An Assessment of Human Exposure to RF radiation from Mobile Transceiver Stations in Minna, Okene and Birnin Kebi, Nigeria

ABSTRACT

In the recent, there has been massive development in the use of mobile phones especially in developing countries. But electromagnetic radiation (EMR) emissions from various mobile transceiver stations (MTS) have raised debates on whether they are hazardous to human or not. In this study, we aim at presenting an assessment of human exposure to RF radiation from mobile transceiver stations in Minna, Okene and Birnin Kebbi. The power flux densities radiations (W/m) on residential buildings around the MTS were measured using a handheld Extech RF EMF strength meter. The highest mean power flux densities values recorded for Minna, Okene and Birnin Kebbi were 69.17mW/m2, 42.98mW/m2 and 37.98mW/m2 while the least values were 2.11mW/m2, 18.27 mW/m2 and 11.83mW/m2 respectively. The results shows that the measured mean power flux densities from individual mobile transceiver stations (Minna, Okene and Birnin Kebbi) have been compared with standard limit set by International Commission on NonIonising Radiation Protection (ICNIRP). The measured values were far below the concern limit. Therefore, RF emission from MTS in these study areas may pose no known health hazards to the general public within the chosen vicinity.

Key words:-RF radiation, Power flux density, Mobile transceiver stations, Minna, Okene, Birnin Kebbi

1.0 Introduction

In the recent, there has been an enormous development as a result of modern technology such as, cellular phones, micro-wave ovens, TVs, wireless communications, computer systems, power transmission lines and high voltage transformers which are sources of electromagnetic fields (EMFs) (Shankar, 2002). Human beings are exposed to these sources of electromagnetic radiations. Most members of the general public are not aware of the hazards associated with mobile phones and cell tower radiations which are harmful due to electromagnetic radiation (EMR) exposure. The exposure of RF radiation beyond the limit of power flux density of $10W/m^2$ for general public and $50\ W/m^2$ for occupational exposure as given in ICNIRP set limit, may be harmful to health (Salford *et al*, 2003).

A cellular phone transmits 1 to 2 Watt of power in the frequency range of 824-849 MHz (CDMA), 890-915 MHz (GSM900), 1710-1780 MHz and 1805-1880MHz (GSM 1800). In Nigeria, the Specific Absorption Rate (SAR) limit for cell phones is 1.6W/kg, which is actually for 6 minutes per day usage (ICNIRP, 1998). It has a safety margin of 3 to 4, so a person should not use cell phone for more than 18 to 24 minutes per day. This information is not commonly

known to most people in Nigeria, so people use cell phones for more than an hour per day without realising the related health hazards (Adekunle *et al.,* 2015).

In 1998, RF power flux density characterisation method was adopted to the impact of EMF radiation on the inhabitants of Elekalia and Choba communities in Rivers State, Nigeria using a broad band RF meter. In their findings, high RF power flux densities were observed near the foot of the MBSs (Jokela, 1998). In 2010, measurement based on assessment approach was presented to study the levels of RF power flux density around MBSs in Lagos city, Nigeria. Their results shows that the measured power flux density values were below the recommended value and are incapable of inducing any dangerous health effects among the people that are living away, least 6m away from the antenna (Asiegbu and Ogunlaja, 2010).

Research carried out by Carl Blackman has shown that electromagnetic fields that are weak release calcium ions from cell membranes (Blackman *et al.,* 1982). An Australian research showed that children living near TV and FM Broadcast towers are more prone to Leukemia than children living far away from these towers (Hocking *et al.,* 1996).

Laboratory experiments have shown that short-term exposure to high levels of RF radiation (100-200 mW/cm^2) can cause cataracts in rabbits (Park, 2002).

1.1 Study Area

The research work was carried out in Minna (lat. $9^0 36' 50"$N and long. $6^0 33' 24"$E) Niger State, Okene (lat. $7^0 33' 4.39"$N and long. $6^0 14' 9.20"$E) Kogi State and Birnin Kebbi (lat. $9^0 27' 7.79"$N and long. $4^0 12' 0.60"$E) Kebbi State. According to the 2007 population census, Minna, Okene, Birnin Kebbi has a total population of 304,113, 279,178 and 125,594 respectively. The teledensity of Minna, Okene, Birnin Kebbi are considerably high due to the communication demands by its large population. Highly populated residential areas were selected for this research.

