are phenomenally motorized with over 6million registered vehicles and an average increase of 400,000 vehicles annually accounting for one third of Nigerians middle class with less than two cars of five years old. This situation is the major cause of air pollution in cities especially Lagos and Abuja due to incomplete combustions contributing high emissions of carbon compounds containing nitrogen e.g. per acetyl nitrides, carbon monoxide, 3:4 benzopyrene, NOx, SOx, chlorinated organic compounds, ozonides aldehydes, peroxides and ketones.

Among the major air pollutants of concern are carbon monoxide, carbon dioxide, oxides of nitrogen, oxides of sulfur and volatile organic compounds such as benzene, polycyclic hydrocarbons and formaldehyde, Loai and Nuha (2018). Each of these pollutants can have severe consequences in both the short- and long-term, resulting in acute and chronic toxicity effects. Exposure to these air pollutants has been associated with increased risk of upper respiratory tract diseases such as asthma, inflammation, fibrosis and chronic obstructive pulmonary disease, exacerbation of heart disease due to hypertension and deterioration of the cells which line blood vessels, irreparable damage to the central nervous system, as well as cancers (Akpan, Sogbanmu, & Otitoloju, 2012; Obanya, Amaeze, Togunde, & Otitoloju, 2018).

Assessment studies on air quality in the Niger Delta region of Nigeria have focused mainly on oil producing communities where majority of the oil exploration and exploitation as well as gas flaring takes place constituting major sources of air pollution (Atubi & Ogbija, 2015; Atubi, 2015a; Atubi, 2015b). There have been high rate of urbanisation in the Asaba and Okpanam region because of its status as the State capital. This rapid urbanisation has brought about more local industrials (manufacturing and craft and the increase on the number of vehicles and market centres in this area with the attendant low level and shortage of infrastructure or amenities. However, the emphasis on only oil producing communities restricted the purview of the study since air quality research in this area is scarcely available or very scanty.

## 2. Study Area

The study area is Asaba and environs. The study area covers some parts of two local government areas in Delta State: Oshimili North and Oshimili South. In Oshinili North LGA two communities were delineated which includes Ibusa and Okpanam while Asaba, Okwe and Anwai were delineated in

Oshimili South LGA respectively. The study area is located between latitude 6°17' and 6°2'N North of equator and longitudes 6°24' and 6°45'E east of the Greenwich Meridian with an aerial extent of 2 about 773km (Abebe, 2013) (See Figure 1).

