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Residential Exposure to Radio Frequency Field (RF) from Global System for Mobile Communication (GSM) Mask

D.A. Shalangwa
Department of Physics, Adamawa State University, Mubi, Nigeria

Abstract: The objective of this study is to draw a conclusive position on the effect of Radio Frequency (RF) radiation from GSM mask on human health. The measurement of the RF was conducted at 100 and 200 m away from the mask of the major GSM operators in Nigeria; GLO, MTN and ZAIN with Giga-Molar counter. The data obtained were analyzed using correlation analysis to establish the fact that whether with time exposure to RF will have discernable effect on human health. The average amount of radiation measured from each GSM mask were 1.87, 2.26 and 1.48 µvS h^{-1} for 100 m and 1.50, 1.32 and 1.87 µvS h^{-1} for 200 m with their corresponding values of coefficient of correlation as 0.008, 0.004, 0.27, -0.027, 0.039 and 0.048, respectively. The study revealed that there is insignificant effect on human health because the non ionizing electromagnetic energy has no sufficient energy to affect any part of human body.

Key words: Radiation, radio frequency, human health, correlation, GSM mask, exposure

INTRODUCTION

GSM is one the fast fastest growing and most demanding telecommunication application in the world today its present a continuously increasing telephone subscription around world. Nigeria is one of the largest user of GSM equipment (mobile unit) in Africa, over 50% of the total population in Nigeria depend on the GSM as the easiest means of communication (Zain, 2005) but since the introduction of mobile phone in Nigeria the health implication of RF radiation from the base station has been a subject of great debate and concern among the Nigerian citizens. Some interested groups opine that radiation from base station (GSM masks are dangerous to health and some believed that to date, human health have the relationship between exposures to RF field. They also believed that exposure to radiation from base station for long period could cause different diseases like cancer, destroys reproductive organs, congenital anomalies, epilepsy and persistent headache. In Nigeria, some of the base stations are planted right in a home of residence.

Some international communities also believed that exposure to RF have effect on two areas of the body like eyes and testes are particularly vulnerable to RF heating because of the relative lack of available blood flow to dissipate the excessive heat load (Hyland, 2000; Cogent EMR Solution Limited, 2006). At relatively low levels of exposure to RF radiation, that is, levels lower than those that would produce significant heating; the evidence for harmful biological effects is ambiguous and unproven. Such effects have sometimes been referred to as non thermal effects. It is generally agreed that further research is needed to determine the effects and their possible relevance, if any to human health (Kelly, 2005; Krzysztof *et al*., 2002; Zsolt *et al*., 2006).

Other also believed that there is risk of RF radiation to pregnant women; a pregnant women and the foetus both are vulnerable because of the fact that these RF radiation continuously react with the developing embryo, increasing cells because of the thermal radiation also, when the pregnant ladies either use mobile phone or when illuminated with RF radiation, the developing child can become affected, the developmental malformation may occur and it may also affect human brain; human brain is the most vulnerable portion to the NIEMR (RFR). Some of the known effects are Neurological effects, increase in ODC (Ornithin De Carboxylase) activity, effects on emzymes and free radicals decreasing the brain metabolism (Cogent EMR Solution Limited, 2006; Thomas *et al*., 2007; Persson, 1997).

Although, some group like the Mobile Manufacturer Forum (MMF) that manufactures mobile equipments and GSM operators across the world insists that there are no discernible effects from the base station radiation (ICNIRP, 2009).

Therefore, to confirm these positions, whether there is scientific evidence or not to suggest that the low power emission levels are inimical to human or animal health; this now prompted the demand for this research.

MATERIALS AND METHODS

The materials/instruments used in the study are measuring tape, stop watch and Giga-molar Counter.

Fig. 1: ZAIN mask

Fig. 2: MTN mask

Method of data collection: The data were collected from the three major GSM operator mask in Nigeria, all the mask are located at unguwar Lokowa/Barama Mubi North Adamawa State of Nigeria. The GSM masks are depicted in Fig. 1-3. For each of these masks the measurement was taken at 100 and 200 m in every 10 min for an hour in front, back and sides of the mask.

