Bima Journal of Science and Technology, Vol. 7 (2) June, 2023 ISSN: 2536-6041

DOI: 10.56892/bima.v7i01.414

ERRECTING TELCOMMUNICATION MAST IN RESIDENTIAL AREA: HEALTH CHALLENGES; A CASE STUDY OF DAMBA, GUSAU LOCAL GOVERNMENT AREA ZAMFARA STATE, NIGERIA

S.B. MUHAMMAD AND I. SANI

Department of Physics, Faculty of Science, Federal University Gusau, Zamfara State, Nigeria

Corresponding Author: ibello.samaila@fugusau.edu.ng, ibrahimsani@fugusau.edu.ng

ABSTRACT

The cases of cancer especially in women and children in Zamfara are drastically increasing and seem to be out of control. Therefore, this research seeks to investigate radiation from telecommunication mast with site number: ZM0017 at Garaza in Damba. Theoretical calculation of power density and a well-structured questionnaire was deployed to investigate the effect of radiation from the telecommunication mast within a 500m radius of its location. The hazard profile showed that 70.6% of the respondent have different and/or multiple symptoms, however, there were no cancer-like symptoms, while 29.4% were symptoms free. The calculated power density from the distance of 5m to 120m away from the mast in the step of 5m was found to be within the range of $0.0000009549 \mu W/m^2$ to $0.000000002387 \mu W/m^2$, and from a distance of 120m up to 160m away from the mast in steps of 20m were found to be within the range of $0.000000001658\ \mu W/m^2$ to $0.0000000003532\ \mu W/m^2$ and from 300m up to 500m in the step distances of 40m were found to be within the range of $0.0000000002653\ \mu W/m^2$ to $0.0000000009549\ \mu W/m^2$, and finally at a distance of 550m was found to be $0.00000000007892 \mu W/m^2$. All of these calculated power densities at variable distances from the mast were very much below the ICNIRP standard adopted by African and Asian countries. The duration of the dwellers in the area, being a newly developed area, was not up to ten years. Thus, the effect of radiation might not be fully accessed due to short-time exposure. There were numerous cases of illness related to radiation but no single case of cancer was found in the area.

Keywords: Power Density, Radiation, Mast, Cancer, Antenna, Exposure.

INTRODUCTION

Communication is an exchange of information by speaking, writing or using some medium like radio, television, newspaper, telephone, etc. Human needs cannot be attained without knowledge and/or accessibility to information(Commission, n.d.). Exchanging ideas or imparting knowledge required a good communication skills. Therefore, communication is inevitable for the successful development of any community or society. Telecommunication and other information technologies have indeed easy communication and accessibility to information, which indeed reduced the entire world to a global sit room(Busari & Awodele, 2009). However, the primordial way of passing information is rapt with difficulties, delays and inefficiency which often lead to communication gap, inaccessibility to and/or loss of information. The more information you get the more progress you make in your life. Due to high technological advancement in communication and networking, humane activities such as health, education, and administration to commerce and industry, are gradually digitalized(Dilli, 2021)(Kim & Yun, 2013)(Ashyap et al., 2020). Thus, the

DOI: 10.56892/bima.v7i01.414

massive proliferation of telecommunication masts everywhere within Zamfara in particular, and the entire country at large(Harcourt & State, 2015), to provide good signals that will yield quality network(Y.Y. Jian and L.Zhang, 2020). Contemporarily, good signal and qualitative network, therefore robust economy(Member et al., 2019)(Ashyap et al., 2021).

However, every coin has two sides; the good and the bad. The radiation emitted by telecommunication gadgets is still debatable with chaotic results(Hansen et al., 2020). The radiation effect(Ceccuzzi et al., 2019) is categorized into two: Thermal and non-thermal(Paffi et al., 2010). The thermal effect is similar to the temperature cooking in the microwave oven(Umbarkar et al., 2014) and the non-thermal effect is not well clear but reported to be more harmful than thermal many-fold(Cones, n.d.). WHO warns against erecting masts in residential areas at a radius less than 10 m away from the residence (Charles & Julian, 2021). The ICNIRP only gives out measures or precautions on how to minimize radiation dosage in either professional practices or in areas where a source is identified. Therefore, the menace of radiation from mast erected in residential area or public centers is substantiated by WHO, which issued a warning specifying the distance between the mast and the residential environment.

