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Assessment of Noise Level from Selected Highways and Motor Parks in the Federal Capital Territory (FCT) Abuja

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Abstract:
This study determined the noise level of specifically selected Highways and Moto parks in the Federal Capital Territory (FCT) Abuja Nigeria, as compared with the regulatory permissible limit for noise exposure. These sources were studied at five specific locations each. A total of 10 locations were studied. Noise level was determined using the Noise Level Meter App (18.0). The minimum, maximum and average noise readings displayed on the noise meter were recorded at 4 sampling points per location. Readings were taken in the morning (7-10am), afternoon (12 noon-2 pm) and evening (5-7pm) per sampling point. Data were analyzed using Minitab 17.0. One Way ANOVA (Analysis of Variance) was applied while mean separation was done using the Fisher's method at P≤0.05 (95% confidence limit). The DNLs (Daytime Noise Level) of highways was 81.5 dB while motor park was 76.1 dB. All noise level parameters exceeded NESREA permissible limits of 65 dB limits and the WHO limit of 75 dB. Significant differences were recorded in noise levels readings at different periods of time (P<0.05) where morning (AMNL) and afternoon (AANL) readings were significantly higher than the evening (AENL) reading. Although nighttime noise level (NNL) was within the acceptable range, the NNL were higher at all motor parks including El-Rufai Park Nyanya (50.2 dB), Benue Links Park Area 1 Graki (49.6 dB), Pleasure Travels Park Mararaba (49.5 dB). Trees were either absent or low in density at motor parks but were in abundantly present at highways. This study found no relationship between noise level and presence of trees at designated places as R-values were very weak. There is need to apply appropriate noise reduction mechanism in the FCT as the seat of the Federal Government since the regulatory limits are exceeded. There is need for appropriate noise regulatory measures by relevant stakeholders in the environmental and health sectors.

Keywords: Noise Level, FCT, Highway, Motor parks, Regulation

INTRODUCTION

Noise pollution is an extensive environmental issue that affects millions of people worldwide (Gupta *et al.*, 2018). It refers to the excessive or disturbing noise that disrupts the normal functioning of human activities and has detrimental effects on physical and psychological well-being (Bragdon, 2016). Noise pollution can arise from various sources, including transportation systems, industrial activities, construction sites, and recreational activities. The increasing urbanization and industrialization of societies have amplified the problem, making noise pollution a significant concern for public health and quality of life (Singh, 2020). Excessive exposure to noise pollution has numerous adverse effects on human health. Prolonged exposure to high noise levels can lead to hearing loss, sleep disturbances, and increased stress levels. It can also contribute to cardiovascular problems, such as hypertension and heart disease (Basner *et al.*, 2014). Noise pollution can impair concentration, hinder productivity, and affect cognitive performance in both

adults and children. Additionally, it can cause annoyance, irritability, and a reduced sense of well-being, impacting overall quality of life (Gupta *et al.,* 2018).

The noise pollution situation in the Federal Capital Territory (FCT) is similar to that in many urban areas. The city is relatively large, having rapid increase in population growth rate. The population the city has expanded continuously in all directions in the past two decades. Many significant changes have been experienced in terms of urbanization, industrialization, expansion of road-network, and infrastructure. The city has been subjected to persistent road traffic and commercial activities due to overall increase in prosperity, fast development, and expansion of the economy (Gadanya and Buhari, 2021). A study by Ibekwe *et al.* (2016) revealed a progressive encroachment and unauthorized conversion of many residential areas in Abuja into business outlets have had consequent increase in human and vehicular traffic.

