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## ENVIRONMENTAL HEALTH | RESEARCH ARTICLE

# Investigation on the ambient air quality in a hospital environment

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**Abstract:** This study examined the ambient levels of criteria air pollutants in the indoor and outdoor environment of a typical hospital facility. Ambient concentration of the criteria pollutants was monitored at nine sampling locations using the ToxiRAE gas monitors both in the rainy and dry seasons. The results showed that the overall 24-h concentrations for CO and NH<sub>3</sub> were  $0.18 \pm 0.19$  and  $0.11 \pm 0.13$  ppm, respectively, for dry season. During the wet season, the extrapolated 24-h concentrations ranged 0.09–1.09 ppm for CO,  $0.04 \pm 0.08$  ppm for NH<sub>3</sub> while NO and NO<sub>2</sub> had 0.03–0.21 ppm and 0–0.06 ppm, respectively. The result of the study shows that the 24-h NH<sub>3</sub> concentration of 0.44 ppm recorded at S5 during dry season breached the National Air Quality Standards of the Federal Ministry of Environment Standard, Nigeria. Similarly, NO and NO<sub>2</sub> levels were higher than other gaseous parameters measured in all the sampling locations during the wet season. This study establishes that human activities may have deleterious effect on air quality in the hospital airshed.

**Subjects:** Ecology - Environment Studies; Environmental Change & Pollution; Environmental Issues; Environmental Law - Environment Studies

**Keywords:** criteria air pollutants; air quality; indoor and outdoor environment; hospital facility; toxicity potential; air quality standards

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## PUBLIC INTEREST STATEMENT

Air pollution is the emission of hazardous substance into the ambient environment in such a concentration that is harmful to humans and animals. The airborne pollutants degrade the air quality and continued exposure to the polluted air may lead to several health challenges such as chronic obstructive pulmonary diseases, bronchitis, asthma, sneezing, and coughing among others. In a hospital environment, exposure of both patients and staff to pollutants should be well avoided and monitored in order not to complicate the condition of patients with certain cardiopulmonary diseases. Hence, all activities within the hospital environment (both indoor and outdoor) should be well controlled to minimize the exposure of patients and staff at the hospital to air pollutants with respect to short-term exposure limit. This paper gives an insight to the impact of various indoor and outdoor activities on the ambient air quality of a hospital environment.



C.O. Ayodele

## 1. Introduction

In recent years, a number of studies have established the link between different anthropogenic activities in our environment and its impact on ambient air quality. In particular, burning of fossil fuel for energy generation, waste management, and other building comfort requirements like heating, ventilation, and air condition (HVAC) systems contribute to degrading indoor air quality (IAQ) (Omer, 2010; Ross, 2007).

In a hospital environment, IAQ is a significant issue needed to be considered with great caution. Air pollution, both indoor and outdoor, is often considered the major cause of environmental health problems (Yousef, Elshareef, Ibraheem, & Alsayed, 2013). Air pollution and its public health impacts are drawing increasing concern from the environmental health research community, environmental regulatory agencies, industries as well as the public (Jank, Soon, & Hwan, 2015; Zahra, 2015).

Epidemiological and experimental evidences have associated exposure to air pollutants with increase in daily mortality and morbidity (Katsouyanni et al., 2001; Pope & Dockery, 2006). Lately, special attention has been given to IAQ since in big urban centers, people spend more than 85% of their time in indoor environments (Klepeis, Tsang, & Bejar, 1996). According to relevant studies, 62–87% of the day is spent in the residential environment, which may be therefore critical for the daily total personal exposure of the population (Adgate, Ramachandran, Pratt, Waller, & Sexton, 2002).

Indoor concentration levels may be attributed to indoor and outdoor sources. Indoor sources include activities related to combustion processes, office equipment (such as fax machine, photocopying machine, and printers), use of spray products, cleaning agents, and re-suspension during intense movement and activity (Nazaroff, 2004; Wallace, 1996). Nevertheless, except for different indoor sources, air pollution from outdoor origin which includes industrial activities, vehicular movement, and construction activities also contributes significantly to the indoor concentration levels of pollutants (Ozkaynak et al., 1996; Riley, McKone, Lai, & Nazaroff, 2002).

