International Journal of Academic and Practical Research
ISSN (Online): 2980-4124 • ISSN (Print): 2980-4116
Volume 2, Issue 1, May 2023
Journal Homepage: http://actonlineedu.org/ijaapr/

Research Article

OPEN ACCESS

Measurement of Electromagnetic Fields (EMF) from Mobile Phone Base Stations and Health Effect in Abeokuta, Ogun State, South-Western Nigeria

Taofeek Kolapo Taiwo[1], Shamsideen Kunle Alausa[2], Aliu Adekunle Adegbile[3], Peter Adefioye Oluwafisoye[4], and Philip Oladele Bayode[4]

[1]Ministry of Education, Oyo State Teaching Service Commission, (TESCOM), Leaf Road, Ibadan, Oyo State, Nigeria, [2]Department of Physics, Olabisi Onabanjo University, Ago-iwoye, Ogun, Nigeria, [3]Department of Computer Science, Federal College of Animal Health and Production Technology, Ibadan, Nigeria, [4]Department of Physics, Osun State University, Osogbo, Nigeria

Article Information

Article ID Number
202211022

Article History

Received	27	Oct	2022
Reviewed	06	Jan	2023
Revised	19	Apr	2023
Accepted	19	Apr	2023
Published	14	Jun	2023

Gunning Fog Index: 11.46

Similarity Index: < 20%

Corresponding Author
Taofeek Kolapo Taiwo
kolataiwo2013@gmail.com

Quick Response Code

Abstract

The general public is concerned about the potentially dangerous health effects of human exposure to electromagnetic radiation (EMR) released by phone base stations. Concerns about the purported detrimental effects of electromagnetic field (EMF) radiation emitted by phone base transceivers prompted protests against the construction of phone base stations (BTS). As a result, measuring levels of EMF exposure in the population and potential hazards is critical. A wide-band TES-90 electrosmog meter was used to measure public exposure to electromagnetic radiation from the BTS at several places in Abeokuta. After surveying using a GPS meter, measurements were taken from 62 base stations in Abeokuta. The greatest power density for the system of mobile telecommunication signals at BTS was 9.02 10^{-4} $mWcm^{-2}$ at a 2 m radius, while the mean value of power densities collected from all base stations was 3.61 10^{-4} $mWcm^{-2}$ at a 2 m radius. The maximum and average power density from all of the investigated base station antennas in Abeokuta were significantly lower than the 1 $mWcm^{-2}$ limit imposed by the International Commission on Non-Ionizing Radiation for Public Exposure (ICNIRP). The measurement of power densities at various distances from BTS-49 demonstrates how the power density varies with distance from the base stations. The measurement was within the ICNIRP-recommended limiting standard (1$mWcm^{-2}$). The conclusion implies that radiation exposure from the BTS poses no health risk and does not appear to have any known harmful effect on human health. This, however, proposed that the government and industry should stimulate science and study in order to assess the degree of EMF radiation exposure from BTS and its health effects.

Keywords

Abeokuta, electromagnetic radiations, electromagnetic field, phone base stations

DOI 10.5281/zenodo.8037217

URL: https://actonlineedu.org/ijaapr-v2i1-202211022

INTRODUCTION

All humans are subjected to electromagnetic fields (EMF) and electromagnetic radiation (EMR) from both natural and man-made sources. Every day, humans are exposed to natural EMFs. These EMFs have an advantage because humans are exposed to natural EMF sources such as the sun, and it is impossible to say whether these EMFs are hazardous to humans. Artificial EMF, on the other hand, has only been introduced into the environment in the last 100 years as a result of technological innovation and research. Humans in modern society are subjected to a growing number of EMFs emitted by the production and distribution of energy, television (TV) sets, personal computers (PC), radio transmission, security equipment, and, most recently, mobile phones and their base stations. Although they have various benefits (e.g., for telecommunication, medical, and agricultural purposes), it has been discovered that exposure to these EMFs might be hazardous to us. As a result, the purpose of this study is to look at the health effects of exposure to EMF from phone base stations (MPBS).

