African Journal of
Medicine, Surgery and Public Health Research

ISSN: 1595-8000

Index: Harvard, Boston, Sydney University, Dimensions, Lens, ResearchGet Scilit, Semantic, Google Scholar, Base etc

https://doi.org/10.58578/AJMSPHR.v3i3.11792

Day-Time and Night-Time Noise Level from Base Transceiver Stations (BTS) and Its Health Effects in Wukari, Taraba State

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Article Info:

Submitted:	Revised:	Accepted:	Published:
Jun 10, 2026	Jul 28, 2026	Aug 9, 2026	Aug 14, 2026

Abstract

Environmental noise pollution poses a substantial threat to public health and well-being, yet noise generated by diesel generators at base transceiver stations (BTSs) often remains inadequately controlled. This study assessed daytime and nighttime noise levels from BTS diesel generators in residential areas of Wukari, Nigeria. A longitudinal research design was employed, and noise levels were measured using a GM1352 digital sound-level meter. The recorded values were evaluated against World Health Organization (WHO) and National Environmental Standards and Regulations Enforcement Agency (NESREA) limits of 40 and 45 dB(A), respectively, for nighttime and 50 and 65 dB(A), respectively, for daytime. At night, Location 22 recorded the highest mean noise level at 71.9 dB(A), whereas Location 10 recorded the lowest at 55.2 dB(A); both values exceeded the WHO and NESREA limits. During the day, Location 22 recorded the highest noise level at 67.4 dB(A), exceeding both standards, while Location 8 recorded the lowest at 56.8 dB(A), which exceeded the WHO limit but remained below the NESREA limit. These findings

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demonstrate that BTS diesel generators contribute to noise pollution in residential areas of Wukari, potentially exposing nearby residents to adverse effects such as sleep disturbance, insomnia, stress, and headaches. The study underscores the need for telecommunications operators to adopt quieter and more sustainable energy sources, including solar power, and for regulatory agencies to enforce appropriate setback distances and noise-control measures around BTS installations in residential areas.

Keywords: Base Transceiver Stations; Daytime and Nighttime Noise; Diesel Generators; Environmental Noise Pollution; Public Health

INTRODUCTION

From the beginning of the universe, noise has been part of the universe in different forms. Human development in all its forms is always accompanied by noise; sometimes the noise is unchecked, which has an effect on all living things. Noise is an unavoidable part of our daily activities and has always become a major burden on the quality of our lives. In most developed and developing countries, noise is all around us, making up a part of environmental pollution. Noise in physics is referred to as unpleasant sound levels that cause or create disturbing vibrational sensations in the auditory nerves of the human ear. Sound is measured in decibels (dB). A-weighting is applied to a sound spectrum to represent the sound that humans are capable of hearing at each frequency. The frequency range at which humans can hear is between 20 Hz and 20 kHz but can vary from individual to individual. Noise as a word is often used to mean unpleasant sound that the listener does not want to hear (Plog & Quinlan, 2002). In physics, noise is indistinguishable from sound, as both are vibrations through a medium, such as air or water; the difference arises when the brain receives and perceives a sound (Glenn, 2016). Sound is measured based on the amplitude and frequency of a sound wave (Patrick & Peter, 2006). There are problems associated with technological development made by man in the modern era that are not receiving enough attention; noise pollution is one such problem. Noise is known as unwanted and irritating sound, a form of environmental pollution, and a source of stress, and loud noises are harmful and impact negatively the quality of the built environment (Ganiyu & Ogunsote, 2010).

In order to have maximum network coverage, Base Transceiver Stations (BTS) or Repeater Stations (RS) are usually located in close proximity to the targeted users; this is the

main reason telecomm operators site their BTS/repeaters in residential neighborhoods (Michael, Nnaemeka, & Matthew, 2013). Following the increase in the number of subscribers in Nigeria, the number of BTS has rapidly increased from less than 80 in 2001 to about 44,000 in May 2014 (NCC 2014). This growth has a high demand for diesel generators to power base stations in order to provide network service; in the process of solving a problem, intentionally or unintentionally create more problems (Aderoju et al., 2013). The poor electricity supply from the national grid in Nigeria is very low, and the supply is not steady and the national electrical grid regularly collapsed hence increasing the demand for alternative power supply. With this, telecommunication companies have mostly been using diesel generators to power their repeater stations in order to provide their million subscribers with network services. For subscribers to have access to a good network at all times, this implies that the base/repeater station must be powered ON by using a diesel generator (Aboche, Chagok, & Yusuf, 2018).