2.0 Materials and Methods

Measurement of Electromagnetic radiation was carried out with the Extech RF EMF strength meter. This meter is a frequency-weighted broadband device for monitoring high-frequency radiation in the specific ranges of 900MHz, 1800MHz, and 2.7GHz. Other measurements can be made, for reference purposes only, using the entire range of 50MHz to 3.5GHz.

The meter measures the value of electric field $\vec{E}$ and converts it into magnetic field $\vec{H}$and the power density **S** using Poynting theorem (Isabona and Odesanya, 2015):

$$P_d = \vec{E} \times \vec{H} \qquad (1)$$

where P_d is power flux density expressed in watt per meter squared (W/m^2); E, electric field strength in volt per meter (V/m); H, magnetic field strength in ampere per meter (A/m).

The magnitude of the power flux density based the sinusoidal nature of the EM wave is expressed by:

$$|P_d| = \frac{|E|^2}{\eta} = \eta|H|^2 \quad (2)$$

where η is the impedance of the free space defined by:

$$\eta = \sqrt{\frac{\mu_o}{\varepsilon_o}} \quad (3)$$

where

$$\mu_{o=4\pi \times 10^{-7} Tm/A} \quad (4)$$

$$\varepsilon_{o=\frac{10^{-7}}{36\pi} C^2/Nm^2} \quad (5)$$

Then $\eta = 120\pi = 377\Omega$

Considering equations (3), (4) and (5) in (2) we have

$$P_d = \frac{E^2}{120\pi} \quad (6)$$

Equation (6) shows that the power flux density is directly proportional to the square of electric field strength.

The meter can also measure E along different axis, but readings can also be taken in all Es at the same time (Triaxial) using

$$E^2 = E_x^2 + E_y^2 + E_z^2 \quad (7)$$

Measurement of radiation power flux densities was made by simply pointing the meter to the source of RF radiation. A maximum of about 15 m distance from the base was considered and measurements were taken at 1.5 m interval from each base station. Each measurement was made by holding the meter away from the body, at 1.5 m above the ground level as suggested by Ismail *et al.* (2010).

3.0 Results and Discussion

Absolute power flux density of the radio frequency radiation from selected mobile transceiver stations were measured with the aid of extech rf meter at different selected areas with their proximity to the residential buildings. The measured values of mean power flux densities at different locations are given in Figure 1. We observed that the mean power flux density of MTS5, MTS4 and MTS7 were considerably high with contributions (69.17 mW/m^2, 42.98 mW/m^2 and 37.98 mW/m^2) when compared with others. MTS14, MTS10 and MTS3 have the least contributions with (2.11 mW/m^2, 18.27 mW/m^2 and 11.83 mW/m^2).

We observed significant fluctuation in data collection during measurement. One would have expected that the variation of the power flux density obeys inverse–square-law ($P_t /4\pi R^2$) as you move farther away from the reference mobile transceiver station, the measured power flux densities however deviated as observed in Figures 2, 3 and 4 respectively. This deviation was as a result of integration of wave interference from other sources of EMR around reference mobile transceiver stations such as TV, Radio antennas and receivers.

The graph shows that power flux density decreases exponentially with distance. That is at distance, $x = 0$, the power flux density P_d is maximum and for $x > 0$, the power flux density decreases exponentially.