It is clear that long-term exposure to poor IAQ could impair and worsen diseases like lung-related disease and blood-related health problems among patients and hospital staff (Brauer et al., 2012; Zhang et al., 2014). The American Thoracic Society (ATS) in its list of adverse health effects of air pollution includes not only clinical outcomes (such as hospital admissions, loss of lung function, and mortality) but also diminished quality of life and subclinical symptoms that may interfere with daily activities (American Thoracic Society, 2000). The aim of the present work was to determine ambient levels of criteria air pollutants in the indoor and outdoor environment of a typical hospital facility based on different activities within the airshed.

In this study, the Federal Ministry of Environment (FMEEnv) Standard for Nigeria and the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Standard (Table 1) were used for comparison.

**Table 1. Standards of ambient air quality**

Air pollutants	Concentrations	
	FMEEnv (FEPA, 1991)	ASHRAE (2007)
CO	10 ppm	100 mg/m <sup>3</sup> (87.32 ppm) (15 min)
		10 mg/m <sup>3</sup> (8 h)
		7 mg/m <sup>3</sup> (6.11 ppm) (24 h)
NO <sub>x</sub>	0.04–0.06 ppm	200 µg/m <sup>3</sup> (0.106 ppm) (1 h)
NH <sub>3</sub>	0.28 ppm	–

## 2. Methodology

### 2.1. Study area

The study area was a Federal Medical Centre Ido, located in Ekiti State, southwestern part of Nigeria. Its geographical coordinates are located at 7°50'18.37–7°50'39.53N and 5°11'06.63–5°11'26.47E (Figure 1). It is situated on the northwestern part of the state within the topographical map of Ekiti State. The hospital also has various sections for day-to-day activities and running of the health care center. It has about 750 bed space for patients across different wards and units.

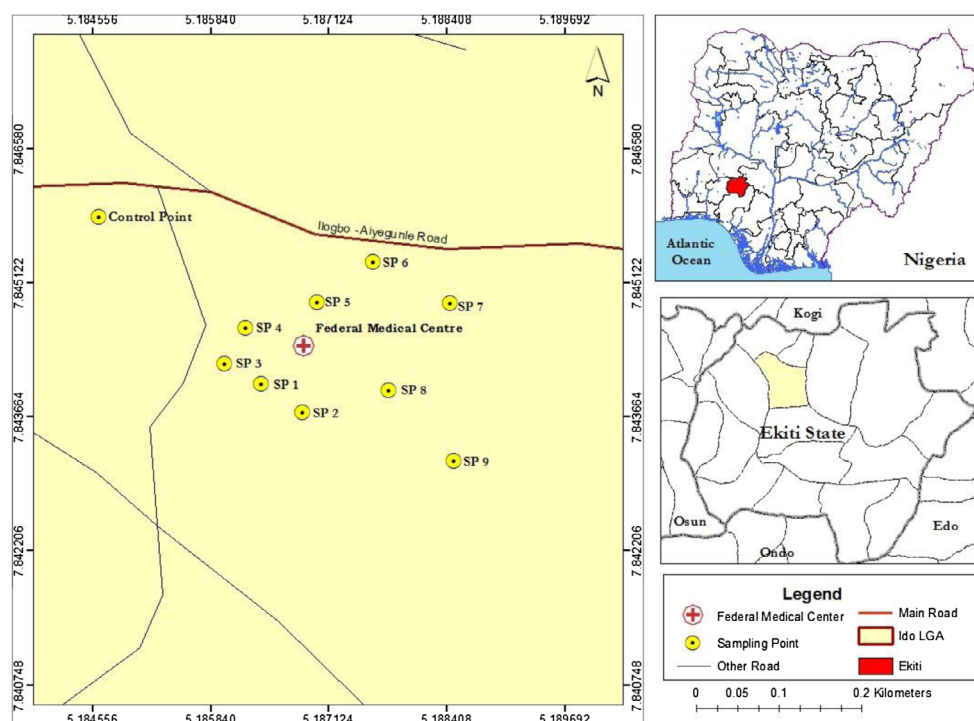
However, nine representative designated sampling locations were determined for the assessment of the impact of hospital activities on its ambient air quality. A control point ( $C_p$ ) was located outside the influence of the hospital environment which will allow for comparison of the hospital's airshed concentrations. Sampling point S1 is an outdoor waiting section beside the pharmacy. Male surgical ward and Female medical ward are denoted as S2 and S3, respectively. S4 is an outdoor location where two power generator sets were situated within the hospital vicinity to provide electricity during power outage. Sampling point S5 is Accident and Emergency and contains 40 bed space, S6 is the main entrance gate to the hospital, and the hospital laboratory is represented by S7. Car Parking Lot and Waste Dumping Site were represented with S8 and S9, respectively. The deleterious effect of air pollutants is of utmost concern, hence this study area was considered in order to determine the impact of gaseous emission from the indoor/outdoor activities on its ambient air quality.