The rising use of mobile phones and the citing of masts and towers inside residential areas have created public concern about potential health risks connected with non-ionization electromagnetic radiation exposure from BTSs and mobile handsets. There is widespread concern about the potentially harmful health consequences of RF EMR generated from mobile phone base station antennas on the human body.

As a result of the massive expansion in phone base stations and other wireless communication device usage around the world, the effect of MPBS and other wireless communication device radiation on human health is a topic of interest and research. The apparent unrestricted development of masts and antennas, in some cases with little public engagement, has sparked suspicion and organized protest, particularly where facilities have been or are scheduled to be located near schools, daycare centers, and other sensitive areas.

Mobile phone base stations emit microwave electromagnetic radiation (450–2100 MHz). Other digital wireless systems, such as communication networks, produce radiation that is similar. This emission may pose a significant health risk; nonetheless, several National Radiation Advisory Authorities have recommended preventive actions to reduce exposure to their citizens without specifying the exact health effect.

According to WHO (2011), no harmful health impacts have been linked to the use of mobile phones or base stations. Several scientific studies have been conducted to evaluate the potential health impacts of mobile phones. Scientific committees analyze these studies on a regular basis to assess the overall danger. An investigation and publication on emergency health risk by the European Commission (EC) in 2007 revealed an increase in health risk due to high exposure levels from phone base stations. However, many nations' regulatory agencies have yet to analyze the issue of human exposure to EMF (radio frequency and microwave radiation) from base stations.

The radiation emitted by fixed infrastructure used in mobile telephony, such as base stations and their antennas that provide the link to and from mobile phones, is a source of concern in the telecommunications industry. Mobile phones continuously release radiation into their surroundings.

Base stations are typically 50 to 200 feet tall. Cell phones that communicate with local cell towers primarily use radio wave energy in the electromagnetic band between FM radio waves and microwaves. They are non-ionizing and differ from strong forms of radiation such as X-rays, gamma rays, and ultraviolet (UV), which can cause health problems such as DNA-cell breakage.

The installation of phone base stations in populated areas has sparked concerns about the potential health impacts of emitted EMF. Nearly every new invention contributes to pollution. The rate of increase is increasing at an exponential rate. This research provides an overview of electromagnetic fields and their negative impact on the human body. The public in Nigeria has voiced concern about living or working near a cell phone tower due to potential health dangers. There have previously been few reports on the health effects of EMR exposure from mobile phone base stations. As a result, it is required to analyze whether or not there is a health effect from MBTS EMF exposure and to provide guidance on the horizontal safety distance of the house or structure from the cell tower. Finally, this study will add to the current literature for future reference. Nigeria joined the rest of the globe in conducting research on mobile phone base stations (MPBS) in response to concerns about the detrimental effects of EMF from BTS and the safety of human exposure.

There is reason to believe that RF-EMFs are bioactive and may have health consequences. According to epidemiological research, RF and EMFs should be recognized as human carcinogens (Khurana et al., 2010). Yet, there is no clear evidence that RF radiation reduces human life expectancy or increases cancer risks (Independent Expert Group on Mobile Phones, 2003; Lin et al., 2010; WHO, 2011).

It is necessary to conduct additional research on radiofrequency (RF) emissions in order to explore the potential effects of EMFs on the human body. The current study aims to look at the level of the electromagnetic field from mobile phone base stations (MPBS) and the safety of human exposure.

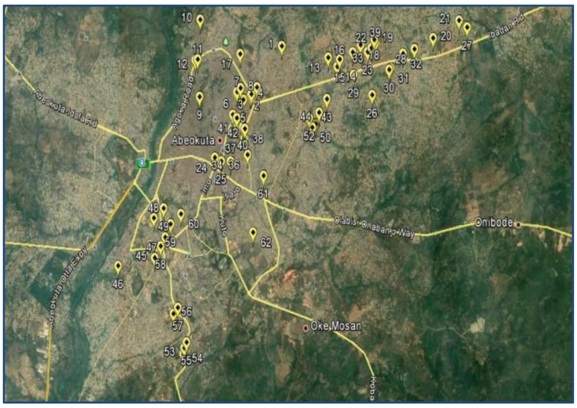
Methods

Study Area

The study's main goal is to measure the power density from each base station in Abeokuta and then statistically analyze these findings to create curves and correlations characterizing the power density behavior as distance changes. The measurements were taken for antennas radiating (800–2300 MHz) on towers ranging in height from 35 to 50 meters.

