

Radiofrequency Radiation (RFR) and Noise Impacts of Positioning Communication Base Station within Residential Area in Ntueke, Nigeria

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Abstract The liberalization of the telecommunication industry in Nigeria in 2001 led to the proliferation of telecom base stations without due consideration of its electromagnetic radiation and noise impacts. In this research work, a survey of the RFR power density, specific absorption rate and noise intensity was carried out within a residence in Ntueke, Nigeria to ascertain the impact of a nearby telecom mast on the inhabitants. ALRF05 Model, Toms Gadgets RFR meter was used in the power density measurement at strategic points. The precision digital noise level meter (CEL 524 model) set on the A weighting scale was used for noise level measurements at the same points. The total RFR power density ranged between 0.02 and 1.80 $\mu\text{W}/\text{cm}^2$ and the computed SAR ranged between 6.71 and 603.87 $\mu\text{W}/\text{kg}$. These results are greater than the permissible limits set by the International Commission for Non-Ionizing Radiation Protection and Federal Communication Commission. The mean noise level within the surveyed residence ranged between 50.3 dBA and 69.1 dBA and are high relative to the World Health Organization guidelines for noise limit set for speech interference [35 dB(A)], sleep disturbance [45 dB(A)] and serious annoyance [55 dB(A)]. They are also greater than the National Environmental Standards and Regulations Enforcement Agency permissible levels of 35dBA and 50dBA for night and daytime respectively for residential areas. Residents are likely to be impacted negatively due to exposure to radiofrequency radiation and high sound intensity.

Keywords Radiofrequency, Noise, Impacts, Residential, Ntueke

1. Introduction

In Nigeria, the telecom industry was liberalized in 2001 and this led to the emergence of so many telecommunication companies, and in turn has brought about the proliferation of new radio antenna sites (base stations). Apart from obvious environmental concerns (poor aesthetics and dangers posed by possible structural failures), scientific experts opine that since telecom masts/antennas emit electromagnetic radiation in the radiofrequency range, people living and doing businesses in the proximity of the masts are likely to encounter bio-radiological interactions. There are insufficient and inconclusive scientific findings to prove any adverse effects caused by RF radiation. However, it can cause thermal effect (heating of body tissues) and this may be detrimental to health if regulatory limits of exposure are exceeded. The eyes and the testes are particularly most vulnerable to RFR thermal effect because of relative lack of available blood flow within these organs to dissipate the excess heat load [1].

Due to power instability in Nigeria, electrical power generating sets have become an integral part of the assemblage of the base stations and may result to elevation of background noise levels within the location of the base stations. A sound-level meter or a dosimeter is usually adopted to monitor precisely an individual's exposure to noise emanating from GSM base stations (power generating sets). Noise is detrimental to health in several respects, such as, hearing impairment, sleep disturbance, cardiovascular effects, psychophysiologic effects, psychiatric symptoms, and fetal development [2]. Studies have shown that neighborhood noise can cause significant irritation and noise stress within people, due to the great deal of time people spend within their residences.

The World Health Organization has declared that diesel fumes cause lung cancer and experts said they were more carcinogenic than second-hand cigarette smoke [3].

Family members of a residential house in Ntueke have continuously been complaining of severe discomfort in their family house. They hardly rest during the day nor sleep during the night because of continuous noise and severe heat which they presume are emanating from a Mobile Telecommunication Network (GSM) base station located at a distance of approximately 1.5 metres from their residential house (see Figure 1). This study was therefore aimed at

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investigating the noise and radiofrequency radiation levels within this family residence to see the extent of environmental perturbation and the level of compliance of telecom network operators with regulatory limits.