### 2.2. Experimental procedure

Sampling was performed both indoor and outdoor of the hospital environment. Measurements were conducted for seven consecutive days for two seasons (dry and wet seasons) from each designated nine sampling locations. The air pollutants that are of concern to health and ambient environment include CO, NO<sub>x</sub>, NH<sub>3</sub>, SO<sub>2</sub>, and VOC and were considered in this study in order to ascertain their concentration in both indoor and outdoor environment of the hospital.

A ToxiRAE model PGM-1140 was used to monitor the ambient levels of NO while NO<sub>2</sub> was measured using ToxiRAE model PGM-1150. Ambient level concentrations of sulfur dioxide (SO<sub>2</sub>), carbon

**Figure 1. The studied area, Federal Medical Center Ido Ekiti, Nigeria (Google map).**



monoxide (CO), ammonia (NH<sub>3</sub>), and volatile organic compounds (VOCs) were determined using ToxiRAE gas monitor models PGM-1130, PGM-1110, PGM-1191, and PGM50-5P, respectively. The ToxiRAE systems are portable devices that provide a continuous and digital display of the gas concentrations in part per million (ppm). They have facility for short-term exposure limit (STEL) of gas concentrations, time-weighted average (TWA), and peak readings as well as a bright red flashing alarm, a loud 90 dB buzzer, and a built-in vibration alarm. During the 1-h sampling period at each designated point, the monitors were positioned at 1-m height above the ground level. The 24-h averaging period concentrations of the measured air pollutants were extrapolated using an atmospheric stability formula (Fakinle, Sonibare, Akeredolu, Okedere, & Jimoda, 2013) given in Equation (1) as:

$$C_0 = C_1 \times F \quad (1)$$

where  $C_0$  is the concentration at the averaging period  $t_0$ ;  $C_1$  is the concentration at the averaging period  $t_1$ ;  $F$  is the factor to convert from the averaging period  $t_1$  to the averaging period  $t_0$ ,  $F = \left(\frac{t_1}{t_0}\right)^n$ , where  $n = 0.28$ , the stability-dependent exponent.

### 2.3. Toxicity potential

Toxicity potential (TP) is a quantitative toxic equivalency introduced to express the potential harm of a unit of chemical released into the environment. This is expressed as the ratio of measured ambient pollutants' concentrations to the statutory limit of ambient concentration (Sonibare, Akeredolu, Osibanjo, & Latinwo, 2005). This is useful in assessing the deleterious effects of the emissions from different activities within the hospital airshed on human health. It was computed using Equation (2) taking into consideration the ambient air quality standard of various air pollutants by the FMEnv Standard and ASHRAE Standard Ventilation for Acceptable IAQ.

$$\text{Toxicity potential} = \frac{M_p}{S_p} \quad (2)$$

where  $M_p$  is the measured pollutant concentration and  $S_p$  is the statutory limit set for such pollutant using FMEnv Standard and ASHRAE Standard.

