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Evaluation of Power Density Radiation from Selected Mobile Base Stations in Ogbomoso, South-Western Nigeria

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ABSTRACT

Background and Purpose: Utilization of mobile phone is tremendously increasing in the society of today, leading to the proliferation of mobile base stations (MBS) which are known Radio-Frequency (RF) emitters. Proximity of mobile base stations to residential building and office buildings are of public health concern. The aim of the study is to assess the Radio-Frequency radiation exposure levels in terms of power density from base stations.
Method: A handheld, three-axis, RF meter was used to measure the values of power density at 25 meter intervals up to 150 meter from base stations. The highest values of power density of were recorded at closest proximity to the base station while the least values were recorded at highest distance (150 m) to the base stations. Generally, the measured power densities decreases as one moves away from the base station. Comparing RF radiation emanating from all Mobile Base Station (MBS), Network-3 MBS in most cases recorded the highest power density values at all radial distances from the foot of the base station.
Results: All the values of the power densities measured in this study fall below the recommended permissible power density exposure for the general public of 4.5 W/m^2 and 9 W/m^2 for frequencies of 900 MHz and 1800 MHz respectively set by ICNIRP.
Conclusion: The EMF exposure from all the base stations investigated in this research work which all fell below the limits recommended in the ICNIRP guidelines do not appear to have any known consequences on human health in the area investigated.

Keywords: Radiofrequency, power density, mobile base station (MBS), electromagnetic fields, Ogbomoso.

1.0 INTRODUCTION

Nigeria is the largest market for mobile communication devices in Africa with more than 192 million subscribers and over 52,000 base stations contributing about 10.88% of the nation's Gross Domestic Product (GDP) as at the first quarter of 2020. [(1)] The increased number of mobile phone users which was 186 million as at January 2020 but now over 192 million as at

July 2020 in Nigeria have resulted in the expansion of mobile base stations in the country. [1] Base stations and mobile phones are integral part of infrastructure needed for communication to be effective. [2] Due to the increase in mobile phone users, service providers are left with no option than to provide adequate coverage by increasing the number of mobile base stations within cities in Nigeria. Nigeria's population has been estimated to be over 206 million people by 2020 and Ogbomoso is one of the largely populated cities with an estimated population of 1.5 million. [3,4] These mobile base stations are installed in strategic places which include residential areas and near office buildings where human beings carry out their daily activities. The rapid growth in the erection of mobile base stations has led to lots of health concerns by the general public, radiation health workers, government agencies and non-governmental organizations alike. One of such common concern about base stations are the long-term health effects that exposure to this radiofrequency radiation may cause.

Radiofrequency electromagnetic fields (EMF) are used to enable a number of devices such as mobile phones, mobile base stations, Wi-Fi, Bluetooth and so on. However, radiofrequency at high power level may have adverse effects on human health. Sequel to the alarming effect of Radio-Frequency (RF) radiation to the general public, mobile base stations (MBS) have been identified as emitters of non-ionizing radiation. They transmit radiation continuously even when mobile phones are not in use. RF radiation ranges from 10 MHz to 300 GHz in the electromagnetic spectrum. It is one of several types of electromagnetic field (EMF), consisting of both electric and magnetic waves propagating through space. The amount of radiation energy deposited in biological tissue is a term known as power density (measured in W/m^2). Studies have shown that people living close to mobile base station have the likelihood of exposure to RF radiation of higher power density and this could consequently cause symptoms like nausea, fatigue, headache, and sleeplessness. [5,6]

Radiation protection agencies such as International Committee on Non-Ionizing Radiation Protection (ICNIRP) issued guidelines on the basis of current scientific knowledge based on established biological and health effects by providing estimation for occupational and general public exposure. The ICNIRP recommended permissible power density exposure for the general public of 4.5 W/m^2 and 9 W/m^2 for frequencies of 900 MHz and 1800 MHz respectively. [7] Therefore, RF exposure at a significantly higher power density above the set standard, recommended by radiation protection agencies can be deleterious to the health of the public. A number of investigation on the possible adverse health effects of radiofrequency EMF exposure from mobile base stations have been carried out in Abia, Bayelsa, Benue, Cross Rivers, Edo, Ekiti, Kogi, Oyo, Lagos, Kaduna, Rivers and Zamfara states as well as the Federal Capital Territory(FCT, Abuja) in Nigeria. [8, 9, 10, 11, 12, 13, 14, 15, 16] All of them reported radiation exposure far below the recommended power density as contained in the ICNIRP guidelines. In this study, the assessment of power density level from selected base stations were measure to investigate the possible adverse health effect that radiation from these base stations may pose to the general public.

