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ASSESSMENT OF RADIOFREQUENCY RADIATION DISTRIBUTION AROUND MOBILE BASE STATIONS IN MAKURDI, BENUE STATE

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ABSTRACT

The radiofrequency field levels of selected MTN and ZAIN base stations in Makurdi were measured using electromagnetic field tester (EMF 827, Lutron). Measurements were done at distances of approximately 5.00, 10.00, 15.00 and 20.00 metres for each base station at the North, South, West, and East directions. Results shows that the average magnetic field levels of MTN and ZAIN base station ranged between 0.09 μT to 0.15 μT. The mean electric field values for eye, brain and muscles ranged between 18.81vm^{-1} to 31.55vm^{-1}. The specific absorption rate (SAR) were found to range between 0.18Wkg^{-1} to 1.03Wkg^{-1} for MTN and ZAIN networks. This work has, therefore shown that the radiation emitted by the mobile base stations are within the regulatory standards and have no adverse effects to the members of the public.

Keywords: Radiation, Mobile communication, SAR, Radiofrequency, Electromagnetic field, Emission.

1. INTRODUCTION

Mobile communications technology are now common in Makurdi Benue State. The introduction of communication systems in the year 2002 in Nigeria has increased radiofrequency radiation exposure of the general public to telecommunications and mobile base stations [1].

There is widespread public concern about the potential adverse health effects of mobile phones and especially their associated base stations alongside with hundreds of apparently conflicting reports in the media about the health effects of mobile phones and base stations as reported by Zenon [2]. Studies have shown that exposure levels of about 3kHz-5MHz generates painful nerves impulses while 100kHz-3GHz leads to temperature rise of the body and frequencies of 300GHz can change the cellular DNA and initiate a carcinogenic transformation [3]. In medicine, it is used for the treatment of liver cancer, cosmetic surgery, sleep Apnea, Snoring, rapid heartbeat syndrome etc, [4].

In view of the above, the present study consider it important to measure the electromagnetic field values and compare it with the international recommended safe limits in order to assess the safety of members of the public.

2. MATERIALS AND METHODS

An electromagnetic tester (EMF 827, Lutron)was used for the measurement. It is a highly sensitive device capable of measuring frequencies in magnetic fields. Measurements were taken at distances of 5.00, 10.00, 15.00 and 20.00 metres from randomly selected base stations three each of MTN and ZAIN in the North, South, west and East directions of Makurdi. The measured values of the magnetic field intensity (B) were converted to electric fields. This is because radiofrequency (RF) and RF fields have both electric and magnetic components and that RF waves propagate outwards with the electric field vectors (E) and the magnetic field vectors (B) in phase, perpendicular to each other and to the direction of propagation of the wave which are in a constant ratio $V=EB^{-1}$. Therefore E=VB. V is the velocity of electromagnetic (EM) wave in tissue (eye, brain and muscle) calculated from $V=Cn^{-1}$ (C= Velocity of EM wave in vacuum $3x10^8$ ms^{-1} and n= the refractive index of tissue) [5].

The SAR of the human tissues were obtained using: $SAR = \frac{\sigma E^2}{2\rho}$

σ = Electrical conductivity of tissue, E = Electric field intensity and ρ = density of tissue [6].

3. RESULTS AND DISCUSSIONS

Table 2.0 shows that the average magnetic field levels of MTN and ZAIN base stations ranged between 0.09μT to 0.15μT and 0.10μT to 0.15μT respectively. The mean electric field values for eye,brain and muscle for MTN ranged between 19.80vm^{-1} to 33.00vm^{-1}, 18.81vm^{-1} to 31.35vm^{-1}, 18.90vm^{-1} to 31.50vm^{-1} while ZAIN base station mean electric field values for eye, brain and muscle ranged from 22.00vm^{-1} to 33.00vm^{-1}, 20.90vm^{-1} to 31.35$vm^{-1}$and 21.00vm^{-1} to 31.50vm^{-1} respectively. There is decrease in field strength due to increasing distance away from the base stations. ZAIN base stations has a slight higher magnetic field than MTN base stations probably due to changing conditions during measurement. Both MTN and ZAIN are considered to be below the threshold limit of 0.2μT as reported by Vecchia [7]. Implying that MTN and ZAIN networks has no adverse health effects on the public within the study region.

