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The Impact of Electromagnetic Radiations from Base Stations on Humans

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ABSTRACT; *The impact of Electromagnetic radiations (EMR) from base stations on humans has gained tremendous research interest in the past decade. This interest has been necessitated by the proliferations of communication mast in cities due to the large increase in use of communication devices (GSM). The objective of this work is to investigate Choba (a sub urban city) in Rivers state, Nigeria. The work seeks to verify if network providers operate at the required limits and standard, in the radiations emitted from the base transceiver stations to ascertain compliance. Secondly, it further establishes if any health risks exist on humans residing close to the base station since the safety range should be about 300 meters away from each station. Radiation measurements were carried out using cellular mobile network analyzer at the specific base stations in the coverage area. Questionnaires were also distributed to individuals residing very close to the base stations as yet another approach implored in actualizing the objective of this work. This collective approach will be used to draw a logical conclusion to ascertain the impacts of Electromagnetic radiations within the area under study. Statistical analysis was also carried out with the data obtained using Microsoft excel and SPSS program. Result obtained highlighted the relationship between distance and power density of Electromagnetic fields emitted from base station. The outcome of the result can serve as guide for the Government and statutory bodies, to play a key role in creating more awareness on the impending health challenges caused by installing communication mast around residential areas.*

KEYWORDS: *GSM Base transceiver Station, Radiation level, power density, Electromagnetic radiation.*

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I. INTRODUCTION

Mobile phones are now an integral part of our modern day communication tool. The large amount of mobile phones in use has brought about a significant increase in the number of base transceiver stations installed to handle the demand posed by users, so as to ensure effective communication process. The base stations towers can be mounted on existing buildings or made to stand alone on high mast to avoid blockage or hindrances from high rise buildings and obstacle. In either case, electromagnetic field radiations are emitted from the antennas on the towers. The towers could be about 50 to 200 feet high. It is known that at frequencies between 900 and 1800MHz, the antennas on GSM base stations emits electromagnetic radiations into space [1]. The radiations from mobile phones tend to be greater than those experienced from base stations. This is due to the proximity of the device to humans [2].

The effect of electromagnetic radiation (EMR) with respect to human health is an area of research interest in the past few years [3]. The study has evolved from the physiological impact, to mental, psychological and behavioral performance of individuals residing close to these communication masts. The proliferation of these communication masts has caused more radiations to be emitted into the environment. The antennas on the BTS are placed in a defined geometrical configuration to provide an Omni directional coverage. The power density of the antenna at lower frequency band is very small. This creates the ability for field patterns to penetrate the human body. This penetration process unlike the high power density antennas has its absorption power occurring near the sky surface [4]. Electromagnetic radiations like light waves, travels in a straight line and exhibits three properties on collision with external body/object. It can transmit through, be reflected and absorbed. The amount of energy propagated tends to reduce with distance travelled and so, individuals residing far away from the base stations receive less exposure compared to those residents living close to the BTS.

The continuous emission of electromagnetic radiations is posing a serious health challenge not just to human life, but to other living creatures in the Eco system. For instance, EMR from cellular phones, handsets and tower-based antennas carry signals, which studies have shown can lead to brain damage, genetic disorders, and a number of hazardous health-related conditions. For this numerous reason, this study was carried out to understand and investigate the impact of EMR on humans in Port Harcourt metropolis using Choba area as a case study. The study also investigates if the threshold limits of electromagnetic radiations emitted are within the range of operational standards set by authorized bodies.

The exposure limits of microwave frequency are defined by the power density values expressed with respect to the frequency of operation. The value of recommended power density limits could be as low as $0.2mW/cm^2$ for the lower frequency range.

Mobile phone base stations can be seen as standalone mast or mast mounted on other structures. Each station carries a number of transmitters of which the latter is dependent on the extent of cell coverage. Conventionally, radio signals are sent via cables to the antennas. The antennas in turn radiate the radio waves into the surrounding. A typical base station consists of three sectorial antennas mounted to offer an omini directional coverage. This base station of low capacity can proffer solution to network accessibility in areas with limited number of mobile phone users. This further implies that, transmission in such area can be achieved by propagating on a single frequency. Very large base station can be installed in areas that are densely populated. They can accommodate a number of transmitters with their corresponding antennas to offer large signal coverage. This can be achieved by transmitting on more than one frequency band to offer effective communication to suit the demand of such region.

Each base station provides a specific output power for operation within the specified area of coverage. The output power depends to a large extent on the terrain of the given area and the extent of coverage. Usually, maximum powers for individual microcellular base station transmitters are within 5 to 10 watts (W) however, it is known that up to 100W total power can be radiated from antennas with more than one transmitter. Power radiated from a single transmitter base station remains almost constant with time or with the number of phone users. Up to seven phone calls can be handled simultaneously by such a base station. With larger capacity base stations having multiple transmitters, the output power can vary over time with the number of calls been handled. The power output of a macro cellular base station with ten 10 W transmitters may possess a minimum of 10 W and a maximum of 100 W over time. Microcellular base stations are known to have smaller coverage area as such they can operate at low power levels. [5].