The Federal Capital Territory Abuja is becoming expanded, heavily populated, and noisy. Major causes of noise pollution identified in many commercial cities are on the increase in the FCT due to urbanization and industrialization, not minding the nature of the Abuja Master Plan. There are increasing numbers of markets, motor parks, worship centers, vehicular movement, traffic congestion, mechanic villages and schools in the FCT. The volumes of noise generated by these sources have not been fully investigated in the study area. It is not certain if the noise levels have exceeded the permissible limits of the World Health Organization (WHO) and the National Environment Standards and Regulations Enforcement Agency (NESREA). This dearth of robust data may hinder appropriate control measures. Depending on its duration and volume, the effects of noise on human health and comfort are divided into four categories: physical effects (such as hearing defects), physiological effects (such as increased blood pressure, irregularity of heart rhythms and ulcers), psychological effects (such as disorders and sleeplessness, irritability and stress) and finally effects on work performance and productivity (Gadanya and Buhari, 2021). The aim of the present study was to assess the noise level generated at highways and motor parks in the Federal Capital Territory (FCT) Abuja and and compare to the permissible limit of the WHO and NESREA

MATERIALS AND METHODS

Study Area

The study was carried out in Abuja, the Federal Capital Territory (FCT) and its environs (10.44594^{0}N, 7.1811^{O}E) in North Central Nigeria. The study was carried from March to September 2023. The study area is the seat of Federal Government of Nigeria designed to accommodate government Ministries, Agencies, and Parastatals. The boundary States are Nasarawa, Niger, Kogi and Kaduna States. The FCT consists of six Area Councils: Abaji, AMAC, Bwari, Gwagwalada, Kuje, and Kwali (Abuja Geographic Information System -AGIS) The temperature ranged from 23.5^{o}C in the night to 39.2^{o}C during at daytime with an elevation of 273m above sea level. The map of the study area is shown in Figure 1.

Study Design

The study targeted two (2) potential sources of noises designated as: Highway and Motor parks. These sources were studied at five specific places chosen based on their potentials to generate noise within the study area. A total of 10 locations were studied. Coordinates were taken using the Coordinate Application downloaded from Google Play Store. Table 1 gives the description of the 10 locations of the 2 designated sources of noise including their codes and coordinates.