2. Methodology

This study was conducted between 17th and 23rd March, 2014 within the premises of a family residence in Ntueke, Ideato South L.G.A, Imo State, Nigeria. This study area was subdivided into twelve representative points (see Table 1 and Figure 1 below). The Radiofrequency Field Strength Meter (ALRF05 Model, Toms Gadgets) was used in the measurement of the power density at strategic representative points away from the masts (see Table 1 and Figure 1 below). The precision digital noise level meter (CEL 524 model) set on the A weighting scale was used for noise level measurements at the same points. These readings were carried out in the mornings (between 6am and 9am), afternoons (between 12pm and 3pm) and nights (between 9pm and 12pm) for seven consecutive days.



Figure 1. Demarcation between the family residence and an MTN mast [see the exhaust vent (right) facing the building directly]

Table 1. Description of Points of Measurements

Points of Measurements	Description	Distance from Mast (Metres)
01	Base of the Mast	0.0
02	Base of the Mast	0.0
03	Room 1	1.5
04	Room 2	1.5
05	Room 3	2.5
06	Room 4	2.5
07	Relaxation Point	6.5
08	Room 5	11.1
09	Room 6	16.8
10	Room 7	11.1
11	Room 8	16.8
12	Kitchen	16.8

2.1. Method of Measurement of Radiofrequency (RF) Power Density

The bandwidth of the RFR field meter was set to “narrow band” to allow a high pass function so that only high frequency radiations emanating from GSM cell towers could be measured. The effective power density from the GSM base station was computed from the vector sum of the measured vertical and horizontal radiofrequency field densities and is given as;

$$p_d = (p_v + p_h)^{\frac{1}{2}} \quad (1)$$

The vertical and horizontal radiofrequency field densities were measured to enable us get the true measurement of the RF radiation propagating towards each point of interest from the vertical (p_v) and horizontal (p_h) axis.

The specific absorption rate (SAR - $\mu\text{W/kg}$) which is a measure of the average rate at which RF energy is absorbed for each kilogram of body tissue was computed using the formula [4];

$$\text{SAR} = p_d \times \frac{A_h}{W_h} \quad (2)$$

Where A_h = human surface area ($20,128.99 \text{ cm}^2$) and W_h = average adult weight (estimated as 60kg).

2.2. Method of Measurement of Noise Levels around the Surveyed Points

To take the noise level measurements, the digital noise level meter was held at arm's length at an estimated height of between 0.5 and 1metre above the ground (estimated to be the average heights of the family residents at standing and sitting positions). The readings were taken on Slow Response Rate which is preferable for audiometric measurements. The response rate is the time period over which the instrument averages the sound level before displaying it on the readout [5].

3. Presentation of Results

The results of the RFR and noise level measurements for the three sections for seven days are presented in Tables 2 to 4. Table 5 compares RFR Levels with Standard Limits. Table 6 compares Noise Levels with Standard Limits.

3.1. Results of RFR Power Density and SAR

The results showed that the total RFR power density had minimum and maximum values of $0.03 \mu\text{W/cm}^2$ and $0.72 \mu\text{W/cm}^2$; $0.03 \mu\text{W/cm}^2$ and $1.23 \mu\text{W/cm}^2$; and $0.02 \mu\text{W/cm}^2$ and $1.80 \mu\text{W/cm}^2$ for the morning, afternoon and evening sessions respectively. The results also showed that the total SAR had minimum and maximum values of $10.06 \mu\text{W/kg}$ and $241.55 \mu\text{W/kg}$; $10.06 \mu\text{W/kg}$ and $412.64 \mu\text{W/kg}$; and $6.71 \mu\text{W/kg}$ and $603.87 \mu\text{W/kg}$ for the morning, afternoon and evening sessions respectively. From Table 5, the maximum levels of RFR power density and SAR recorded are greater than the permissible limit set by the International