Several works, both experimental and qualitative analysis has been performed to investigate the effect/impact electromagnetic radiations have on human health. Adekunle [6] performed experimental measurement on radiations using a Gauss meter. Results from other notable experimental approach has revealed that the measured power density level were less than the safety recommended values [7, 8] Further research conducted by the American National standard institute [9] found out that there are psychological and physiological reactions of individual living around the mobile phone transceiver stations. The outcome of their findings showed that most people suffer symptoms of nausea, headache, dizziness, irritability, discomfort, nervousness and depression. Loss of memory and sleep disturbances was other likely symptoms of EM exposure. A comparative analysis was performed on the performance of base transceiver stations and their impact on the human body. The study determined the power density and field intensity of the radiations and further showed that the field strength experienced was within the ICNIRP standard limits [10]. It was also recorded that long and large exposure to EM waves from base stations can also increase the risk of cancer development, affect the tissues of the brain thereby inhibiting its performance while increasing headache and memory loss [11]. Polk [12] determined an expression which relates the penetration of electric fields on the human body as a measure of the frequency of propagation. Adair and Peterson [13] determined the specific absorption rate for which electromagnetic fields are converted into heat on interaction with the body metabolism. Analytical approach has also been sought to study the impact of EM radiations from base stations. The outcome showed that three parameters affect the radiation extent; they include frequency, power and time of exposure. The result further showed that short time exposure for a long period of time is equivalent to long term exposure for a short period of time [14].

II. MATERIALS/METHODOLOGY

The research methodology adopted are categorized in two aspects, these include

- Quantitative approach; this method required the use of Survey questionnaires as a primary tool used for data collection. The information required on the questionnaire included; age of the individual, residential distance from the base station, period of residence, likely health observation from the individual, general feeling/observation and sex of the individual.

- Use of signal propagation device to measure the electromagnetic radiation in the environment where the BTS are located. This is to ensure adequate and substantial comparison with the standard limits is carried out.

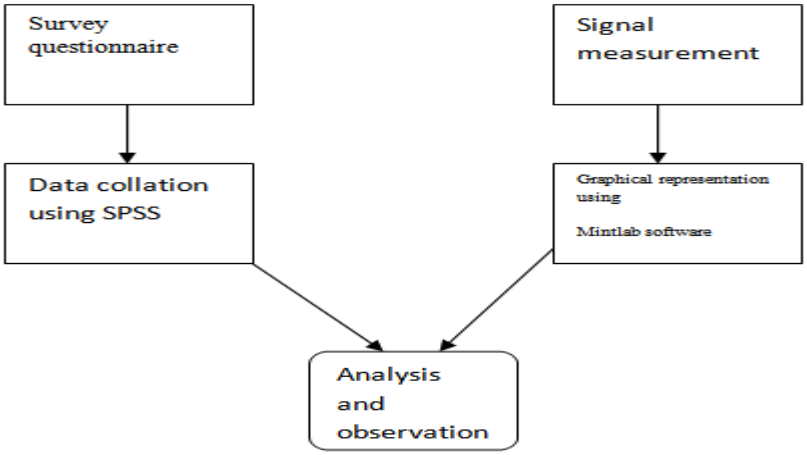

Figure 1: Block diagram of Research Methodology.

To ensure that the objective of this study is been achieved, a quantitative approach was part of the methodology adopted. This involved the use of survey questionnaire as a primary tool for data collection. The questionnaire included questions about sources of EMF exposure, medical history, and questions related to health problems such as sleep disturbances, dizziness, headache, and hypertension. The approach adopted in the process of completing the requirements of the questionnaire includes personal interviews and interactions. The period of this study was between June and November 2018.

Data collected from the questionnaire were entered in an excel file and with the aid of spss program. A chi test analysis was conducted from the data collected. Result showed that there was no real significant health challenges recorded for those residing far away from the BTS and there was no clear indication that EMF exposure was responsible for the minor health cases recorded.

In order to ascertain the radio signal propagation characteristic from the transmitters, a handheld electro smog meter was used to collect power density readings from the specified base stations. The device operates within the frequency range of 50 MHz to 3.5 GHz. Precautionary measures were taken to ensure measurements are of less human and experimental errors. The readings were taken at specific incremental distance from the base station. It was also ensured that the meter was in a steady state condition before measurements were made and taken.

Measurement of the Electric Field intensity E was made. The latter was therefore used on conversion using the constitutive relation to determine the corresponding Magnetic Field intensity H. With these values, the power density S emitted by EMF from the base station was determined. The power density (in W/m^2) can be described as the power radiated per unit area.

