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Comparative Analysis of Ambient Air Pollutants and Possible Health Risks of Atmospheric Air of Port Harcourt and Isiokpo, Rivers State, Nigeria

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ABSTRACT

The study utilizes various methods to comparatively evaluate the amount and possible health risk of ambient air pollutants in atmospheric air of Port Harcourt and Isiokpo areas in Rivers state. The pollutants checked were particulate matter, organic, and inorganic pollutants, while meteorological parameters were also assessed. The air pollutants were monitored using onsite portable aeroqual gas detector and particulate matter counter monitor. The air quality index (AQI) and possible health risk estimation for air pollutant was carried out using standard USEPA models. The mean results were as follow: PM2.5; Isiokpo (0.007±0.00 mg/m3), Port Harcourt (0.086±0.01 mg/m3); PM10; Isiokpo (0.013±0.01 mg/m3), Port Harcourt (0.318±0.02 mg/m3), CO; Isiokpo (0.006±0.00 mg/m3), Port Harcourt (0.003±0.010mg/m3) and VOC; Isiokpo (0.179±0.03 mg/m3), Port Harcourt (0.044±0.02 mg/m3). The air pollution levels of the two areas reveals more pollutants in Port Harcourt than it was at Isiokpo apart from VOC, and CO which had a slightly higher value. Air Quality Index (AQI) rating reveals that the air quality of Port Harcourt was more severe than Isiokpo. This investigative study has revealed that selected meteorological factors had minimal effect on the quality of the atmospheric air within the areas selected for this study. The non-carcinogenic risk factor indicated that air pollutants are of great risk for infants than adults for both areas of the study and that of Port Harcourt than Isiokpo. There should be provision of stringent laws and regulations to ensure that release of pollutants of harmful nature are prohibited and defaulters punished accordingly.

Keywords: Air Pollutants, Comparative analysis, Health risk, Port Harcourt and Isiokpo

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1.0 INTRODUCTION

The environmental stability and sustainability for betterment of man is reliant on many factors and of which the quality of the atmospheric air which is termed "ambient air" because of its pure or clean nature is one of such (WHO, 2016). There is need to always re-emphasize on the quality of the atmospheric air because the pole position it takes on our daily lives, as such all eyes are on its quality. Akinfolarin et al. (2017), identifies that air is an important component for human existence since we all live by breathing oxygen which is a major component of air. Although human actions have altered the very good quality of the air, we are supposed to breath with obnoxious substances such as particulate matter (PM), Sulphur oxides, Nitrogen oxides, Carbon (ii) oxide (CO), methane (CH_4), Hydrogen sulphide (H_2S) (Ibe et al., 2017). The state of the atmosphere been impaired by non-existing substances has become a global issue that need to be addressed by all. This is occasioned by industrialization and urbanization which has brought about higher concentrations of human population in cities with viable economic opportunities such as commercial cities (Eze et al., 2014).

Records have it that human activities in industrial and commercial cities; including those of small and medium scale industries such as paints, dyes, fertilizer, ceramics, glass and textile industries, to sales of electronics and household items, abattoir services, auto-repairs, hotel and restaurants, shopping malls and freelance street side trading have a considerable impact on the quality of the air (Eze et al., 2014). In the western part of Africa, industrial and commercial centres in cities like Lagos, Ouagadougou, Accra, Dakkar, Abidjan, Cotonou, Kano, Zaria, Aba and Port Harcourt are the support of national economic growth and development (Ana et al., 2009). In these cities and also in those within the Niger Delta region of Nigeria, rapid advancement in vehicular movement, roasting of animals with tyres and burning of large municipal waste produced in these areas has led to presence of particulate matter in ambient air (Njoku et al., 2016; Nwokocha et al., 2015). In the Nigeria, some of the cities confronted with these challenges of decreased air quality are Port Harcourt environs in Rivers State and Aba City in Abia State (Fagbeja et al., 2008).