Method of data analysis: The data obtained were analyzed using correlation analysis to determine the coefficient of correlation between the exposure to GSM RF to human health and the period of exposure and bar chart to

Fig. 3: GLO mask

Table 1: Radiation from GLO mask at 100 m

Y	X_1	X_2	X_3	X_4	X
10	0.45	0.41	0.30	0.27	0.36
20	0.40	0.40	0.25	0.21	0.32
30	0.21	0.40	0.20	0.21	0.26
40	0.40	0.45	0.40	0.20	0.26
50	0.45	0.40	0.40	0.20	0.36
60	0.40	0.30	0.30	0.25	0.31
3.5 h	2.31 μSv h^{-1}	2.36 μSv h^{-1}	1.87 μSv h^{-1}	1.34 μSv h^{-1}	1.87 μSv h^{-1}

Table 2: Radiation from GLO mask at 200 m

Y	X_1	X_2	X_3	X_4	X
10	0.25	0.20	0.20	0.40	0.26
20	0.20	0.10	0.20	0.20	0.18
30	0.20	0.10	0.30	0.32	0.23
40	0.40	0.20	0.31	0.31	0.31
50	0.30	0.40	0.32	0.27	0.32
60	0.20	0.10	0.21	0.28	0.20
3.5 h	1.55 μSv h^{-1}	1.10 μSv h^{-1}	1.51 μSv h^{-1}	1.78 μSv h^{-1}	1.50 μSv h^{-1}

Table 3: Radiation from MTN mask at 100 m

Y	X_1	X_2	X_3	X_4	X
10	0.60	0.40	0.40	0.40	0.45
20	0.20	0.40	0.30	0.40	0.33
30	0.40	0.30	0.30	0.30	0.33
40	0.50	0.35	0.40	0.20	0.36
50	0.40	0.30	0.30	0.60	0.40
60	0.45	0.30	0.40	0.40	0.39
3.5 h	2.55 μSv h^{-1}	2.05 μSv h^{-1}	2.10 μSv h^{-1}	2.30 μSv h^{-1}	2.26 μSv h^{-1}

Field survey (2009)

analyzed the total amount of radiation obtained at each GSM mask (Table 1-15) Y: Time taken during the measurement (min); X_1: Amount of radiation measured in front of the Antenna, X_2: Amount of radiation measured at the back of the Antenna; X_3 = Amount of radiation measured at side 1 of the Antenna; X_4: Amount of radiation measured at side 2 of the Antenna; X: Average

Table 4: Radiation from MTN mask at 200 m

Y	X_1	X_2	X_3	X_4	X
10	0.25	0.19	0.19	0.20	0.21
20	0.21	0.25	0.25	0.30	0.25
30	0.30	0.25	0.25	0.20	0.25
40	0.30	0.15	0.20	0.20	0.21
50	0.27	0.10	0.19	0.21	0.19
60	0.25	0.15	0.18	0.24	0.21
3.5 h	1.60 μSv h^{-1}	1.09 μSv h^{-1}	1.26 μSv h^{-1}	1.35 μSv h^{-1}	1.32 μSv h^{-1}

Table 5: Radiation from ZAIN mask at 100 m

Y	X_1	X_2	X_3	X_4	X
10	0.25	0.11	0.20	0.26	0.21
20	0.27	0.20	0.25	0.21	0.23
30	0.25	0.25	0.30	0.20	0.25
40	0.20	0.20	0.25	0.22	0.22
50	0.49	0.20	0.30	0.22	0.30
60	0.30	0.25	0.28	0.25	0.27
3.5 h	1.76 μSv h^{-1}	1.21 μSv h^{-1}	1.58 μSv h^{-1}	1.36 μSv h^{-1}	1.48 μSv h^{-1}

Table 6: Radiation from ZAIN mask at 200 m

Y	X_1	X_2	X_3	X_4	X
10	0.20	0.20	0.20	0.40	0.25
20	0.30	0.30	0.20	0.20	0.28
30	0.40	0.20	0.20	0.30	0.28
40	0.40	0.30	0.40	0.38	0.35
50	0.50	0.30	0.40	0.38	0.38
60	0.40	0.20	0.40	0.32	0.33
3.5 h	2.20 μSv h^{-1}	1.50 μSv h^{-1}	1.80 μSv h^{-1}	2.00 μSv h^{-1}	1.87 μSv h^{-1}

Table 7: Total amount of radiation from the three major GSM operators at 100 m

GSM operators	X	Y
GLO	1.87	1.00
MTN	2.26	1.00
ZAIN	1.48	1.00
Total	5.610 μSv h^{-1}	3.00 h