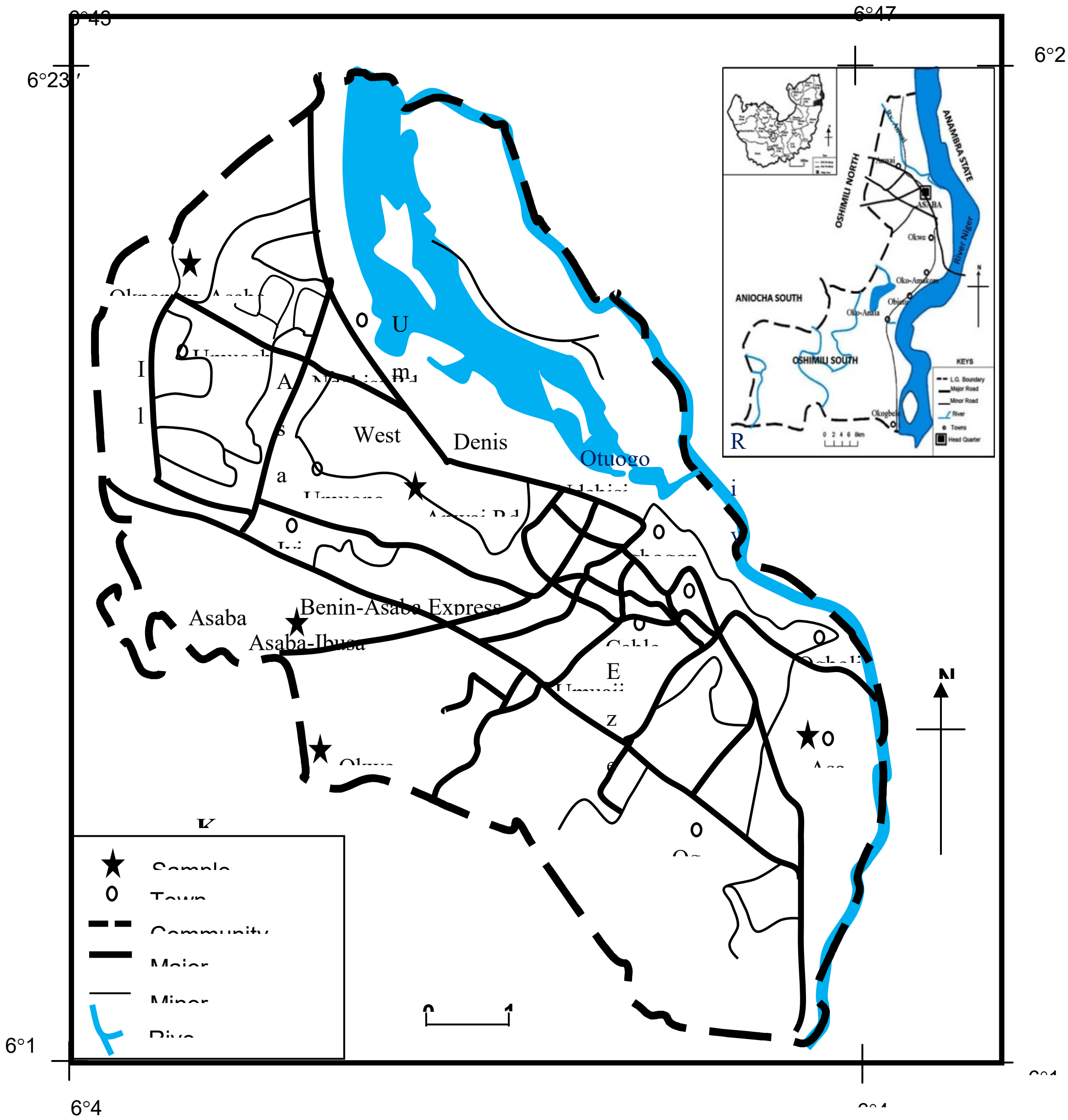


**Figure 1. Map of Asaba Showing Sampled Sites**

*Source*: Ministry of Lands, Survey and Urban Development, Asaba, 2006.

## 3. Research Methods

The study adopted a survey research design. The survey research design involved measurement of air pollutant to compare with the National Ambient Air Quality Standard (NAAQS) data and the Updated World Health Organization Air Quality Guideline (WHOAQG) in order to ascertain the level of air pollution. The data used for this research was based on primary data. The primary data was acquired from the field through measurement of pollutants. In order to collect the primary data, air pollution monitoring was made in the Months of October and November 2018 ($24^{th}$ October – November $21^{st}$ 2018). The pollutant data include Sulfur dioxide ($SO_2$), Nitrogen Dioxide ($NO_2$), Carbon Monoxide (CO), Hydrogen Sulphide ($H_2S$) and Volatile and organic compounds (VOC).

The study area was stratified into five locations (communities) based on residential, industrial and commercial areas. The five communities sampled are Asaba, Anwai and Okwe, Ibusa and Okpanam and the places sampled include the major road intersections for vehicular emissions, dumpsites for open burning emissions and industrial and residential areas.

Air quality was measured in the locations sampled reflecting the major and different land use types in the city using the portable digital hand held air monitors to measure the air pollutants such as Gasman monitors with model CE 89/336/EEC and LASCA USB-CO data logger equipment in each location while Garmin10E GPS Global Positioning System was used for field observations to indicate the latitude and longitude location of measurement site for ease of geo-referencing on the map. Field Sample collections were done 8 hourly at peak and off-peak periods (morning and evening) against WHO and NAQS standards in the Months of October and November 2018 ($24^{th}$ October-November $21^{st}$ 2018). Measurements were made during weekdays especially on Wednesdays being the middle of the week.