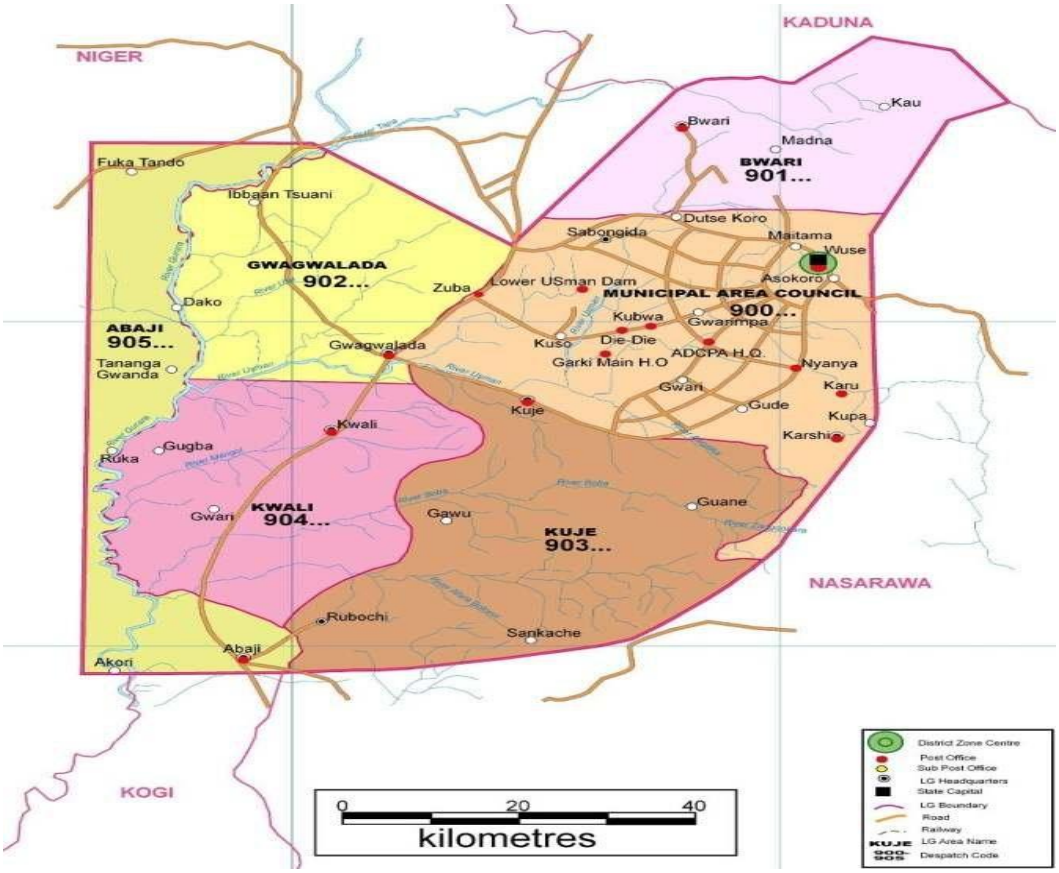

Figure 1: Map of the Study Area (Abuja Geographic Information System -AGIS)

Table 1: Study Locations and Coordinates

Designation	Code	Location	Coordinates
High Way-1	AHW-1	Shehu Shagari Way, Maitama	E-7.4952838/N-9.0704454
High Way-2	AHW-2	Olusegun Obasanjo Way, Wuye	E-7.469609/N-9.053600
High Way-3	AHW-3	Ibrahim Babangida Way, Wuse	E-7.484241/N-9.076242
High Way-4	AHW-4	Zuba-Kubwa Express Way	E-7.428019/N-9.304604
High Way-5	AHW-5	Murtala Mohammed Express Way	E-7.330934/N-9.142231
Motor Park-1	AMP-1	El-Rufai Park Nyanya	E-7.572863/N-9.004531
Motor Park-2	AMP-2	Jabi Motor Park- Jabi	E-7.423680/N-9.060280
Motor Park-3	AMP-3	Benue Links, Area 1, Garki	E-7.485015/N-9.033834
Motor Park-4	AMP-4	Zuba Motor Park, Zuba	E-7.087496/N-8.940141
Motor Park-5	AMP-5	Pleasure Travels Park, Mararaba	E-7.424033/N-10.445949

Noise Level Determination

Noise level was determined using the Noise Level Meter App (18.0) downloaded from the Google Play Store (Figure 3) into a Mini tablet (*Itel* android). The method of Ibekwe *et al.* (2016) was adopted where use of mobile phones noise level app was validated for environmental sound level measurement. Validation was further carried out through the use of three different android phone to obtain synchronous values. The phones were held 1.5 meters above ground levels at each sampling point for uniformity in measurements, Readings were taken from 4 sampling points at each location, 5 minutes per sampling point (Oyedepo *et al.*, 2019). Noise level was determined from a total of 140 points (7 designations x 5 places x 4 points). This is equivalent to 35 locations and 4 points per location. The minimum, maximum and average noise readings displayed on the noise meter were recorded at each sampling point. Daytime readings were taken for all

designated places in the morning (7-10am), afternoon (12 noon-3 pm) and evening (5-8pm) per sampling point (Oyedepo *et al.*, 2019). Nighttime (12- 2pm) readings were carried out. Data were collected from Monday-Saturday except at worship centers. In the latter, data were collected on Sunday only during church service in the morning/afternoon, evening and night because some church services extended into the afternoon session. Hence morning/afternoon was assessed together. Large crowded worship centers were targeted.

Noise Data Collection

The collected were entered into the field log book and transferred into the Microsoft Excel Workbook (Window 2010) for arrangements and computation of parameters. The following noise parameters were computed in decibels (dB): AMNL (Average Morning Noise Level), AANL (Average Afternoon Noise Level) and AENL (Average Evening Noise Level) The DNL (Daytime Noise Level) was computed as average of AMNL, AANL and AENL while MNLR (Maximum Noise Level Recorded) was recorded as the highest value of noise reading taken within 5 minutes at a location. Nighttime noise level (NNL) was taken as a single parameter

Data Analysis

Data were analyzed using Minitab 17.0. One Way ANOVA (Analysis of Variance) was applied while mean separation was done using the Fisher's method at P≤0.05 (95% confidence limit). Chi-Square distribution was computed to determine association between noise level and locations. Pearson's correlation analysis was applied to determine the relationship between noise level and tree density. Results were presented in tables, box plots and bar graphs. Noise level parameters were compared with regulatory permissible limits of exposure as given by WHO and NESREA.