Moreso, various scientific researches indicated that people living around telecommunication masts even at a distance greater than 10m away, are susceptible to some ailments caused by electromagnetic radiation (Shalangwa, 2010). The greatest challenges posed by radiation are the distortion of sleep patterns which drastically impacts memory, especially in children and the lack of clarity in speech in elderly people (Batool et al., 2019). Depending on the durations and intensity of the radiation, the emission of radiation over a period of time results in cancer, Alzheimer's disease, brain tumours, fatigue, high body temperature, depression, leukaemia, lymphoma, neutropenia, lymphocytosis, and platelet(Lin & Paper, 2017)(Morris et al., 2015)(Mobilee-study et al., 2008). In most cases, dizziness, bleeding from the nose and memory loss are common symptoms of radiation in children (Shalangwa, 2010). The gases from the exhaust of the generator, used to power the mast, may also affect neurological function and the immune system. The persisting vibration of the generator often give rise to resonance which will widen cracks on the wall and eventually lead to collapse of some building around the mast. The oozing sound of the muzzled generator (shown in plate I) may increase the level of noise above the prescribed noise in a residential area.

Bima Journal of Science and Technology, Vol. 7 (2) June, 2023 ISSN: 2536-6041

DOI: 10.56892/bima.v7i01.414

Plate I: ZM0017 site generators (MEKANO's)

However, radiation is inversely proportional to the square of the distance from the source (Mast). (Charles & Julian, 2021) Shows that at a distance of 10m away from the mast the dose is 0.1% that of a 1-meter distance, and at 20m away the dose is 0.0125% that of 1-meter distance. Nigerian Communication Commission (NCC) reduced the distance from 10m to 5m as the minimum distance away from the mast to the residential area but National Environmental Standard Regulatory Agency (NESREA) insist on 10m as the minimum distance to erect a telecommunication mast away from the residential area [1]. This research seeks to investigate the power density of the radiation emitted from the mast (ZM0017) at variable distances in Garaza, Damba village.

Theory: The antenna is used to received or radiate energy in space. The energy radiated per second is called power. Thus, the magnitude of the energy is measured by Power meter or spectrum analyzer at any distance R. Power (P_r) received or radiated by an antenna at a distance R is given by

$$P_r = P_t \times G_t \times G_r \times \left(\frac{\lambda}{4\pi R}\right)^2$$

Radiating or receiving power is directly proportional to the transmitted power, gain of transmitting and receiving antennas(Penchel et al., 2019), and square of

DOI: 10.56892/bima.v7i01.414

the signal wavelength and is inversely proportional to the square of a distance R.

Radiation from the Mast (Tower)

Most of the base station antenna mounted on telecommunication masts are directional antennas with a gain of either 17dB or 20dB and a transmission frequency range from 935 to 960 for a GSM 900(Ding et al., 2015). This antenna has a frequency band of 25MHz which is divided into twenty sub-band of 1.2MHz, allotted to various operators. Of cause there are many carrier frequencies allocated to one operator with an upper limit of 6.2MHz bandwidth. Each carrier frequency may transmit 10 to 20W of power. Thus, one operator may transmit 50 to 100W of power and there may be more than one operator on a tower. For two or three operators 200 to 300W is transmitted(To & By, 2010)(Dai et al., 2021). For many operators, huge KW of power is expected to be transmitted especially in the main lobe direction. The mast (ZM0017) (see plate 1) in Garaza, Damba host both Airtel and MTN operating concurrently at different frequency. Therefore, two radio frequency (RF) antennas and six (6) Micro wave (MW) antennas (see plate 2) were mounted on the mast. The power density in this area would as well increase accordingly.