The types and trend of air pollutants/pollution as well as the ambient air quality from the respective sites in the study locations were analyzed descriptively (Mean±SD) and to determine the levels and spatial distribution of pollutant gases. The air quality data was generated from measurement of $NO_2$, $SO_2$, $H_2S$, CO and VOC in the five locations. The National Ambient Air Quality Standard (NAAQS) data and the summary of the Updated World Health Organization Air Quality Guideline (WHOAQG) data were also collected for the purpose of comparison as secondary data.

## 4. Discussion of Results/Findings

The study examined the levels and spatial distribution of key air quality parameters or quality indicators within Asaba and its environs. The assessed parameters ($NO_2$, $SO_2$, $H_2S$, CO and VOC) as compared to the World Health Organization (WHO) and the Nigerian National Air Quality Standard (NAQS) for Maximum Exposure are presented in Table 1 and figures 2 to 6.

**Table 1. Concentrations of Air pollutants in Asaba**

| **Pollutant (ppm)** | **Morning** | | | | | **Evening** | | | | | **WHO Standard (ppm)** | **NAQS (ppm)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Asaba | Okwe | Anwai | Okpanam | Ibusa | Asaba | Okwe | Anwai | Okpanam | Ibusa | | |
| $NO_2$ | 0.22 | 0.23 | 0.12 | 0.20 | 0.25 | 0.21 | 0.22 | 0.11 | 0.20 | 0.23 | 0.10 | 0.04-0.06 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $SO_2$ | 0.17 | 0.21 | 0.25 | 0.17 | 0.2 | 0.16 | 0.20 | 0.24 | 0.15 | 0.2 | 0.175 | 0.01-0.10 |
| $H_2S$ | 0.09 | 0.1 | 0.05 | 0.01 | 0.1 | 0.10 | 0.1 | 0.03 | 0.01 | 0.09 | 22.4 | Nil |
| CO | 0.08 | 0.17 | 0.04 | 0.2 | 0.15 | 0.2 | 0.15 | 0.05 | 0.08 | 0.14 | 26 | 10-20 |
| VOC | 20 | 15 | 14 | 16 | 16 | 20 | 14 | 13 | 15 | 15 | 30.3 | Nil |

*Source*: Field work, 2018.

