

Noise and Gaseous Pollutants Profiles of Outdoor Air Envelopes in Selected Areas Within Abeokuta, South Western Nigeria

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Abstract
This study examined the noise and gaseous pollutant levels associated with outdoor air envelopes of selected areas in Abeokuta, South Western Nigeria. Twenty-six locations were selected; Adata, Adigbe, Asero Estate, Ake, Elega, Ibara, Idi-Aba, Ilupeju, Kolobo, Itoko, Government Residential Area (GRA), Totoro, Ogbe, Onikaro, Oke Aregba, Oniyanrin Adatan, Iberekodo, Ijaye, Ita-Oshin (market), Ita-Oshin (industrial) Kuto, Itoku, Panseke, Omida, and Lanfewa. On-field measurement of CO, SO_2, NO_2, H_2S, CH_4 and noise was achieved using an automated gas sampler and a sound meter. Mean noise levels varied from 36 ± 0.9 to 89 ± 0.3 dBA whilst CO values ranged from 25 to 74 ppm. SO_2 and NO_2 measurements ranged from 0.02 to 0.50 ppm and 0.1 to 0.4 ppm. The H_2S and CH_4 values varied from 0.07 to 0.23 ppm and 0.07 to 0.24 ppm. The evaluated potential health risks to exposed individuals in the sampled areas especially concerning CO levels was worryingly very high. The observed differences between the noise and outdoor gaseous pollutant values for the different locational groups were significant (*P<0.05*). All the mean noise values and gaseous air pollutants for the residential areas were comparatively lower than those observed for both the industrial and commercial areas. All the examined outdoor air envelopes surrounding the commercial areas are polluted with varying levels of gaseous contaminants and noise.
Keywords: Abeokuta, Gaseous Pollutants, Commercial Area, Noise, Industrial area, Outdoor air
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1.0 INTRODUCTION

In the course of achieving developmental objectives, urbanization, technological advancement, and industrialization, humans have remained the principal cause of environmental pollution. Atmospheric and noise pollution are well-documented consequences of anthropogenic activities. Air pollution has been described as the introduction of several airborne moieties such as chemicals, particulate matter, or biologically derived substances that trigger negative anthropogenic health effects and physical discomfort (Njoku *et al.*, 2018).

Several prevalent air pollutants in urbanized areas include; dioxides of sulphur and nitrogen; (SO_2) and (NO_2), carbon (II) oxide (CO), volatile organic compounds (VOCs), hydrogen sulphide (H_2S), suspended particulate matter (SPM) with aerodynamic diameters under 2.5 and 10µm, lead (Pb) and ozone (O_3) (Garba and Yunusa, 2016; Ipeaiyeda and Adegboyega, 2017; Njoku *et al.*, 2018; Nwosisi *et al.,* 2021). These air pollutants have been described as criteria contaminants as they are strongly suspected to have negative health effects on both humans and the biotic and abiotic components of the environment (Ipeaiyeda and Adegboyega, 2017). Different sources of these air pollutants have been described in various scientific literary sources and they include; road transport associated traffic (vehicular exhaust), industrial sources, open burning of municipal and agricultural solid wastes, forest fires, domestic cooking and heating with solid fuels; wood, charcoal and coal, power plants and generating sets (Njoku *et al.*, 2018).

It has been observed that developing nations in sub-Saharan Africa, especially Nigeria, are bedeviled by several developmental challenges (Garba and Yunusa, 2016). These challenges include; an increase in automobile ownership and usage, dependence on alternative power sources such as fossil fuel-powered generators for supply, indiscriminate open burning of solid wastes, usage of dirty fuels, and absence of or non-implementation of environmental laws and edicts (Garba and Yunusa, 2016). These anthropogenic activities have been known to escalate the poor quality of outdoor air associated with urbanized areas (Garba and Yunusa, 2016).

Sound has been described as an energy form dissipated by a vibrating body culminating in the hearing sensation passing through the nerves onto the ears (Usikalu and Kolawole, 2018). Noise has also been described as an unwanted sound and is also a natural consequence of anthropogenic activity (Usikalu and Kolawole, 2018). However, not all sound forms generated by vibrating entities are audible (Usikalu and Kolawole, 2018). The health effects of noise exposure are known to vary according to the type, duration, exposure time, and susceptibility of the individual. Concerning audibility, sound frequencies are known to vary from 20 Hz to 20 kHz (Usikalu and Kolawole, 2018). Noise is an unwanted side product of anthropogenic technological advancement and awareness about the negative health impacts of noise pollution has progressively increased among individuals, public health stakeholders, and policymakers (Usikalu and Kolawole, 2018). After air and water pollution, noise pollution has been ranked as the third most prominent form of environmental pollution, especially in urbanized areas (Usikalu and Kolawole, 2018).