PlateII: Site number of the mast located in Garaza, Damba

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Plate III: Two RF and six MW antennas

Radiation Norms Adopted in Nigeria

Though there are no clear radiation norms specified by NCC or NESREA, most African and Asian countries adopted 1998 guidelines issued by ICNIRP for the safe power density of $\frac{f}{200}$. Where f is a frequency in MHz. For GSM 900 transmitting band (935 – 960 MHz), the power density is 4.7W/m^2 and GSM 1800 transmitting band (1810 – 1880 MHz), the power density is 9.2W/m^2(To & By, 2010). The guidelines show that the sum of all radiation is taken into cognizes for concurrent exposure to multiple frequencies field. We often consider only one carrier frequency other than the total number of transmitters in that area, which will by far exceed the ICNIRP limit. People living near (not quite close) the tower are steadily exposed to radiation 24hrs per day. There is less radiation emitted vertically downward compared to horizontal radiation. Though, the radiation is inversely proportional to the square of the distance. The two important parameters mostly considered are intensity and duration, with sufficient time (ten years and above) the radiation may cause damage to living organisms (Miura et al., 2021).

MATERIALS AND METHODS

Damba is located at Latitude 12.15873 and longitude 6.743366 and is about 7 km away from the capital city of Zamfara State. There are three masts erected in this area. Two of them are closed with a distance of about 100m apart and the third one is around 400m away from the first two. But this study focuses on the third mast with the site number ZM0017 which was erected 14 years ago (i.e., 2009). Being the most recent and deeply into residential at no reasonable gap from the houses and shops around it. All these houses and shops were built after the mast was established many years ago. Some

DOI: 10.56892/bima.v7i01.414

shops and houses very close to the mast were delipidated and those completed were empty and abandoned.

Determination of the study population

The criteria for inclusion were people living or working, in public centres (Schools, mosques etc.) within 500 meters radius around the mast.

The houses around the mast were categorized into four categories with respect to their distance from the mast as follows:

1. A distance of 1m up to 100m in step of 5m.
2. A distance of 120m to 260m in steps of 20m.
3. A distance of 260m to 500m in steps of 40m
4. A distance above 500m.

Determination of sample size

The research targeted a population close to 15,000 and since the number of the sample size is greater than 10,000 this relation was used in calculating the sample size.

$$N = \frac{Z^2 Pq}{E^2}$$

Where
N – desired sample size, Z- standard deviation (set here at 2) corresponding at 95% confidence level, P- the proportion in the target population estimated to have a certain characteristic, q = 1- p , E – degree of accuracy (0.05),
n = 385 was the sample size.

The sampling Method is subject selection

Multi – stage sampling technique was deployed to select respondent for the questionnaire survey.

Data collection

A well-structured questionnaire was designed for gathering relevant information from the respondent (Dwellers in the area) as an instrument for data collection. The questionnaire is made of two sections: section A on demography and section B ~~is~~ on health issues in the area.

Calculation of power density

Power density is the power received or absorbed by the human body from a source of radiation.

Power density at distance R is given by

$$P_d = \left(\frac{P_t \times G_t}{4\pi R^2}\right) Watt/m^2$$

Where $P_t - Transmitter\ power\ in\ wall$
$G_t - Gain\ of\ transmitting\ antenna$
$P_d - Power\ density$
$R - Distance\ from\ the\ antenna$

Specific Absorption Rate is defined as the rate at which biological tissue absorbs energy by the Head and BODY. It can also be described as the power absorbed per mass of the biological tissue. Its SI unit is Watt per kilogram

$$Specific\ Absorption\ Rate = \int \frac{\sigma(r)|E(r)|^2}{\rho(r)} dr$$

SAR is a function of the following:
σ
$- Electric\ conductivity\ measured\ in\ siemens\ per\ metre\ (S/m)$
E
$- Induced\ electric\ fields\ from\ radiated\ energy\ measured\ in\ volt\ per\ metre (V/m)$
ρ
$- Mass\ density\ of\ the\ Biological\ tissue\ measured\ in\ kilogram\ per\ cubic\ metre$

SAR is usually integrated over one gram or 10 grams when calculated. The SI unit of SAR is Watt per kilogram. SAR limit differs in various countries as shown in the table below.

