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Measurement and Analysis on the Health Effect of Electromagnetic Radiation from Telecommunication Masts in Some Selected Areas in Kaduna Metropolis

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ABSTRACT— this study presents the practical analysis on the electromagnetic exposure emitted by telecommunications mast on the human body in some selected areas in Kaduna metropolis, Kaduna State. In this study electromagnetic radiation from base station antennas installed for various wireless communication purposes was investigated based on the electric field strength E, magnetic field strength H and power density S, at some distances from telecommunication masts owned by the four network providers, namely Airtel, Etisalat, Glo and MTN Nigeria. Five base stations/ masts from each service provider were selected making a sum total of twenty base stations that were surveyed. The EMF Strength meter was used for the measurement then compared the Electromagnetic field (EMF) emission with the International Commission on Non ionizing Radiation Protection (ICNIRP), Federal Communication Commission (FCC) and Institute of electrical and electronic engineers (IEEE) limits to know if the service provider did adopt the precautionary majors. The all measured power density of the Service provider falls low from 60m to 100m as such it is safe to adequately install a telecommunication masts from 100m away from a residential or public buildings and the percentage ratio of the maximum power density is 1.3034% and 1.0687% observed high at Airtel Mast whereas the least is 0.0308% and 0.0252% obtained at Etisalat mast and said did not exceed the limit.

KEYWORDS— Electromagnetic Radiation, Base Station Antenna, Electric field, Magnetic field, Power density

INTRODUCTION

Since the introduction of wireless telecommunication in the 1990s, there has been unending argument, whether telephone networks emit electromagnetic radiation, EMR, which pollutes cities and rural areas. With multiple sources of mobile communication technology, people fear that it could result in exposure of people and wide-life to microwaves that can have intense adverse health effects. Expectedly, the effect of telecommunications equipment, such as masts, have been a subject of interest and concern to people worldwide, given the speed of mobile phone penetration in both developed and developing nations. However, the Nigerian Communications Commission (NCC) had, on various occasions, dismissed the fear that radiation from telecom masts could have negative health implications, insisting that no known study has proved so. Meanwhile the National Environmental Standard, Regulatory and Enforcement Agency, NESREA, appears to be stoking fire on the debate. Director General of the agency, Dr Lawrence Anukam, in a television interview recently, called for caution in sitting telecom masts around living areas, admitting that there have been conflicting reports about the level of radiation coming from telecom masts. (Vanguardngr, 2017).

Radiation has also been linked in a host of researches to brain tumours, depression, miscarriage, Alzheimer's disease, and other deadly illnesses. Children are said to be at the greatest risk because of their special vulnerability during periods of development before and after birth. Over 100 physicians and scientists at Harvard and Boston University Schools of Public Health have called cell towers a radiation hazard while 33 delegate physicians from seven countries have declared cell phone towers a 'public health emergency'.(Gerald et at., 2011).

A base station and its transmitting power are designed in such a way that mobile phones should be able to transmit and receive enough signal for proper communication up to a few kilometers. Majority of these towers are mounted near the residential and office buildings to provide good mobile phone coverage to the users. These cell towers transmit radiation every second, so people living within tens of meters from the tower will receive 10,000 to 10,000,000 times stronger signal than required for mobile communication. Buildings located at certain distances from cell towers are found to absorb high power densities which are dangerous to humans. The Base Stations, The mobile and wireless communication networks transmit radiations through antennas mounted on the base station. (ICNIRP, 2009).