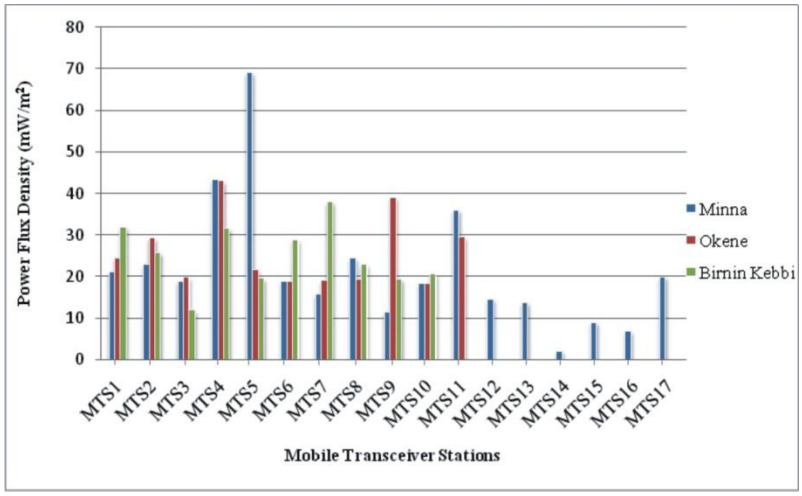

Figure 1: Mean power flux density for all locations

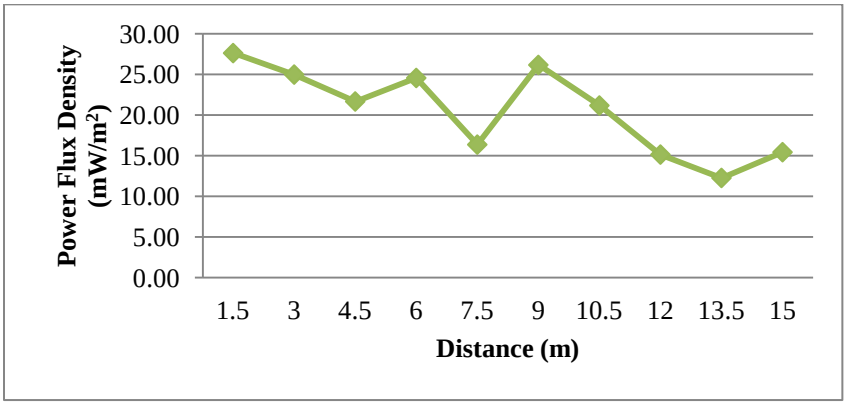

Figure 2: Mean Power Flux Density Vs Distance Plot (Minna)

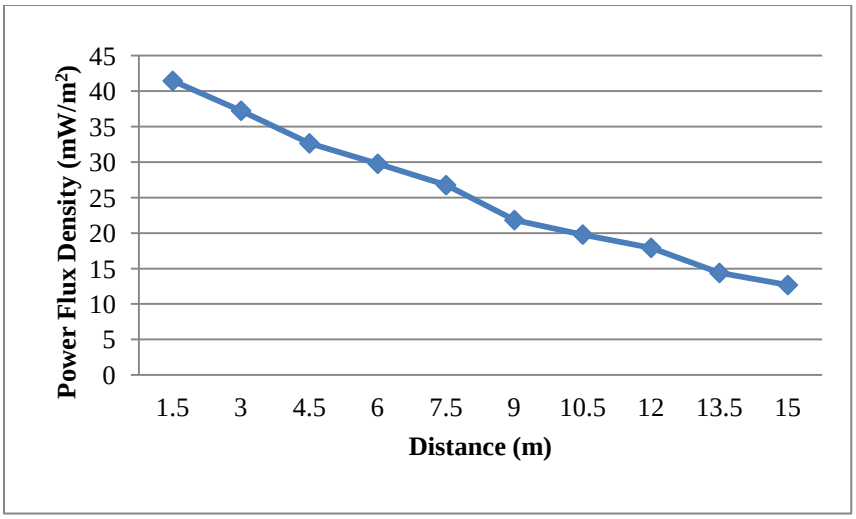

Figure 3: Mean Power Flux Density Vs Distance Plot (Okene)

