PRINT ISSN 1119-8362
Electronic ISSN 1119-8362

Full-text Available Online at
https://www.ajol.info/index.php/jasem
http://ww.bioline.org.br/ja

J. Appl. Sci. Environ. Manage.
Vol. 24 (2) 253-256 February 2020

Health Hazards Associated with Electric and Magnetic Field Intensities around Mobile Base Stations in Katsina State, Nigeria

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ABSTRACT: This work was carried out to assess the health hazards associated with exposure to radiofrequency electromagnetic fields from mobile base stations (MBS) within Katsina, Nigeria. Seventy seven MBS were identified through reconnaissance survey. Received radiated power was measured at a distance of 0, 20, 40, 60 and 80m from the MBS using a handheld B and K precision spectrum analyser. Electric and magnetic field intensities (E and H) were calculated. E (mV/m) and H (μA/m) had average values of; 21.03 and 55.78 for MTN; 9.41 and 24.96 for GLO; 2.33 and 6.18, for Etisalat; 18.32 and 48.62 for Airtel. Our results indicated that the general public exposure from radiofrequency electromagnetic radiation from all the considered mobile base stations is within the acceptable threshold of 61 V/m for Electric field intensity and 0.16A/m for Magnetic field intensity.

DOI: https://dx.doi.org/10.4314/jasem.v24i2.10

Dates: Received: 16 November 2019; Revised: 11 January 2020; Accepted: 22 February 2020

Keywords: Mobile base stations, Radiation, Katsina, Health hazard, Electric field, Magnetic field

Mobile base stations (MBS) communicate in the range of radiofrequency, which is a low frequency non-ionizing radiation, it is designed in such a way that the cell phones coming under its coverage area should be able to transmit and receive enough signal which enables proper communication within a few kilometers. In Nigeria, most network providers mount MBS near populated areas in order to establish more network coverage at the detriment of the health of the public members. Radiation exposure from MBS antenna depend on the antenna characteristics. The biological impacts of EMF can be classified as thermal and non-thermal, the former is associated with the heat created by EMFs in a certain area while the letter is associated with changes in the tissues in association with the amount of energy absorbed (Challis, 2005; Megha et al., 2012).

Epidemiological studies have shown that there is a very close association between some health effects (such as brain cancer, higher scores in psychological strain scales, significantly higher concentrations of alpha-amylase in saliva, obsessive-compulsive characteristics, anxiety, well-being and performance) and living very close to MBS (Eger and Neppe., 2009; Augner and Hacker., 2009 and Akintonwa et al., 2009). In Nigeria, the indiscriminate manner in which network providers mount MBS in close proximity to residential homes, offices, hospitals and schools increases the exposure level in such environment and is a case of utmost health concern. Precautionary measures need to be put in place alongside environmental impact assessments prior to installation, laws need to be promulgated to ban the installation of MBS in protected natural areas and where endangered species are present. Mobile base stations (MBS) are among the environmental sources of continuous exposure to non-ionizing radiation that are located at a certain distance from the exposed individual, even though it may be low in intensity (ICNIRP, 2009a). However, the level of exposure at a given location depends on several factors such as; direction of signal transmission, radiated power, diffusion due to buildings and trees and attenuation due to obstructions (Neubauer et al., 2007). Due to the ubiquitous long-term radiofrequency exposure from MBS, Evaluation of the radiofrequency electromagnetic exposure can be regarded as an important step towards management of electromagnetic hazards and detail epidemiological studies (ICNIRP, 1998; Karpowicz *et al.,* 2006; Karpowicz and gryz., 2007; Hansson *et al*., 2009).

Therefore, this work was carried out to assess the health hazards associated with exposure to radiofrequency electromagnetic fields from mobile base stations (MBS) within Katsina, Nigeria.

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MATERIALS AND METHODS

Data collection: The study was carried out within Five (5) Local governments in Katsina Central; namely, Katsina (KT), Batagarawa (BT), Rimi (RM), Charanchi (CR) and Jibia (JB). Reconnaissance survey revealed that the mobile base stations (MBS) within these local governments belong to MTN, GLO, ETISALAT and AIRTEL network providers.