Commission for Non-Ionizing Radiation Protection (ICNIRP) which are $0.2 \mu\text{W}/\text{cm}^2$ and $83.87 \mu\text{W}/\text{kg}$ per every second respectively [6]. They are also above the Federal Communication Commission (FCC) limit set as $0.033 \mu\text{W}/\text{cm}^2$ and $110.71 \mu\text{W}/\text{kg}$ per every second respectively [7]. These results are within the range of radiofrequency radiation/Microwave exposures below $2 \mu\text{W}/\text{cm}^2$ reported by Cherry to have a link to severe health problems and mortality risks [8]. Therefore, the operators of the surveyed base station should consider the principle of ALARA (reducing the output RFR power density and SAR “As Low as Reasonably Achievable”) to ensure prudent avoidance of exposure to RFR from base stations. They should do so by complying with the guidelines on technical specifications for the installation of telecommunications masts and towers issued on the 9th day of April, 2009 by the Nigerian Communication Commission (NCC) which stated that [9];

- (i) All towers sited within residential areas must conform to the set back stipulated in the Guidelines under Subsection 5 below and Section 9 (9) to mitigate the effect of heat, smoke and noise pollution arising from generating sets.
- (ii) Under Subsection 5 of section 3 on Siting of Towers And Masts, it states that where towers in excess of 25 meters in height are permitted to be sited, they should be placed at a minimum setback of 5 meters distance to the nearest demised property, excluding the fence. Prior permission must be obtained from the Commission before siting of such mast.

Unfortunately, the siting of MTN mast at a distance of 1.5 metres from a family residence in Ntueke, Ideato South L.G.A. is highly unethical and environmentally unfriendly as this telecom company has acted in contravention of these guidelines. There are also possible indications that the

structures of GSM mast could crash and destroy lives and properties.

3.2. Results of the Noise Level Measurements

The results of the mean noise level measured within the surveyed residence showed minimum and maximum values of 53.35 dBA and 66.35 dBA; 52.6 dBA and 57.15 dBA and; 50.3 dBA and 69.1 dBA for the morning, afternoon and evening sessions respectively. These results from Table 6 are high relative to National Environmental Standards and Regulations Enforcement Agency (NESREA) permissible noise levels of 35dBA and 50dBA for night time (10pm-6am) and daytime (6am-10pm) respectively as stipulated for residential areas [10]. The noise levels recorded during this survey were higher than the World Health Organization guidelines for community noise limit set for speech interference [35 dB(A)], sleep disturbance [45 dB(A)] and serious annoyance [55 dB(A)] [11]. Residents of the surveyed area have been subjected to this level of sound exposure since the erection of this base station. This action is in contravention to the NCC guidelines on technical specifications for the installation of telecommunications masts and towers which stated that;

In view of the permissible generator setback, sound level, smoke and vibration,

- (i) All generators within a base station must be sited at least 5 metres away from all demised properties excluding the fence.
- (ii) All generating sets must be sound proof
- (iii) All generating sets must be installed on good shock absorbers so as to minimize vibrations to the barest minimum
- (iv) The exhaust of all generators must not be directed towards any demised property.

Table 2. Results of RF power density and Noise levels for Morning Sessions

Measured Points	Distance From Mast (m)	Effective RF Power Density ($\mu\text{W}/\text{cm}^2$)	Specific Absorption Rate ($\mu\text{W}/\text{kg}$)	Mean Noise Levels (dBA)
01	0	0.70	234.84	58.60
02	0	0.50	167.74	66.35
03	1.5	0.22	73.81	64.20
04	1.5	0.72	241.55	57.65
05	2.5	0.06	20.13	48.10
06	2.5	0.06	20.13	52.55
07	6.5	0.14	46.97	55.65
08	11.1	0.08	26.84	55.15
09	16.8	0.03	10.06	54.85
10	11.1	0.08	26.84	54.95
11	16.8	0.05	16.77	54.35
12	16.8	0.06	20.13	53.35