Africa, for example showed that household $PM_{2.5}$ concentrations greatly decreased when households in Kikati areas switched from use of firewood to biogas for cooking. It has been suggested by another study that advanced stoves, which burn fuel more efficiently and reduce smoke emissions, could help to reduce indoor air pollution in poor, rural areas. The results from other studies also suggest that economic growth and rising incomes may matter in African countries in order to curb pollution, but more stringent policy measures, especially at the industrial level would be required to curb environmental degradation. Some Countries such as South Africa have already set up targets for mitigation strategies. It is estimated that these targeted potential mitigation strategies can avoid up to about 37% of the estimated annual premature deaths by 2030 with the largest opportunity being a reduction of 10,868 annual deaths from switching half of the energy generation in South Africa to renewable technologies. Exploring the effects of different types of $PM_{2.5}$ is necessary to reduce associated deaths, especially in developing African countries.

Studies conducted throughout Africa have shown that air pollution from all the sources adversely affects people's respiratory health. Despite this realization however, little attention has been paid to the issue and in so doing, the control of this man-made hazard very difficult (Ana et al., 2009). In order to woe foreign investments into their mining sectors, many countries in Africa have been and are willing to overlook instances of mining company non-compliance with environmental standards and regulations. Such acts have led to high levels of pollution in many mining areas (Ibe et al., 2017). This however is causing big problems on both the African people's health and the continent's economy. Economically, it was estimated that as at 2013, the African continent incurred costs up to USD 215 billion as a result of outdoor air pollution related premature deaths. While USD 232 billion was the estimated cost of premature deaths from household air pollution.

This present study emphasis is on the determination and comparative analysis of ambient air pollutants and health risks of atmospheric air of Port Harcourt and Isiokpo areas of Rivers State. This was achieved through: the determination of the concentrations of quality of air of Port Harcourt and Isiokpo, comparing the levels of air pollutants in Port Harcourt and Isiokpo, and selectively evaluates the health risks of ambient pollutants in the study areas.

2.0: Materials and Methods

2.1: The study Area

Port Harcourt and Isiokpo are part of Rivers State one of the states that makes up the south-south region of Nigeria and it is also part of the oil rich Niger Delta region of Nigeria. The total land area of the state is about 11,077 km^2 (4,277 square miles) and the total population is 5,198,716 million people according to the 2006 census figures. The Rivers state economy is dominated by the booming crude oil and gas (petroleum) industry of the world. The state is primarily low-lying pluvial state in the south southerly part of Nigeria, located in the eastern part of the Niger delta on the ocean-ward extension of the Benue trough. The inside or mainland consist of tropical rainforest, and towards the coast the typical mangrove swamps. The state is surrounded by many other states like Abia, Imo and Anambra on the north, Akwa Ibom to the east, and Bayelsa, Delta to the west, and Atlantic Oceans on the south. Its topography ranges from flat plains with networks rivers to tributaries. The rainfall within the state is always seasonal, varies, heavier than many parts of Nigeria, and it's always between March through October to

November. The peak of rainy season is always June and July, lasting for more than 290 days. January and February are the months with no rainfall and driest. The total annual rainfall decreases from about 4,700 mm (185 in) on the coast, to about 1,700 mm (67 in) in the extreme north. The temperature within the state especially Isiokpo and Port Harcourt city is fairly constant with slight variations in some parts of the year. The average temperature is between 25 to 28^oC (77 and 82^oF). The dry season is not entirely dry as some part of the state receive around 150 mm(6 in) of rainfall. The relative humidity falls below 60% but varies between 90% to 100% for major part of the year. The terrain of Rivers state is divided into three zones: freshwater swamps, mangrove swamps and coastal sand ridges.

One of the study areas, Port Harcourt, is a cosmopolitan city with different people and various anthropogenic activities which had significant effect. It is the capital city of Rivers State and also the largest city in the Niger Delta area of Nigeria with lots of industries. The Port Harcourt industrial areas that were studied here includes; Trans Amadi, Industry Road, Rumuokoro, Mile III, Old GRA, and Old township. The second area which is Osiokpo, is the local government headquarters of Ikwerre Local Government Area, the area is a centre for commercial, light industrial activities and residential zone for indigenes/locals of the said local government area. The commercial sites studied include the Isiokpo main market, and Isiokpo Motor Park which also have moderate traffics while light industrial and residential areas were also investigated.