Just as the antennas on a typical base station are aimed at 360^o omini directional coverage [15], readings can therefore be taken in any prescribed direction within the station. Measurements were made within 50m to 300m from each mast. The readings include values of the instantaneous power density at three cardinal point of the base station.

III. RESULT AND ANALYSIS

Signal Measurement

For the purpose of this study, the absolute power readings were determined and used in plotting the graphs. The standard unit for measurement of radiated signal is in Wcm^2 or $mWcm^2$ or $nWcm^2$. Figures 2 to 3 illustrates the graph of received power density versus distance covered.

1dBm = 1.258925mW, 1 nW/cm^2 = 10 $\mu W/m^2$

Table 1: Measured values of Power density with distance for different network providers in Choba metropolis

S/N	Distance (m)	BST 1 (µW/m2) ETISALAT	BST 2 (µW/m2) ETISALAT	BST 3 (µW/m2) ETISALAT	BST 4 (µW/m2) ETISALAT	BST 5 (µW/m2) GLO	BST 6 (µW/m2) GLO	BST 7 (µW/m2) GLO	BST 8 (µW/m2) GLO	BST 9 (µW/m2) MTN	BST 10 (µW/m2) MTN	BST 11 (µW/m2) MTN	BST 12 (µW/m2) MTN
1	0	706.7	832.4	750.3	820.3	476.3	356.4	485.6	458.3	480.5	543.6	456.3	523.1
2	50	605.3	620.3	845.3	754.3	309.3	320.3	398.3	366.5	411.6	498.6	423.5	487.6
3	100	458.2	415.3	523.6	655.8	298.6	285.6	352.5	298.2	375.9	398.4	398.3	411.8
4	150	375.6	300.3	485.6	623.2	242.4	211.7	268.3	235.4	301.5	311.2	354.2	380.9
5	200	290.8	270.6	358.2	455.8	224	189.5	254.3	178.3	278	278.5	297.3	315.6
6	250	215.3	179.3	425.6	358.2	172	100.3	187.6	132.4	206.3	178.9	211.6	196.3
7	300	185	152.7	198.5	155.6	115.3	89.8	152.2	100.3	187.3	154.6	175.4	170.7