### 3. Results

Summarized in Tables 2 and 3 are the overall measured average concentrations of air pollutants from various samplings points during dry and wet seasons, respectively. Measured ambient concentrations from the sampling locations were of the range 0.07–1.64, 0–0.04, and 0–1.07 ppm for CO, NO<sub>2</sub>, and NH<sub>3</sub>, respectively, for dry season period but at the control point during this season, all measured pollutants except NH<sub>3</sub> which reads 0.09 ppm were not detected. However, the concentrations ranged 0.22–2.65 ppm with average concentration of 0.79 and 0.07–0.50 ppm with average

**Table 2. Average measured pollutants' concentrations level during dry season**

Sampling points	Concentrations (ppm)		
	CO	NO <sub>2</sub>	NH <sub>3</sub>
S1	0.50 ± 0.30	0.00 ± 0.00	0.00 ± 0.00
S2	0.29 ± 0.40	0.00 ± 0.00	0.29 ± 0.21
S3	0.07 ± 0.10	0.00 ± 0.00	0.22 ± 0.30
S4	0.29 ± 0.40	0.00 ± 0.00	0.29 ± 0.21
S5	0.29 ± 0.21	0.04 ± 0.05	1.07 ± 0.91
S6	1.64 ± 2.12	0.00 ± 0.00	0.00 ± 0.00
S7	0.36 ± 0.30	0.00 ± 0.00	0.22 ± 0.30
S8	0.22 ± 0.30	0.00 ± 0.00	0.14 ± 0.06
S9	0.29 ± 0.40	0.00 ± 0.00	0.22 ± 0.11
CP	0.00 ± 0.00	0.00 ± 0.00	0.09 ± 0.05

Note: Mean ± SD.

**Table 3. Average measured pollutants' concentrations level during wet season**

Sampling points	Concentrations (ppm)			
	CO	NO	NO <sub>2</sub>	NH <sub>3</sub>
S1	1.00 ± 0.20	0.07 ± 0.10	0.16 ± 0.22	0.43 ± 0.20
S2	0.50 ± 0.30	0.36 ± 0.10	0.00 ± 0.00	0.50 ± 0.10
S3	0.65 ± 0.30	0.50 ± 0.10	0.00 ± 0.00	0.07 ± 0.10
S4	2.65 ± 2.54	0.36 ± 0.30	0.07 ± 0.10	0.22 ± 0.11
S5	0.36 ± 0.30	0.07 ± 0.10	0.00 ± 0.00	0.36 ± 0.10
S6	0.72 ± 0.40	0.22 ± 0.30	0.00 ± 0.00	0.00 ± 0.00
S7	0.22 ± 0.11	0.07 ± 0.10	0.00 ± 0.00	0.07 ± 0.10
S8	0.43 ± 0.20	0.22 ± 0.30	0.02 ± 0.03	0.00 ± 0.00
S9	0.64 ± 0.10	0.15 ± 0.21	0.13 ± 0.18	0.29 ± 0.40
CP	0.00 ± 0.00	0.01 ± 0.00	0.00 ± 0.00	0.02 ± 0.01

Note: Mean ± SD.

concentration of 0.22 ppm for CO and NO, respectively, for wet season sampling. Also, ambient measurements for NO<sub>2</sub> and NH<sub>3</sub> during the wet season were in the range of 0–0.16 ppm with average concentration of 0.04 and 0–0.50 ppm with average concentration of 0.21 ppm, respectively, while at the control point, NO and NH<sub>3</sub> were 0.01 and 0.02 ppm, respectively.

On extrapolation to 24-hour concentrations, the measured CO became 0.03–0.67 ppm, NO<sub>2</sub> ranged between 0 and 0.03 ppm and NH<sub>3</sub> ranged between 0 and 0.44 ppm during dry season while at the control point, NH<sub>3</sub> became 0.04 ppm (Table 4). On the other hand, their wet season extrapolated 24-h concentrations ranged 0.09–1.09 ppm, 0.03–0.21, and 0–0.06 ppm for CO, NO, and NO<sub>2</sub>, respectively. Likewise, a range of 0–0.21 ppm was recorded for NH<sub>3</sub> during wet season period but for NO and NH<sub>3</sub> at the control points, the 24-h averaging concentrations were 0.0 ppm and 0.01, respectively (Table 5).