2.2 Measurement of Air Quality Parameters

The following materials were used for the studies

2.2.1 EXTECH Anemometer

A multi-parameter digital anemometer Model No. 45170 was employed to monitor the wind speed, and direction in m/s, pressure, temperature, relative humidity and other meteorological parameters. It was held up in an open space with a consideration of a distance as indicated above from source. This was to avoid unnecessary interference from shades. Measurement was taken on an hourly basis.

2.2.2 Gas Analyser

TESTO 350-XL, from Testo Inc. (Testo, 2009), was used to analysed the following contaminants; O_2, CO, NOx, NO, NO_2, SO_2, CH_4, and H_2S. Features include a menu driven user interface and LCD display. Auto calibration and probe blow back was offered. Flow rate and sensor temperature monitoring for US EPA CTM-030, -034 and ASTM D6522 requirements. For Simple onsite sensor, calibration capability including diagnostics and sensor output is from about (0– 100%).

A Mini Volume instrument, Aerosol gas monitor was used to measure Particulate Matters. Mini-Volume Portable Air Sampler manufactured by Air metrics is a portable ambient air sampler for particulate

(PM_{10} and $PM_{2.5}$) and/or nonreactive gas CO. The sampler consists of a vacuum system and filter housed in a shelter and operates on the same principle as a vacuum cleaner. A known volume of air was drawn through a pre-weighed filter for an 8-hour period. The filter was then re-weighed to determine the mass of the particles collected.

2.2.3 Air Quality index due to particulate matter

In this study, air quality index developed by US Oak Ridge National Laboratory previously described by Tiwari (2015) applied by Edokpa and Ede (2019) and Kanee et al. (2020) was applied. Edokpa and Ede (2019) and Kanee et al. (2020) stated that the advantage of this index is the ability to rank overall air quality of different locations with different pollutant parameters. This is a non-linear index with exponential function and a coefficient (which may be a constant or may vary) with other non-linear relationship (Edokpa & Ede, 2019). The authors further reported that the relationship contain one or more variable with exponential function.

$$\text{Air Quality analysis} = [5.7\Sigma I]^{1.37} \quad (1)$$

Where I is the ratio of the observed concentration of the pollutant to the pollutant standard at National hourly value of 70µg/m^3 and 30 µg/m^3 for PM_{10} and $PM_{2.5}$, respectively (Edokpa & Ede, 2019; Kanee et al. 2020). 5.7 and 1.37 are constant, the resultant values were categorized as: 00 $<$AQI$\leq$25 (Clean air), 25 $<$AQI$\leq$50 (slight contamination), 50 $<$AQI$\leq$75 (moderate contamination), 75 $<$AQI$\leq$100 (heavy contamination), and AQI$>$100 (severe contamination) (Edokpa & Ede, 2019).

2.3 Health Risk Assessment

2.3.1 Non-carcinogenic Risk Calculation 1

The hazard quotient (non-carcinogenic risks) due to the inhalation of H_2S, and SO_2 was evaluated using equation (3.2) (EPA, 2009):

$$\text{Non-carcinogenic risk (HQ)} = EC/MR \quad (2)$$

where EC = exposure concentration (μg/m^3) and MRL= minimal risk level (μg/m^3).

For acute exposures (exposure lasting 24 hours or less),

EC = CA (EPA, 2009), where CA = contaminant concentration in air (μg/m^3). Hence, equations (1) become

$$HQ = CA/MRL \quad (3)$$

MRLs of H_2S, and SO_2 are 0.07 ppm (98 $\mu g/m^3$) (ATSDR, 2014), and 0.01 ppm(26.2 $\mu g/m^3$) (ATSDR, 1998), respectively.