Electricity-generating plants are among the main sources of noise pollution in Nigeria. To effectively deal with the problem of noise pollution, there is a need to first identify the sources of noise, and the major sources of noise can be broadly divided into two: external and internal sources (Ogunsote, 1991). The outdoor sources of noise have a larger share compared to indoor sources when it comes to polluting the environment. According to the acoustic glossary, the hours of 7:00 to 19:00 are the day noise level, and the hours of 23:00 to 7:00 are the night noise level. In Nigeria, the National Environmental Standard and Regulation Enforcement Agency (NESREA) was established by an act in 2007. NESREA defines daytime from 6:00am to 10:00pm and nighttime from 10:00pm to 6:00am (NESREA, 2011). NESREA permissible noise regulation: for semi-residential, noise level ranges from 50 – 65 dBA during the daytime and 35 – 50 dBA at night (NESREA 2011). The WHO guideline for community noise level was revised in 1999; it recommends a nighttime L_{eq} of 30 dBA, and a peak of 40 dBA or more should be avoided. During the daytime, the recommended noise limit is 50 dBA LA_{eq} (WHO, 1999). Noise generated from the diesel generators at base/repeater stations has gone unchecked for a very long time now; the damages incurred seem almost irreparable. Noise disturbs sleep by a number of direct and indirect pathways. Even at very low levels, physiological reactions (increase in heart rate, body movements, and arousals) can be reliably measured (W.H.O. 1999). Noise-Induced Hearing Loss (NIHL) occurs when a human is exposed to one-time exposure or continuous exposure to noise > 80 dBA over an extended period of time.

Studies on electricity demand, especially by the Energy Commission of Nigeria (ECN), have shown that even with the ongoing efforts, the installed generation capacity will not be able to meet the requirements of the projected growth rate of the country for attaining the Millennium Development Goals (MDGs) and the recent Vision 2020 (N.C.C. Act 2003), therefore, noise pollution will be around for a while.

There is existing evidence indicating that noise pollution has negative impacts on human health, which justifies research in order to provide better understanding of noise pollution problems and control (Georgiadou, Kourtidis & Ziomas, 2004). Noise pollution has been stated as a serious health hazard, with noise-related damage to humans ranging from annoyance to difficulty in falling asleep and high blood pressure (Ugwuanyi, Ahemen, & Agbendeh, 2004; Saadu et al., 1998; Ahmad, Abbas & Reem, 2006; Schwela & Zali, 1999). The effects of noise pollution on human beings and their environs are as follows: Stress and insomnia It causes blood pressure: - Noise pollution causes certain diseases in humans etc. (W.H.O., 1999; Schwela & Zali, 1999). Noise affects a person's peace of mind. Noise is recognized as a major contributing factor in increasing the already existing tensions of modern living. These tensions result in certain diseases, like high blood pressure, mental illness, etc. Temporary or permanent deafness: - The effect of noise on audition is well recognized (W.H.O. 1999). Physicist, Physicians & Psychologists are of the view that continued exposure to noise level above 80 to 100 dB is unsafe; loud noise causes temporary or permanent deafness (Aderoju, et al., 2013). Other studies show insomnia and psychiatric conditions, a risk predictor of strokes and heart attacks, linearly increase with total and/or partial sleep loss (W.H.O. 1999). Every noise level has a frequency; from the equation 1 below:

$$f_{mn} = \frac{1}{2\pi}\frac{j_{mn}}{a}\sqrt{\frac{T}{\rho}} \quad \text{Eq. 1}$$

it can be seen that the vibrational frequency (f) is inversely proportional to the radius (a) of the membrane. The vibrational frequency is inversely proportional to the square root of the density ϱ. The vibrational frequency is also directly proportional to the square root of the tension T (Teru et al., 2019). The relationship between frequency and period of sound shows that a high-intensity noise level has a high effect on the ear as it causes short or long time. Induced hearing loss. The aim of this study is to measure the noise level from diesel generators from all repeater stations within Wukari town for daytime from 7am to 6pm and nighttime from 8pm to 6am and to compare it to NESREA

or WHO thresholds if the noise levels are below or above the NESREA or WHO permissible noise level standards for residential areas. Environmental noise is a threat to public health, having negative impacts on human health and well-being (Ahmad, Abbas & Reem, 2006). The lack of data on the level of noise generated from diesel generators from repeater stations is lacking in most developing nations, including Nigeria. This research provides a recent noise measurement level from the base station within Wukari town, which will help in understanding the noise level and its impact on the residents around the repeater station in Wukari by day and night. The extent of noise generated from diesel plants has a serious adverse effect on human health and the environment as a whole. Hence, there is a need to monitor and manage the level of noise in our environment for health reasons and also for our environmental sustainability.