Abeokuta is a commercial hub and the administrative capital of Ogun State, South Western Nigeria. The metropolis is known to occupy a land area of about 781.16 sq km and as of the year 1991 during the national census, the estimated number of inhabitants was given as 374,843 individuals. The city has been and is still expanding in all directions and the expansion rate has been documented to be astounding at an incremental rate of about 40 square kilometers within 3 years; 1981-1984 (Olayinka *et al*., 2015). The construction and dualization of an inter-city road network connecting the city to Lagos in the southward direction, Ibadan in the North-westward direction, Benin Republic in the westward direction, and Sagamu along the southern corridor have created and attracted a rapid level of urbanization along these traffic vicinities (Olayinka *et al*., 2015).

Levels of gaseous air and noise pollution are known to affect anthropogenic activities, especially in large expansive urban centers such as Abeokuta. This study attempted to investigate the detectable levels of noise and selected gaseous pollutants at selected locations within Abeokuta municipality.

1.1 MATERIALS AND METHODS

1.11 Study area and sampling procedure

Prior to sampling, a reconnaissance survey of noisy and air polluted areas within the metropolis was conducted and a sampling map was constructed. Twenty-six locations within the city were identified within the Abeokuta municipality (Figure 1). Sixteen of these locations were residential areas whilst nine were municipal markets. Only one of the sampled areas was an industrial site. The sixteen residential locations were; Adata, Adigbe, Asero Estate, Ake, Elega, Ibara, Idi-Aba, Ilupeju, Kolobo, Itoko, Government Residential Area (GRA), Totoro, Ogbe, Onikaro, Oke Aregba, and Oniyanrin. The nine markets sampled were; Adatan, Iberekodo, Ijaye, Ita-Oshin, Kuto, Itoku, Panseke, Omida, and Lanfewa. The sole industrial location was in the Ita-Oshin area. The noise level was determined using the calibrated sound level meter (TEST 1350) (NAAFIE, India), and the duplicate concentrations of the gases; CO, SO_2, NO_2, H_2S, and CH_4 were evaluated using a Gasman air autosampler (Crowcon^{TM} Detection instruments Ltd., United Kingdom). The range of the sound level meter was indicated as either low range; 35-100 dB or high range; 65-130 dB. At each location, noise reading was taken four times and the mean reading was calculated. For the airborne gases, a duplicate steady meter reading was recorded for each location and the average reading was calculated and recorded.

1.12 Determination of Air Quality Index

The AQI values were derived for the respective sampling sites using the mean concentrations of measured air pollutants. The individual air quality index for a given pollutant concentration was calculated using the formula stated by USEPA (2006);

$$AQI = \frac{Ihigh - Ilow}{BPhigh - BPlow} X\ (Cp - Bplow) + Ilow$$

Where: AQI = Index of the pollutant;
Cp = the rounded concentration of pollutant p;
BP_{high} = the breakpoint greater or equal to Cp;
BP_{low} = the breakpoint less than or equal to Cp;
I_{high} = the AQI corresponding to BP_{high};
I_{low} = the AQI corresponding to BP_{low}.

The AQI values were interpreted using the interpretative index as described by USEPA (2006) and presented in Table 1. The index was separated into six categories of health impact and their implications namely: good (0–50), which implied that the AQI was satisfactory; moderate (51–100*), AQI is acceptable; however it is unhealthy for sensitive groups (101–150), which implied that although this range might not affect the general public, it could negatively affect individuals with heart and lung diseases, older adults and children. Unhealthy (151–200), which indicated that the exposed individuals might begin to experience some adverse health effects; very unhealthy (201–300), which indicated that exposed individuals could experience adverse health effects and hazardous (301–500), this range would trigger health warning of emergency conditions.

Table 1: Air quality index values and the levels of health concerns

AQI Values	Levels of Health Concern	Colours
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for sensitive groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Marron

Source: (USEPA, 2006)

