EVALUATION OF PERCEPTIVE RESPIRATORY HEALTH PROBLEMS OF TRAFFIC OFFICIALS AND VEHICULAR EMISSIONS WITHIN ABEOKUTA METROPOLIS

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ABSTRACT

Vehicular pollutants influence respiratory effects identifiable through human perceptions and estimation of air pollutant concentrations. Twenty-four officials were examined at four traffic stations; six officials per station, twice a month for three months, considering early and late daily rush hours and vehicle volume using questionnaire. Six air pollutants were quantified three times per week for three months using air samplers. The results were subjected to descriptive and inferential statistics; the obtained data were compared with the United States Environmental Protection Agency National Ambient Air Quality Standards (USEPA-NAAQS). About 67, 95, 22, 78, and 50 % of the respondents complained about air pollution, declined smoking, had protective equipment, severe respiratory symptoms, and health conditions. Also, 95, 73.3, 60, and 53.5 % had cases of runny nose and sneezing, headaches, airway allergies, and respiratory infections, respectively. Positive correlation existed between NO and NO_2 at both early hour (0.744: $p < 0.05$ significant level) and late hour (0.867: $p < 0.01$ significant level) while negative correlation between NO and CO_2 at early hour (0.768: $p < 0.05$ significant level). A negative correlation was observed between CO_2 and NO_2 at both early hours (0.765: $p < 0.05$ significant level) and late hour (0.914: $p < 0.01$ significant level). The analysed parameters had varied air quality index categories from very poor to very good when compared with USEPA-NAAQS across the stations. Traffic officials' perception indicated severe respiratory health effects in the metropolis, where vehicular emissions adversely influence air quality.

Keywords: Air quality index categories, Correlation, health, pollutants
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INTRODUCTION

Transportation enhances easy access of people and goods. It is an integral part of modern life which allows freedom to travel short and long distances. Road transportation is a very flexible major transport mode. Despite the importance of road transportation, the associated hazardous effects on humans and the environment mostly through emissions to the air are grievous [1]. Air is polluted when harmful amounts of natural and synthetic materials in the form of dust, gases, or droplet are released into the atmosphere. Air quality in the metropolis is thus obliterated by both mobile and stationary sources. The former includes automobiles, trains, and aeroplanes while the latter ranges from generators, incinerators, and machines. The profile of air pollution by type and source in Metropolis revealed that road traffic is the major source of air pollution. Public transport throughout the city had released vehicular emissions to the inhabitants in the nooks and crannies. The problems from emissions are exacerbated by the high numbers of old and poorly maintained vehicles [2].

Among the pollutants emitted from automobile exhausts are NOx, volatile Hydrocarbons, carbon monoxide (CO) and suspended particulate matters (SPM); some react to form aerosol, smog, and fog. Fuels (petrol and diesel); local landscape, settlement, and climate; as well as additives (lubricants, antirust agents, antioxidants, pre-ignition preventers, and anti-knock agents) influence the level of such pollutants. The resulting hazardous effects when such pollutants are inhaled could be severe. This is because a multitude of air pollutants with varying toxicity associate with vehicular emissions, and these originate from the tailpipes of vehicles with internal combustion engines, other vehicle components (such as brake, clutch linings, pads, tyres, and fuel tanks), road-surface wear and treatment materials. The release of these pollutants has made vehicular emissions a major source of the criteria pollutants that are ubiquitous in the metropolis across the universe [3]. Vehicular pollution can hardly be avoided as the emissions occur near the ground level, where breathing is adversely threatened. It was estimated that over millions of people worldwide are exposed to hazardous levels of traffic-generated pollutants as the human population and vehicle numbers increase. Many studies have documented adverse health effects associated with high concentrations of transport-related pollutants such as in

Abeokuta [4], Akwa-Ibom [5], India [6], and the United States [7]. Health impacts of exposure to vehicular pollution are serious and diverse. Impacts of vehicular emissions on occupationally exposed people had been carried out in Lagos metropolis by Adeleke *et al.* [8].