A test of significance on the relationship between measured air pollutants' concentrations during dry and wet seasons was carried out using paired sample *t*-test at *p*-value < 0.05. The calculated *t*-test for the concentrations of CO during the wet season sampling was not significantly larger than the dry season sampling result (*t* = –1.23, *p* < 0.05). Likewise, *t*-test value for the concentrations of NO<sub>2</sub> and NH<sub>3</sub> during the wet season sampling was not significantly larger than their dry season sampling results (*t* = –1.68, *p* < 0.05) and (*t* = 0.54, *p* < 0.05) respectively. On the other hand, the *t*-test

**Table 4. Extrapolated 24-h averaging period's pollutants' concentrations during dry season**

Sampling points	Concentrations (ppm)			
	CO	NO	NO <sub>2</sub>	NH <sub>3</sub>
S1	0.21		0.00	0.00
S2	0.12		0.00	0.12
S3	0.03		0.00	0.09
S4	0.12		0.00	0.12
S5	0.12		0.01	0.44
S6	0.67		0.00	0.00
S7	0.15		0.00	0.09
S8	0.09		0.00	0.06
S9	0.12		0.00	0.09
CP	0.00		0.00	0.04
FMEV Standard	10	0.04–0.06		0.28

**Table 5. Extrapolated 24-h averaging period's pollutants' concentrations for wet season**

Sampling points	Concentrations (ppm)			
	CO	NO	NO <sub>2</sub>	NH <sub>3</sub>
S1	0.41	0.03	0.06	0.18
S2	0.21	0.15	0.00	0.21
S3	0.26	0.21	0.00	0.03
S4	1.09	0.15	0.03	0.09
S5	0.15	0.03	0.00	0.15
S6	0.29	0.09	0.00	0.00
S7	0.09	0.03	0.00	0.03
S8	0.18	0.09	0.01	0.00
S9	0.26	0.06	0.05	0.12
CP	0.00	0.00	0.00	0.01
FMEEnv Standard	10	0.04–0.06		0.28

value for the concentration of NO during the wet season was recorded to be significantly larger than the dry season ( $t = -4.37$ ,  $p < 0.05$ ).

As summarized in Tables 6 and 7, the TP of the study area was calculated using the Nigeria's 24-h standard averaging period of FMEEnv and ASHRAE Standard Ventilation for Acceptable IAQ. The TP from the sampling points ranged between 0 and 0.07 and 0 and 0.11 for CO when FMEEnv Standard and ASHRAE Standard were used, respectively, during the dry season. The TP for NO<sub>2</sub> was 0–0.36 for lower limit and 0–0.24 for upper limit when FMEEnv was used. Indications show from the 24-h averaging period that extrapolated gaseous concentrations and the standards for CO, NO, and NO<sub>2</sub> recorded minimum TP values across all the sampling locations during the dry season period. Meanwhile, maximum TP value of 1.57 was recorded at S5 for NH<sub>3</sub> during the dry season sampling when the FMEEnv Standard was used. The reason for this trend might be as earlier stated for the measured gaseous levels.

The study area's meteorological parameters during dry season period were 28.47–32.26°C with an average of 29.65°C, 57.99–66.16% with an average of 62.25%, and 0.71–1.62 m/s with an average of 1.05 m/s for temperature, relative humidity, and wind speed in the northeast direction, respectively. The readings for wet season for temperature, relative humidity, and wind speed were 26.19–27.56°C with a mean of 26.82°C, 70.95–75.30% with a mean of 73.31, and 0.63–1.65 m/s with a mean of 1.23 m/s in the northeast direction, respectively. The fairly high temperature might have aided the

**Table 6. Computed TP from measured concentration levels for dry season**

Sampling points	CO FMEEnv	CO ASHRAE	NO <sub>2</sub> FMEEnv lower limit	NO <sub>2</sub> FMEEnv upper limit	NO <sub>2</sub> ASHRAE	NH <sub>3</sub> FMEEnv
S1	0.02	0.03	0.00	0.00	0.00	0.00
S2	0.01	0.02	0.00	0.00	0.00	0.42
S3	0.00	0.00	0.00	0.00	0.00	0.32
S4	0.01	0.02	0.00	0.00	0.00	0.42
S5	0.01	0.02	0.36	0.24	0.14	1.57
S6	0.07	0.11	0.00	0.00	0.00	0.00
S7	0.01	0.02	0.00	0.00	0.00	0.32
S8	0.01	0.01	0.00	0.00	0.00	0.21
S9	0.01	0.02	0.00	0.00	0.00	0.32