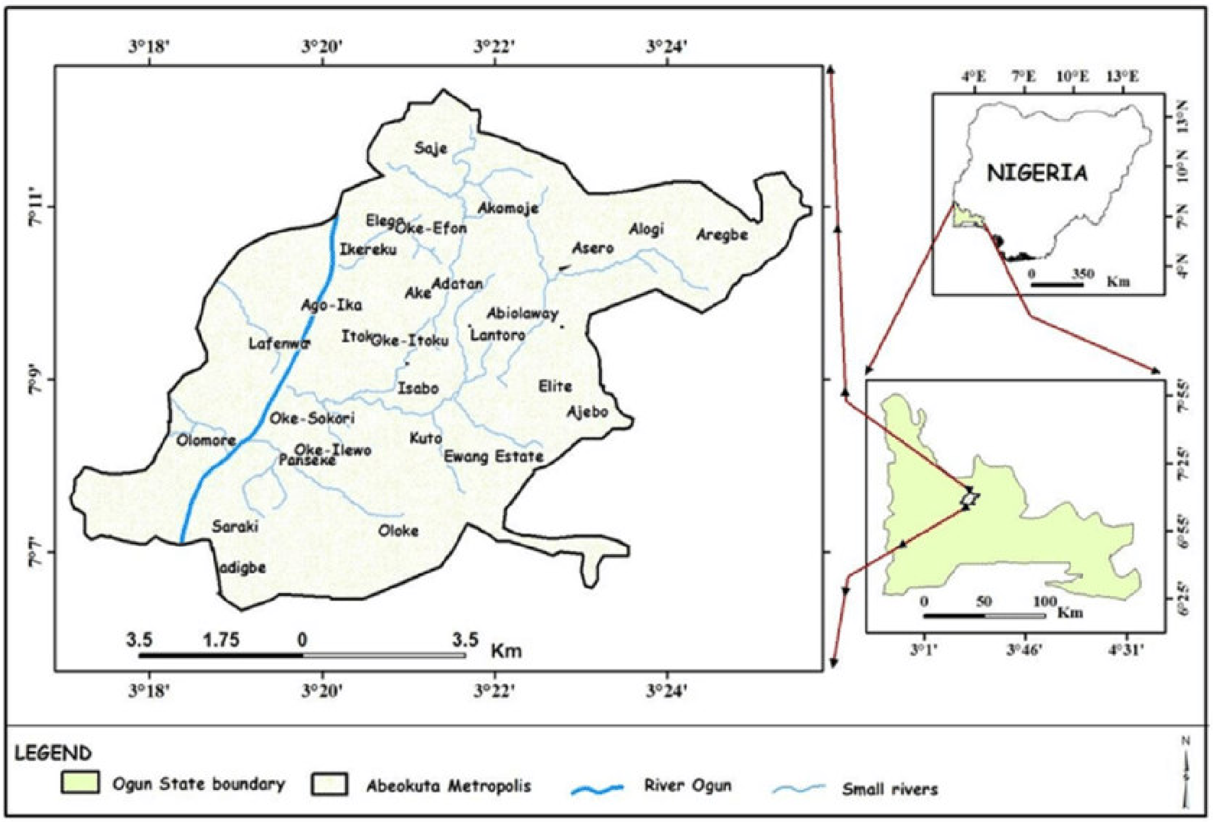

Fig.1: Map of Abeokuta showing the sampled locations

1.13 Statistical analysis

A non-parametric one-way F test equivalent; Kruskal Willis was utilized to ascertain if the observed differences amongst the respective mean noise values and gas readings obtained for the locations were significant at a 95% probability level.

1.2 RESULTS AND DISCUSSION

The mean noise values recorded for sampled areas were shown in Figures 2 and 3. For the residential locations, the noise levels ranged from 36 ± 0.9 for GRA to 74 ± 0.2 dBA for Itoko (Fig. 2). Concerning the commercial locations, the mean noise values varied from 68 ± 0.1 for Iberekodo to 89 ± 0.3 dBA for Ita-Oshin (Fig. 3). Usikalu and Kolawole (2018) reported that the permissible noise limit prescribed by the WHO for commercial, industrial and residential locations was 65 dB and 55 dB respectively. Except for Adata, Oke-Aregba, Totoro, and Itoko, all the mean noise levels were below the WHO noise limit for the residential area (Fig. 2). All mean noise data recorded for the commercial areas and industrial areas in this study were above this limit (Fig. 3).

Aside from the Itoko residential area, all the mean noise concentrations for the residential areas were comparatively lower than those observed for both the market and industrial areas. The observed differences between the noise and outdoor gaseous pollutant values for the different locational groups; residential, market, and industrial were significant (*$P<0.05$*).

The elevated noise levels at the market locations and the industrial area could be directly attributed to the cumulative effects of various types of anthropogenic activities at these places. Some of these activities occurring at a greater magnitude at these places include; trading activities, heavy vehicular traffic at the market vicinities, and noise emanating from relaxation centers located at the market vicinities (Oguntoke *et al.* 2019a). Additional activities include; Different sounds from various music players in some of the market stores and hawkers of music CDs, noise emanating from electricity generators, and heavy-duty machinery in the industrial area. The mean noise levels recorded for Kuto, Oke Aregba and Asero estates contrasted slightly from a range of values earlier recorded for these areas by Oguntoke *et al.* (2019a).