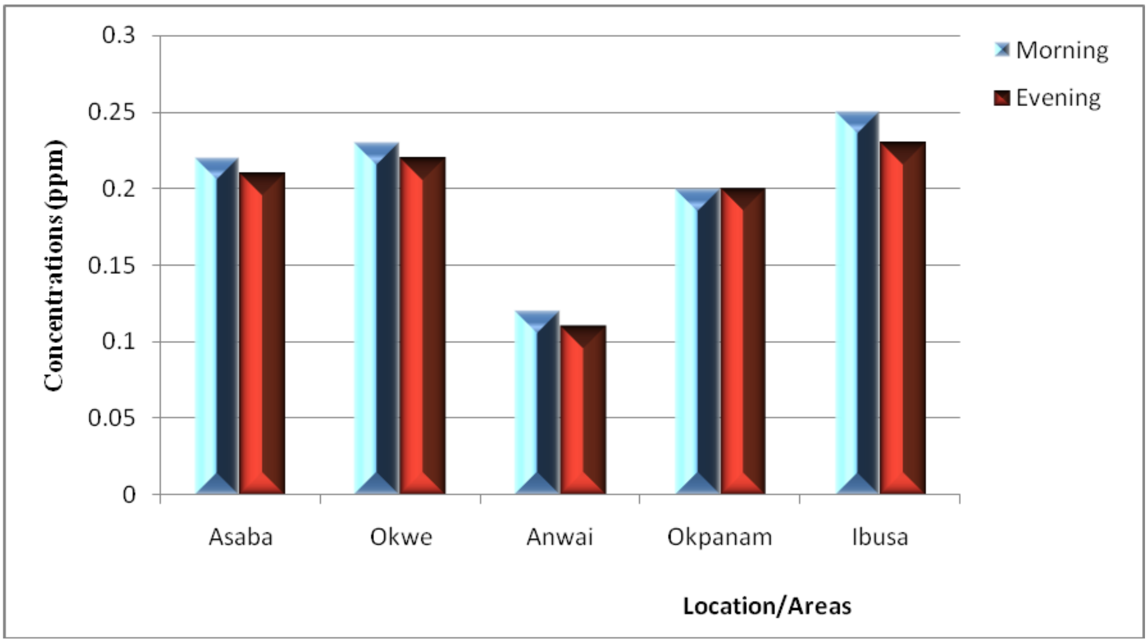


**Figure 2. Mean Variation of $NO_2$ Pollutant Across Periods at Sampling Points**

From Figure 2, the mean concentration of $NO_2$ pollution was high at all the cities with the highest at Ibusa sampling point with value ranging from 0.23 to 0.25 ppm. The oxide of nitrogen ($NO_2$) has concentrations ranging between 0.11-0.25 ppm and by implication is above the WHO and NAQ standards tolerance limit for quality air. It could be deduced from the Figure 2 that higher concentration of the oxide in Ibusa was recorded in the morning hour and least in the evening hour. However, Anwai had the least concentration of the oxide, closely followed by Okpanam, Asaba and then Okwe. The outcome of the finding showed that there is a high rate of fossil fuel combustion taking place in Ibusa than any other sampled areas. In accordance to the findings, biomass, coal smoke emissions and industrial sources have been reported to emit many health-damaging pollutants, including nitrogen oxides (Olajire, Azeez, & Oluyemi, 2011; Akpoghelie *et,* Irerhievwie, Agbaire, & Orisaremi, 2016). Studies have revealed that Nitrogen dioxide has the ability to irritate the lungs and lower resistance to respiratory diseases (Akpoghelie *et al*., 2016).