There were also records of mixed evidence for a relationship between exposure and low birth weight, preterm birth, and congenital disabilities [9]. Nitrogen and sulfur oxides are said to associate with immune system impairment, exacerbation of asthma and chronic respiratory diseases, reduced lung function, and cardiovascular diseases. Long term exposure to the exceeding level of CO (40.00 µg/ m^3) can result in fatigue, headaches, dizziness, loss of consciousness, and even death at very high concentrations; particulates are dangerously linked to the development of lung cancer and high rates of mortality [10]. Acute exposure to vehicular emissions in an epidemiological study was observed to reduce lung function among tunnel officers and confirmed the prevalence of chronic bronchitis and asthma in street cleaners exposed to pollutants from vehicles with significantly increased respiratory problems [11]. Ogun State government embarked on individual and joint efforts to improve air quality to ascertain healthy lives by the introduction of emission tests for vehicles much earlier than 2013; the effort was frustrated due to non-compliance with the populace. Efforts from the federal government also included legal sanctions on the age of vehicles to be imported; setting guidelines on vehicular emissions, and regulatory framework. Despite all these conscious efforts to improve air quality, the problem of vehicular emissions and associated health problems persist. It is worthy to note that Ogun state because of her proximity to Lagos state and congestion in the latter is gradually being populated both in persons, industries, and vehicles. To understand the complex chain of events from transport demand and traffic activities to emissions, ambient air quality, exposure, and effects require information from a variety of scientific disciplines. The scientific discipline involves research on complex relationships. Thus, findings through sample analyses should not only serve as evidence but also perceptive researches. The latter could, therefore, play important roles in decision making on transportation development and in evaluating its benefits and danger to society. This study assessed levels of air quality and health effects from vehicular emission based on the experience of traffic officials in Abeokuta metropolis.

MATERIALS AND METHODS

Study area

The research monitored four traffic-congested areas (**Figure 1**) within the capital city (Abeokuta metropolis) of Ogun State. The metropolis is densely populated as a result of the continuous migration of people from neighbouring states. Vehicular densities of some areas within Abeokuta Metropolis were presented in the study of Bada *et al.* [12]. Having reported 24.45 % along with Brewery – Ita Oshin, 31.46 % along Presidential Boulevard - Kuto, 9.51 % along Pasenke - Ojere, 14.90 % along Iyana mortuary – Idi aba, and 19.68 % along Asero - Obantoko as the average % of the total estimated passing vehicle within 12 h period (7.00 AM to 7.00 PM) of the day, the authors reiterated that there is a high possibility of vehicular emissions with obnoxious gases. Such emissions pose a threat more to the officials whose occupation relies on vehicular movements.

Samples collection and data gathering

Air quality parameters were monitored three times in a week (Monday, Wednesday and Friday) for three months using hand-held equipment: Land-duo for CO, CO_2, NO_2 and NO **(**Industracom, North Sydney, Australia**)**, QRAE$^+$ meter for SO_2 **(**Fisher Scientific, Loughborough, UK**)**, and DustTrak for SPM (TSI, Air Met Scientific, UK). The equipment was placed 2.5 m above ground level, the point where man is exposed to the prevailing pollutants [13]. Air monitoring was done three hours, both in the early hours (7.00 - 10.00 AM) and late afternoon (3.30 - 6.30 PM) of the day. The durations were chosen to capture the range of daily exposure of the traffic officials [7]. Information on perceived health effects of the targeted traffic officials as respondents was gathered using a questionnaire having informed them and got their permission before the study period. The questionnaire was administered to 6 officials (3 different corps) per site, twice a month in four different locations: Kuto; Lafenwa; Adatan; and Iyana Mortuary throughout the three-month sampling period, considering the number of junctions where traffic wardens stand within the Abeokuta metropolis. Repeatedly claimed respiratory health effects by the 24-traffic officials were considered related to the research to provide information on the effects of vehicular emissions to corroborate literature. One hundred and forty-four (144) copies of the questionnaire were used. The themes on the questionnaire were (1) symptoms, and conditions change with season and duration; and (2) responses on health symptoms and health conditions. Both themes had sub-themes which the responses addressed.