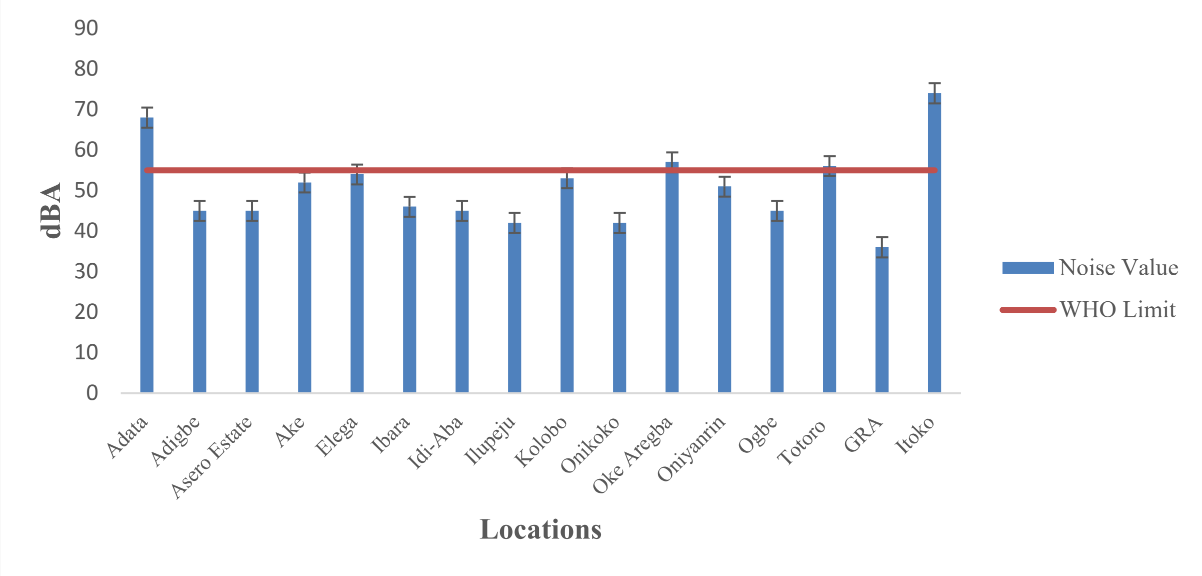

Fig. 2: Mean Noise concentrations for the residential areas

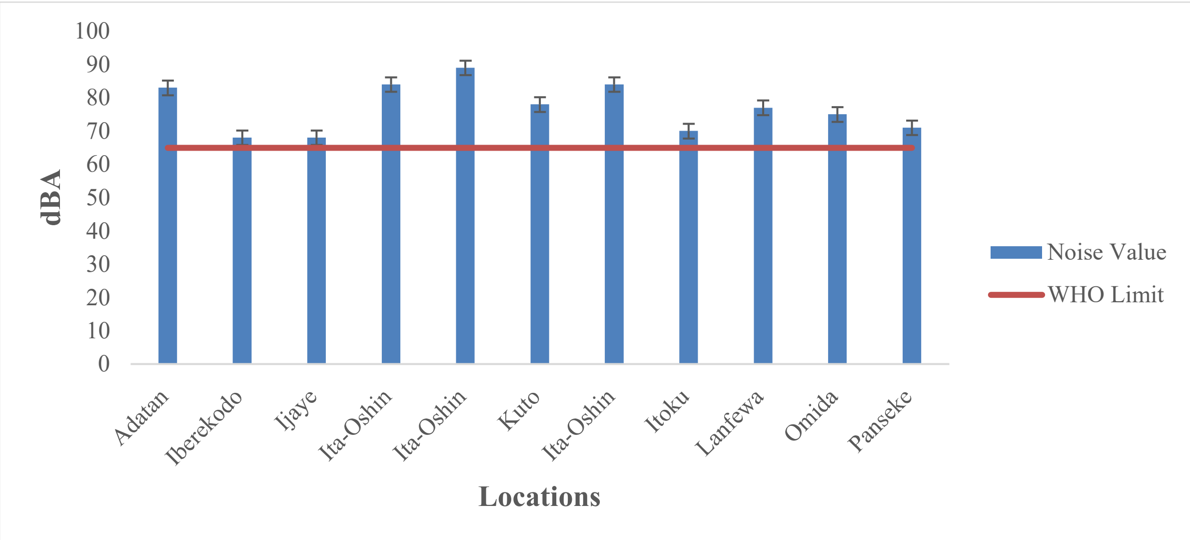

Fig. 3: Mean noise concentrations for the commercial locations

The concentration of the airborne gaseous pollutants in the different areas in the Abeokuta municipality was presented in Figures 4, 5, 6, 7, and 8. The CO values varied from 25 ppm for Asero estate which is a residential area to 74 ppm for Ita-Oshin. (Fig. 4). All the CO values were above the Federal ministry of environment (FMEnV) allowable airborne limits as reported by Obanya *et al.* (2018) (Fig. 4). SO_2 readings ranged from 0.02 ppm for several residential locations which included; Adigbe. Asero Estate, Elega, Idi-Aba, Ilupeju, GRA, Itoko, Oke Aregba, Ibara, and Oniyanrin to 0.50 ppm for Adatan and Ita-Oshin (Fig. 5). SO_2 values recorded for Adatan, Iberekodo, Ijaye, Ita-Oshin, Itoku, Lanfewa, Omida, and Panseke were above the FMEnV allowable limit. (Fig. 5). NO_2 values varied from 0.1 ppm for several areas which included; Adata, Adigbe, Asero Estate, Ake, Ibara, Idi-Aba, Ilupeju, Onikoko, Oke Aregba, Oniyanrin, Ogbe, Itoko and GRA to 0.4 ppm for Adatan and Ita-Oshin (Fig. 6). All the NO_2 values recorded for the locations were above the FMEnV stipulated limit (Fig. 6). The H_2S and CH_4 values ranged from 0.07 ppm for GRA and 0.07 ppm for Oniyanrin to 0.23 ppm for Ita-Oshin and 0.24 ppm for Ita-Oshin (Fig. 7 and 8).