2.3.2 Non-carcinogenic Health Risk Assessment II

Thus, the preliminary health risk assessment analysis, which had to answer the general question of whether the health risk existed in the investigated tourist areas, was performed. For that reason, our risk assessment was based on mean values of the contaminant contents determined during the measuring period in the dry and wet season of 2022, respecting the conservative risk assessment principle that recommends to obtain the risk values which describe a worst-case scenario in the case of uncertain input data for calculation process. Based on the results of our measurements, human health risk (HHRA) was assessed in the inhalation exposure route. The United States Environmental Protection Agency (USEPA) methodology (USEPA, 1989), specifies the following three exposure routes in the risk assessment analysis: inhalation, ingestion, and dermal contact. As inhalation is the most rapid exposure pathway (WHO, 2016; POEU, 2020; USEPA,1989), it was investigated in our research. The US EPA risk assessment methodology was applied in our calculations, as described below. Non-carcinogenic risk was defined with the use of the hazard quotient (HQ). The target non-carcinogenic risk value was set at 1 (USEPA, 1989), indicating lack of negative health effect on humans when risk values were <1. Non-carcinogenic risk was calculated for NO_2, PM_{10}, and $PM_{2.5}$ because the reference values of those contaminants, i.e., the reference dose (RfD) for NO_2 and PM_{10} and the reference concentration (RfC) for $PM_{2.5}$, were available in the toxicological databases (Garbero et al. 2012; De oliveira et al. 2012; USEPA, 2020). However, for all the measured contaminants, the mean daily values of intake through the inhalation exposure pathway were estimated. In our investigations, resident exposure scenarios were analysed. The following subpopulations were considered: adults (>7 years), and children (1–7 years). To obtain the daily intake of pollutants through the inhalation exposure pathway, either exposure concentration (EC) or mean daily dose (MDD) values were calculated according to Equations (4) (OERR, 2009) and (5) (WHO, 2016), respectively, depending on the available reference values:

$$EC = (C \times ET \times EF \times ED)/AT \quad (4)$$

$$MDD = (C \times IR \times ET \times EF \times ED)/(BW \times AT) \quad (5)$$

where EC, exposure concentration (mg/m^3); MDD, mean daily dose (mg/kg-day); C, contaminant concentration in air (the measured values were converted to mg/m^3); IR, inhalation rate (m^3/h); ET, exposure time (h/day); EF, exposure frequency (days/year); ED, exposure duration (years); BW, body weight (kg); AT, averaging time: ED, in years x 365 days/year x 24 h/day, in hours. The exposure parameters used in the analysed scenarios are given in Table 1.

Table 1. Exposure parameters used for the risk estimation in this study

Parameters	Adult	Child	Reference
IR Inhalation rate per person (m^3/h)	0.83	0.31	
ET Exposure time per person (h/day)	24	24	
ED Exposure duration (year)	24	6	
EF Exposure frequency (days/year)	365	365	
BW Body weight (Kg)	70	16	
AT Averaging time (hours)	210,240	52560	

(OERR, 2002; USEPA, 2008;)

Although all the analysed pollutants were considered to be toxic, only non-carcinogenic risk was calculated, using the hazard quotient (HQ) values, according to Equations (6) and (7), with respect to the available toxicological data:

$$HQ = EC/RFC. \quad (6)$$

$$HQ = MDD/RFD \quad (7)$$

Where HQ, hazard quotient (unitless); EC, exposure concentration (mg/m^3); MDD, mean daily dose (mg/kg-day); RfC, reference concentration (mg/m^3); RfD, reference dose (mg/kg-day). The following RfD values were used for calculations: NO_2: 1.1 x 10^{-2} (mg/kg-day) (Garbero et al. 2012), PM_{10}: 1.1 x 10^{-2} (mg/kg-day) (Garbero et al. 2012). The following RfC value was used for calculations: $PM_{2.5}$: 5.00 x 10^{-3} (mg/m^3) (De Oliveira et al. 2012).

3.0 RESULTS AND DISCUSSIONS

3.1 Comparative and correlational analysis of the air pollutant levels

The variation, and comparative study of the air pollutants in samples from Isiokpo and Port Harcourt metropolis are analysed and discussed below.