Table 3. Results of RF power density and Noise levels for Afternoon Sessions

Measured Points	Distance From Mast (m)	Effective RF Power Density ($\mu\text{W}/\text{cm}^2$)	Specific Absorption Rate ($\mu\text{W}/\text{kg}$)	Mean Noise Levels (dBA)
01	0	0.90	301.93	57.15
02	0	1.23	412.64	56.70
03	1.5	0.17	57.03	54.55
04	1.5	0.56	187.87	54.35
05	2.5	0.12	40.26	55.75
06	2.5	0.04	13.42	53.25
07	6.5	0.26	87.23	52.60
08	11.1	0.05	16.77	53.55
09	16.8	0.03	10.06	55.70
10	11.1	0.06	20.13	54.50
11	16.8	0.03	10.06	54.35
12	16.8	0.07	23.48	49.35

Table 4. Results of RF power density and Noise levels for Evening Sessions

Measured Points	Distance From Mast (m)	Effective RF Power Density ($\mu\text{W}/\text{cm}^2$)	Specific Absorption Rate ($\mu\text{W}/\text{kg}$)	Mean Noise Levels (dBA)
01	0	0.63	211.35	61.85
02	0	1.57	526.71	69.10
03	1.5	0.39	130.84	65.70
04	1.5	1.80	603.87	64.85
05	2.5	0.36	120.77	63.00
06	2.5	0.05	16.77	59.30
07	6.5	0.57	191.23	51.75
08	11.1	0.06	20.13	50.30
09	16.8	0.03	10.06	53.10
10	11.1	0.30	100.64	52.45
11	16.8	0.02	6.71	52.85
12	16.8	0.10	33.54	51.75

Table 5. Comparison of Power Density and SAR Levels with Standard Limits

Sessions	Maximum P_d ($\mu\text{W}/\text{cm}^2$)	Minimum P_d ($\mu\text{W}/\text{cm}^2$)	Maximum SAR ($\mu\text{W}/\text{kg}$)	Minimum SAR ($\mu\text{W}/\text{kg}$)	ICNIRP (1998) Limit	FCC(1997) Limit
Morning	0.72	0.03	241.55	10.06	15 $\mu\text{W}/\text{cm}^2$ min. 0.25 $\mu\text{W}/\text{cm}^2$ sec. 5032.25 $\mu\text{W}/\text{kg}$ per min 83.87 $\mu\text{W}/\text{kg}$ sec	20 $\mu\text{W}/\text{cm}^2$ per min. 0.33 $\mu\text{W}/\text{cm}^2$ per sec. 6709.66 $\mu\text{W}/\text{kg}$ per min 110.71 $\mu\text{W}/\text{kg}$ per sec
Afternoon	1.23	0.03	412.64	10.06		
Night	1.80	0.02	603.87	6.71		

Table 6. Comparison of Measured Noise Levels with Standard Limits

Sessions	Max (dBA)	Min (dBA)	NESREA Limit (dBA)	WHO Limit (dBA)
Morning	66.35	53.35	50.00	35.00 (speech interference)
Afternoon	52.60	57.15	50.00	45.00 (sleep disturbance)
Night	69.10	50.30	35.00	55.00 (serious annoyance)

4. Conclusions

A survey of the RFR and noise levels within a residential house in Ntueke, Nigeria has been carried out to ascertain the impact of a telecom mast positioned very close to the house. The results of the survey showed that the total RFR power density ranged between 0.02 and 1.80 $\mu\text{W}/\text{cm}^2$ and the computed SAR ranged between 6.71 and 603.87 $\mu\text{W}/\text{kg}$. These results are greater than the permissible limits set by the International Commission for Non-Ionizing Radiation Protection and Federal Communication Commission. Based on these results, the positioning of the telecom mast within this residential area may pose a health risk to the residents. The telecom base station sited at a distance of 1.5 metres from the surveyed residential area is in violation of the NCC guidelines on technical specifications for the installation of telecommunications masts and towers. The mean noise level within the surveyed residence ranged between 50.3 dBA and 69.1 dBA and are high relative to the World Health Organization guidelines for noise limit. These levels of noise are capable of causing great discomfort, fatigue, headache, serious annoyance, sleep disturbance and speech interference. All telecommunication companies should strictly consider the technical specifications before the construction of masts. Companies that violate these rules should be punished to act as a deterrent to others.

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