RESULTS

Noise Level Parameters at Highways

Table 2 shows day time noise level parameters at 5 busy highways (AHW1- AHW5) in the FCT Abuja. The Average Morning Noise Level (AMNL) was 82.3 - 84.5 dB and all values were higher than the WHO and NESREA limits of 75 dB and 65 dB respectively. The Average Afternoon Noise Level (AANL) ranged from 81.1 to 82.5 dB, and all values were higher than the regulatory limits of exposure. The Average Evening Noise Level (AENL) readings were between 78.5-80.5 dB and were all found higher regulatory permissible limit. Significant differences were recorded in noise levels readings at different periods of time ($F=34.61$, $P<0.05$) where morning noise readings (83.2 dB) were significantly higher than afternoon (81.8 dB) and evening time (79.4 dB) (Figure 2). The Daytime Noise Level (DNL) readings ranged from 81.1 dB at AHW1 (Shehu Shagari Way, Maitama) to 82.0 dB at AHW3 (Ibrahim Babangida Way, Wuse). Results showed that DNL values were statistically the same at the five highways ($F= 0.10$, $P>0.05$) and were found higher than regulatory permissible limit. The highway locations had Maximum Noise Level (MNL) readings of 108.1 -186.6 dB above WHO and NESREA limits

Table 2: Day Time Noise Level Parameters along Highways in the FCT

High Way code	Location	AMNL dB	AANL dB	AENL dB	DNL dB	MNL dB	NNL dB	WHO PL dB	NESREA PL dB
AHW1	Shehu Shagari Way, Maitama	83.3	81.4	78.5	81.1[a]	186.6	NA	75	65
AHW2	Olusegun Obansanjo Way Wuye	82.6	81.6	79.4	81.2[a]	148.2	NA	75	65

AHW3	Ibrahim Babangida Way, Wuse	84.5	82.5	79.0	82.0[a]	108.1	NA	75	65
AHW4	Zuba-Kubwa Express Way	83.4	81.1	79.5	81.3[a]	129.0	NA	75	65
AHW5	Murtala Mohamed Express Way	82.3	82.3	80.5	81.7[a]	149.6	NA	75	65
		83.2[a]	81.8[b]	79.4[c]					

F (Daytime Noise Level Vs Locations) = 0.10, P= 0.979 (P>0.05)
F (Daytime Noise Level Vs Period) = 34.61, P= 0.000 (P<0.05)

Legend:
AHW= Abuja High Way
AMNL= Average Morning Noise Level
AANL= Average Afternoon Noise Level
AENL= Average Evening Noise Level
DNL= Daytime Noise Level
MNLR = Maximum Noise Level Recorded
PL= Permissible Limit