MATERIALS AND METHOD

The materials used for the collection of noise levels from diesel generators at base stations within Wukari town are a GARMIN 72H GPS device, a BENETECH Digital Sound Level Meter (Model GM 1352), etc. The study used a longitudinal research method for data collection. The field measurements readings were taken from each BTS from 7am to 6pm for daytime noise level and 7pm to 5am for night-time noise level at different BTS within Wukari. At each base station, the maximum and minimum noise levels from the diesel generators were measured and recorded using a sound level meter at a height of 1.6 meters using a baton. The readings were taken at an interval of 2 to 10 meters from the four-square sides of the base stations. The distance away from the base station depends on the buildings around the base station. In some cases, residential buildings share the same perimeter fence with the base station. Two sets of values for the maximum and minimum noise levels were recorded for each point; the mean readings were also taken to reduce possible errors and also increase the accuracy of the readings. Daytime and night-time noise levels were taken within the stipulated time. Figure 1 shows a digital sound level meter and a base station or base transceiver station (BTS) with equipment found within the perimeter fence, such as A = Tower, B = Antennas, C = Routers/switch house, D = Diesel generator, E = Reserve tank, F = House, and G = Gate and perimeter fence around the BTS. Table 1, below, shows the location information, such as northings, eastings, and the elevation of all the base station points in Wukari town. The study area is Wukari town,

which is the Wukari Federation, a traditional state for the Jukun people; Wukari is a Local Government Area in Taraba State, Nigeria. It covers an area of 4,308 square kilometers and a population of 241,546 as at the 2006 census. It lies between Latitude 7° 51' 17.00″N and Longitude 9° 46' 40.30″E.

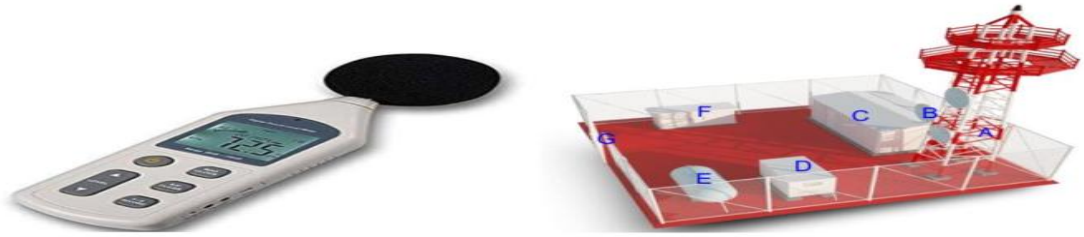


Figure 1: Digital Sound Level Meter and Base transmitter station or Repeater station (BTS)

RESULTS

The results for the daytime and night-time noise levels are presented in tables; a sample of measured and recorded noise levels from the T-junction area in Wukari and other similar readings were taken for all the base stations within Wukari. Table 1 shows a sample of noise level readings for a T-junction that was taken and recorded, and Table 2 shows a sample of a day and night min/max noise level taken at Location 11 (T-junction area, Wukari). Table 3 shows the location information, network name, and types of generators at each BTS. Table 4 shows the mean minimum and maximum noise levels from each BTS by daytime and at night-time, and Table 5 shows the mean noise level only for each base transceiver station (BTS) by daytime and night-time. The analysis of the results for the measurements of noise levels at base stations by daytime and at night-time in Wukari are presented in the figures below. The mean noise levels during the day and at night for each BTS in the study area are shown in Figure 2. WHO/NESREA standard was compared to the daytime mean noise level from each BTS in Wukari in Figure 3A, and the WHO/NESREA standard was compared to the night-time mean noise level from each BTS in Wukari in Figure 3B. The mean day and night-time noise levels from every BTS in the research area were shown in descending order in Figures 4A and 4B. All BTS daytime and night-time mean noise level was compared to W.H.O. standards in Figure 5A, whereas Figure 5B show BTS daytime and night-time mean noise level was compared to NESREA standards.