In Table 3.0 it was observed that the averaged specific absorption rate (SAR) values for the eye ranged from 0.37$Wkg^{-1}$to 1.03 $Wkg^{-1}$and 0.46 $Wkg^{-1}$to 1.03$Wkg^{-1}$for MTN and ZAIN respectively. The mean values recorded for the brain ranged between 0.18 $Wkg^{-1}$to 0.50$Wkg^{-1}$and 0.22 Wkg^{-1} to 0.50 $Wkg^{-1}$for MTN and ZAIN respectively. The average SAR values for the muscles were found to range between 0.21$Wkg^{-1}$to 0.58 $Wkg^{-1}$and 0.26$Wkg^{-1}$to 0.58$Wkg^{-1}$for MTN and ZAIN respectively. The result of the study revealed that the SAR values for MTN and ZAIN are the same at the distances of 5m and 15m with the mean SAR values of 1.03$Wkg^{-1}$and 0.56 $Wkg^{-1}$for eye. The same applies to the brain having the same

mean SAR value of 0.50 Wkg^{-1}at a distance of 5m for MTN and ZAIN, and mean SAR values of 0.27$Wkg^{-1}$for the both MTN and ZAIN at distances of 15m respectively. The mean SAR value for the muscle indicates that 0.58$Wkg^{-1}$are the same values for MTN and ZAIN at distances of 5m and 0.31Wkg^{-1}same for MTN and ZAIN networks at 15m respectively. This is because dielectric parameters for head models in SAR calculations remains unchanged [8]. The remaining SAR values for the eye, brain and muscle shows that MTN base stations are higher than those of ZAIN. Specific absorption rate generally vary across the frequency bands and also depends on the tissue parameter of human head tissues (i.e conductivity, permittivity and density) since these parameters are distinct for each test target. According to Cember and Johnson [3],the localized SAR limit for the human head is set at 2.0 Wkg^{-1} and the magnitude of the electric fields calculated for the human head tissues were found to be below the accepted reference of $61vm^{-1}$ for occupational exposure reported by Vecchia [7]. Thus, the radiation absorbed by the human head from exposure to fields from the various GSM base stations monitored were below the safe limit.

4. CONCLUSION

The result of the study emitted by GSM base stations are within standards of the regulatory agencies and has no health risk to residents found within the study area.

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Table-1. Refractive Indices, Velocity of EM Wave and tissue Parameters

Types of tissue	Refractive Index	Velocity of EM Waves (ms^{-1})	Density(kgm^{-3})	Conductivity (sm^{-1})
Muscle	1.431	$2.10x10^8$	1070	1.26
Eye	1.336	$2.20x10^8$	1000	1.90
Brain	1.433	$2.09x10^8$	1030	1.05

Source: Dirckx [5], Le-wei [9]

Table-2. Magnetic and electric field for human head tissues from MTN and ZAIN Base Stations

	5m		10m		15m		20m	
	MTN	ZAIN	MTN	ZAIN	MTN	ZAIN	MTN	ZAIN
Magnetic field B(μT)	0.15±0.03	0.15±0.03	0.13±0.03	0.11±0.02	0.11±0.02	0.11±0.03	0.09±0.02	0.10±0.02
Eye E(vm^{-1})	33.00±0.03	33.00±0.03	28.60±0.03	24.20±0.02	24.20±0.02	24.20±0.03	19.80±0.02	22.00±0.02
Brain E (vm^{-1})	31.50±0.03	31.35±0.03	27.17±0.03	22.99±0.02	22.99±0.02	22.99±0.03	18.81±0.02	20.90±0.02
Muscle E(vm^{-1})	31.35±0.03	31.50±0.03	27.30±0.03	23.10±0.02	23.10±0.02	23.10±0.03	18.90±0.02	21.00±0.02

Table-3. Mean specific absorption rate (SAR) for human tissue from MTN and ZAIN Base Stations

	5m		10m		15m		20m	
	MTN	ZAIN	MTN	ZAIN	MTN	ZAIN	MTN	ZAIN
Eye (Wkg^{-1})	1.03	1.03	0.78	0.56	0.56	0.56	0.37	0.46
Brain (Wkg^{-1})	0.50	0.50	0.43	0.27	0.27	0.27	0.18	0.22
Muscle (Wkg^{-1})	0.58	0.58	0.44	0.31	0.31	0.31	0.21	0.26