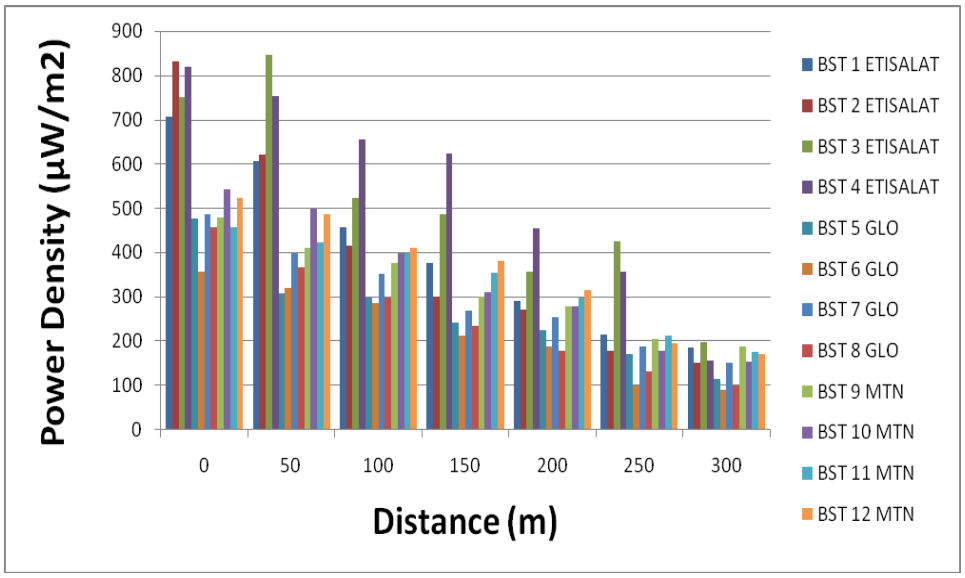

Fig 2: Plot of power density (µW/m^2) against distance (m) all BTS

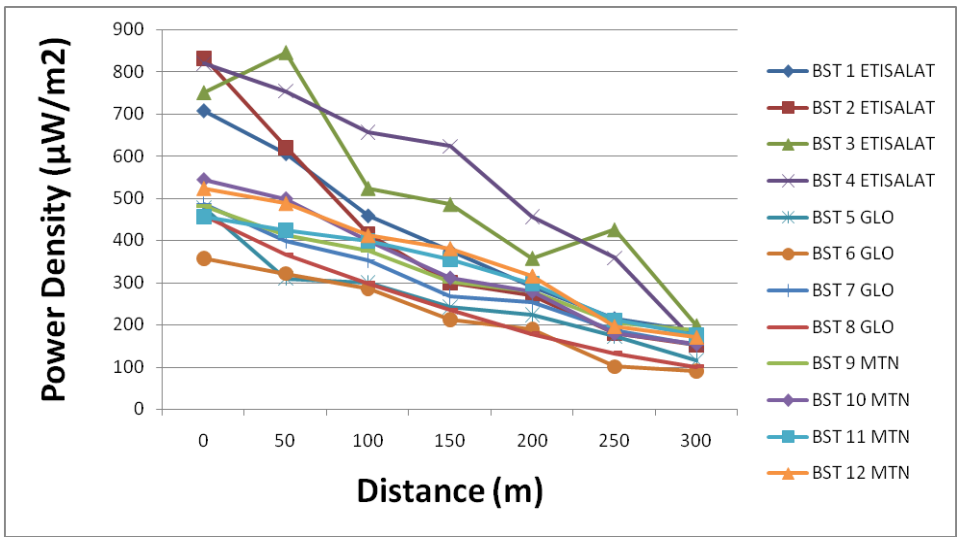

Fig 3: Line graph representation of power density vs distance radiation from all stations

A total of twelve BTS were visited, four MTN BTS, Globacom (Glo) BTS and Etisalat BTS respectively. Figure.3 shows that as distance increases, the power density reduces. This indicates that distance from the base station is an important factor to achieve reduced exposure to electromagnetic radiation.
In the different scenarios considered in this study, the values of the emissions radiated are below $107\mu Wm^{-2}$. This value happens to be a standard limit prescribed by the international commission on non-ionizing radiation protection [16].

The data collated was compiled in a Microsoft Excel Spreadsheet. The Chi-square test was performed on the data to determine the significant levels based on the outcome of the data. The study involved a total number of 200 participants. These comprises of equal number of male and female. The population includes; children, youth and adults. The significance of the Chi-square test revealed that; electromagnetic radiation exposure in the environment under consideration has negligible effect on human health. The chi- square test result is as shown in table 2 below

Table 2 Chi square test result.

VARIABLE	OBSERVED N	DF.	CHI – SQUARE	SIGNIFICANT
Q1. Headache YES NO NEUTRAL TOTAL	 49 146 5 200	2	156.130*	0
Q2. Body Pain YES NO NEUTRAL TOTAL	 44 3 153 200	2	180.310*	0
Q3. Stomach Disorder YES NO NEUTRAL TOTAL	 20 178 2 200	2	281.320*	0
Q4. Brain tumor YES NO NEUTRAL TOTAL	 2 189 6 200	2	336.730*	0
Q5. Hypertension YES NO NEUTRAL TOTAL	 32 166 2 200	2	228.760*	0
Q6. Dizziness YES NO NEUTRAL TOTAL	 38 154 8 200	2	178.360*	0
Q7. Sleep Disturbance YES NO NEUTRAL TOTAL	 24 172 4 200	2	252.640*	0
Q8. Body weakness YES NO NEUTRAL TOTAL	 46 156 2 200	2	191.560*	0
Q9. Skin cancer YES NO NEUTRAL TOTAL	 0 182 18 200	2	300.760*	0
Q10. Nervousness YES NO NEUTRAL TOTAL	 16 180 4 200	2	290.080*	0

However from the response of the questionnaire, the most prominent source of health challenge noticed by people living within 300m of the base station was headache and discomfort posed by the humming sounds from diesel engines and transmitters which power and services the station respectively. This challenge is not very noticeable in children but is more pronounced in adults between ages 30 to 70years. Other challenges include depression and hearing impairment in adults. In youths and children sleep disorders are major health concerns. Other intense health challenges like tissue damage and brain disorders are likely to occur in people residing very close to the cell site.

IV. CONCLUSION

In this work, the radiations from base station antennas were measured within choba metropolis to ascertain its effects/impact on humans. The research was successfully carried out. Based on the outcome of the analysis and results, the level of electromagnetic radiation emitted within 300m of the base station site reduced with increase

in distance but quite high about 0.207nW very close to the base of the cell site. It is therefore advisable to reside at distances greater than 300m to avoid the effect of these radiations based on the power density values.

The Chi-square test of significances revealed that electromagnetic radiation exposure within the said environment under consideration has negligible effect on human health. Although research has shown that individuals residing within the region not prescribed by adequate authorities suffer know health challenges with headache recording the highest value. It is therefore not advisable for resident to reside close to the base station.

It is necessary to create more intense awareness on the possible negative health effects of electromagnetic radiation from the base transceiver stations.

It is therefore recommended that continuous test and measurement should be performed on regular basis to ensure people living around communication equipment, high tension lines and other electronic devices are safe and healthy while carrying out their day to day activities.

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