Based on accessibility, physical sighting and proximity to the members of public, thirty-eight (38) MTN mobile base stations (MBS), twenty-three (23) GLO MBS, thirteen (13) AIRTEL MBS and three (3) ETISALAT MBS were identified. GPS receiver was used to obtain the location coordinates of the identified mobile base stations and the coordinates were presented in table 1. B and K precision spectrum analyser (Model 2658A) obtained from Electronics and telecommunication laboratory, Ahmadu Bello University Zaria was used in measuring the received radiated power in decibel relative milli-watts (dBmW). The meter is an extremely sensitive handheld broad band device for monitoring high frequency radiation in the range of 50 kHz to 8.5 GHz covering most of the wireless communication frequency spectrum. It has three-axis (isotropic) measurement mode, an adjustable threshold, 200-point manual memory function and an average noise level of -127 dBmW at 1GHz which provides a wide dynamic range with a display scale of 100 dB/10div (at 10 dB/div) in the amplitude axis. The spectrum analyser has a USB device for PC connectivity and 5.7 inches, 640×480 color LCD display (Umar, 2016).

However, the received signal powers detected by the measuring instrument at various distances are the received radiated powers with respect to distances from the transmitting tower. The spectrum was obtained by setting the analyser at a frequency of 2115MHz for MTN MBS, 2130MHz for GLO MBS, 2145MHz for AIRTEL MBS and 2160MHz for ETISALAT MBS. Each of the measurements was determined by holding the spectrum analyser away from the body and at about 1.5 m above the ground level with the meter pointing towards any of the antenna sectors as suggested by (Ismail et al., 2010).

Movement of the meter during measurements was avoided and where possible, movement of cars and phone calls were reduced before taking measurements in order to ensure that the measured values were not influenced by unwanted sources and disturbances. Due to fluctuations in the measured power densities, the measured values were recorded after at least 5 minutes in order to obtain a stable value. The studied mobile base stations have sectorial antennas capable of covering 360^0 sector area, hence, power density measurements were taken in a convenient direction around the foot of each of the mobile base station (0m) and then at every 20m, 40m, 60m and 80m. The choice of this distance was done while taking into cognizance the proximity of residential buildings and the manner in which structures were erected around the mobile base stations. Five (5) measurements were taken from each MBS making a total of 190 measurements for MTN MBS, 115 for GLO MBS, 65 for AIRTEL MBS and 15 for ETISALAT MBS.

Data analysis: In order to convert the measured power in dBmW to the international standard (watts/metre^2). The measured power was converted from dBmW to Watts (W) by using equation 1 and then to the standard power density P_d (watts/metre^2) at a distance R through equation 2 (Girish, 2010). The Electric and magnetic field intensities were obtained from the power density P_d using equation 3.

$$P_w = \frac{10^{\frac{P(dBmW)}{10}}}{1000} \quad 1$$

$$P_d = \frac{P_w \times 4\pi \times f^2}{G \times C^2} \quad 2$$

$$P_d = EH = \frac{E^2}{377\Omega} \quad 3$$

Where, P (dBmW) = Measured power in dBm W, P_w = Power in Watts, P_d = power density (watts/metre^2), G = 2.14 (Gain of receiving antenna), f = frequency in Hz, C = Velocity of light, E= electric field intensity (V/m) and H= magnetic field intensity in (A/m).

RESULTS AND DISCUSSION

Table 1 and 2 presented the summary statistics of the electric field intensity E (mV/m) and magnetic field intensity H (µA/m) for the MTN, GLO, Etisalat and Airtel mobile base stations respectively. Considering the average Electric field intensities (E) and Magnetic field intensities (H) from each MBS studied; it could be observed that for MTN, the highest values of E and H were obtained as 74.69 mV/m and 198.12 µA/m (observed at MTN MBS KT14 located around Kofar Kaura union bank) and the least was 0.62 mV/m and 1.65 µA/m (observed at MBS CR1 located at Are village Charanchi).