Data analysis

Obtained data were subjected to descriptive (Mean and standard deviation, frequency and percentage, Tables, and Charts) and inferential (ANOVA: Analysis of Variance and DMRT: Duncan Multiple Range Test) statistics. The questionnaire was coded and analysed. Average values of air pollutants were calculated for mean and standard deviation; the obtained results were further analysed for variance using ANOVA, while mean separation was performed with DMRT at $p < 0.05$ level of statistical significance. The gathered data through copies of the questionnaire were handled using both frequency and percentage, which were represented on tables and charts. Air quality indices (AQI) were computed for the values of air parameters using the model available on https://airnow.gov/index.cfm?action= airnow.calculator (accessed on 9th April 2019). The results obtained in this study were then compared with the USEPA [14] for AQI categories, which have ranges for very poor, poor, moderate, good, and very good.

RESULTS

Perceived respiratory health symptoms and conditions

Thirteen percentage (13%) of the respondents were indicated to gainfully be employed as a traffic official between 1996 and 2000, 33% between the year 2001 and 2006, while 54% between 2007 and 2012 (Fig. 2). This indicated that the 13% traffic official had worked for 17-21 years, 33% for 11-16 years, and 54% for 5-10 years. It was observed that 66.7% of the respondents (traffic officials) agreed to have air pollution complaints referred to and pointed at dust in the air, smoke/ fumes as exhaust from the vehicles, and the odours they usually perceived. The examples cited by the officials indicated their knowledge of air quality pollution. Almost 95% of the respondents declined smoking cigarettes; this indicated that any health symptoms and conditions complained would hardly be associated with cigarette habits. Only 21.7% of the traffic officials were used to being equipped with personal protective equipment like nose masks, earmuff, and gloves.

Exact 78.3% of the respondents admitted that their health symptoms and conditions were more prevalent in the dry season (Table 1). This meant that levels of vehicular emissions might be high and more dispersed in the dry seasons. Also, 50% of the traffic officials responded that the health issues were more felt in the early hours of the day when the vehicular movements in the metropolis were high as the rush hours. It was detected that the most common symptoms associated with the traffic officials were runny nose and sneezing: 95%, headaches: 73.3%, body weakness/ fatigue: 46.7%, and itching eyes: 13.3%. The officials responded that they had been treated for airway allergies: 60% and respiratory infections: 53.5%, while 13.3% said they had never been diagnosed with any health conditions (Table 2). The respondents declared that they hardly took medications as such symptoms disappeared at night and over the weekends when not at their traffic control stations.

Average levels of air quality parameters

The average levels of CO were observed to range from 1.548 ± 7.46 µg/ m^3 at Adatan to 4.470 ± 2.33 µg/ m^3 at Iyana-Mortuary with no significant ($p > 0.05$) difference in the early hours of the day (7 - 10 AM) while it ranged from 1.198 ± 1.73 µg/ m^3 at Kuto to 5.450 ± 0.00 µg/ m^3 at Adatan also with no significant ($p > 0.05$) difference in the late hours of the day (3.30 – 6.30 PM) (Table 3). There was no significant correlation between CO and other five air quality parameters analyzed in the early and late hours of the day (Table 4). It was observed that average levels of SO_2 ranged from 0.023 ± 0.14 µg/ m^3 at Iyana-mortuary to 0.087 ± 0.37 µg/ m^3 at Lafenwa with no significant ($p > 0.05$) difference in the early hours of the day (7 - 10 AM) while it ranged from 0.008 ± 0.05 µg/ m^3 at Iyana-mortuary to 0.066 ± 0.06 µg/ m3 at Kuto significantly ($p < 0.05$) in the late hours of the day (3.30 – 6.30 PM). There were no significant correlations between average levels SO_2 and other five air quality parameters analyzed in both the early and late hours of the day.