The concentrations of gaseous pollutants were comparatively lower in the sampled residential areas than in the industrial and market locations. This trend could be attributed to lower vehicular movement around these areas in comparison to the industrial and commercial areas visited in this study. Olayinka *et al.* (2015) and Garba and Yunusa, (2016) reported that the source of outdoor airborne gaseous pollutants in Abeokuta and Kano metropolis, North Central Nigeria was vehicular exhaust emissions and observed high concentrations of these pollutants in municipal areas where the vehicular traffic was also high. The values of the gaseous pollutants observed at Kuto and Panseke in this study contrasted with seasonal values reported by Olayinka *et al.* (2015).

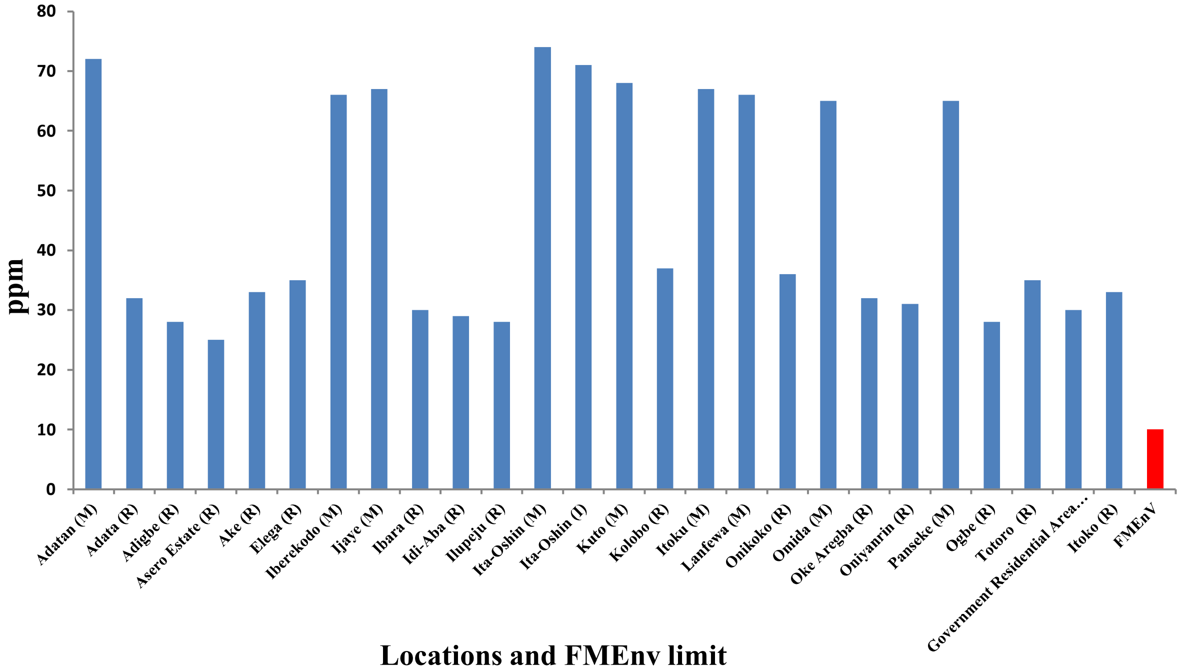

Fig. 4: Measured average levels of CO at the locations

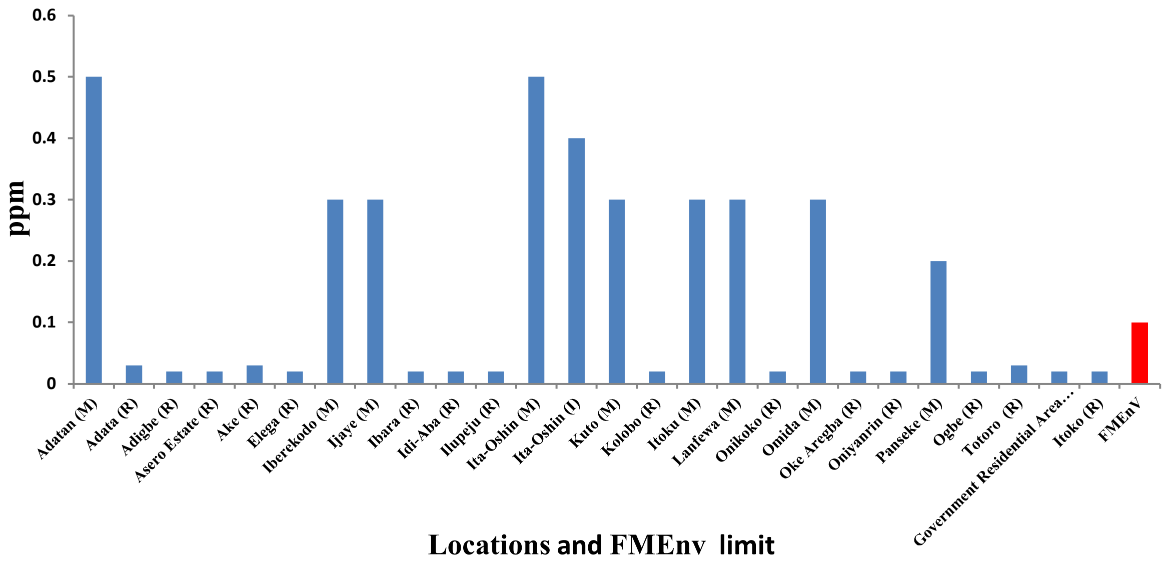

Fig. 5: Measured average levels of SO_2 at the locations

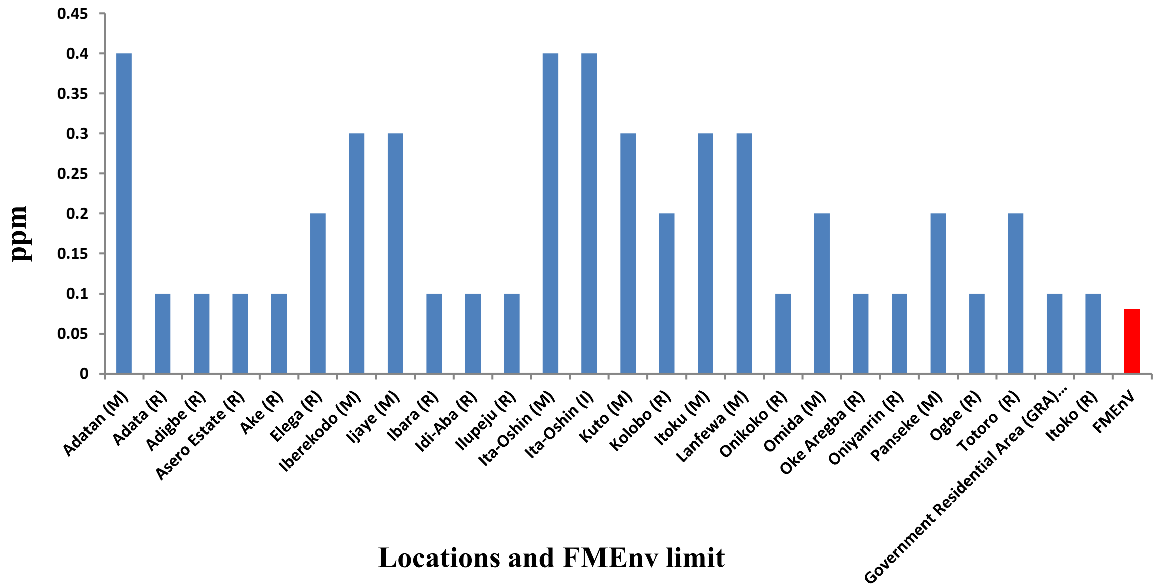

Fig. 6: Measured average levels of NO_2 at the locations

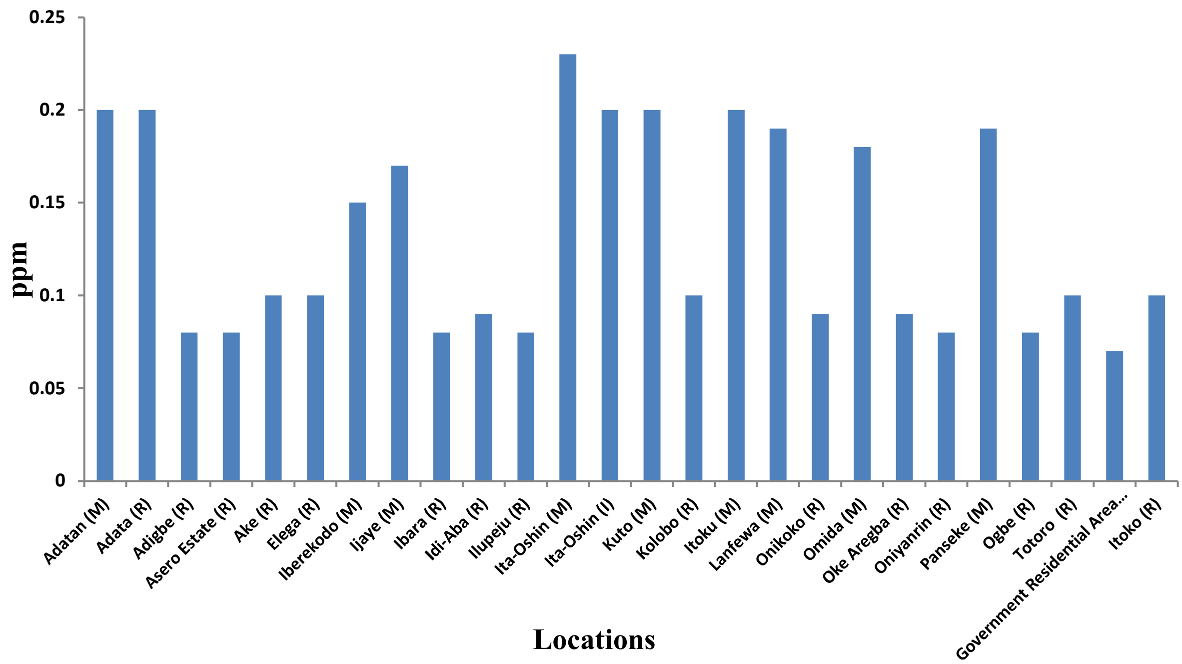

Fig. 7: Measured average levels of H_2S at the locations

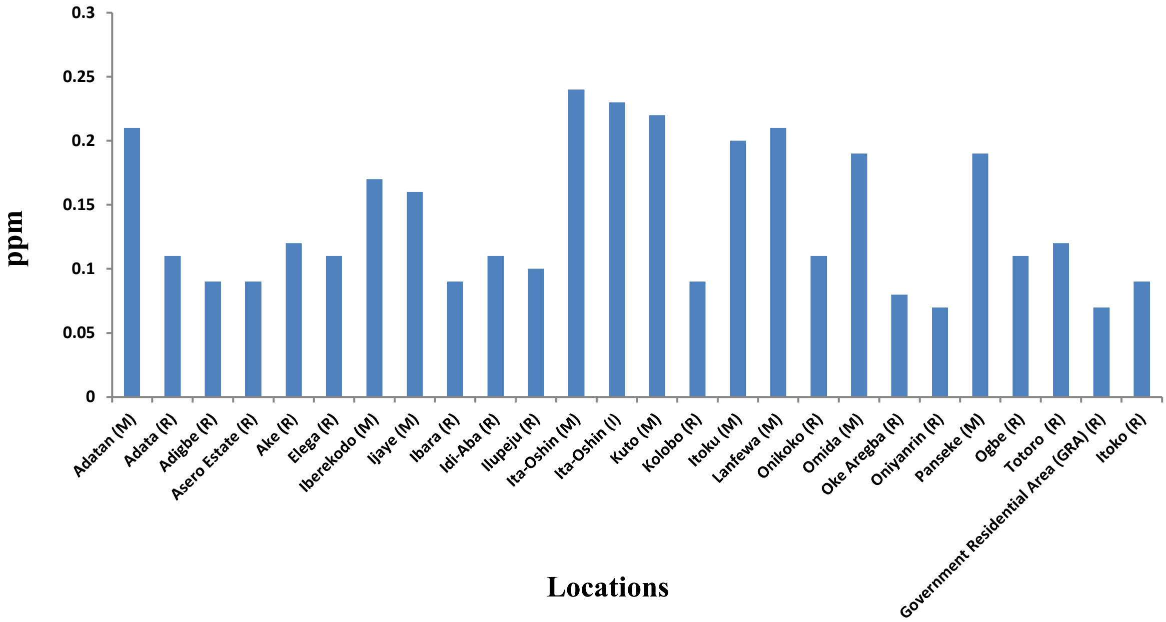

Fig. 8: Measured average levels of CH_4 at the locations

