RADIOFREQUENCY ELECTROMAGNETIC FIELD FROM MOBILE BASE STATIONS IN SOME LOCAL GOVERNMENT AREAS IN KATSINA STATE, NIGERIA: ARE HUMANS AFFECTED?

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Abstract: The power density of the radiofrequency electromagnetic field from mobile base stations in some Local Government Areas of Katsina, Nigeria were studied to ascertain the safety of human health and the environment from radiations from the base stations. A handheld B and K precision spectrum analyzer (Model 2658A) capable of monitoring high-frequency radiation in the range of 50 kHz to 8.5 GHz was used in measuring the received radiated power. Measurements were taken conveniently at distances of 0, 20, 40, 60 and 80 m from the foot of each of the 77 masts earlier identified through reconnaissance survey. The power density varies with the network type and the distance from the foot of the mobile base stations. The overall average power density for the studied mobile base stations was 5.58 μW/m^2 with a minimum value, 1.28 μW/m^2 and a maximum value, 19.53 μW/m^2. The obtained results were lower than the international commission for non-ionizing radiation protection recommended limit of 9.2 W/m^2 for GSM 1800 and 4.7 W/m^2 for GSM 900 which was adopted in Nigeria. Our results have shown that no health symptoms related to the radiofrequency electromagnetic exposure may be observed by members of the public at present. However, the possibility of long term effects could not be ruled out, hence, appropriate measures should be taken to minimize exposure.

Keywords: Electromagnetic, Katsina, mobile base station, power density, radiation, radiofrequency

Introduction

There exist more than 1.4 million mobile base stations (MBS) worldwide due to the growing communication demand, and the number is increasing significantly on daily basis (WHO, 2006; Neubauer *et al*., 2007). Consequently, the research Agenda of the World Health Organization (WHO) considered the quantification of radiofrequency electromagnetic field (RF-EMF) exposure and identification of the causes of the exposure in the general population as a high priority research need (WHO, 2010). However, exposure quantification is complex due to the high variability of RF-EMF levels in the environment (Bornskessel *et al*., 2007; Frei *et al*., 2009; Joseph *et al*., 2009; Roosli *et al*., 2020). Research has shown that the fixed location measurement method is the most accurate method for the determination of exposure at a specific point in space and time (Bornskessel *et al*., 2007; Joseph *et al*., 2009). The strength of EMFs can be measured using Power density P_d (Watts/m^2), the electric field strength E (V/m) as well as the magnetic field intensity (S/m) (Levy *et al*., 2006).

The risks associated with the radiation emitted from the mobile base stations concerning its proximity to residential and other public areas are of great concern worldwide. Radiation emitted from MBS adds to the already existing background radiation thereby harming plants and animals (Girish, 2010). In the studied area, MBS were erected close to schools, daycares, retirement homes, agricultural farmlands, and residential buildings and this is of utmost concern considering the exposure duration. Scientifically, there were several reports that the electromagnetic radiation released by mobile telecommunications, has now become the main man-made source of environmental pollution from radiation sources (Andrew, 2008). Though the radiations emitted from antenna are non-ionizing, but exposure to these radiations over a long time may become harmful (Bhat, 2013). It was established that the radiofrequency exposure indices in many parts of the world are below the recommended exposure limits of ICNIRP (Baltrenas and Buckus, 2011; Bolaji and Idowu, 2012; Ibitoye and Aweda, 2011; Jagbir and Dhami, 2012; Victor *et al*., 2010). Studies on RF radiation from mobile towers based on power density measurements in residential areas close to MBS were carried out by Urbinello (2014) and Singh (2012) who reported that the exposure levels are within the regulatory requirements.