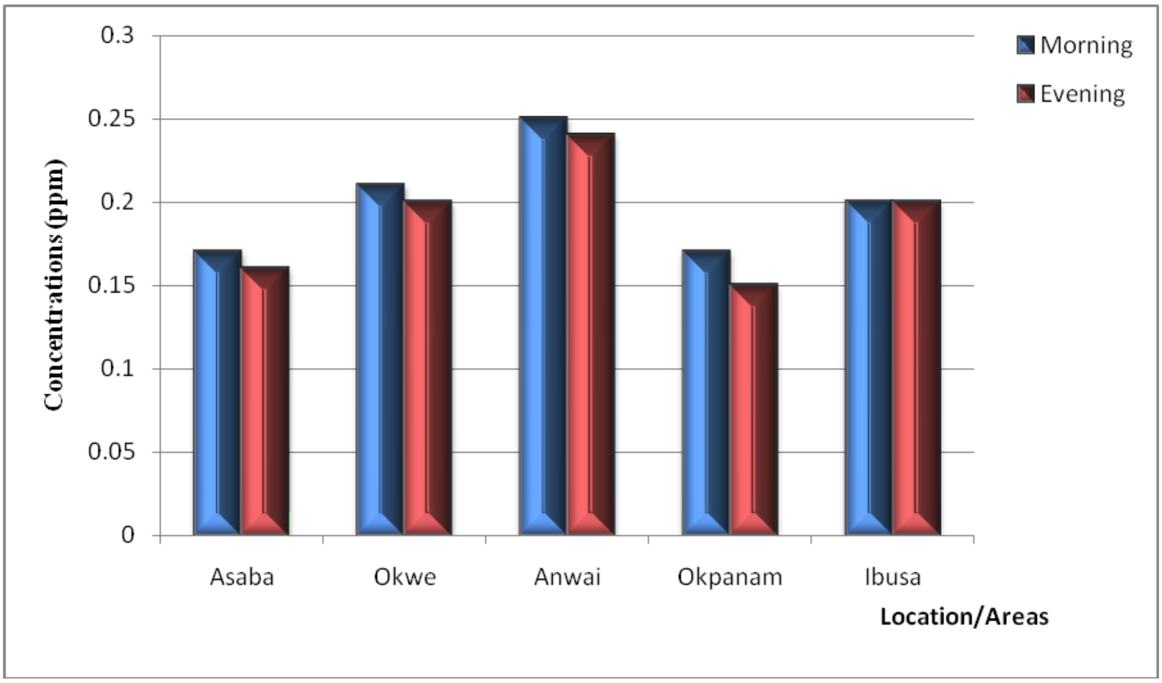


**Figure 3. Mean Variation of $SO_2$ Pollutant across Periods at Sampling Points**

The result obtained from $SO_2$ pollutant in figure 3 revealed that Anwai had the highest rate of $SO_2$ pollutant with value ranging from 0.24 to 0.25 ppm. Higher concentration of the oxide was recorded in the morning hour and least in the evening hour. Okwe had the least concentration of the oxide, closely followed by Ibusa, Asaba and then Okpanam. The outcome of the finding revealed that burning of fossil fuels such as coal, oil and natural gas were main source of sulphur dioxide emissions in the study areas. General survey also showed that the exposure to sulphur dioxide occurs primarily through direct breathing of contaminated air (Akpoghelie et al., 2016). The Agency for Toxic Substance and Disease Registry (2016) reported a long-term study surveying large numbers of children and the finding revealed possible associations between sulfur dioxide and symptoms of respiratory diseases. $SO_2$ pollution may result to corneal haze, breathing difficulty, airway inflammation, eye irritation, psychic alterations, pulmonary oedema, heart failure and circulatory collapse. Sulphur dioxide is also associated with asthma, chronic bronchitis, morbidity and mortality increase in old people and infants (Akuro, 2012).