Average levels of NO_2 were between 0.015 ± 0.14 µg/ m^3 at Adatan and 0.068 ± 0.18 µg/ m^3 at Lafenwa with no significant ($p > 0.05$) difference in the early hours of the day (7 - 10 AM) while between 0.018 ± 0.25 µg/ m^3 at Lafenwa and 0.103 ± 0.25 µg/ m^3 at Adatan significantly differ ($p < 0.05$) in the late hours of the day (3.30 – 6.30 PM). There was a positive correlation between the average levels of NO and NO_2 (0.744: in the early hour, $p < 0.05$ and 0.867: in the late hour, $p < 0.01$) while the negative correlation between NO and CO_2 (0.768: in the early hour, $p < 0.05$). On the other hand, negative correlation existed between the average levels of CO_2 and NO_2 (0.765: in the early hour, $p < 0.05$ and 0.914: in the late hour, $p < 0.01$). Levels of suspended particulate matter (SPM) were determined to vary between 26.200 ± 5.09 µg/ m^3 at Adatan and 241.678 ± 9.65 µg/ m^3 at Iyana-Mortuary varying significantly ($p < 0.05$) in the early hours of the day (7 - 10 AM) while between 30.575 ± 2.16 µg/ m^3 at Adatan and 148.740 ± 121.35 µg/ m^3 at Iyana - Mortuary with no significant ($p > 0.05$) difference in the late hours of the day (3.30 – 6.30 PM). There were no significant correlations between average levels SPM and other five air quality parameters analysed in both the early and late hours of the day. Levels of the analysed parameters in this study were compared with the air quality index [14] for AQI categories.

DISCUSSION

Perceived respiratory health symptoms and conditions

The traffic officials had been exposed to vehicular emissions in their respective years of working experiences. The conditions that would contribute to and influence the emissions the officials were being exposed to are not limited to the traffic load, duration at work stations, age and wellbeing of the official, condition of the moving vehicles, weather conditions, concentrations, and directions of the emissions [15]. There was an indication that 78.3% of the traffic officials were exposed to vehicular emissions through dermal, inhalation, and ingestion routes for not being provided with personal protective equipment (PPE). All of the respondents worked at least 7 hours per day, and 28 hours per week (excluding Saturdays and Sundays when they were sometimes deployed). This made them vulnerable to high levels of pollution and, in turn, likely to experience health symptoms and conditions aggravated from exposure to air pollution [16] as most of the respondents hardly smoke and still had air pollution complaints.

The severity of the health complaints in early hour of the day could be traced to the incomplete combustion of the engine due to constant switching on and off of the engine, slow movements, the high volume of the vehicles [17], and slow dispersal of air pollutants in the early hours of the day [18]. Respiratory problems being complained by the traffic officials showed that vehicular emissions clearly and immensely pollute the air and, in turn, deteriorate air quality to influence various health symptoms and conditions [7,16]. This showed that the vehicular emissions compromised the health status of the officials [10,19], and more especially on the officials without PPE under study. The respiratory effects possible from obnoxious vehicular emission [21-22] could have made some of the officials absent from work for being under medications or admitted to the hospital.

Average levels of air quality parameters

The values of CO were below the EPA [23] standard limit of 40.00 µg/ m^3 per hour. Long term (chronic) exposure to CO below the threshold is possible to influence neuropsychological responses that include weariness, headaches, poor concentration, and remembrance [24]. The health conditions associated with exposure to CO are due to its affinity with the haemoglobin molecule, thereby forming carboxyhemoglobin (COHb) [24]. Myocardial infarction in cardiovascular disease patients had been associated with CO [10]. Comparing the CO values detected with the Air Quality Index [14], CO levels were observed to be moderate in the late hour of the day at Adatan and early hour of the day at Iyana-mortuary but very good and good at both Kuto and Lafenwa respectively. High concentrations of SO_2 leave an odour of burning matches with associated possible health conditions that include respiratory disorder, especially asthma; airways irritations and eyes itching; chronic cardiovascular conditions; and bronchitis [10]. High exposure to acute concentrations of SO_2 could trigger asthmatic attacks, and possibly death in asthmatic patients or dysfunctional breathing amongst asthmatic patients [10]. The environmental implication of SO_2 is that it contributes to acid rain with resultant environmental damages and ecosystems' upsets [25]. Comparing the SO_2 values observed with the Air Quality Index [14], SO_2 levels were detected to be poor and very poor at Kuto and Lafenwa in both periods of the day but very good and good at both Adatan and Iyana-mortuary.