Table 1: Sample Noise level reading from T-Junction Area Wukari

Location 11 : T-Junction Area Wuk			Generator Type: ASCOT HYBRID					
NETWORK:MTN Nigeria			GENERATOR: ON					
Distance (m)	Point 1		Point 2		Point 3		Point 4	
	Min(dBA)	Max(dBA)	Min(dBA)	Max(dBA)	Min(dBA)	Max(dBA)	Min(dBA)	Max(dBA)
0	75.4	81.2	66.0	77.3	58.3	72.9	59.2	70.8
2	71.9	78.9	63.8	73.4	56.4	70.8	55.5	70.1
4	House	House	62.1	71.6	55.4	67.8	54.8	69.8
6	House	House	61.4	70.5	House	House	54.0	70.7
Last	60.6	78.8	60.4	63.4	House	House	51.9	60.7

Table 2: A Sample Mean Noise level by Day- and at Night-Time arrangement

Distance (m)	Day Noise		Night Noise	
	Min (dBA)	Max (dBA)	Min.(dBA)	Max (dBA)
0	64.7	75.6	65.67	71.57
2	61.9	73.3	63.28	71.51
4	58.6	70.2	62.85	70.58
6	57.7	70.6	61.33	68.68
Last	56.2	68.4	54.69	60.09
Average	**59.8**	**71.6**	**61.6**	**68.5**

Table 3: Location name, Coordinates, Network Name and Types of Generators at each BTS

s/n	Location Name	Northings	Eastings	Elevation (m)	Network Name	Generator Type
1	Campo Area Wukari	07° 50' 52.6	09° 46' 45.3	160	MTN-NG	ASCOT HYBRID
2	Karofi Lodge Area Wukari	07° 51' 00.5	09° 46' 28.5	159	GLOBA COM NG	MANTRAC
3	Mission Quarters Wukari	07° 51' 37.9	09° 47' 11.1	170	AIRTEL NG	ASCOT HYBRID
4	Takum Junction Area	07° 51' 34.9	09° 47' 22.5	181	MTN-NG	ASCOT HYBRID
5	AVI Pwadzu Area Wukari	07° 52' 33.8	09° 46' 27.7	180	MTN-NG	ASCOT HYBRID
6	Near GSS Staff Quarters	07° 53' 20.6	09° 48' 20.1	195	AIRTEL NG	MIKANO
7	G.R.A. Area Wukari	07° 52' 13.0	09° 46' 57.0	198	MTN-NG	ASCOT HYBRID
8	Old B.B Area Wukari	07° 52' 11.4	09° 46' 02.6	194	GLOBA COM NG	MANTRAC
9	Jantukpa Area Wukari	07° 52' 02.4	09° 45' 46.7	188	MTN-NG	ASCOT HYBRID
10	Sundi Road Wukari	07° 52' 17.1	09° 46' 23.0	186	MTN-NG	ASCOT HYBRID
11	T-Junction Area Wukari	07° 52' 07.5	09° 46' 15.8	185	MTN-NG	ASCOT HYBRID
12	Along T-junction Rd.	07° 52' 09.9	09° 46' 26.4	185	AIRTEL NG	MIKANO
13	Opp. East Primary School	07° 52' 31.8	09° 47' 08.3	186	AIRTEL NG	JMG
14	Kinkiso area Wukari	07° 52' 47.1	09° 47' 31.9	194	MTN-NG	ASCOT HYBRID
15	Opp. B.B Bread Wukari	07° 52' 25.9	09° 47' 03.5	184	9MOBILE NG	ASCOT HYBRID
16	Behind BB Bread Wukari	07° 52' 21.8	09° 47' 04.4	184	GLOBA COM NG	MANTRAC
17	Opp. F.G.C Wukari	07° 53' 07.4	09° 46' 46.5	194	MTN (BTC) NG	MIKANO
18	Before F.G.C Jalingo Rd	07° 53' 12.8	09° 48' 11.9	195	GLOBA COM NG	MIKANO
19	Rice Mill Road Wukari	07° 52' 14.9	09° 47' 02.2	178	MTN-NG	ASCOT HYBRID
20	Angwan Sishi Wukari	07° 52' 03.3	09° 46' 53.0	175	MTN-NG	ASCOT HYBRID
21	Opp Marmara Primary School	07° 51' 47.8	09° 46' 49.6	168	MTN (BTC) NG	ASCOT HYBRID
22	MDG Area Wukari	07° 51' 37.9	09° 46' 28.5	179	MTN-NG	ASCOT HYBRID
23	Idofi Area 1 Wukari	07° 50' 23.7	09° 49' 56.2	193	MTN	ASCOT HYBRID
24	Idofi Area 2 Wukari	07° 50' 43.4	09° 49' 16.5	187	AIRTEL NG	MIKANO