For GLO, the highest average E and H were obtained as 31.73 mV/m and 84.16 µA/m (observed at MBS KT2 located at Iyatanchi) and the least were obtained as 1.35 mV/m and 3.58 µA/m (observed at MBS JB3 located at Citadel Jibia). For Etisalat, the highest average E and H were obtained as 3.76 mV/m and 9.98 µA/m (observed at KT1 located around Ikhwan eye Katsina) and the least were obtained as 1.41 mV/m and

3.75 µA/m (observed at RM1 located at Abukur Rimi). For Airtel, the highest average E and H were obtained as 47.77 mV/m and 126.71 µA/m (observed at MBS KT2 located at Iyatanchi quarters) and the least were obtained as 1.38 mV/m and 3.65 µA/m (observed at MBS RM2 located at Lambar Rimi). Considering the individual measured power densities for all the distances and networks, the highest maximum E and H were 128.02 mV/m and 339.58 µA/m (observed at MTN MBS KT5 located at Dutsen Amare) at 20m from the MBS and the least maximum were obtained as 3.73 mV/m and 9.90 µA/m (observed at Etisalat MBS KT1 located around social centre tudun wada Katsina) at 40m from the MBS. Our results indicated that the general public exposure from radiofrequency electromagnetic radiation from all the considered mobile base stations for all the network providers is within the acceptable threshold of 61 V/m for Electric field intensity (for a frequency range of 2000-3000MHz) and 0.16A/m for Magnetic field intensity (for a frequency range of 2000-3000MHz) (ICNIRP, 1998).

Table 1: Electric field strength (mV/m) associated with the MBS in Katsina

Network provider	Statistical Parameter	0m	20m	40m	60m	80m	Average
MTN	Mean	29.32	24.73	20.06	16.33	14.69	21.03
	Min	1.20	1.31	0.16	0.16	0.16	0.60
	Max	104.06	128.02	63.21	81.43	97.90	94.92
GLO	Mean	10.54	12.05	12.49	5.75	6.23	9.41
	Min	1.35	1.34	1.13	0.96	0.82	1.12
	Max	37.74	51.27	64.69	25.34	41.10	44.03
Etisalat	Mean	2.53	2.56	2.17	2.19	2.19	2.33
	Min	1.41	1.411	1.37	1.38	1.38	1.82
	Max	3.77	3.75	3.73	3.79	3.77	3.76
Airtel	Mean	22.98	21.39	22.80	13.53	10.94	18.32
	Min	1.39	1.37	1.38	1.17	0.97	1.26
	Max	70.53	54.19	78.96	53.75	38.14	59.12

Table 2: Magnetic field strength (µA/m) associated with the MBS in Katsina.

Network provider	Statistical Parameter	0m	20m	40m	60m	80m	Average
MTN	Mean	77.78	65.60	53.21	43.31	38.97	55.78
	Min	3.18	3.47	0.42	0.42	0.42	1.58
	Max	276.02	339.58	167.67	216.00	259.68	251.79
GLO	Mean	27.95	31.95	33.13	15.25	16.52	24.96
	Min	3.57	3.56	2.99	2.56	2.18	2.97
	Max	100.12	135.99	171.60	67.22	109.02	116.79
Etisalat	Mean	6.72	6.78	5.76	5.82	5.81	6.18
	Min	3.73	3.73	3.65	3.65	3.67	3.69
	Max	10.00	9.94	9.90	10.05	9.99	9.98
Airtel	Mean	60.96	56.74	60.48	35.89	29.03	48.62
	Min	3.68	3.62	3.67	3.11	2.57	3.33
	Max	187.09	143.73	209.44	142.58	101.17	156.80

Conclusion: The general public exposure from radiofrequency electromagnetic radiation from all the considered mobile base stations is within the acceptable threshold of 61 V/m for Electric field intensity and 0.16A/m for Magnetic field intensity. However, it is still not justified to ignore the possibility of health hazards because limited number of epidemiological studies reported that exposure to RF EMF below ICNIRP exposure limits are statistically linked with more frequently diagnosed cancer diseases.

Acknowledgments: The authors will like to thank the management of Umaru Musa Yar'adua University, Katsina for providing available funds for this research through Tet fund research grant.

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