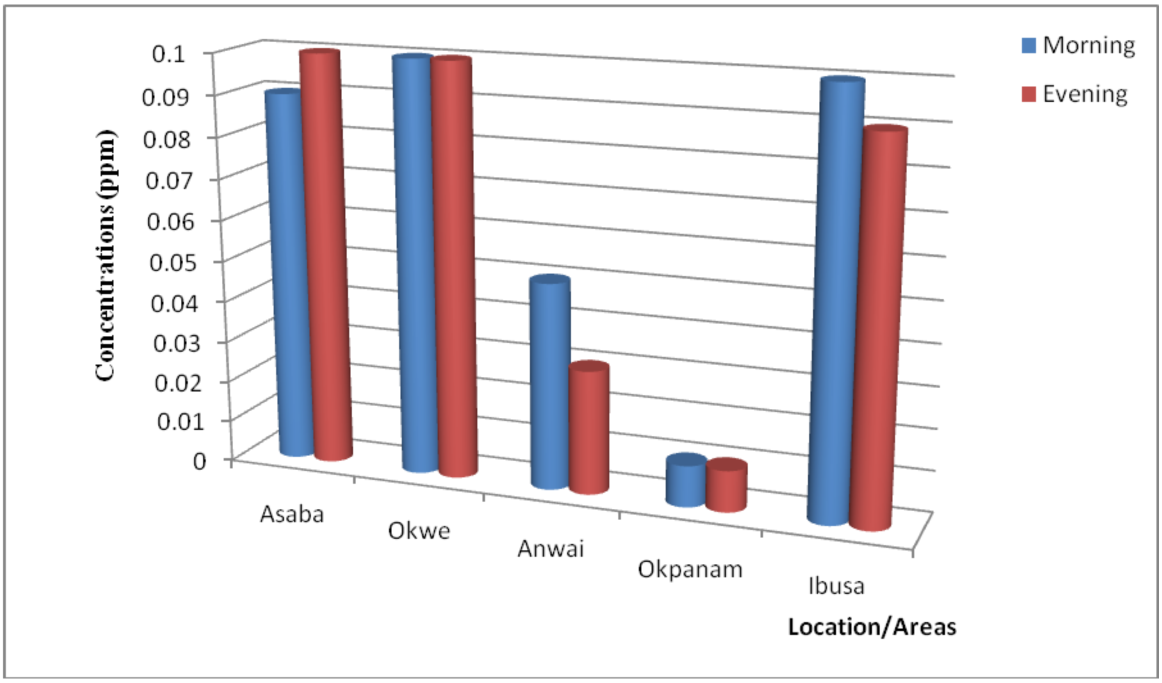


**Figure 4. Mean Variation of $H_2S$ Pollutant across Periods at Sampling Points**

From the result obtained for $H_2S$ in figure 4, it was observed that all the values at different sampling locations for sulphide ($H_2S$) were below the World Health Organization (WHO) Guidelines and Standards for Ambient Air Quality which stipulates a range of 22.4 ppm. This implies that there are low anthropogenic activities emitting $H_2S$ to the environment of Asaba, Delta State. Short-term exposure to $H_2S$ may cause irritation to the throat, nose, eyes, tiredness, headaches, and breathing difficulties in asthmatic patients while long-term exposure may affect the nervous system and respiratory tract (ATSDR, 2016).