Because of its geographical setting (near rocky outcrops, relief characterized by escarpments that rose from the river plane to a height of approximately 150 m above sea level in the west, southern, and northern plains, and spatial distribution of BTS in the city), Abeokuta, the capital of Ogun State, was chosen as a study area (Figures 1 and 2). Around 90% of base stations are in close proximity to human habitation. Over a surface mass of 879 km2 (339 ml^2), Abeokuta contains about seventy mobile phone base stations with a population density of 510 km-^{2} (1300 ml^2). Masts were calculated based on the size of the study region, and a total of 62 masts formed the sample frame.

Figure 1
Distribution of Telecommunication Masts in Abeokuta



Measurement and Computation

The study evaluated 62 base stations throughout the Abeokuta metropolitan area. The power density was measured during the investigation. The power density was assessed using an RF-EMF strength meter, and the locations of each base station were established using a global positioning system (GPS). Engineering steel tape was used to measure distance and height.

GPS is a gadget that receives signals in order to determine the precise location of any object on the earth's surface. GPS devices provide information about a location's latitude, longitude, and elevation (altitude).

The coordinates of the stations in Abeokuta were determined using a portable GPS. The RF power density of selected base stations in Abeokuta was measured using a radio frequency meter (Electromog meter). The meter is a wide-band device for measuring high-frequency radiation ranging from 50 MHz to 3.5 GHz. It is a non-directional digital (isotropic radio frequency) meter with three axes.

The RF meter measures the strength of the electric field (E) and translates it to the magnetic field (H) and power density (S). When set to the triaxial mode of operation, the meter may measure field strength along several axes and collect measurements at all field strengths at the same time. Power density S in milliwatts per square centimeter is connected to both E and H (mWcm^{-2}).

An electromagnetic wave's propagation conveys energy. Albert Einstein was awarded the Nobel Prize in Physics in 1921 for his discovery that electromagnetic waves are conveyed by discrete particles (photons). Each photon in the wave train has the following energy:

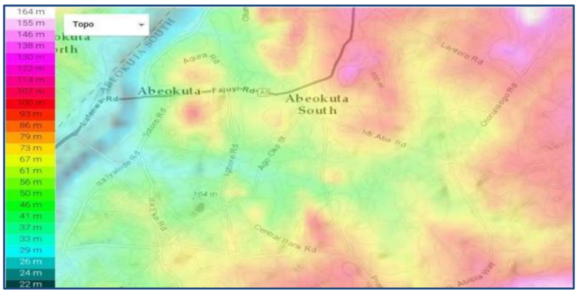
$$E = hf \qquad (1)$$

When f is the frequency and h is a constant known as Plank's constant (6.63 10^{-34} J.s), the frequency of an EM field dictates the amount of energy it carries and, thus, how it will interact with the medium in which it is traveling. The amount of power per unit area in a connected electromagnetic field is measured as power density (S). The power density (energy per unit area) received at a place is used to calculate human exposure to radiation (RF). According to Lin et al., (2010), the magnitudes of the electric field strength (E) and magnetic field strength (H) are related to power density S as follows:

$$S = E = E^2/377 = 377\Omega\, H^2 \qquad (2)$$

Where 377 Ω is the typical impedance of empty space, E is the intensity of the electric field, and H is the strength of the magnetic field. Power density characterizes the external EMF and can be measured experimentally. The strength of an electric or magnetic field is measured or computed.

Figure 2
Topographical Map of Abeokuta



ISSN (Print): 2980-4116 • ISSN (Online): 2980-4124

In general, the field strength drops fast with distance from the source due to geometric dilution matching point source radiation into three-dimensional space, as predicted by the inverse square law.