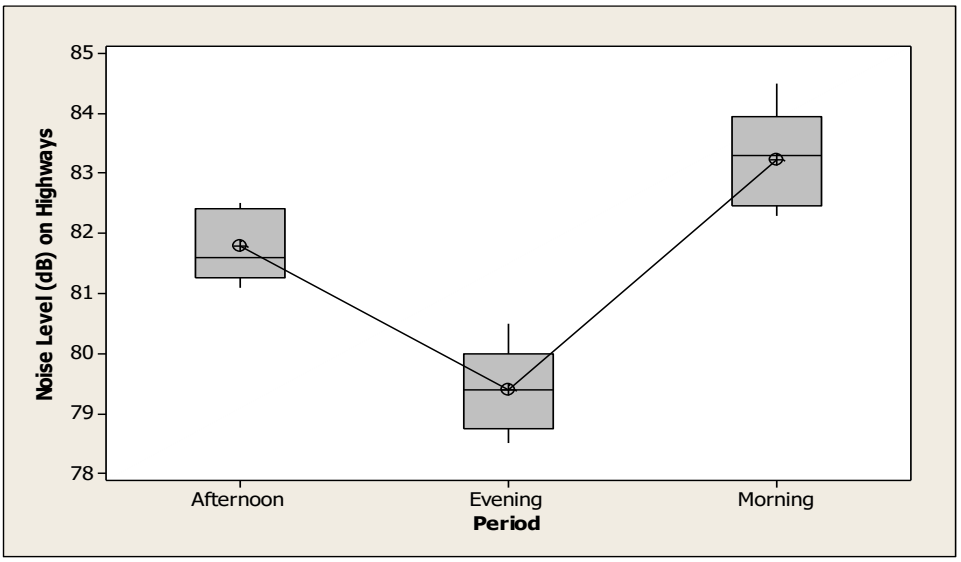

Figure 2: Box Plot of Periodic Noise Level at Highways in the FCT

Noise Level Parameters at Motor Parks

Table 3 gives the day time noise level parameters at 5 motor parks (AMP1- AMP5) in the FCT Abuja. The Average Morning Noise Level (AMNL) was 78.7 – 80.0 dB and all values were higher than the WHO (75 dB) and NESREA (65 dB) limits. The Average Afternoon Noise Level (AANL) ranged from 74.0 to 75.3 dB, and they were found above the NESREA (65 dB) limits and only AMP1 (the El-Rufai Park Nyanya) had its AANL above the WHO (75 dB) limit of exposure. The Average Evening Noise Level (AENL) readings were in the range of 72.7-76.3 dB and were all found above the NESREA (65 dB) limits while two parks (AMP1 and AMP2) had their AENLs higher than the 75 dB maximum limit as recommended by the WHO. Significant differences were recorded in noise levels readings at different periods of time (F=52.0, P<0.05) where morning noise readings (79.4 dB) were significantly higher than other periods, although the afternoon (74.4 dB) and evening noise levels (74.4 dB) were the same (Figure 3). The Daytime Noise Level (DNL) readings ranged from 75.4 dB at AMP-5 (Pleasure Travels Park Mararaba) to 77.1 dB at AMP1 (El-Rufai Park

Nyanya). Results showed that DNL values were statistically the same at the five motor parks (F= 0.17, P>0.05) and that values were found higher than the WHO (75 dB) and NESREA (65 dB) limits. The Maximum Noise Level (MNL) was at the highest peak at the El-Rufai Park Nyanya (183.8 dB) while the lowest MNL was recorded at Zuba Motor Park (91.3 dB). The recorded MNLs were above the regulatory limits of exposure. However, Nighttime Noise level (NNL) of 44.6-50.2 dB recorded at parks was below the permissible limit.

Table 3: Day Time Noise Level Parameters at Motor Parks in the FCT

Motor Parks code	Location	AMNL dB	AANL dB	AENL dB	DNL dB	MNL dB	NNL dB	WHO PL dB	NESREA PL dB
AMP-1	El-Rufai Park Nyanya	79.7	75.3	76.3	77.1[a]	183.8	50.2	75	65
AMP-2	Jabi Motor Park	80.0	74.2	75.1	76.4[a]	122.4	44.6	75	65
AMP-3	Benue Links Area 1, Garki	79.3	74.0	73.7	75.7[a]	130.2	49.6	75	65
AMP-4	Zuba Motor Park	78.7	74.4	74.0	75.7[a]	91.3	48.1	75	65
AMP-5	Pleasure Travels Park Mararaba	79.3	74.1	72.7	75.4[a]	109.1	49.5	75	65
		79.4[a]	74.4[b]	74.4[b]					

F (Daytime Noise Level Vs Locations) = 0.17, P= 0.949 (P>0.05)
F (Daytime Noise Level Vs Period) = 52.00, P= 0.000 (P<0.05)

Legend:
AMP= Abuja Motor Parks
AMNL= Average Morning Noise Level
AANL= Average Afternoon Noise Level
AENL= Average Evening Noise Level
DNL= Daytime Noise Level
MNLR = Maximum Noise Level Recorded
PL= Permissible Limit