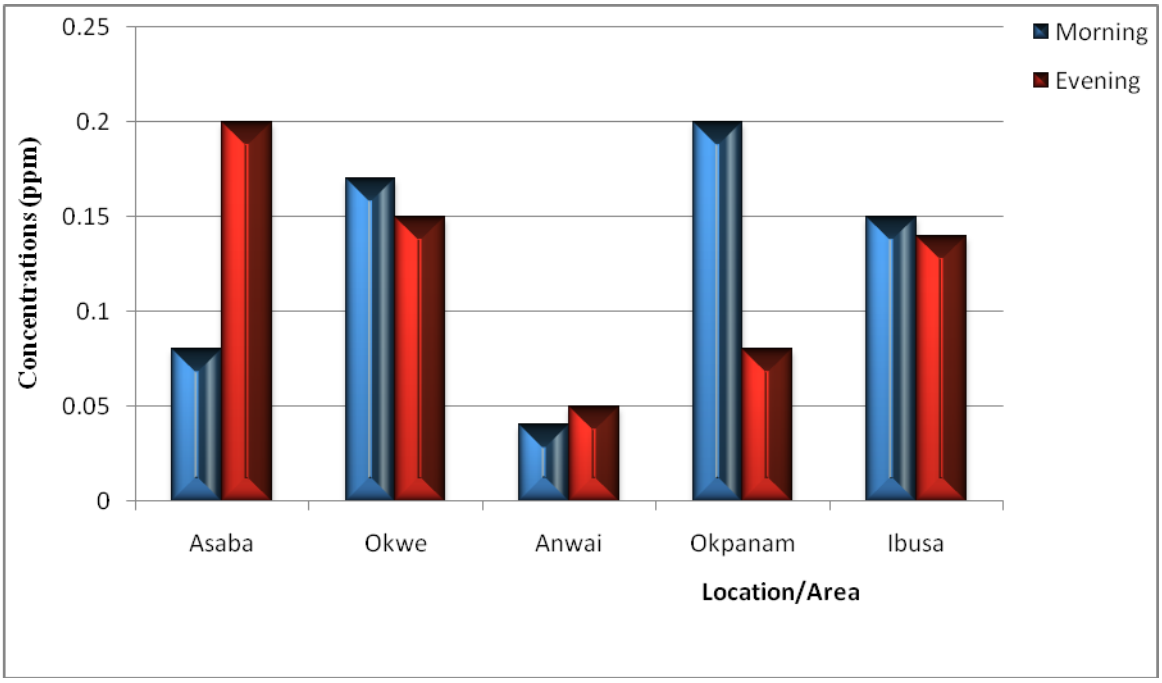


**Figure 5. Mean Variation of CO Pollutant across Periods at Sampling Points**

From Figure 5, it was observed that Carbon monoxide (CO) measured at all the sampling locations were between the ranges of 0.08 to 0.20 ppm. This implies that the concentration of CO measured in all the sampling stations were below the WHO and NAQ standards tolerance limit for air quality, which stipulates a range of 26 ppm and 10 to 20 ppm for an 8–hourly average time respectively and therefore may pose no immediate hazard to the exposed population. Anwai had the lowest concentration value ranging from 0.04 to 0.05 ppm. This low concentration of CO is due to the fact that CO is naturally oxidized by oxygen to carbon dioxide in the earth atmosphere. Carbon monoxide levels in urban and semi-urban areas closely reflect traffic density (in combination with weather conditions) and also open incineration of wastes (Njoku, Rumide, Akinola, Adesuyi, & Jolaoso, 2016). In this study the two highest CO concentrations were recorded at two major traffic intersections areas (Asaba and Okpanam), these may be due to the high presence of vehicular activities and road construction along Federal Medical Center during the sampling period. Health effects of CO pollution may include eye, nose and throat irritation, headaches, nausea lost, liver and kidney damage. Also, carbon monoxide binds to haemoglobin in red blood cells, reducing their ability to transport and release oxygen throughout the body. It contributes to the formation of $CO_2$ and ozone ($O_3$), greenhouse gases that warm the atmosphere (USEPA, 2007).