**Table 7. Computed TP from measured concentration levels for wet season**

Sampling points	CO FMEEnv	CO ASHRAE	NO FMEEnv lower limit	NO FMEEnv upper limit	NO ASHRAE	NO <sub>2</sub> FMEEnv lower limit	NO <sub>2</sub> FMEEnv upper limit	NO <sub>2</sub> ASHRAE	NH <sub>3</sub> FMEEnv
S1	0.04	0.07	0.72	0.48	0.27	1.59	1.06	0.60	0.63
S2	0.02	0.03	3.70	2.46	1.39	0.00	0.00	0.00	0.73
S3	0.03	0.04	5.13	3.42	1.94	0.00	0.00	0.00	0.10
S4	0.11	0.18	3.64	2.43	1.38	0.72	0.48	0.27	0.32
S5	0.01	0.02	0.72	0.48	0.27	0.00	0.00	0.00	0.53
S6	0.03	0.05	2.21	1.47	0.83	0.00	0.00	0.00	0.00
S7	0.01	0.01	0.72	0.48	0.27	0.00	0.00	0.00	0.10
S8	0.02	0.03	2.21	1.47	0.83	0.21	0.14	0.08	0.00
S9	0.03	0.04	1.49	0.99	0.56	1.33	0.89	0.50	0.42

criteria air pollutants' dispersion in the ambient airshed of the study area. The relative humidity on the other hand could have supported their retention in the ambient environment.

#### 4. Discussion

During the course of this study, SO<sub>2</sub> and VOC were not detected for both seasons. Likewise, NO was not detected during the dry season only. The gaseous pollutants were taken to be within their regulatory permissible limit in the airshed of the study area. This shows that both NO and NO<sub>2</sub> were within 0.04–0.06 ppm FMEEnv Standard limit during the period they were not detected.

During the course of sampling for both seasons, a mean peak concentration value for CO was recorded at S4 during the wet season. Next to this reading was sampling point S6 which was recorded in dry season. Major activities at these locations include higher traffic volumes of vehicular movement in and out of the hospital and engine idling during stop and search at the gate. In S4 where the mean peak concentration value for CO during the wet season was recorded could be attributed to the location being an outdoor environment where two large power generating sets were strategically placed due to epileptic power supply in the study area compared to any other sampling locations. However, the peak concentration values were noted to be within the FMEEnv Standard of 1991.

Sampling locations S2, S3, and S4 recorded higher concentration values for NO among all sampling locations for wet season period. When comparing the extrapolated concentration levels with the 24-h averaging period's national ambient standard in Nigeria, it was observed that the extrapolated 24-h averaging period of NO breached the standard during wet season sampling period. The most likely sources for these readings could be attributed to the continuous usage of power generating sets, burning of hospital wastes, and vehicles being parked directly opposite the sampling locations. The extrapolated 24-h NO<sub>2</sub> concentration values were noted to be within limit during both seasons when compared with FMEEnv Standard of Nigeria.

During dry season, the extrapolated 24-h averaging period for NH<sub>3</sub> was breached at S5 when compared with the national regulated standard. This could be a result of human waste being generated (urine bags) by patients seen during sampling period. The wet season readings were noted to be within their permissible limit owing to the fact that they were well below the FMEEnv Standard of Nigeria.

For the *t*-test carried out, the calculated *t*-test values for CO, NO<sub>2</sub>, and NH<sub>3</sub> were not significantly different when comparing their wet season sampling period concentrations with that of the dry season. This confirmed that concentration of these air pollutants was independent of sampling period, either dry season or wet season. However, *t*-test value for NO was recorded to be significant.

This indicates that the parameter is dependent on the seasonal measurement during the research study. In the research work of El-Sharkawy and Noweir (2014) on the IAQ in health care facilities (HCFs), it was observed that outdoor levels of all pollutants except VOCs were higher than the indoor levels. This means that IAQ inside HCFs is greatly affected by outdoors, particularly by movement of traffic. Similarly, in this study, the average outdoor levels of all pollutants measured were higher to their indoor measurements except for  $\text{NH}_3$ . The difference in gaseous pollutants' measurement was as a result of the proximity of each sampling location to road network (Dickey, 2000; Leung & Chan, 2006), generating set, construction site, and the incinerator within the hospital environment.