Figure 1 depicts the spread of GSM base stations, whereas Figure 2 depicts a computerized topographical map of Abeokuta. The study included both primary and secondary data collection methods. Primary sources include measurement and observation, whereas secondary sources include the internet and journal papers. Measurements were taken from 800 to 2300 MHz exposure frequencies. This frequency range corresponds to mobile phone BTS frequencies in Nigeria. The frequency of each antenna can be precisely calculated using the field measuring technique. To check the flux pattern, the RF was measured at various distances such as 0, 5, 10, 20, 40, 50, 100, 150, 200, 250, and 300 m from a properly selected base station.

The presentation and interpretation of the collected data served as the basis for data analysis. The power density was compared with the reference point to determine whether the power density value was less or more than the recommended exposure limits (10 Wm^{-2} = 1$mWcm^{-2}$).

Results

Measurement of Power Density from MPBS

Table 1 displays the power densities recorded at various BTS. The highest power density was found at BTS-15 and the lowest at BTS-54. The average power density in the research region was 3.61 10^{-2} $mWcm^{-2}$, which is substantially lower than the maximum permissible exposure of 1$mWcm^{-2}$ set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP).

Variations of Power Density With Distance (BTS-49)

The findings of electromagnetic power density measurements in the MPBS surrounding area as a function of distance from the antenna, which is 50 m high, are presented here.

The association between RF power density and distance from the tower where the mobile phone base antenna was positioned is shown in Table 2. Table 2 displays the measured power densities from the tower. At 300 m, the value was 6.30 10^{-8} $mWcm^{-2}$, while at 0 m, the value was 6.42 10^{-4} $mWcm^{-2}$. At a distance of 150 m from the BTS, the power density encounters interference from other adjacent communication infrastructure, causing the recorded value of 2.50 10^{-6} $mWcm^{-2}$ to fluctuate.

The graph (Figure 3) depicts the behavior of power density as distance changes. It demonstrates that the RF field strength is greatest at the source and rapidly decreases with distance. However, the intensity of the radiation decreases quickly as one moves away from the transmitter's base due to power attenuation. Power density characterizes the external EMF and can be measured experimentally or computed from the measured electric or magnetic field strength.

When combining the materials, which are flour, water, clay filler, and powder pigment, the result was a paste that resembled paint. The researchers then tested if it would stick to the wood piece, and the experiment went well. This shows that the experiment was a success, and the researchers have made a paint that is made from flour. The researchers learned that making home-made flour is indeed possible and can be used.

Figure 3
Power Density vs. Distance

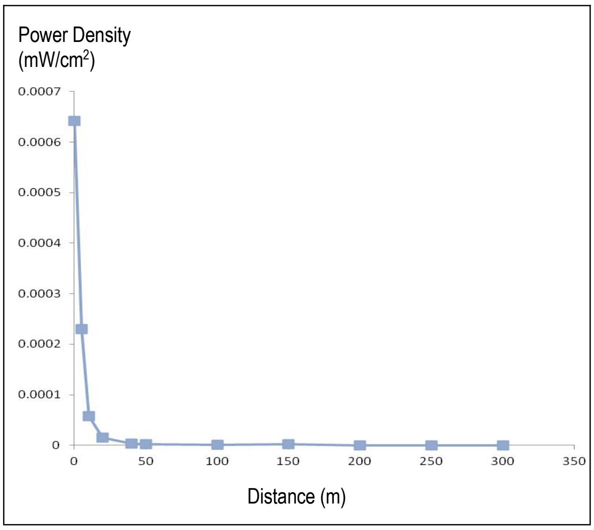
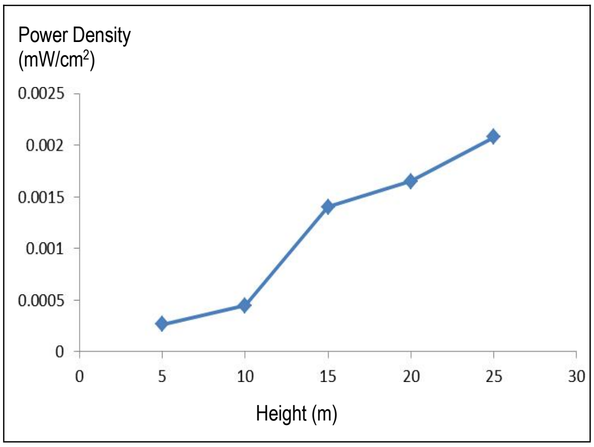