1.1 Study Area

Ogbomoso is the second largest city after Ibadan in terms of population and land mass in Oyo state, southwestern Nigeria. Ogbomoso, which is geographically located within 4^o 10'E to 4^o 20' E longitude and 8^o 00'N to 8^o 15'N latitude is situated within the crystal-like Vault of Nigeria. [17] Ogbomoso lies about 100 km north of Ibadan and 80 km south of Ilorin, Kwara state. Ogbomoso had a population of over 354,000 in 2006 with estimated population to over 1.5 million in 2020. [18] The incremental change in population of

Ogbomoso has contributed to the expansion of the built area and the number of base stations within the city.

2.0 MATERIALS AND METHOD

Considering proximity to residential houses, a total of twenty (20) mobile base stations were randomly selected in the study area. The selected base stations are from the four major network providers: Network 1 (6MBS), Network 2 (6 MBS), Network 3 (4MBS) and Network 4 (4MBS) Environmental assessment (such as vegetation, tress and other RF radiation emitting gadget) around the selected base station was done. A handheld three-axis RF meter (Electrosmog meter) was used to measure radio-frequency radiation from the base stations. The RF meter used in this study is capable of measuring high frequency radiation in the range of 50 MHz to 3.5 GHz. The RF meter works by measuring electric field, E in a region and converts it to magnetic field, H and power density P (W/m$^{'}$). Power densities were measured in a convenient direction around the base station as suggested by [14] and [19]. A maximum of about 150 m radial distance from the foot of the base station was considered and measurement were taken at 25 m interval. Maximum instantaneous and tri-axial measurement mode were activated on the RF meter. From each base station, power density measurement was done by holding the RF meter away from the body, at arm's length and at about 1.5 meter above the ground, pointing towards the base station according to the manufacturer's instructions. The value of power density was taken and recorded after few minutes when there is a consistent/stable value from the meter. Precautions were taken during measurement so that the measured values were not influenced by other radiation sources.

3.0 RESULT AND DISCUSION

3.1 Result

The results of the measurement of the power density levels in microwatt per square meter (μW/m^2) obtained at different intervals from the 20 base stations investigated are presented in Table 1.

Table 1: The results of the power density measurement of the selected base stations

Network	Base Station	Power Density (μW/m^2)					
		25 m	50 m	75 m	100 m	125 m	150 m
1	MBS 1	967.60	798.30	711.40	693.40	410.50	499.80
	MBS 2	909.00	644.90	507.10	271.40	135.50	100.80
	MBS 3	858.70	655.90	301.70	243.30	101.30	68.90
	MBS 4	908.30	754.40	681.80	435.00	314.20	408.20
2	MBS 5	946.90	378.40	241.20	181.20	292.80	168.80
	MBS 6	906.10	298.00	226.70	180.90	236.30	121.70
	MBS 7	689.50	271.40	201.00	150.70	152.00	75.00
	MBS 8	435.20	276.10	251.60	179.50	278.70	28.50
3	MBS 9	840.60	810.80	944.15	681.22	972.80	740.80
	MBS 10	1272.00	969.08	784.90	507.30	488.45	663.39
	MBS 11	1174.50	1020.11	1001.11	979.80	865.90	112.55
	MBS 12	270.61	365.06	290.86	125.09	175.56	173.02
	MBS 13	516.02	659.23	423.10	249.50	207.00	108.81
	MBS 14	704.79	433.71	208.50	559.10	270.70	300.79
4	MBS 15	303.50	177.80	154.70	127.20	209.70	118.30
	MBS 16	301.50	184.80	140.20	138.30	196.40	120.60
	MBS 17	229.80	192.60	147.30	177.90	215.50	107.50
	MBS 18	357.60	236.20	207.10	233.30	344.90	250.90
	MBS 19	290.40	229.50	155.60	200.80	173.90	228.60
	MBS 20	294.90	208.10	240.60	160.40	399.10	253.50
	Mean	658.88	478.22	391.03	323.77	322.06	232.53