COMPONENTS OF ELECTROMAGNETIC FIELD

Radio frequency gives rise to electric field and magnetic fields which can directly couple into people inducing fields and currents in their bodies. Electric fields are associated only with the presence of electric charges and exert forces on the electric charge, whereas magnetic fields are associated with the physical movement of charges and exert physical forces on the electric charges only when the charges are in motion (ICNIRP, 1996). Electric field strength, E, is defined as the force, F, per unit charge q, on infinitesimally small charge at any given point in space and its unit is volt per meter (V/m). It is given as

$$E=F/Q \quad (1)$$

The force on a charge q, places in electric field, is then

$$F=qE \quad (2)$$

Magnetic Field Strength, **H** is equal to magnetic flux density, **B** divided by the permeability of the medium, given as

$$H=B/\mu \quad (3)$$

Its Unit is ampere per meter (A/m). Magnetic flux density is a vector force field defined as the force ($\mathbf{F}_m$) per unit charge on as infinitesimal moving charge q_v, at a given point in space. Its unit is Tesla (T) and it is given as:

$$B = F_m/q_v \quad (4)$$

The force $\mathbf{F}_m$ exerted on q by **B** is always perpendicular to both the velocity of the particle and the direction of **B.** The force is given as

$$F=q(v\times\mathbf{B}) \quad (5)$$

(NCRP, 1993).

A magnetic field can be expressed as a magnetic flux density **B**, or as Magnetic field strength, H. The both are related by

$$B=\mu H \quad (6)$$

Why μ is the constant of proportionality called the magnetic materials permeability, given as 4×10^{-7}H/m in air, vacuum and non magnetic materials (ICNIRP, 1996).

Another component of Electromagnetic field that is used to quantify Radiofrequency for health hazard assessment is the power density. Power density S, is the power per unit area to the direction of propagation. Power density is obtained from Poynting's theorem which relates the rate of absorption in an object to the incident fields. The theorem is a statement of conservation of energy, if A is any enclosed surface and V is the volume inside A, then

$$\frac{\delta}{\delta t}\int_v (w_c + \varepsilon E.E + \mu H.H)dV + \oint_A E\times H.da = 0 \quad (7)$$

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Where: w_c is the energy per unit volume possessed by charged particles at a given point in the volume $\varepsilon E.E.\varepsilon E.E$, is the energy per unit volume stored in the electric field at a given point in the volume, $\mu H.H\ \mu H.H$ is the energy per unit volume stored in the magnetic field at a given point in the volume, da is a differential surface elements of A.

Since a closed surface is any surface that completely encloses a volume, the volume integral corresponds to summing the terms in the integrand over all points inside the volume. Then, the integral over the volume corresponds to the total energy possessed by all charged particles within the volume plus the energy stored in the electric and magnetic fields. The integral on the left is the time rate of change of the total energy within the volume and is equal to the total power. The term on the right of the equation is an integral over the closed surface enclosing the volume. The equation (7) becomes

$$S= E\times H \quad (8)$$

Where S is called the Poynting vector with W/m^2 and is interpreted as power density. The direction of the cross product of E and H is perpendicular to both E and H and the vector dot product of E × H with **da** selects the component of E × H that is parallel **da.** So S.da is the power d**p** passing out through the differential surface element da and the surface integral is the sum of the power passing through each surface element over the entire surface A, which is equal to the total power passing out through A.

Extensive studies have nevertheless been done to critically investigate the effect of EM Radiation from mobile and wireless telecommunication masts in various cities all over the world (e.g. Manteuffel et. al., 2002; Hirata et. al., 2003; Adilza et. al., 2011; Michael et al, 2013). In Nigeria, there have been reports on the cities of ikeja Area of Lagos Akinyemi et al, 2014, P. Enyinna and G. Avwir, 2010, In Aba, Asiegbu, A. and O. Ogunlaja, 2010, among probably many others.

MATERIALS AND METHODS FOR THE MEASUREMENT

This includes calibration of the equipment, data collection from the surveyed masts of the UMTS service providers. The data collected was used to calculate the power density beamed out from the masts at different distances.