Table 2: Air pollutant levels in air samples of Isiokpo vs Port Harcourt

S/No	Parameters	Isiokpo	Port Harcourt

1	PM2.5 (mg/m^3)	0.007±0.00	0.086±0.01
2	PM_{10}(mg/m^3)	0.013±0.01	0.318±0.02
3	CO_2 (ppm)	394.5±5.09	601.4±10.9
4	CO (ppm)	0.006±0.00	0.003±0.00
5	NO_2 (ppm)	ND	ND
6	VOC (ppm)	0.179±0.03	0.044±0.03
7	H_2S (ppm)	ND	0.525±0.05
8	NH_3 (ppm)	ND	ND
9	CH_4 (ppm)	0.062±0.01	0.202±0.02
10	SO_2 (ppm)	ND	ND
11	O_3 (ppm)	ND	ND

Table 2 present the comparative analysis of pollutant levels in air samples of Isiokpo study locations and Port Harcourt locations. The results varied considerably though tilting towards Port Harcourt in terms of highest concentrations.

$PM_{2.5}$ had higher value in samples across Port Harcourt (0.086 mg/m^3) as against the lower value for Isiokpo (0.007 mg/m^3). This higher value in Port Harcourt could be due to so many factors, which seasonal variations of atmospheric parameter cannot exclude. The presence of $PM_{2.5}$ indicates the level of traffic and human activities within the Port Harcourt metropolis of the study.

The value of PM_{10} was more in Port Harcourt location (0.318 mg/m^3) than the Isiokpo area (0.013 mg/m^3). The Pollution level of Port Harcourt due to PM_{10} is 24.5 times more that for Isiokpo area, meaning the activities within Port Harcourt that releases PM_{10} was higher. Urban development could be a major factor as this has resulted in poor housing, inadequate waste disposal system, flooding which is cause by poor drainage system, and others.

The closeness of the Port Harcourt to the ocean influenced its relative density as compared to that of Isiokpo. The CO_2 content was higher in Port Harcourt than Isiokpo, which could be due to the proximity of the former to the sea. The level of CO was higher at Isiokpo than Port Harcourt. The figure stood at 0.006 ppm for Isiokpo and 0.003 ppm for Port Harcourt. The volatile organic compounds (VOC) were also higher in Isiokpo (0.179 ppm) to that of Port Harcourt (0.044 ppm).

The level of H_2S was higher in Port Harcourt (0.525 ppm), as compared to zero in Isiokpo area. The Methane level was also higher in Port Harcourt (0.202 ppm) to that of Isiokpo (0.062 ppm).

The major reasons for the high air pollution levels in Port Harcourt as compared to Isiokpo includes illicit oil bunkers activities which has led to the destruction and confiscation of their locally manufactured steel fractionating drums, burning of the crude as to wasting it. Secondly, Port Harcourt has more industries such as foundries, chemical and solvents, automobile, construction, and agriculture which contribute more to poor air quality as compared to what is obtainable at Isiokpo area. The other issues are also due to burning of petroleum products and tyres, asphalt production and burning of open dump waste.