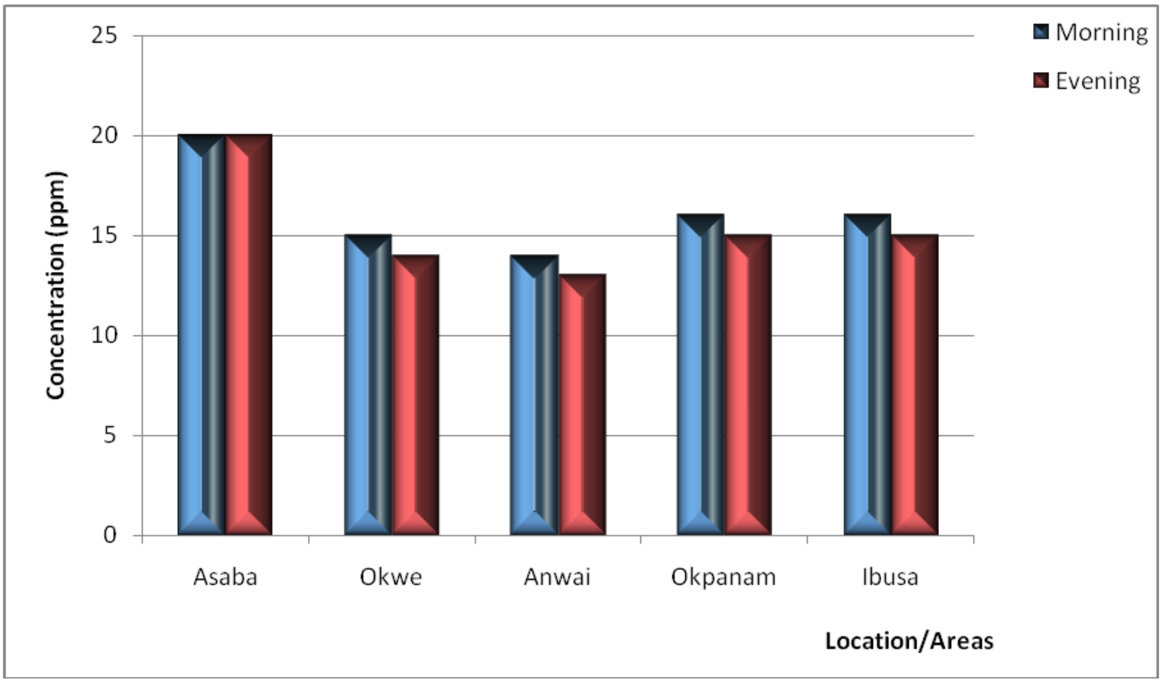


**Figure 6. Mean Variation of VOC Pollutant across Periods at Sampling Points**

The data in Figure 6 revealed that values for VOC concentrations ranges from 13.00 to 20.00 ppm which falls below the maximum WHO standard (30.3 ppm) in fresh air which is safe for healthy adults for an 8-hour work day (WHO, 2009). It was observed that Asaba had the highest concentration of VOC with value of 0.20 ppm. This showed that there is a high traffic density and other anthropogenic activities taking place in Asaba than any other study areas. Anwai had the least concentration of the VOC, closely followed by Ibusa and Okpanam which had similar concentrations for both sampling periods and then Okwe. The United States National Library of medicine (2015) reported that people are at highest risk of prolonged exposure to VOC from heavy motor vehicle traffic. The major symptoms associated to VOCs exposure include: irritation of the conjunctiva, discomfort of the nose and throat, headache, skin allergic reaction, dyspnea, serum cholinesterase levels declines fatigue and dizziness.

## 5. Policy Implications/Recommendations

There is a need for a government-led scientific enquiry to identify and analyse the sequential components of air pollution problems in Nigeria. This enquiry should include enforcement mechanisms, systematic collation, environmental education, public participation in environmental protection and the management of ambient air pollution and however, the deployment of air quality concentration and monitoring of stations across major cities is essential to identifying and analyzing the nature and the scale of the air pollution challenge, its sources and impacts.

A body analogous to the former UK Expert Panel on Air Quality Standards (EPAQS) should be established and facilitated by National Environmental Standards and Regulation Enforcement Agency

(NESREA) to ensure environmental awareness and compliance on the concentrations of air pollution at which little or no health effects are likely to occur in Nigeria.

The Federal Ministry of Environment, through its relevant agencies, should design or adopt policies to deal with large polluting sectors as well as the urban air pollution, taking into account health effects of exposures to air pollution, people that are most vulnerable within the population, outdoor environments and determinants

Government agencies such as the Niger Delta Development Commission (NDDC) in conjunction with other multinationals and stakeholders in air pollution management should set up a comprehensive Air Quality Management scheme, in particular regarding outdoor sources and individual level of activities in the region.

There should be reassessment and continuous evaluation of the existing air quality monitoring programmes and new programmes should be introduced to decide the most efficacious means of mainstreaming national programmes with regional projects to improve air quality

There should be an air quality assessment to construct an Air Quality Index (AQI). The AQI construct should indicates how moderately clean or polluted the ambient air is, and the accompanying possible health effects which might be of concern for sensitive receptors

## 6. Conclusion

The assessment of different air pollutants such as $NO_2$, $SO_2$, $H_2S$, CO and VOC was carried out in Asaba and its environs of Delta State using a multifunctional air detector. The result obtained from the study showed that the concentrations of CO, $H_2S$ and VOC for the five location sites within Asaba and its environs and the $SO_2$ concentrations in Ibusa and Okwe were within stipulated standards and therefore safe for human health. However, the residents of the study areas are exposed to varying concentrations of $NO_2$ that could exhibit human health challenges such irritate the lungs and lower resistance to respiratory infections. This is because the $NO_2$ concentrations for all locations were higher than the ambient air quality guidelines stipulated by WHO and NAQ. Similarly, the residents of Asaba, Anwai and Okpanam are exposed to varying concentrations of $SO_2$ that could exhibit serious human health challenges. Hence, constant monitoring of the locations assessed should be enforced to prevent the aforementioned human health challenges associated with $NO_2$ and $SO_2$.

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