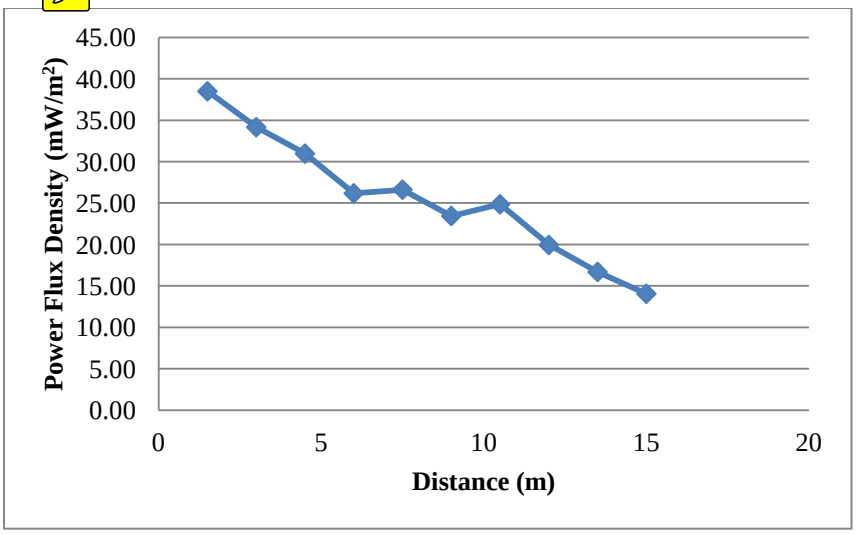

Figure 4: Mean Power Flux Density Vs Distance Plot (Birnin Kebbi)

4.0 Conclusion

The present study was carried out with the sole aim to assess the RF radiation exposure from mobile transceiver stations. From the findings it has been observed that the measured values of power flux densities across all the sites are well below the RF radiation exposure safety limit set by ICNIRP for the general public and occupational exposure when compared with the findings in this study. Thus, RF radiation exposure from MTSs (Minna, Okene and Birnin Kebbi) may pose no health risk to the people living within the areas. However, mobile network providers should site mobile transceiver stations at least 15 m distance away from residential building areas.

References

1. Shankar, P. Mohana (2002). Introduction to Wireless System, ISBN 0471321672, Wiley.

2. Salford, Leif G., Arne E. Brun, Jacob L. Eberhardt, Lars Malmgren, & Bertil R. R. Persson, (2003). Nerve cell Damage in Mammalian Brain after Exposure to Microwaves from GSM Mobile Phones. *Environmental Health Perspectives* (United States: National Institute of Environmental Health Sciences) 111(7): 881-887.

3. Adekunle, A., Ibe, K.E., Kpanaki, M.E., Umanah R.I., Nwafor C.O, & Esseng, N.A (2015). Evaluating the Effects of Radiation from Cell Towers and High Tension Power Lines on Inhabitant of Buildings in Ota, Ogun State. *Journal of communications in applied sciences* 3(1): 1-21.

4. Jokela, K (1998), Theoretical and measured power density in front of VHF/UMF broadcasting antennas. *Journal of Health Physics*, Vol. 54, (5), pp. 533-543.

5. Asiegbu, A.D. & O.O. Ogulaja (2010). Preliminary Investigation of RF Exposure levels from mobile. Telephone base stations in Abia, South east Nigeria," *International Journal of Current Research,* Vol.11 pp 47-53.

6. Blackman, C.F., Benane S.G., Kinney, L.S, & Joines, W.T. (1982) "Effects of ELF Fields on calcium ion efflux from brain tissue in vitro", Radiation Research, 92: 510-520.

7. Hocking, B., Gordon, I. R., Grain, H. L, & Hatfeild, G. E. (1996). Cancer incidence and mortality and proximity to TV tower. *Medical Journal of Australia*, 165: 601-605.

8. Park, Robert L. (2002). Voodoo Science: The road from foolishness to fraud. Oxford UK and NY; Oxford University press.

9. Isabona, J., & Odesanya, I. (2015). Quantitative Estimation of Electromagnetic Radiation Exposure in the Vicinity of Base Transceiver Station via in-situ measurements Approach, Vol. 3 (2), pp. 28-40.

10. Ismail, Aiman, Norashidah, M. Din, Md Z. Jamaludin, & Nagaletchumi Balasubramamaiam. (2010). Mobile phone Base stations Radiation study for Addressing Public concern. *American Journal of Engineering and Applied Science*, 3 (1): 117-120.