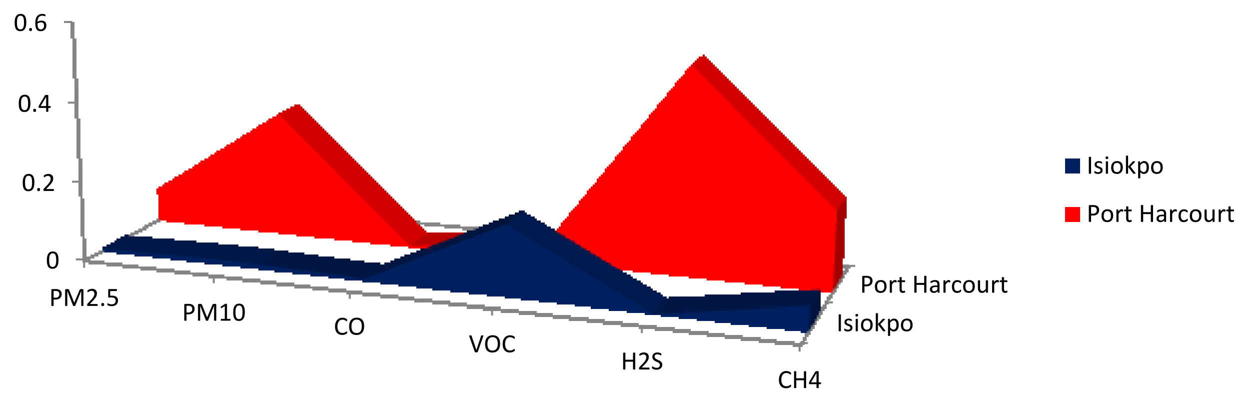

Figure 1: Variations of the pollutant levels in samples of the two study areas

Figure 1 clearly shows that the air pollution levels of the two locations was more in Port Harcourt than it was at Isiokpo metropolis apart from CO which had a slightly higher value. The value of CO might be attributed to the pollutants emanating from the construction site of Wigwe University at Isiokpo which has attracted huge traffic to the area and therefore the increment in pollutant levels.

It is expected that Port Harcourt should be more polluted than Isiokpo metropolis owing to lots of factors like Size of the city, pollution, volume of traffic within the area, industries and commercial centres etc.

Table 3: Estimated meteorological parameters of Old Township, Port Harcourt

Parameter	Port Harcourt	Isiokpo
RH (%)	78.98	76.00
WS (m/s)	3.20	2.00
WD(^{o})	nil	Nil
Temp. (^{o}C)	38.00	34.10
Pressure (Pa)	1005	1012
Altitude	11.00	28.00

Noise (decibel)	82.00	75.00

RH = Relative humidity, WS = Wind speed, Temp. = Temperature.

Table 3 present the meteorological parameters which varied across the two areas, with Port Harcourt study location having more values for the parameters than Isiokpo which could be connected to the levels of human activities that have had effect on weather conditions and also the topography of the two areas.

3.2 Air quality index measurement of pollutants in samples of Isiokpo and Port Harcourt

The estimated air quality of the sample locations are displayed in tables 3 and 4 below.

Table 4: Air quality index of selected pollutants in ambient air of Isiokpo study locations

Parameters	February	March	April	May	June	July
$PM_{2.5}$	Clean air	Clean air	Clean air	Clean air	Clean air	Clean air
PM_{10}	Clean air	Clean air	Clean air	Clean air	Clean air	Clean air
CO	-	Clean air	Clean air	Clean air	Clean air	Clean air

Cont. = Contamination

Table 4 shows the results of air quality index II for air pollutant levels in samples of Isiokpo metropolis. The result shows clean air due to $PM_{2.5}$, PM_{10} and CO respectively.

Table 5: Air quality index of selected pollutants in ambient air of Port Harcourt study locations

Parameters	February	March	April	May	June	July
$PM_{2.5}$	Slight cont.	Clean air	Slight cont.	Severe Cont.	Heavy cont.	Heavy cont.
PM_{10}	Slight cont.	Clean air	Clean air	Severe cont.	Severe cont.	Severe cont.
CO	-	-	-	Clean air	Clean air	Clean air
H_2S	Slight cont.	-	Clean air	-	Severe cont.	Severe cont.

Cont. = Contamination

Table 5 reveals the air quality index estimation for Port Harcourt study locations which shows a varied result. The air quality due to the presence of $PM_{2.5}$ was thus: February; clean air, March and April; slight contamination, June and July; heavy contamination, and May; severe contamination. PM_{10} inferred the following quality on the air: slight contamination, clean air, and severe contamination. CO showed clean air for all the locations as its presence was relatively lower than the other contaminants detected. H_2S also reveals that the air was as follows: slight contamination, and severe contamination.

3.3 Health risk assessment (HRA) of the air pollutants from the study area

The health risk assessment (HRA) of the examined population probable to air pollutants daily inhalation was calculated and the result is displayed.

Table 6: Health risk estimation of non-carcinogens from the study

Parameters Isiokpo	February	March	April	May	June	July
H_2S	-	-	-	-	-	-
SO_2	-	-	-	-	-	-
Port Harcourt	February	March	April	May	June	July
H_2S	1.545	-	1.286	-	23	19.16
SO_2	-	-	-	-	-	-

The health risk assessment depicted (HRA) in table 6 represent the hazard quotient based on H_2S and SO_2. The two gaseous pollutants were not detected via the monitor in the Isiokpo study area as such, the result assessment based on both pollutants reveals no possible risk, though presence of other pollutants might still be of risk.