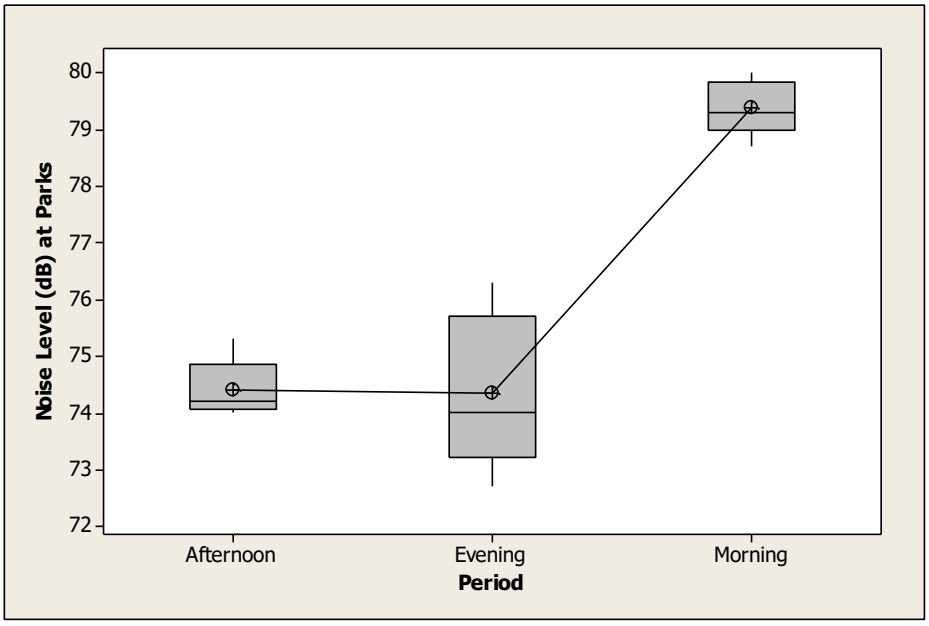

Figure 3: Box Plot of Periodic Noise Level at Motor Parks in the FCT

DISCUSSION

The present study has determined the noise level at seven designated noise sources within the Federal Capital Territory Abuja and its environs. The detemination of noise level using validated mobile/tablet application software has achieved good results as prevuously recommended in monitoring environmental noise (Maisonneuve *et al.,* 2010; Leao *et al.,* 2014; Ibekwe *et al.,* 2016). Noise level from five designated sources calls for serious concern as it is found above permissible limits. Among the implicated sources of noise that exceeded the WHO/NESREA limits, highways (81.5 dB) came top. Wuse area was was found to be very noisy as daytime noise level was 81.5 dB in highways thereby exceeding WHO/NESREA noise limits. The proximity of residential areas to busy roads could intensifies the impact of transportation-related noise pollution on individuals (Mobasseri and Soltani, 2014). Cars, trucks, motorcycles, and buses generate significant noise levels due to engine noise and tire friction,

The above findings could have serious implications on the wellbeing of those working and living in the FCT and it environ due to frequent exposure to noisy environment. Many studies have reported the ill effects of excessively high noise level on human health among which are hearing loss, sleep disturbances, increased stress levels and cardiovascular problems, such as hypertension and heart disease (Basner *et al.,* 2014; Ibekwe *et al.,* 2016). It was also reported that it could impair concentration, hinder productivity, affect cognitive performance in both adults and children and cause annoyance thereby reduce the overall quality of life (Gupta *et al.,* 2018). Sorensens *et al*. (2011) noted that a 10dB increase in chronic exposition of noise in humans increases the risk of cardiovascular accident (CVA) by 14% and systolic blood pressure appreciation by 0.26mmHg. This was confirmed by Erikson *et al*. (2012) who stated that a persistent noise level ≥50dB is associated with the risk of cardiovascular disease.