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COUNTRY	SAR LIMIT	AMOUNT OF BIOLOGICAL TISSUE
USA and Canada	1.6 W/Kg	Integrated over ONE gram of biological tissue
Europe	2.0 W/Kg	Integrated over TEN grams of biological tissue
India	1.6 W/Kg	Integrated over ONE gram of biological tissue

Limitation

The simplest way in an experiment to obtain a specific absorption rate (SAR) is by using Dosimetric Assessment System (DASY6) manufactured for SAR measurement. However, due to the unavailability of these instrument and other instruments to measure different components that will enable us to compute SAR, the research is limited to survey and computation of power density.

RESULTS AND DISCUSSION

Results

Table1: Age distribution of the respondents

Age	Frequency	Percentage (%)
Less than 10	47	22.1
10 – 20	63	29.6
20 – 30	37	17.4
30 – 40	46	21.6
40 – 50	15	7.0
Above 50	5	2.4
Sex Pattern of Respondents		
Male	63	30.9
Female	134	65.7
No Response	7	3.
Place of Exposure to the Mast		
House	252	70
School	75	20.8
Work Place	21	5.8
Work Place & House	7	1.9
No Response	5	1.4
Distance from mast in meter (m)		
Less than 5	5	0.4
5 – 50	68	5.9
50 – 100	279	24.1
100 – 500	376	32.4
Above 500	431	37.2

Table2: Hazard profile

SYMPTOMS	FREQUENCY (Hz)	PERCENTAGE (%)
Multi Symptoms	42	11.7
Anxiety	15	4.2
Dizziness	14	3.9
Headache	53	14.7
Memory loss	5	1.4
Sleep disorder	11	3.1
Skin irritation	9	2.5
Poor eyesight	8	2.2
Itching	57	15.8
Weight loss	18	5.0
Nose bleeding	13	3.6
Low blood level	0	0
Extra-chromosomes	4	1.1
Neck swelling	0	0
Chronic fatigue	5	1.4
No symptoms	106	29.4
Total	360	100

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Table 3: Calculation of power density around ZM0017 mast
(The antenna output is 20W and its gain is 15dB, for GSM 9OO with frequency band 25MHz).

S/N	Distance (m)	Power density (W/m^2)	Power density ($\mu W/m^2$)
1	5	0.9549	0.0000009549
2	10	0.2387	0.0000002387
3	15	0.1061	0.0000001061
4	20	0.5968	0.0000005968
5	25	0.03820	0.00000003820
6	30	0.02653	0.00000002653
7	35	0.01949	0.00000001949
8	40	0.01492	0.00000001492
9	45	0.01179	0.00000001179
10	50	0.009549	0.000000009549
11	55	0.007892	0.000000007892
12	60	0.006631	0.000000006631
13	65	0.005650	0.000000005650
14	70	0.004872	0.000000004872
15	75	0.004244	0.000000004244
16	80	0.003730	0.000000003730
17	85	0.003304	0.000000003304
18	90	0.002947	0.000000002947
19	95	0.002645	0.000000002645
20	100	0.002387	0.000000002387
21	120	0.001658	0.000000001658
22	140	0.001218	0.000000001218
23	160	0.009325	0.000000009325
24	180	0.007368	0.000000007368
25	200	0.005768	0.000000005768
26	220	0.0004932	0.0000000004932
27	240	0.0004145	0.0000000004145
28	260	0.0003532	0.0000000003532
29	300	0.0002653	0.0000000002653
30	340	0.0002065	0.0000000002065
31	380	0.0001653	0.0000000001653
32	420	0.0001353	0.0000000001353
33	460	0.0001128	0.0000000001128
`34	500	0.0009549	0.0000000009549
35	550	0.00007892	0.00000000007892

DISCUSSION

The results obtained in this research showed that non-ionizing radiation from the telecommunication mast (ZM0017) is much below the ICNIRP standard and thus, trivial. However, there were few cases of illness among the dwellers around the mast which were similar to those caused by exposure.