Table 4: Mean Min. and Max. Noise Level from each BTS by Day- & at Night-time.

Location No.	Location Name	Day Time Noise		Night Time Noise	
		Min dBA	Max dBA	Min dBA	Max dBA
Location 1	Campo Area Wukari	57.5	69.1	64.2	67.1
Location 2	Karofi lodge Area Wukari	51.3	70.9	56.9	59.5
Location 3	Mission Quarters Wukari	55.9	70.2	56.6	60.2
Location 4	Takum junction area	59.8	73.5	54.3	64.8
Location 5	Avi Pwadzu Wukari	61.6	70.7	61.1	77.1
Location 6	Near GSS staff quarters	50.4	65.4	57.1	66.6
Location 7	G.R.A. area Wukari	54.9	66.8	62.6	77.1
Location 8	Old B.B area Wukari	47.7	65.8	53.5	68.6
Location 9	Jantukpa Area Wukari	56.2	66.5	63.6	76.5
Location 10	Sundi road Wukari	49.9	66.9	50.5	59.8
Location 11	T-junction Wukari	59.8	71.6	61.6	68.5
Location 12	Along T-junc. road. Wukari	56.1	70.6	54.2	61.6
Location 13	Opp. East Prim. school	53.1	64.5	61.7	71.2
Location 14	Kinkiso Area Wukari	63.3	68.8	65.9	71.7
Location 15	Opp. B.B. bread Wukari	54.1	64.6	59.4	66.6
Location 16	Behind B.B bread Wukari	51.5	66.1	54.8	73.4
Location 17	Opp. F.G.C. Wukari	55.1	68.9	53.5	61.4
Location 18	Before F.G.C Jalingo rd.	56.8	68.8	53.8	60.1
Location 19	Rice Mill Road Wukari	54.5	68.5	58.1	73.1
Location 20	Angwan Sishi Wukari	59.6	66.9	63.5	69.6
Location 21	Opp Marmara Primary School	58.5	72.3	66.6	73.3
Location 22	MDG area Wukari	60.1	74.7	67.3	76.5
Location 23	Idofi Area 1 Wukari	52.9	65.1	57.1	66.7
Location 24	Idofi Area 2 Wukari	54.2	65.6	57.5	68.3

Table 5 Mean Noise Level for each Base Transceiver Station (BTS) by Day-time & Night-time

Location No.	Location Name	Day Noise dBA	Night Noise dBA
Location 1	Campo Area Wukari	63.3	65.7
Location 2	Karofi lodge Area Wukari	61.1	58.2
Location 3	Mission Quarters Wukari	63.1	58.4
Location 4	Takum junction area	66.7	59.6
Location 5	Avi Pwadzu Wukari	66.2	69.1
Location 6	Near GSS staff quarters	57.9	61.9
Location 7	G.R.A. area Wukari	60.9	69.9
Location 8	Old B.B area Wukari	56.8	61.1
Location 9	Jantukpa Area Wukari	61.4	70.1
Location 10	Sundi road Wukari	58.4	55.2
Location 11	T-junction Wukari	65.7	65.1
Location 12	Along T-junc. road. Wukari	63.4	57.9
Location 13	Opp. East Prim. school	58.8	66.5
Location 14	Kinkiso Area Wukari	66.1	68.8
Location 15	Opp. B.B. bread Wukari	59.4	63.0
Location 16	Behind B.B bread Wukari	58.8	64.1
Location 17	Opp. F.G.C. Wukari	62.0	57.5
Location 18	Before F.G.C Jalingo rd.	62.8	57.0
Location 19	Rice Mill Road Wukari	61.5	65.6
Location 20	Angwan Sishi Wukari	63.3	66.6
Location 21	Opp Marmara Primary School	65.4	70.0
Location 22	MDG area Wukari	67.4	71.9
Location 23	Idofi Area 1 Wukari	60.0	58.0
Location 24	Idofi Area 2 Wukari	59.9	62.9