As many countries did, the Nigerian communications commission adopted the ICNIRP and WHO guidelines and limits as national reference safety standard for public exposure to RF EMFs, which is 9 W/m^2 (power density) or 58 V/m (electric field strength) for 1800MHz (ICNIRP, 1998). But, many scientific organizations and some countries like Russia have concluded that the existing ICNIRP recommendations are inadequate for the safe living of humans (IEGMP, 2000; IST, 2010; Saeid, 2008 and SCENIHR, 2009). Despite the increasing trend of MBS installations and the evident health hazards it is associated with, to the best of our knowledge, our recent study is to determine the Health Hazards Associated with Electric and Magnetic Field Intensities around Mobile Base Stations in Katsina State, Nigeria. However, the power density associated with the electric and magnetic fields around these mobile base stations remained unreported, therefore, this work was carried out to assess the power density of the radiofrequency electromagnetic field from mobile base stations (MBS) in Katsina, Nigeria.

Materials and Method

The study area

The study was carried out within five (5) Local government Areas in Katsina Central; namely, Katsina (KT), Batagarawa (BT), Rimi (RM), Charanchi (CR), and Jibia (JB). Reconnaissance survey revealed that the mobile base stations within these local government Areas belong to MTN, GLO, Etisalat, and Airtel network providers. Reconnaissance survey based on accessibility, physical sighting, and proximity to the members of the public revealed thirty-eight (38) MTN mobile base stations (MBS), twenty-three (23) GLO MBS, thirteen (13) AIRTEL MBS, and three (3) ETISALAT MBS. GPS receiver was used to obtain the location coordinates of the identified mobile base stations.

Data collection

B and K precision spectrum analyzer (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 a handheld broadband 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 a three-axis (isotropic) measurement mode with an adjustable threshold and 200-point manual memory function, it is extremely sensitive, it has 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 analyzer has a USB device for PC connectivity and 5.7 inches, 640×480 color LCD (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 analyzer 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 analyzer away from the body 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 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 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 (0 m) and then at every 20, 40, 60 and 80 m, respectively. The choice of this distance was done while taking into cognizance the proximity of residential buildings and how 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; A method adopted by Abdulsalam *et al*. (2020).

Data analysis

The measured power was converted from dBmW to Watts (W) by using equation 1 and then to the standard power density P_d in (watts/metre^2) at a distance R through equation 2 as provided by Girish (2010). The computations were done using Microsoft Excel version 2016 and descriptive statistics were employed to summarize the data.

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

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

Where: P (dBmW) = Measured power in dBmW, P_w = Measured 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.

Results and Discussion

The average power density (μW/m^2) at various distances from the foot of the MBS were presented in Table 1 for all the network providers. Considering the average P_d (average P_d for 0, 20, 40, 60, and 80 m) from each MBS studied, for MTN, the highest P_d of 15.32 μW/m^2 was observed at MTN MBS KT14 (located around Kofar Kaura union bank) and the least was 0.00 μW/m^2 at MBS BT5 and CR1(located at Batagarawa and Charanchi). For GLO, the highest average P_d was obtained at KT2 (located at Iyatanchi) and the least was recorded at RM1, JB2, JB3, and JB4 (Abukur Rimi and Jibia (Kadobe, Magama and Citadel)). For Etisalat, the highest average P_d was obtained at KT1 (located around Ikhwan eye) and the least at RM1 (located at Abukur Rimi). For Airtel, the highest P_d was obtained at Airtel MBS KT2 (located at Iyatanchi quarters) and the least at Airtel MBS KT5 (located at Dutsen Amare). Considering the individual measured power densities for all the distances and networks, the highest maximum recorded P_d was 43.47 μW/m^2 from MTN MBS KT5 (located at Dutsen Amare) at 20 m from the MBS and the least maximum was 17.59 μW/m^2 from MTN MBS KT14 (located around Kofar Kaura Union Bank) at 40 m from the MBS. It was observed that at all the distances Etisalat MBS produced the highest P_d.