The AQI of three gaseous pollutants (CO, SO_2, and NO_2) as shown in Table 2 were derived to evaluate the level of health risks posed to individuals who either reside in the sampled areas (for the residential sites) or conducted their commercial business activities daily at the respective commercial locations. The AQI values associated with CO levels were above 201 and implied that CO levels were very unhealthy and hazardous (Table 1). This trend would indicate that the CO levels could pose a short and long-term health risk to exposed individuals. It is worthy to note that 18 sampled locations had "hazardous" CO AQI values and these sites were; Adatan (M), Adata (R), Ake (R), Elega (R), Iberekodo (M), Ijaye (M), Ita-Oshin (M), Ita-Oshin (I), Kuto (M), Kolobo (R), Itoku (M), Itoku (M), Lanfewa (M), Onikoko (R), Omida (M), Oke Aregba (R), Panseke (M), Totoro (R) and Itoko (R) (Table 2). The observation of some municipal areas within Abeokuta with hazardous CO levels in this study was in agreement with findings reported by Oguntoke *et al.* (2019b) who indicated similar observation in respect of some areas which included; Lanfewa and Eleweran located close to a sawmill and municipal dumpsites in Abeokuta. It has been stated that although AQI evaluation was not a direct assessment of the anthropogenic health impact of gaseous pollutants, it is a strong indicator of the potential detrimental impacts of air pollution on the health status of exposed individuals (Oguntoke *et al.*, 2019b). It has been reported that anthropogenic exposure to "moderate' airborne CO concentrations can cause symptoms ranging from throat irritation to headaches whilst exposure to "hazardous" CO levels, the inhaled gas can act as an asphyxiant *via* carboxyl-haemoglobin formation (Oguntoke *et al.*, 2019b).

Aside from Adatan (M), Iberekodo (M), Ijaye (M), Ita-Oshin (M), Ita-Oshin (I), Kuto (M), Itoku (M), Lanfewa (M), Omida (M) and Panseke (M) which had "unhealthy" and "very unhealthy" status, all the other location had nil SO_2 AQI status classified as good. As these sampled areas which were classified as "good" in terms of SO_2 AQI valuation were residential areas (Fig. 1), this trend would suggest that the evaluated SO_2 levels did not pose any risk to the health of the exposed individuals residing in the respective areas.

NO_2-related AQI values for the residential areas were all classified as "moderate" while aside from Adatan (M), Ita-Oshin (M), and Ita-Oshin (I) commercial areas which were generally "unhealthy", all the commercial locations were classified as "unhealthy for specific individual groups". A likely cause for this variation between the nitrate AQI levels for both sampled residential and commercial sites might be the differences in emission levels from vehicular exhausts and generating sets in these areas.