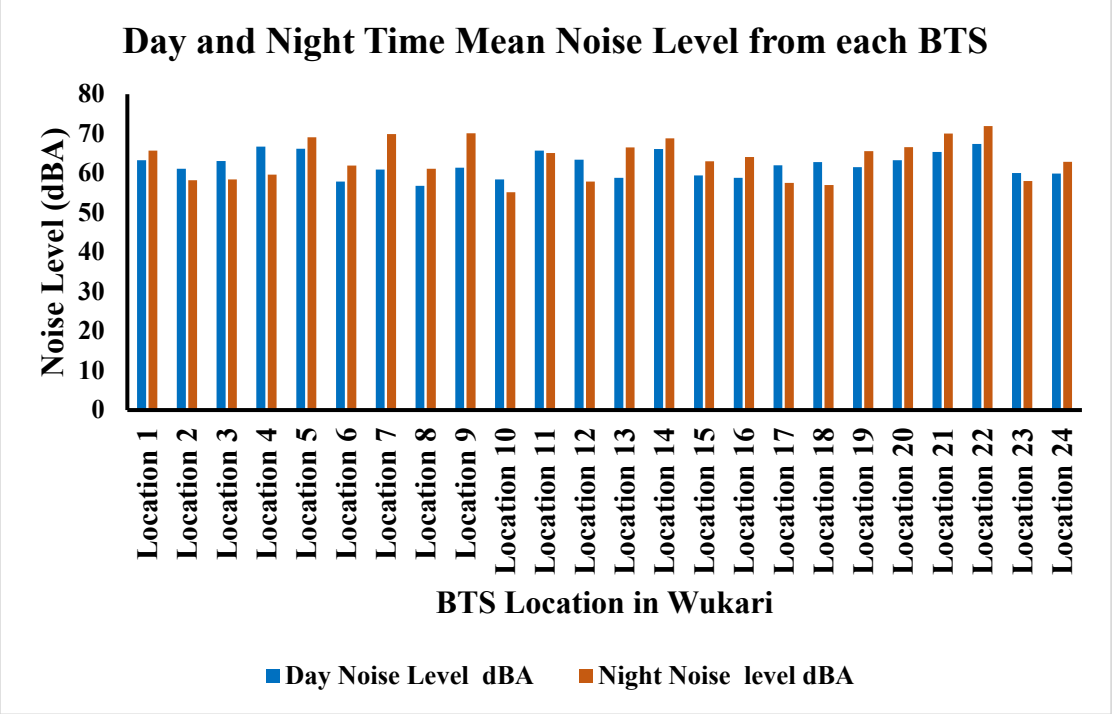


Figure 2: Day-time and Night-time mean Noise level for all Base Transceiver Station (BTS)