Figure 4
Power Density vs. Height



Variables influencing RF from BTS tower cells include: (a) Frequency and wavelength of transmitted RF signals, (b) Number of antennas attached per BTS, (c) Length of RF signal exposure at a particular distance, (d) Exposure from other antennas in the neighborhood, (e) Duration and/or frequency of recurrent exposure, (f) Environmental temperature and humidity, and (g) Antenna height.

Personal exposure levels are typically accurately assessed by onsite field measurements, as indicated in Figure 1. Equation 3 represents an approximation of far-field free space in which the reflected effect is ignored.

Table 1
RF Energy Levels in Abeokuta

BTS No.	Station location-(GPSY)	RF Level (Power Density) ($mWcm^{-2}$)
1	07°10·448^{1}N,03°22.180^{1}E	1.71×10^{-4}
2	07°10·185^{1}N,03°21·560^{1}E	1.5×10^{-4}
3	07°10.092^{1}N,03°21.461^{1}E	3.0×10^{-4}
4	07°10·084^{1}N,03°21.440^{1}E	5.60×10^{-4}
5	07°10.016^{1}N,03°21.192^{1}E	3.68×10^{-4}
6	07°10.099^{1}N,03°21.316^{1}E	2.58×10^{-4}
7	07°10.112^{1}N,03°21.204^{1}E	4.19×10^{-4}
8	07°10.174^{1}N,03°21·266^{1}E	1.49×10^{-4}
9	07°11.054^{1}N,03°20.531^{1}E	3.0×10^{-4}
10	07°11.106^{1}N,03°20.538^{1}E	2.02×10^{-4}
11	07°10.567^{1}N,03°20.493^{1}E	2.20×10^{-4}
12	07°10.557^{1}N,03°20.451^{1}E	1.89×10^{-4}
13	07°10.591^{1}N,03°22·833^{1}E	2.46×10^{-4}
14	07°10.648^{1}N,03°22.995^{1}E	5.44×10^{-4}
15	07°10.5661N,03°23.0381E	9.02×10-4
16	07°10.667^{1}N,03°23.271^{1}E	6.16×10^{-4}
17	07°10.637^{1}N,03°21.258^{1}E	3.90×10^{-4}
18	07°10.768^{1}N,03°23.411^{1}E	2.36×10^{-4}
19	07°10.841^{1}N,03°23.653^{1}E	4.64×10^{-4}
20	07°10.864^{1}N,03°24.705^{1}E	2.17×10^{-4}
21	07°11.108^{1}N,03°25.169^{1}E	6.7×10^{-5}
22	07°10.839^{1}N,03°23.655^{1}E	4.64×10^{-4}
23	07°10·674^{1}N,03°23. 538^{1}E	2.67×10^{-4}