Table 2: AQI values for the measured gaseous pollutant at the municipal locations

Sample location	**AQI (CO)**	**AQI (SO_2)**	**AQI (NO_2)**
Adatan (M)	678	201	151
Adata (R)	301	0	51
Adigbe (R)	264	0	51
Asero Estate (R)	235	0	51
Ake (R)	311	0	51
Elega (R)	329	0	101
Iberekodo (M)	621	151	101
Ijaye (M)	631	151	101
Ibara (R)	282	0	51
Idi-Aba (R)	273	0	51
Ilupeju (R)	264	0	51
Ita-Oshin (M)	696	201	151
Ita-Oshin (I)	668	201	151
Kuto (M)	640	151	101
Kolobo (R)	348	0	101
Itoku (M)	631	151	101
Lanfewa (M)	621	151	101
Onikoko (R)	339	0	51
Omida (M)	612	151	101
Oke Aregba (R)	301	0	51
Oniyanrin (R)	292	0	51
Panseke (M)	612	101	101
Ogbe (R)	264	0	51
Totoro (R)	329	0	101
Government Residential Area (GRA) (R)	282	0	51
Itoko (R)	311	0	51

KEY: AQI: Air quality index, R; Residential, M; Market, I; Industrial.

1.3 CONCLUSION

The availability of clean outdoor air is a necessity for all living components of the environment. All the examined outdoor air envelopes surrounding the commercial areas are polluted with varying levels of gaseous contaminants and noise. Although the exposure rates of the individuals within these locations vary and are dependent on the length of time these persons spend in these locations, there is a need for intervention by relevant stakeholders. These stakeholders include Governmental tiers, agencies, and Non-Governmental agencies and possible intervention approaches could include; the re-location of motor parks that are sited very close to some of these markets such as Kuto and Panseke, the creation of more parking spaces around these commercial areas and sensitization of store owners and sellers on the health hazards of prolonged exposure to noise. The evaluated potential health risks to exposed individuals in these areas especially concerning CO concentrations were worryingly very high. In light of this trend, it is recommended that the Ogun State Ministry of the environment should in conjunction with members of the academia, especially from the Federal University of Agriculture who have conducted earlier research on the levels of environmental noise and gaseous pollutants conduct a comprehensive survey of air and noise pollution of circulating outdoor air in Abeokuta metropolis.

REFERENCES

Garba, M. D. and Yunusa, M. S. (2016). Assessing gaseous pollutants and air quality in some areas of Kano metropolis, Kano, Nigeria. *WIT Transactions on Ecology and The Environment*. 203, doi:10.2495/EID160121.

Ipeaiyeda, R. A. and Adegboyega, A. D. (2017). Assessment of air pollutant concentrations near major roads in residential, commercial, and industrial areas in Ibadan City, Nigeria. *Journal of Health and Pollution* 7(13): 11-21.

Njoku, K. L., Rumide, T. J., Akinola, M. O., Adesuyi, A. A. and Jolaoso, A. O. (2018). Ambient air quality monitoring in the metropolitan city of Lagos, Nigeria. *Journal of Applied Sciences and Environmental Management* 20 (1): 178-185.

Nwosisi, M. C., Oguntoke, O. and Taiwo, A. M. (2021). Dispersion Modeling of PM10 from Selected Flow Stations in the Niger Delta, Nigeria: Implications on Soot Pollution. *Environmental Systems Research* 10(9):

1 – 16. DOI: https://doi.org/10.1186/s40068-020-00207-z.

Obanya, E. H., Amaeze, H. N., Togunde, O. and Otitoloju, A. A. (2018). Air pollution monitoring around residential and transportation sector locations in Lagos mainland. *Journal of Health & Pollution* 8 (19): 1-10.

Oguntoke, O., Tijani, Y. A., Adetunji, O. R. and Obayagbona, O. N. (2019a). Spatial analysis of environmental noise and auditory health of Abeokuta residents, Ogun State, Nigeria. *Journal of Applied Science and Environmental Management 23* (9) 1699-1707.

Oguntoke, O. Emoruwa, O. F. and Matthew A. Taiwo, A. M. (2019b). Assessment of air pollution and health hazards associated with sawmill and municipal waste burning in Abeokuta Metropolis, Nigeria. Environmental Science and Pollution Research https://doi.org/10.1007/s11356-019-04310-2.

Olayinka, O. O., Adedeji, O. H. and Ajibola, F. O. (2015). Monitoring gaseous and particulate air pollutants near major highways in Abeokuta, Nigeria. *Journal of Applied Sciences and Environmental Management* 19 (4): 751 -758.

Usikalu, M.R. and Kolawole, O. (2018). Assessment of noise pollution in selected locations in Ota, Nigeria. *International Journal of Mechanical Engineering and Technology*, 9(9):1212–1218.

United States Environmental Protection Agency (USEPA) (2006). Guidelines for the reporting of daily air quality – the air quality index (AQI). Office of air quality planning and standards. EPA-454/R-99-010. Available at www.epa.gov/ttn/oarpg/t1/ memoranda/rg701.pdf