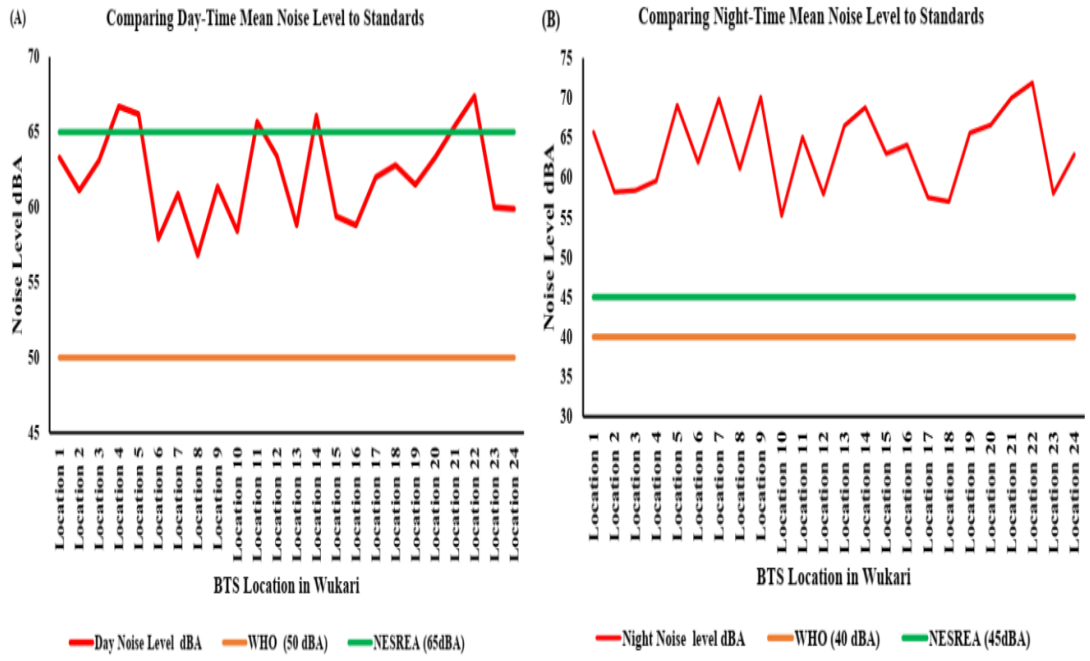


Figure 3(A & B): Comparing Day-time Mean Noise level from all Base Transceiver Station (BTS) in Wukari to W.H.O/NESREA standard

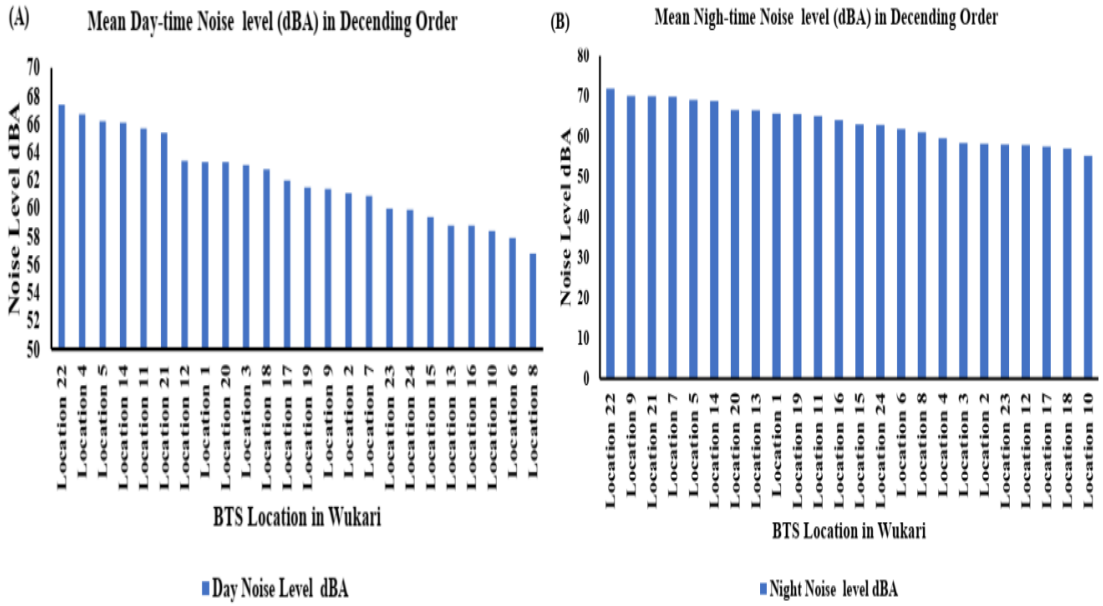


Figure 4(A & B): Mean Day- & Night-time Noise level from Base Transceiver Station (BTS) in desecdng order