The shops and street vendors engaging in marketing activities near the sampling stations and the passerby are exposed to high vehicular and traffic emissions during these rush hours due to diffusion and dispersion of the pollutants. Such people are prone to a high risk of developing poor health conditions as identified by previous studies [26]. Vehicular emission had been reported to affect commuters adversely, and significantly higher concentrations of CO and SO_2 had also been documented from vehicular emission during the early hours of the days [27,28]. Thus, continuous exposure to CO and SO_2 in this study might influence health implications not only exposed to traffic control officials but also the general public. All the sampling stations except Adatan in the late hour had their NO_2 levels below the threshold 0.1 µg/ m3 [23]. Health conditions linked to NO_2 exposure were reported to have harmful effects on the lungs, which include increased airways inflammation, exacerbated cough and wheezing, dysfunction, high asthmatic attacks, and the likelihood of being hospitalized; proneness to respiratory infection including influenza [11]. Comparing the NO_2 values observed with the Air Quality Index [14], NO_2 levels were detected to be very good at late hour in Lafenwa and early hour in Adatan. This was moderate during the early hours in Kuto. All the sampling stations, except Iyana-Mortuary, had their SPM levels below the threshold of 150 µg/ m^3 [14]. The mean values of all the analysed parameters in this study at both the early and late hours were respectively lower than the mean values previously reported [7]. When compared to the levels of SPM observed with the Air Quality Index [14], levels of SPM were observed to be poor at the late hour and very poor at an early hour in Iyana-mortuary. Levels of air quality were determined to be good and very good at the other three sampling stations. Variations in the air quality indices in all the sampling traffic stations were recorded in various sampling locations of the previous study [7].

CONCLUSION

The determined levels of air pollutants indicated that vehicular movement releases emissions which varied in concentration across the selected junctions. At the same time, responses of the traffic officials showed that they are highly prone to adverse health effects influenced by vehicular emission. The complained about health symptoms and conditions of the officials was associated with vehicular pollution as 95% of respondents declined smoking, 21.7 % were equipped with personal protective equipment. Health issues complaints were said by 78.3% to higher in the dry season, and 50% said such issues were more prevalent in the early hours of the day. There was a positively strong correlation between NO and NO_2 but negatively strong correlation between NO_2 and CO_2. However, SPM had no significant correlation with all the assessed gaseous parameters.

Air quality management as a priority to prevent environmental degradation and health symptoms/conditions such as airway allergies and respiratory infections with effective policy implementation such as targeting high-emitting commercial vehicles and vehicle emission tests ought to be seen necessary to save lives of the traffic control officials and the general populace. The traffic officials ought to be provided with the related, required, efficient, and effective protective equipment such as nose guard, mask, face masks, earmuffs, and gloves to shield them against gaseous pollutants and particulates. There is a need for education on and protection techniques against vehicular emissions associated effects to gain public and government support for pollution control and make air quality a real priority. Improvement of fuel quality through sulfur reduction is also relevant to have a facelift for environmental health improvement.

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Table 1: Symptoms and conditions change with season and duration

	Season	
Response	**Frequency**	**Percent**
Dry season	47.0	78.3
Rainy season	1.0	1.70
No change	9.0	15.0
Undecided	3.0	5.0

	Duration	
Response	**Frequency**	**Percent**
Early hours	30.0	50.0
Late afternoon	14.0	23.3
No changes	3.0	5.0
Undecided	13.0	21.7

Table 2: Responses on health symptoms and health conditions

Experienced/ perceived health symptoms		
Health Symptoms	Frequency	Percent
Runny nose and sneezing	57	95
Headaches	44	73.3
Body weakness/fatigue	28	46.7
Chest pain	2	3.3
Sore throat	5	8.3
Itching eyes	8	13.3
Wheezing	7	11.7
Nausea	2	3.3
Experienced/ perceived health conditions		
Health conditions	Frequency	Percent
Airway allergies	36	60.0
Respiratory infection	32	53.3