From the demographic section (Table1), it is shown that the characteristic of the respondent with the highest number fall within the age range of 10 – 20 years (29.6%). While only 2.4% of the respondent fell in the age range of 50 - 60 years. This can be interpreted as the environment being newly occupied area, thus referred to as the Damba extension (Sabon Garin Damba). A large number of the respondent were female 65.7% while the male carries 30.9% which was small number compared to that of the female. This was according to their religious believe and ethics that females are the home

DOI: 10.56892/bima.v7i01.414

keepers and the males are the breadwinners of the family. So, the males were constantly out to struggle for the lively hood of their family. However, this was not indicated on the questionnaire, the vast majority of the respondent suffering from different or multiple symptoms were females and children, being at home throughout the day (24/7).

For the proximity to the mast, though the mast was established long before the area was converted from a farming area to a residential area, people were constantly shunning away from the mast despite the availability of unoccupied plots around it. This can be seen from the percentage of houses around the mast at distance of less than 5m and 5m to 50m were 0.4% and 5.9%. From a distance of 50m to 100m away from the mast, the number of houses increase significantly to 24.1%. The number of the house and public centres raised to 37.2% distances above 500m away from the mast. This showed that even without enlightenment, people naturally developed a phobia against the mast.

From the hazard profile (table 2), the majority of the respondent, as large as 70.6% of them had symptoms related to radiation hazards, while only 29.4% were symptoms free. The persistent head- ache might be a symptom of many illnesses, not necessarily radiation. The extra-chromosome that accounted to 1.1% were for three individuals with six fingers in one of their hands and one person with goitre. However, there was no report of clear cancer-like symptoms due to low intensity and short duration of the radiation exposure in the area. Since the mast was just 14 years old. The mast was established in 2009 when the places where farms and gardens. Later around 2016, due to the establishment of Federal University Gusau (FUG) the area begins to develop though many houses were still at completion stage and several undeveloped plots here and there. The high Voltage Cable sighted at plate 2 was not yet connected.

Power density is the power received or absorbed by living organisms due to radiation. Table 3 showed the calculated power density at a variable distance from the mast (ZM 0017) at Garaza in Damba. The calculated power density from the mas was for one antenna. However, there are six micro wave (MW) antennas and two radio frequency (FR) antennas on the mast. Though, the calculated power density at the closest distance was 5m away and continues up to 100m in steps of 5m, with a power density range [0.0000009549 $\mu W/m^2$ to 0.000000002387 $\mu W/m^2$], and from 120 to 260 in the step of 20m with a power density range [0.000000001658 $\mu W/m^2$ to 0.0000000003532 $\mu W/m^2$] and from 300m up to 500m in steps of 40m, with power density ranging [0.0000000002653 $\mu W/m^2$ to 0.0000000009549 $\mu W/m^2$], and finally, 550m away from the mast with power density was found [0.00000000007892 $\mu W/m^2$]. All the calculated power densities were very low even when multiplied by six (6) compared to the ICNIRP standard adopted by African countries (4.7W/m^2). Also, there were no cases of radiation effect discovered in the area cut across all ages and genders.

CONCLUSION

A large number of the respondent (70.6%) were having one or multiple symptoms and only a few of them (29.4%) were symptoms free. All the calculated power densities were found to be below the ICNIRP standard adopted by African and Asian countries. However, the duration of the dwellers in the area, being a newly developed area, was not

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up to ten years. Thus, the effect of radiation might not be fully accessed due to short-time exposure. There were numerous cases of illness related to radiation but no single case of cancer was found in the area.

Recommendation

More studies should be done on this topic in different areas in Nigeria, but let there be adequate equipment that will enable the calculation of some important parameters such as specific absorption rate (SAR), power density, etc. Also, let there be a cordial interaction between the researchers and telecommunications industry whenever the need arises. This will enable a researcher to use animals (Rats, Rabbits e.t.c.) for effective and holistic evaluation of the radiation effect in the area.

Acknowledgement

I would like to appreciate the support of IBR, colleague and my family.

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