The FCT environment, as the seat of the Federal Government of Nigeria which accommodates all public parastatals, is expected to be serine and peaceful because it is where decision making and governmental activities that affect the entire nation takes place. A study by Ibekwe *et al.* (2016) revealed a progressive encroachment and unauthorized conversion of many residential areas in Abuja into business outlets have had consequent increase in human and vehicular traffic. The present study is in agreement with outcome of other previous assessment of noise level in commercial nerves of Yenagoa metropolis, South-South Nigeria (Arokoyu *et al.,* 2016); Ota South West Nigeria (Usikalu and Kolawole, 2018) and Makurdi North Central (Ugwuanyi *et al*., 2004). On the contrary, Oyedepo *et al.* (2019) carried out noise level measurement at 41 different locations in Ota metropolis, Nigeria where they obtained 96 dB at commercial areas. Anomohanran *et al*. (2008) also found that the peak noise level at road junction in Abraka, Nigeria to be 100 dB(A).

Motor parks came second as source of noise in the FCT as the daily noise level of 76.1 xceeded both WHO and NESREA limit. The five motoparks genetated much noise beyond the regulatory limits in the FCT. The daytime noise level was 76.1 dB where it was as high as 80.0 dB in the morning time. Noise is generated from public address system that calls help travelers locate the buses they are travelling with. Noise is also generated from high volume of vehicular movement in and out of the park, and those generated among the travelers and those selling their goods within the parks. Daytime noise level of was 77.1 dB at El-Rufai Park Nyanya was the highest recorded. The worst hit are the traders who are exposed to this noise level for more than 8 hours in aday and those who help drivers/passengers load their goods. The daily crowd witnessed in the park could be a reflection of the human population in the city especially in the Nyanyan, Mararaba, Karu and Jikwoyi areas. This finding is in tandem with some reports that the Abuja

environs or outskirts are densely populated (Ibekwe *et al.,* 2016). This may therefore account for the high volume of traffics entering into the FCT on daily basis, thus imparting on the high noise level recorded.

The present study foulnd that noise generated in the morning and afternoon time was more than than the eveining noise. This could be attributed to the high volume of activities within the FCT in the morning and afternoon that exceeded regularory limits. However, night time noise level was found within normal values typical of a serine city. The identified sources of noise in this study are in tandem with other reports (Andringa and Lanser, 2013; Gadanya and Buhari, 2021). It is identified that automobiles, motorcycles, vehicular traffic, pressure horns, construction or industrial noise, machinery noise, electricity generating plants, and noise from religious worship are some the factors responsible for most of the noise experienced in Nigeria (Gadanya and Buhari, 2021). This outcome was also in tandem with the work of Anomohanram (2013) who recorded 83dB(A) in Abuja. To a large extent, the present investigation aligned with previous study by Ibekwe *et al.* (2016) who found 73 to 92dB(A) in Abuja municipals where day time noise levels at market and motor park areas of the Abuja municipality were generally high and mostly unsatisfactory. The authors found that the Jabi Park/Market was the nosiest part of the municipality mainly due to the very high human and vehicular activities within this confine. The noise level around the business areas and motor-parks in Abuja municipality has reached an unsatisfactory threshold and needs urgent attention. In this work, Jabi motopark was the second noisiest park after El-Rufai Park Nyanya. The rapid migration of internally displaced citizens as a result of insurgency and terrorism in the North-East, and daily migration of people into the city for business, contracts and greener pasture is believed to have increased human population in Abuja and its environs (Ibekwe *et al.,* 2016).

CONCLUSION

The outcome of noise levels from the two designated sources calls for serious concern as they were found above regulatory permissible limits. These include the highways (81.5 dB) and motor parks (76.1 dB). Noise was higher in the morning and afternoon than in the eveining. All nighttime readings were satisfactory. Noise levels that exceeded the regulatory permissible limits as astated above could have serious implications on the well-being of those working and living in the FCT and it environ due to frequent exposure to noisy environment. The noise data in this study are useful as reference and guideline for future regulations on noise limit to be implemented for FCT and other urban cities in Nigeria.

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