Table 3: Average levels of air quality parameters

Sampling Location	NO µg/ m³	CO µg/ m³	SO_2 µg/ m³	CO_2 µg/ m³	NOx µg/ m³	SPM (µg/ m³)
Early Hours (7 – 10 AM)						
Kuto	0.375[a] ± 0.53	2.148[a] ± 25.07	0.078[a] ± 0.83	2.590[a] ± 1.92	0.035[a] ± 0.49	52.900[a] ± 2.48
Lafenwa	0.650[a] ± 0.35	3.745[a] ± 38.33	0.087[a] ± 0.37	1.720[a] ± 0.48	0.068[a] ± 0.18	58.430[a] ± 67.08
Adatan	0.200[a] ± 0.28	1.548[a] ± 7.46	0.030[a] ± 0.07	3.920[a] ± 0.20	0.015[a] ± 0.14	26.200[a] ± 5.09
Iyana-mortuary	0.250[a] ± 0.14	4.470[a] ± 2.33	0.023[a] ± 0.14	2.780[a] ± 0.64	0.040[a] ± 0.21	241.675[b] ± 9.65
EPA (2016)	--	40.00	0.10	10.00	0.05	150-250
Significant levels at p < 0.05	0.628	0.606	0.480	0.343	0.447	0.010
Late hours (3.30 – 6.30 PM)						
Kuto	0.825[a] ± 0.18	1.198[a] ± 1.73	0.066[b] ± 0.06	2.380[b] ± 0.04	0.070[b] ± 0.00	37.475[a] ± 3.50
Lafenwa	0.325[a] ± 0.46	2.870[a] ± 33.80	0.041[ab] ± 0.23	4.380[c] ± 0.35	0.018[a] ± 0.25	65.775[a] ± 4.84
Adatan	0.975[a] ± 0.25	5.450[a] ± 0.00	0.021[a] ± 0.11	0.835[a] ± 0.56	0.103[b] ± 0.25	30.575[a] ± 2.16
Iyana-mortuary	0.400[a] ± 0.21	1.840[a] ± 9.55	0.008[a] ± 0.05	2.780[b] ± 0.55	0.055[ab] ± 0.00	148.740[a] ± 121.35
EPA (2016)	--	40.00	0.10	10.00	0.05	150-250
Significant levels at p < 0.05	0.217	0.223	0.044	0.006	0.035	0.324

Mean ±SD, values with the same superscripts were not significantly different at p > 0.05

Table 4: Correlations among the average levels of various pollutants

Air quality parameters (7 – 10 AM)						
	NO	**NO_2**	**SO_2**	**CO**	**CO_2**	**SPM**
NO	1					
NO_2	0.744*	1				
SO_2	0.067	-0.166	1			
CO	0.703	0.430	-0.104	1		
CO_2	-0.768*	-0.765*	0.052	-0.628	1	
SPM	-0.253	0.166	-0.416	0.275	-0.040	1

Air quality parameters (3.30 – 6.30 PM)						
	NO	**NO_2**	**SO_2**	**CO**	**CO_2**	**SPM**
NO	1					
NO_2	0.867**	1				
SO_2	0.326	-0.077	1			
CO	0.600	0.520	-0.092	1		
CO_2	-0.648	-0.914**	0.260	-0.331	1	
SPM	-0.552	-0.254	-0.472	-0.343	0.152	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 5: Air quality index (AQI)

In this study					
Monitoring site	**Sampling period**	**AQI (CO)**	**AQI (SO_2)**	**AQI (NO_2)**	**AQI (PM10)**
Kuto	Early hour	B	E	C	B
	Late hour	A	E	E	A
Lafenwa	Early hour	B	E	E	B
	Late hour	B	D	A	B
Adatan	Early hour	A	B	A	A
	Late hour	C	B	E	A
Iyana mortuary	Early hour	C	B	D	E
	Late hour	A	A	D	D

Rating					
AQI Category	**AQI Rating**	**CO (μg/ m^3)**	**SO_2 (μg/ m^3)**	**NO_2 (μg/ m^3)**	**SPM_{10} (μg/ m^3)**
Very good (0-15)	A	0-2	0-0.002	0-0.02	0-50
Good (16-31)	B	2.1-4.0	0.02-0.03	0.02-0.03	51-75
Moderate (32-49)	C	4.1-6.0	0.03-0.04	0.03-0.04	76-100
Poor (50-99)	D	6.1-9.0	0.04-0.06	0.04-0.06	101-150
Very poor (100 or over)	E	>9.0	>0.06	>0.06	>150