Table 1: Summary of the power densities (μW/m^2) for various distances from the MBS

Network Provider	Statistical Parameter	0 m	20 m	40 m	60 m	80 m	Average
MTN	Mean	3.74	3.19	1.88	1.59	1.36	2.35
	Min	0.00	0.00	0.00	0.00	0.00	0.00
	Max	28.72	43.47	10.60	17.59	25.42	25.16
GLO	Mean	0.72	1.01	1.30	0.21	0.32	0.71
	Min	0.00	0.00	0.00	0.00	0.00	0.00
	Max	3.78	6.97	11.10	1.70	4.48	5.61
Etisalat	Mean	19.53	19.76	15.75	16.13	16.03	17.44
	Min	5.25	5.27	5.01	5.02	5.08	5.13
	Max	37.72	37.28	36.94	38.06	37.63	37.53
Airtel	Mean	2.58	2.01	2.86	1.04	0.59	1.82
	Min	0.00	0.00	0.00	0.00	0.00	0.00
	Max	13.10	7.79	16.54	7.66	3.89	9.81
Overall	Mean	6.64	6.49	5.45	4.74	4.58	5.58
	Min	1.31	1.32	1.25	1.26	1.27	1.28
	Max	20.83	23.88	18.80	16.25	17.86	19.53

Generally, there was a significant variation in P_d across the network providers and the distances. Our data does not fit the inverse square law, possibly due to interference from electromagnetic radiation sources such as receivers, TV antennas, moving objects, other MBS clustered around and the attenuation constituted by the structures erected within the line of sight of measurement. All the obtained results were lower than the ICNIRP recommended limit of 9.2 W/m^2 for GSM 1800 and 4.7 W/m^2 for GSM 900 which was adapted in Nigeria (ICNIRP, 1998). However, according to the widely acclaimed building biology institute, Germany, all the obtained power densities for Etisalat MBS are a source of severe concern because they are within 10 –1000 μW/m^2 while that of MTN, GLO and Airtel are of slight concern because they are within 0.1–10 μW/m^2 (Girish, 2010). On the other hand, the power densities for all the network providers MBS were lower than 100 μW/m^2 recommended by EU Parliament (Girish, 2010). The obtained results were in agreement with that obtained by Baltrenas and Buckus (2011); Ibitoye and Aweda (2011); Jagbir and Dhami (2012); Bolaji and Idowu (2012); Victor *et al*. (2010). Epidemiological studies reported health symptoms such as appetite, cancer, anxiety, weight loss, sleep disorder, sperm head abnormalities, difficulties to concentrate, feeling strained, and urge for sleep to be associated with exposure to RF at 24-60 m for MBS at 50 μW/m^2 (Otitoloju *et al*., 2010; Akintonwa *et al*., 2009; Wolf and Wolf, 2004; Viel *et al*., 2009; Augner and Hacker, 2009). Our results have shown that no health symptoms related to the radiofrequency electromagnetic exposure may be observed since all our values were lower than 50 μW/m^2.

Conclusion

For all the network providers considered (MTN, GLO, Airtel, and Etisalat), the obtained power densities from all the masts were lower than the ICNIRP recommended limit of 9.2W/m^2 for GSM 1800 and 4.7 W/m^2 for GSM 900 which was adapted in Nigeria (ICNIRP, 1998). Though the power density from Etisalat is about eight times higher than that of the other network providers, it was also within ICNIRP regulatory limits. However, according to the widely acclaimed building biology institute, Germany, all the obtained power densities for Etisalat MBS are a source of severe concern because they are within 10-1000 $\mu W/m^2$ while that of MTN, GLO and Airtel are of slight concern because they are within 0.1-10 $\mu W/m^2$ (Girish, 2010). On the other hand, the power densities for all the network providers MBS were lower than 100 $\mu W/m^2$ recommended by EU Parliament (Girish, 2010). Our results have shown that no health symptoms related to the radiofrequency electromagnetic exposure may be observed since all our values were lower than 50 $\mu W/m^2$. All the obtained results were lower than the ICNIRP recommended limit of 9.2 W/m^2 for GSM 1800 and 4.7 W/m^2 for GSM 900 which was adopted in Nigeria.

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Conflict of Interest

Authors declare that there is no conflict of interest related to this study.

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