The Equipment and Calibration: The instrument for the study was the RF EMF Strength meter, model 480836. The RF EMF strength meter is a broadband isotropic instrument. It is designed to measure electric, magnetic field strength and power density of EMF of frequency of 50 MHz to 3.5GHz with specified frequency of 900MHz, 1800MHz and 2.7GHz. (Aliyu and Ali 2012). The unit of measurement and the measurement types are expressed in units of electrical and magnetic field strength and power density given as mV/m, V/m, μA/m, mA/m, μW/m^2, W/m^2, μW/cm^2, mW/cm^2. The instrument displays instantaneous measured values, maximum values, average values and maximum average values. The display resolution is 0.1mV/m, 0.1μA/m, 0.1μW/m^2, and 0.001μW/cm^2. The setting is typically 1second. The absolute error at 1V/m and 50MHz is ±1.0dB. The instrument was calibrated with a factor of 1.00 based on the manufacturer's instruction.

MEASUREMENTS OF ELECTRIC FIELD, MAGNETIC FIELD, AND POWER DENSITY

Measurements were taken at 0, 20, 40, 60, 80, and 100 away from the masts, starting from 100m to 0m. The base of the fence served as the origin of the measurement, since the study focuses on the safety of the general public who lie or spend a lot of time around the mast, we felt that it may not be necessary to struggle to gain access into masts bases.

Measurements were taken at this six position starting from 100m to 0m. At each of these points, the values of the electric field strength, magnetic field strength and power density were measured while the equipment was in maximum mode. The instrument used for the study at the point of measurement was held at 1.5m height above ground level which is the standard height of an average man.

ANALYSIS OF THE RESULTS

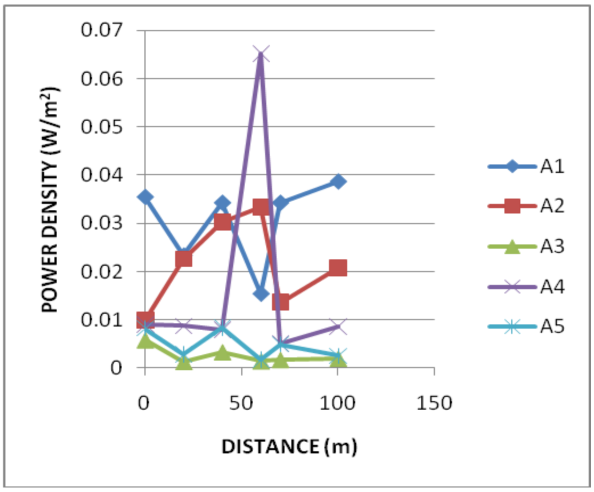

Fig. 1: A Plot of Power density (W/m^2) against Distance (m) for the measured Aitel Service provider, the graph depicted that the maximum value of S measured is 0.06517W/m^2 at 60m and the minimum value of S measured is 0.00133W/m^2 at 20m

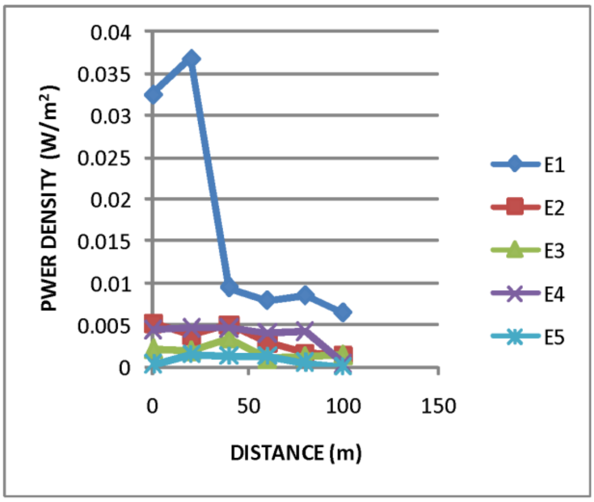

Fig. 2: A Plot of Power density (W/m^2) against Distance (m) for the measured Etisalat Service provider, the graph depicted that the maximum value of S measured is 0.03677W/m^2 at 20m and the minimum value of S measured is 0.00008W/m^2 at 100m