Over the years, there has been extensive international body of literatures on the health impacts of air pollution, reporting a wide range of adverse health outcomes, including exacerbation of chronic respiratory and cardiovascular diseases and premature mortality. Air pollution worsens asthma and chronic obstructive pulmonary disease and can increase the risk of cardiac arrhythmia, heart attack, stroke, and lung cancer, and hinders lung development. This translates to increases in emergency department presentations and hospital admissions, as well as deaths (Abelsohn, Stieb, Sanborn, & Weir, 2002; Brook et al., 2004; Clark et al., 2010).

Health effects occur even at exposure levels below current air quality guidelines, and for many pollutants, it is unclear whether a safe threshold exists. Susceptibility to the effects of air pollution differs. The young and old and those with existing cardiac and respiratory diseases are generally most at risk (Kjellstrom, Neller, & Simpson, 2002; World Health Organization, 2005).

Cardiovascular and respiratory effects have been postulated to be due to air pollutants inducing oxidative stress, inflammatory responses, and disturbances in cardiac autonomic control (Routledge, Ayres, & Townend, 2003).

Carbon monoxide is linked to premature death and worsening of cardiovascular disease. Australian studies have found associations between CO at current levels and increases in mortality and hospital admissions for cardiovascular disease. The strongest effects are in the elderly and people with pre-existing heart disease (Cohen et al., 2005). Short-term increases in nitrogen dioxide concentrations have been associated with increases in asthma, hospital admissions, and emergency department presentations for respiratory symptoms and increased cardiovascular and respiratory mortality. Long-term exposures to  $\text{NO}_2$  are linked to changes in lung growth in children and respiratory symptoms in asthmatic children (Gauderman et al., 2004).

As mentioned earlier, TP values above unity pose great health concerns to the immediate occupants of the airshed where such was detected. The highest TP during the dry season sampling was at S5 (Accident and Emergency section) for  $\text{NH}_3$  and is a major concern since most patients that require immediate health care attention were usually located in this location. Similarly, the hospital staff is not left out from this health concern warning.

Summarized in Table 7 are computed TPs from the 24-h extrapolated averaging period concentration during wet season. Generally, CO TP for wet season in all the sampling points remains below the unity value of 1.00 for all the sampling locations. Similarly, NO was detected to be above the TP unity value in 67% of the sampling locations when FMEV lower limit standard was used.

The upper limit for FMEV Standard indicates NO to be above the unity value in five locations that ranges from 1.49 to 5.13 of TP. The same readings were recorded when ASHRAE Standard Ventilation for Acceptable IAQ was used. TP for  $\text{NO}_2$  was 1.59 and 1.33 for sample location S1 and S9, respectively, during the wet season. The reason for this might be as earlier adduced for the measured pollutants levels coupled with the fact that vehicular emission, over dependence on diesel-powered generating set, and meteorological condition of the location.



S6 being the entrance gate to the hospital environment recorded a mean peak concentration value for CO during the dry season. Likely sources of this pollutant include vehicle movement in and out of the hospital and engine idling during stop and search at the gate. Similarly, an outdoor environment where two generator sets were strategically placed (S4) recorded peak concentration for CO measured in wet season compared to other sampling locations during this study. This could be attributed to the high rate at which diesel-powered generating set are been used in this vicinity.

## 5. Conclusion and recommendation

The study provides a valuable baseline data on impact of various activities in a hospital environment on ambient air quality of their host airshed using ToxiRAE gas models to monitor the 1-h averaging period gaseous concentrations in the Federal Medical Centre Ido-Ekiti, Ekiti State, Nigeria. The result of the study indicated that the extrapolated 24-h  $\text{NH}_3$  concentration of 0.44 ppm recorded at S5 during dry season breached the National Air Quality Standards (NAQS) of the FMEV Standard, Nigeria.

Similarly, NO and  $\text{NO}_2$  levels were higher than other gaseous parameters measured in all the sampling locations during the wet season when compared with FMEV Standard, Nigeria. Six locations were recorded to breach the FMEV Standard for extrapolated 24-h NO measured in wet season and this represents about 67% of the sampling locations. The TP exceeding unity at some of the designated sampling points calls for major concern, particularly people with susceptible health conditions which include children and aged people (patient) as well as patients with respiratory or heart diseases. It is therefore recommended that citation of diesel-powered generating sets should be located away from the health care facilities and other human activities in this area be regulated.

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