A= very good; B= good; C= moderate; D= poor; E= very poor
Source: USEPA [14]

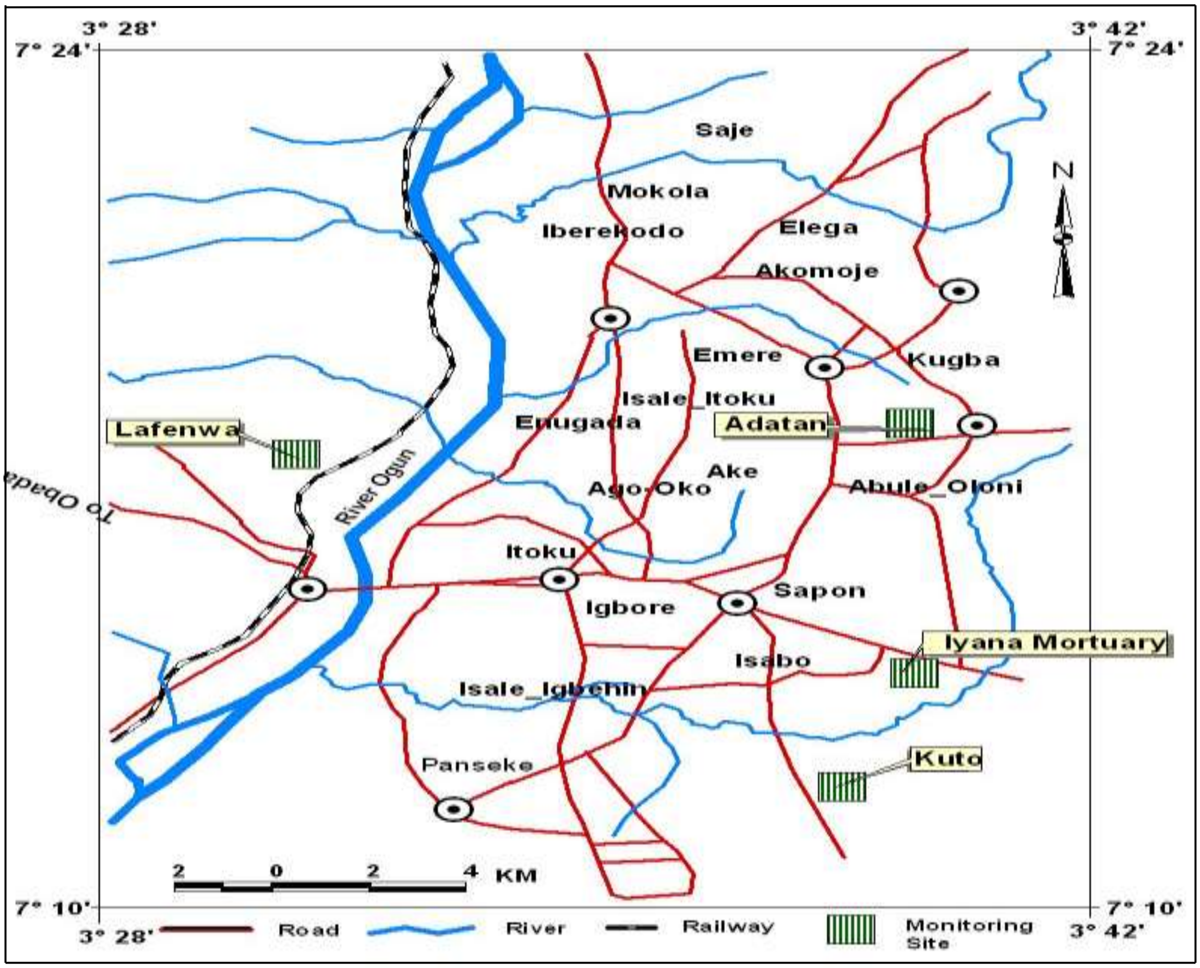

Figure 1: Map of the study area
Source: Cartographic laboratory, Federal University of Agriculture, Abeokuta