24	07°09.225^{1}N,03°20^1.809^{1}E	1.97×10^{-4}
25	07°09.175^{1}N,03°20.925^{1}E	1.96×10^{-4}
26	07°10.085^{1}N,03°23.620^{1}E	8.61×10^{-4}
27	07°11.016^{1}N,03°25.315^{1}E	1.10×10^{-4}
28	07°10.714^{1}N,03°24.373^{1}E	1.84×10^{-4}
29	07°10.360^{1}N,03°23.288^{1}E	1.83×10^{-4}
30	07°10.431^{1}N,03°23.924^{1}E	1.87×10^{-4}
31	07°10.452^{1}N,03°23.949^{1}E	2.16×10^{-4}
32	07°10.651^{1}N,03°24.170^{1}E	2.27×10^{-4}
33	07°10.728^{1}N,03°23.606^{1}E	2.92×10^{-4}
34	07°09.174^{1}N,03°21.092^{1}E	2.34×10^{-4}
35	07°09.178^{1}N,03^{v}21.243^{1}E	2.68×10^{-4}
36	07°09.267^{1}N,03°21.395^{1}E	3.55×10^{-4}
37	07°09.490^{1}N,03°21.336^{1}E	7.12×10^{-4}
38	07°09.620^{1}N,03°21.346^{1}E	4.66×10^{-4}
39	07°10.799^{1}N,03°23.677^{1}E	4.50×10^{-4}
40	07°09.644^{1}N,03°21.310^{1}E	2.68×10^{-4}
41	07°09.763^{1}N,03°21.203^{1}E	3.57×10^{-4}
42	07°09.808^{1}N,03°21.132^{1}E	2.95×10^{-4}
43	07°10.028^{1}N,03°22.813^{1}E	2.29×10^{-4}
44	07°09.845^{1}N,03°22.674^{1}E	1.27×10^{-4}
45	07°07.851^{1}N,03°19.737^{1}E	7.39×10^{-4}
46	07°07.739^{1}N,03°19.76^{1}E	8.41×10^{-4}
47	07°08.132^{1}N,03°19.924^{1}E	1.52×10^{-4}
48	07°08.395^{1}N,03°19.716^{1}E	5.68×10^{-4}
49	07°08.529^{1}N,03°19.891^{1}E	6.42×10^{-4}
50	07°09.641^{1}N,03°22.554^{1}E	6.69×10^{-4}
51	07°09.685^{1}N,03°22.617^{1}E	2.04×10^{-4}
52	07°09.770^{1}N,03°22.497^{1}E	2.76×10^{-4}
53	07°06.545^{1}N,03°20.256^{1}E	2.30×10^{-4}
54	07°06.625^{1}N,03°20.274^{1}E	6.0×10^{-5}
55	07°06.702^{1}N,03°20.315^{1}E	2.08×10^{-4}
56	07°07.091^{1}N,03°20.080^{1}E	5.30×10^{-4}
57	07°07.175^{1}N,03°20.158^{1}E	3.55×10^{-4}
58	07°08.012^{1}N,03^{v}19.843^{1}E	7.25×10^{-4}
59	07°08.313^{1}N,03^{v}20.018^{1}E	5.11×10^{-4}
60	07°08.453^{1}N,03°20.203^{1}E	5.12×10^{-4}
61	07°08.982^{1}N,03°21.684^{1}E	3.23×10^{-4}
62	07°08.207^{1}N,03°21.502^{1}E	1.14×10^{-4}
Mean		**3.61×10^{-4}**