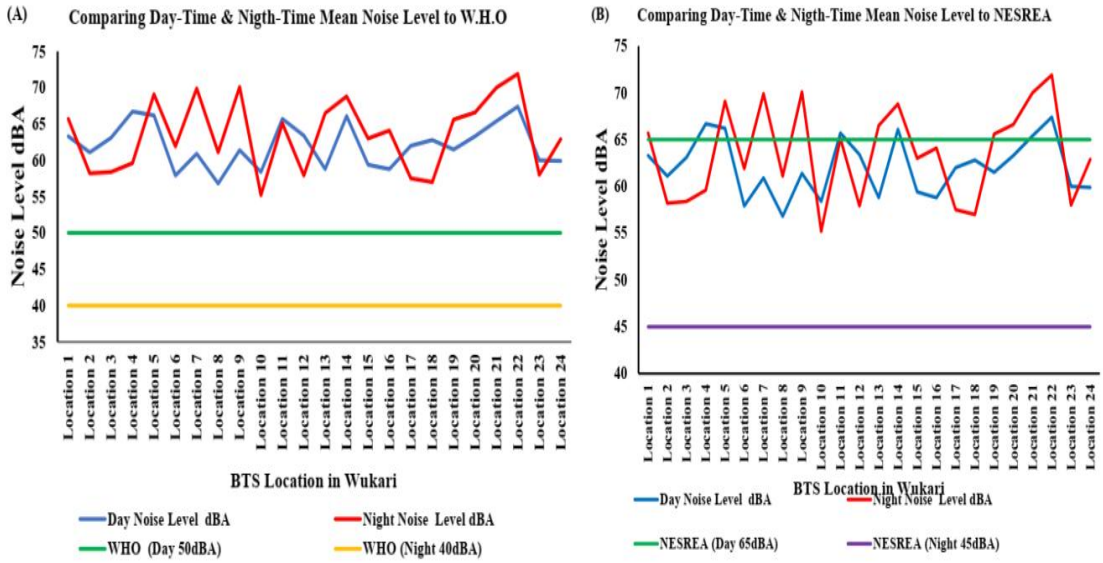


Figure 5(A&B): Comparing BTS Day- & Night-time Mean Noise Level to W.H.O & NESREA Standards

DISCUSSION

The pattern of noise pollution from all BTS in the study area shows that the noise generated by the diesel generators by daytime and at nighttime is higher than standard as shown in Figure 2. From figure 3A, it was observed that all BTS mean noise levels during the day are all above W.H.O. 50 dBA. Also, from the figure, it can be seen that 6 BTS have noise levels above NESREA 65 dBA by day, while 18 BTS have noise levels < 65 dBA for

residential areas. Figure 3B shows all BTS at nighttime have noise levels above WHO and NESREA nighttime noise standards of 40 dBA and 45 dBA for residential areas. From figure 4A, which shows the noise level from all BTS in descending order during the day, it showed BTS at location 22 has a noise level of 67.4 dBA and location 8 has a value of 56.8 dBA. These values are above the W.H.O. and NESREA daytime noise levels of 50 and 65 dBA for residential areas. Also, from figure 4B location 22 has a noise level of 71.9 dBA, while location 10 has a value of 55.2 dBA at night, which are above the W.H.O./NESREA standard for noise level for residential areas at nighttime of 40 and 45 dBA, respectively. When the BTS noise levels are compared to the W.H.O. standard for day and nighttime noise levels as shown in Figure 5A, all the noise levels are above the standard threshold for residential areas, while Figure 5B shows the comparison of BTS noise levels to the NESREA standard. At nighttime all BTS are above the 45 dBA standard, while by daytime six BTS have noise levels above 65 dBA and 18 BTS have values below 65 dBA, although higher than the WHO standard for residential areas. The results also showed that Location 22 has the highest mean noise level at night with 71.9 dBA, followed by Locations 9, 21, and 7 having 70.1, 70, and 69.9 dBA, respectively. Although location 10 has the least noise level at night with 55.2 dBA, it is still above the standard level; other locations with low values are 18 and 17 with 57 and 57.5 dBA. The permissible noise level standards during the day by the WHO and NESREA are 50 and 65 dBA. Comparing the values measured by daytime, Location 8 has the least with 56.8 dBA, although it is below the NESREA standard but above the WHO value. Also, locations 6 and 10, with 57.9 and 58.4 dBA, are below NESREA but above the WHO standard; location 22 has a value above WHO and NESREA with a noise level of 67.4 dBA; others are locations 5 and 4 with 66.2 and 66.7 dBA.

CONCLUSION

In conclusion, the values of noise pollution from the base transceiver stations exist at the residential location where the BTS are situated. The research has been justified in order to provide a better understanding of noise pollution problems and control because there is evidence that noise pollution has detrimental effects on human health. Sleep disruptions, stress, communication difficulties, sleeplessness, elevated blood pressure, and mental disease are among the negative health effects of BTS noise pollution on locals, temporary deafness, etc. Hence, there are possibilities that residents living around BTS in

Wukari may be exhibiting symptoms associated with noise pollution unknowingly. Telecomm operators in Nigeria should explore other ways of powering their Base transceiver stations other than the use of diesel generators such as solar, but even if the generators will be used, sound proof for the generator house should be effective. Regulatory agencies should enforce setback distance were the BTS is to be located and noise control measures.

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