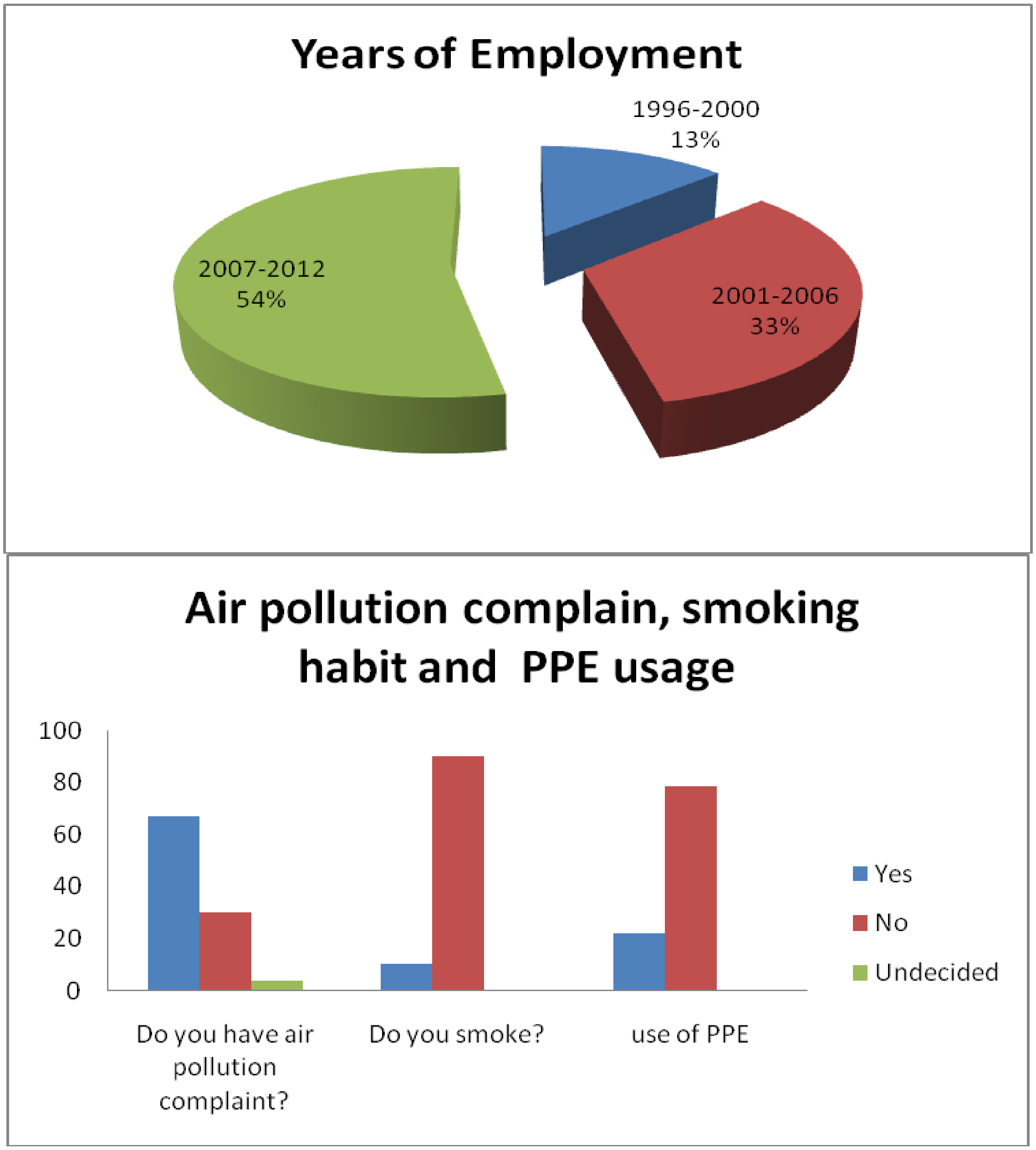

Figure 2: Years of employment and assessed issues
PPE = Personal protective equipment