Table 2
Measurement of Power Density with Distance

Distance (m)	Power Density ($mWcm^{-2}$)
0.0	6.42×10^{-4}
5.0	2.30×10^{-4}
10.0	5.72×10^{-5}
20.0	1.45×10^{-5}
40.0	3.58×10^{-6}
50.0	2.28×10^{-6}
100.0	5.70×10^{-7}
150.0	2.50×10^{-6}
200.0	1.42×10^{-7}
250.0	9.10×10^{-8}
300.0	6.30×10^{-8}

It does, however, provide a tolerable prediction of radio frequency radiation level based on free propagation loss as follows:

$$S = P4\pi Z^2 \quad (3)$$

Where P represents total EMF power (watts) (Equivalent Isotropic Radiated Power EIRP), S represents EMF power density (W/m2), and Z represents the distance from the radio source (m).

All sector antennas have an isotropic antenna radiating pattern, which means that radiation power is distributed evenly in all directions:

$$P = X - Y + G \quad (4)$$

Where X is total output power TRX, Y is loss of wave guide, G is antenna gain, and S is limit = EIRP total/4piZ^2.

Discussion

The data provided here showed that the maximum power density was 9.02 10^{-4} $mWcm^{-2}$ at BTS-15 and the lowest was 6.0 10^{-4} $mWcm^{-2}$ at BTS-54, with a mean value of 3.61 10^{-4} $mWcm^{-2}$ (Table 1). The study's finding is approximately 1.2 times greater than the value reported by Ayinmode and Farai (2013) in Ibadan. The outcome is approximately 99.96% less than the ICNIRP exposure limit. This is approximately 2770 times less than the ICNIRP standard. The ICNIRP and FCC recommended safety limits are greater than the study's exposure levels.

Because of the small vertical spread of the beam, the RF intensity reduces rapidly as one moves away from the antenna, as seen in Table 2. The lowest power density figure was 6.30 10^{-8} m Wcm^{-2} at 300 m, and the highest was 6.42 10^{-4} $mWcm^{-2}$ at the BTS basement. The power density fluctuates at a distance of 150 m from the BTS.

ISSN (Print): 2980-4116 • ISSN (Online): 2980-4124

Table 3
Measurement of Power Density With Height

Height (m)	Power Density (mWcm^{-2})
5.0	2.65×10^{-4}
10.0	4.48×10^{-4}
15.0	1.40×10^{-3}
20.0	1.65×10^{-3}
25.0	2.08×10^{-3}

Table 4
Measurement of Power Density from Two BTS of Different Height

Height (m)	Power Density (mWcm^{-2})
BTS-15 (height 35m)	9.02×10^{-4}
BTS-54 (height 50m)	6.0×10^{-4}

However, EM field intensities decrease quickly as one moves away from a mobile base station due to power attenuation with the square of the distance. This could be attributed to the environment of the tower's location as well as the effect of hills and buildings on EMF radiation caused by multiple reflections (interference) from other nearby communication infrastructure or multipath propagation from the transmitting antenna on the tower to the receiving probe, causing a fluctuation in the recorded value of 2.5 10^{-6} mWcm^{-2}. It begins to drop after 150 m and continues to decrease until it reaches 300 m. As a result, it remains within the permitted limited standard (1 mWcm^{-2}). Power density (S) at a point source is defined as $S \propto 1/R^2$, where R is the distance from the tower. Figure 2 depicts the radiation pattern observed to obey the inverse square rule from a GSM tower antenna. When the distance from the GSM tower antenna doubles, the power density drops to 1/4, 1/9 when the distance triples, and so on. The fluctuation of power density with height from the ground of a 50-m antenna is shown in Table 3. Measurements at varied heights of 5, 10, 15, 20, and 25 m were found to increase as the height from the ground increased. As a result, the RF field intensity at the ground level of the tower cell is significantly lower than at the height above the ground. Figure 3 depicts the linear fluctuation of power density with heights ranging from 5 to 25 m above ground. These results are substantially below the ICNIRP maximum exposure limit when compared to those achieved by others.

Table 4 depicts the link between RF power density and cell tower heights of 15 and 54 m. Table 4 displays the measured values from cell towers BTS-15 and BTS-54. The maximum power density measured from the two towers BTS-15 (35 m) and BTS-54 (50 m) was 9.02 10^{-4} and 6.0 10^{-4} mWcm^{-2}, respectively. The findings of this analysis also revealed that the higher the BTS tower, the lesser the risk, yet both measures are significantly below the ICNIRP public exposure standards.

The average horizontal safe distance from a phone base station (MPBS) is calculated to be 10 to 13 m. The horizontal and vertical position in relation to the transmitter antenna is the most essential parameter in identifying the radiation intensity area on occupants, according to the study.

The results imply that radiation exposure from the BTS poses no health risk because the limits established in the International Commission on Non-Ionizing Radiation Protection (ICNIRP) recommendations do not appear to have any known harmful effect on human health.
Yet, chronic exposure to EMFs in the human body has been linked to immune system weakening (Johansson, 2009). Such disruptions enhance the likelihood of disease transmission.

The findings of this study revealed that the fluctuations in power density with distance from mobile base stations follow the inverse square law, which means that the intensity decreases rapidly with distance from the tower. The finding was consistent with other international and national investigations. As a result, there is no reason to believe that mobile phone base stations (MPBS) pose a potential health risk to humans. To avoid any negative health impacts, we must operate our gadgets in accordance with scientifically established safety standards.