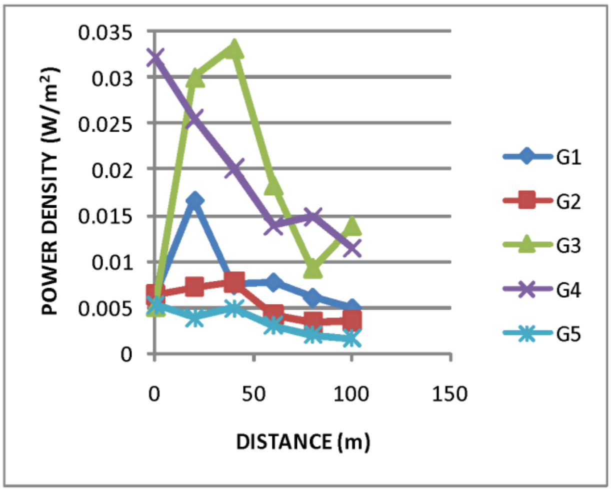

Fig. 3: A Plot of Power density (W/m^2) against Distance (m) for the measured Glo Service provider, the graph depicted that the maximum value of S measured is 0.03321W/m^2 at 40m and the minimum value of S measured is 0.0.00163W/m^2 at 100m**.**

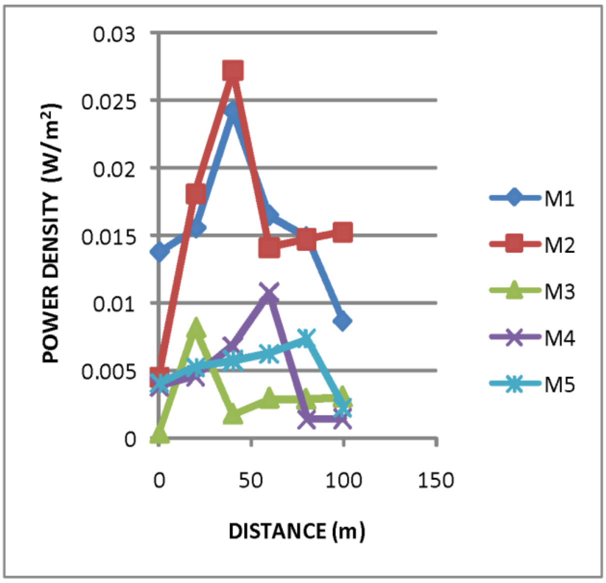

Fig. 4: A Plot of Power density (W/m^2) against Distance (m) for the measured MTN Service provider, the graph depicted that the maximum value of S measured is 0.02723W/m^2 at 40m and the minimum value of S measured is 0.00033W/m^2 at 0m.

The pattern of the measured values of Power density S is as expected. The mode or pattern of increase, decrease, increase and decrease of the values of Power density S are due to interference of the radiofrequencies resulting in wave crests and troughs. The graph depicted that from 0m to 40m the power density is high, but still falls within the limit, the all measured power density of the service provider falls low from 60m to 100m, except for Airtel service provider which falls low from 80m to 100m as such it is safe to adequately install a telecommunication masts from 100m away from a residential or public buildings.

To compare the measured power density of each service provider to the ICNIRP, FCC and IEEE power density limits where calculated. From the results the highest percentage ratio was 2.96% and 3.62% observed at Airtel Mast whereas the least was 1.00% and 1.21 observed at MTN masts while 1.76% and 2.15% observed at Etisalat masts and 1.40% and 1.70% observed at Glo masts falls in between the highest and the least percentage ratio, This confirms that all audited sites comply with the standards of the ICNIRP, IEEE and FCC in terms of the amount of EMFs that the base station is radiating.

CONCLUSION

In conclusion, this study was based on Measurement and Analysis on the Health Effect of Electromagnetic Radiation from Telecommunication Masts in Some Selected Areas in Kaduna Metropolis, Nigeria. it is adequately advisable that telecommunication masts are installed at 100m away from residential or public building and that the radiofrequency emission from the measured mast are low and falls within the exposure limits set by the International Commission on Non-Ionizing Radiation Protection, Federal Communication Commission and Institute of Electrical Electronics Engineers and a good agreement was obtained therefore, people around these vicinity are safe to live, work, or transact.

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