Table 6 also displays the estimation of the non-carcinogenic risks linked with the inhalation of H_2S, and SO_2 for Port Harcourt study area which were estimated by calculating the hazard quotient (HQ). Matooane and Diab, (2003); Kitwattanavong et al. (2013) stated that HQ values below 1.0 indicate that the pollutant under investigation is not likely to cause health impairment, whereas HQ values above 1.0 indicate risk levels that are likely to damage health. The hazard quotient (non-carcinogenic risk) values for H_2S were 1.545, 1.286, 23.00, and 19.16 from February to July respectively. These values are higher than the threshold value of 1, which is an indication of possible severe health issue if the inhabitants inhaled such air at regular interval. It is also necessary to state that the time spent on these areas will also affect the amount of the pollutants inhaled and the possible risk such individual may face. Though the risk value may be above threshold but the probability may not be as high as most possible do not spent much time at such heavy traffic junctions. The most vulnerable are motorists, vendors and street sellers.

Table 7: Exposure concentration of $PM_{2.5}$ pollutants of the study

		Isiokpo			
February	March	April	May	June	July

0.007	0.005	0.010	0.004	0.008	0.008
		Port Hacourt			
February	March	April	May	June	July
0.072	0.021	0.060	0.138	0.118	0.107

The exposure concentration (EC) calculation methodology, applied to $PM_{2.5}$ to describe the estimated daily intake, indicated that the risk values did not depend on the body weight factor. Table 7 present the EC value for Isiokpo as follows: 0.007, 0.005, 0.010, 0.040, 0.008, and 0.008 for February to July. The EC value for Port Harcourt sites are thus: 0.072, 0.021, 0.060, 0.138, 0.118, and 0.107 from February to July.

Table 8: Hazard quotient (health risk analysis) due to exposure concentration of $PM_{2.5}$

		Isiokpo			
February	March	April	May	June	July
1.400	1.000	2.000	0.800	1.600	1.600
		Port Hacourt			
February	March	April	May	June	July
14.40	4.200	12.00	27.60	23.60	21.80

The matter of persistent air pollution and its related impact on health has been discussed for a number of years not only by health and environmental activists. Table 8 represent the hazard quotient (non-carcinogenic risk) due to exposure to $PM_{2.5}$ pollutants. The results for Isiokpo were 1.400, 1.000, 2.000, 0.800, 1.600, 1.600 for the various months sampled. This result shows that all the locations had values greater than 1.00 apart from some few months. The most risks were June and July. The HQ for Port Harcourt sites were 14.40, 4.200, 12.00, 27.60, 23.60, and 21.80 for different months. The result shows that the HQ was higher for Port Harcourt than Isiokpo areas. HQ values below 1.0 indicate that the pollutants under investigation are not likely to cause health impairment, whereas HQ values above 1.0 indicate risk levels that are likely to damage health (Kitwattanavong, 2013). The risk levels in this study especially in Port Harcourt is high and even higher than the threshold but might have been overestimated as the chemical concentrations were measured hourly instead of one year. Contrastingly, risks might have been underestimated because only the concentrations of PM_{10} among a multitude of volatile toxic compounds that might be present were considered for the assessment of health risk. Furthermore, only exposure via inhalation was considered although exposure via ingestion and inhalation is also possible.

4.0 CONCLUSION

The findings from the comparative assessment of ambient air quality monitoring of air pollutants of Isiokpo and Port Harcourt revealed that all the air pollutants did not exceed the stipulated permissible limit except for H_2S which could be due to heavy traffic, seasonal and climatic variations, within the zones of this recent study. The pollutant levels observed in this present research work is seen to be moderate to severe in concentration as the values were below the hourly air quality monitoring standard of the World Health organisation (WHO) and United State Environmental Protection Agency (USEPA). The findings from this research work makes it necessary to recommend that there should be provision of stringent laws and regulations to ensure that the release of pollutants of harmful nature are prohibited and defaulters punished accordingly.

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