Table 2: The Mean Power Density for Each Network

Base Station	Power Density (μW/m^2)					
	25 m	50 m	75 m	100 m	125 m	150 m
1	910.90	713.38	550.50	410.78	240.38	269.43
2	744.43	305.98	230.13	173.08	239.95	98.50
3	796.42	709.67	608.77	517.00	496.74	349.89
4	296.28	204.83	174.25	172.99	256.58	179.90

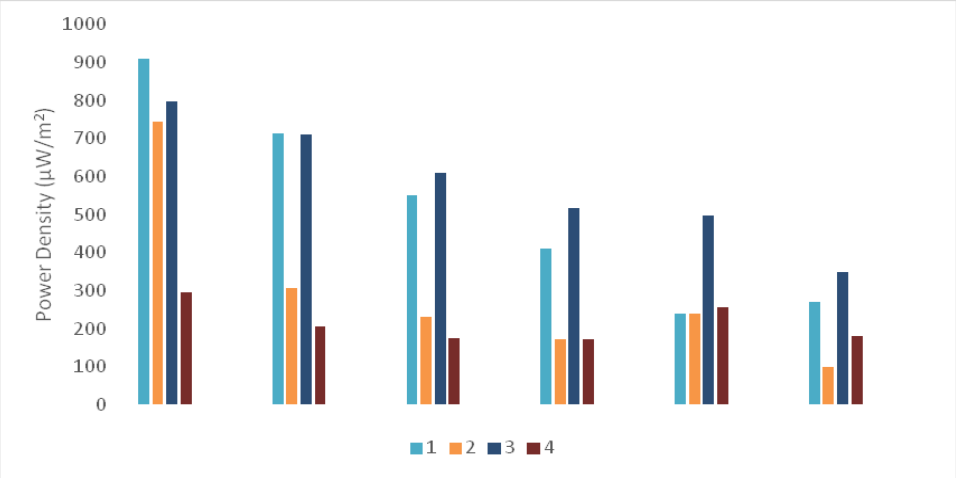

Figure 1: The mean power density at various interval for each network

3.2 DISCUSSION

The values of power density measured from all base stations are presented in Tables 1. The maximum power density of 1272 µW/m^2 which an individual can be exposed to was observed at 25 meter radius with a Network-3 base station (MBS 10). The minimum power density exposure of 28.5 µW/m^2 was observed at 150 m radius with a Network-2 base station (MBS 8). Based on the mean value of the power density of all the base stations investigated, it was observed that the mean power density decreases with increasing distance in accordance with the inverse square law. However, a deviation from this trend was observed in some base stations; as the values at some distances before it dropped again to follow the trend. The observed decline was also recorded in similar study conducted by Ushie [20] where the power density value increase at some higher distances and then dropped again. The increased value at some higher distances can be associated to other RF emission gadgets that might be present in that region. Also, fluctuation could be attributed to other factors as highlighted by Victor. [19] At a distance of 25 m which is the closest to the base station, the Network-3 MBS radiated the highest power density while the Network-4 MBS recorded the least. From the mean power density estimated for each of the network mobile base stations in Figure 1, the Network-1 base stations radiated the highest power density at 25 m and 50 m radial distance while the Network-3 base stations radiated the highest power density at 100 m, 125 m and 150 m radial distance. The Network-4 base stations radiated the lowest power density at all the radial distances investigated in this research work except at the 125 m radial distance. The mean power density estimated for each of the base station for all network providers, general decreases with increase in the radial distances from the base stations. The values recorded from each of the base stations examined were extremely low and fall below permissible level recommended by ICNIRP. All the values of power density measured in this study were all found to lie below the permissible power density level to the general public of 9 W/m^2 recommended by ICNIRP. [7] However, a research, associated common symptoms such as, fatigue, irritability, headache, sleep disorder and nausea to RF radiation exposure at distances less than 350 meter. [21] Therefore, exposure to low level RF radiation should be kept as low as reasonably achievable.

4.0 CONCLUSION

The assessment of the power density of 20 base stations belonging to the major network provider in Nigeria were randomly selected within Ogbomoso was carried out using a handheld three-axis RF Electrosmog

meter. It was observed that the Network-1 base stations presented the highest mean power density while the Network-4 base stations presented the lowest mean power density. There was a general decreasing trend in the power density measurement as the radius from the base station increases. The highest value of the power densities were recorded at closest proximity to base stations. All values of the power density investigated in this research work were found to be below 9 W/m^2 standard limit set by ICNIRP. [7] The radiation emitted from the base station investigated in this work will not pose any health effect to the inhabitants of houses around these base stations.

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