Conclusion

The study included radiofrequency data from BTS in Abeokuta, Nigeria. According to the findings, the maximum power density in Abeokuta is 9.02 10^{-4} mWcm^{-2}, while the mean power density is 3.61 10^{-4} mWcm^{-2}. According to the study's findings, residents in Abeokuta are exposed to significantly less RF radiation from MPBS than the ICNIRP's maximum allowable exposure of 1 mWcm^{-2}. The RF exposure hazard index in Abeokuta was significantly below the ICNIRP-recommended RF exposure limit for the population; however, preventive steps are required for a safer environment.

Yet, the consequence of modest EMF exposure can only be the heating of the bodily tissues. As a result, residents in the research area should not be concerned about the health effects of radiation exposure from phone base stations.

REFERENCES

Ayinmode B. O., Farai I. P. (2013). Review of Variation EMF with distance from mobile phone base station. *Radial pros Dosimetry 154*(4), 424-428.

Independent Expert Group on Mobile Phones (2003). Health Effects from Radiofrequency Electromagnetic Fields: Report of an Independent Advisory Group on Non-Ionizing Radiation. *NRRPB, 14*(2).

Johansson, O. (2009). Disturbance of the immune system by electromagnetic fields—A potentially underlying cause for cellular damage and tissue repair reduction which could lead to disease and impairment. *Pathophysiology*, *16*(2-3), 157-177.

Khurana, V. G., Hardell, L., Everaert, J., Bortkiewicz, A., Carlberg, M., & Ahonen, M. (2010). Epidemiological evidence for a health risk from mobile phone base stations. *International journal of occupational and environmental health, 16*(3), 263-267.

Lin, J., Saunders, R., Schulmeister, K., Söderberg, P., Swerdlow, A., Taki, M., ... & Roy, C. (2010). ICNIRP Guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz to 100 kHz). *Health physics*, *99*, 818-836.

World Health Organization. (1997). Electromagnetic fields and public health: health effects of radiofrequency fields. In *Electromagnetic fields and public health: health effects of radiofrequency fields*.

Author(s)' Statements on Ethics and Conflict of Interest

Ethics Statement	The author/s hereby declare that research/publication ethics and citing principles have been considered in all the stages of the study. The author/s take full responsibility for the content of the paper in case of dispute.
Originality and Plagiarism Assessment	The manuscript has a similarity assessment of less than 20% in accordance with the publication ethics in terms of originality and plagiarism and the plagiarism policy of the journal.
Statement of Interest	The author/s have no conflict of interest to declare.
Funding	None

Suggested Citation

American Psychological Association (APA)	Taiwo, T. K., Alausa, S. K., Adegbile, A. A., Oluwafisoye, P. A., & Bayode, P. O. (2023). Measurement of electromagnetic fields (EMF) from mobile phone base stations and health effect in Abeokuta, Ogun State, South-Western Nigeria. *International Journal of Academic and Practical Research*, *2*(1), 123–129.

Author Biographies

Taofeek Kolapo Taiwo, Ministry of Education, Oyo State Teaching Service Commission, (TESCOM), Leaf Road, Ibadan, Oyo State, Nigeria. Email: kolataiwo2013@gmail.com

Shamsideen Kunle Alausa, Department of Physics, Olabisi Onabanjo University, Ago-iwoye, Ogun, Nigeria. Email: alausa.kunle@oouagoiwoye.edu.ng

Aliu Adekunle Adegbile, Department of Computer science, Federal College of Animal Health and Production Technology, Ibadan, Nigeria. Email: alibimpe@gmail.com

Peter Adefioye Oluwafisoye, Department of Physics, Osun State University, Osogbo, Nigeria. Email: paoluwafisoye@yahoo.com

Philip Oladele Bayode, Department of Physics, Osun State University, Osogbo, Nigeria. Email: oladelephilo@rocketmail.com

ISSN (Print): 2980-4116 • ISSN (Online): 2980-4124

This page is intentionally left blank.