Table 8: Total amount of radiation from the three major GSM operators at 200 m

GSM operators	X	Y (h)
GLO	1.50	1.00
MTN	1.32	1.00
ZAIN	1.87	1.00
Total	4.67 μSv h^{-1}	3.00

Table 9: Total amount of radiation measured at 100 and 200 m of GSM operator

GSM operators	X	Y (h)
GLO	3.37	3.50
MTN	3.58	3.50
ZAIN	3.35	3.50
Total	4.67 μSv h^{-1}	10.50

Field survey (2009)

Table 10: Analysis of radiation from the GLO mask at 100 m

X	Y	XY	X^2	Y^2
0.36	10	3.60	0.130	100.0
0.32	20	6.40	0.102	400.0
0.26	30	7.80	0.068	900.0
0.26	40	10.40	0.068	1600.0
0.36	50	18.00	0.130	2500.0
0.31	60	18.60	0.096	3600.0
1.87 μSv h^{-1}	3.5 h	64.80	0.463	9100.0
		(1.08) μSv	$\mu^2S^2v^2$ h^{-2}	(151.67) h^2

r = 0.008

Table 11: Analysis of radiation from the GLO mask at 200 m

X	Y	XY	X^2	Y^2
0.26	10	2.60	0.068	100.0
0.18	20	3.60	0.130	400.0
0.23	30	6.90	0.053	900.0
0.31	40	12.40	0.096	1600.0
0.32	50	16.00	0.102	2500.0
0.20	60	12.00	0.040	3600.0
1.50 μSv h^{-1}	3.5 h	53.50	0.489	9100.0
		(0.89) μSv	$\mu^2S^2v^2$ h^{-2}	(151.67) h^2

r = 0.0004

Table 12: Analysis of radiation from the MTN mask at 100 m

X	Y	XY	X^2	Y^2
0.45	10	4.50	0.203	100.0
0.33	20	6.60	0.109	400.0
0.33	30	9.90	0.109	900.0
0.36	40	14.40	0.130	1600.0
0.40	50	20.00	0.160	2500.0
0.39	60	23.40	0.153	3600.0
1.50 μSv h^{-1}	3.5 h	78.80	0.864	9100.0
		(1.31) μSv	$\mu^2S^2v^2$ h^{-2}	(151.67) h^2

r = 0.27

Table 13: Analysis of radiation from the MTN mask at 200 m

X	Y	XY	X^2	Y^2
0.21	10	2.10	0.044	100.0
0.25	20	5.00	0.063	400.0
0.25	30	7.50	0.063	900.0
0.21	40	8.40	0.044	1600.0
0.19	50	9.50	0.036	2500.0
0.21	60	12.60	0.044	3600.0
1.32 μSv h^{-1}	3.5 h	45.10	0.2934	9100.0
		(0.75) μSv	$\mu^2S^2v^2$ h^{-2}	(151.67) h^2

r = -0.0027

Table 14: Analysis of radiation from the ZAIN mask at 100 m

X	Y	XY	X^2	Y^2
0.21	10	2.10	0.044	100.0
0.23	20	4.60	0.053	400.0
0.25	30	7.50	0.025	900.0
0.22	40	8.80	0.048	1600.0
0.30	50	15.00	0.090	2500.0
0.27	60	16.20	0.073	3600.0
1.48 μSv h^{-1}	3.5 h	54.20	0.371	9100.0
		(0.90) μSv	$\mu^2S^2v^2$ h^2	(151.67) h^2

r = 0.039

Table 15: Analysis of radiation from the ZAIN mask at 200 m

X	Y	XY	X^2	Y^2
0.25	10	2.50	0.063	100.0
0.28	20	5.60	0.078	400.0
0.28	30	8.40	0.078	900.0
0.35	40	14.00	0.048	1600.0
0.38	50	19.00	0.144	2500.0
0.33	60	19.80	0.109	3600.0
1.87 μSv h^{-1}	3.5 h	69.30	0.545	9100.0
		(1.16) μSv	$\mu^2S^2v^2$ h^{-2}	(151.67) h^2

r = 0.048

amount of radiation measured across the all sides of the Antenna. Equation 1 was considered to determine the coefficient of correlation.

$$r = \frac{\Sigma XY - \frac{(\Sigma X)(\Sigma Y)}{n}}{\sqrt{\left(\Sigma X^2 - \frac{(\Sigma X)^2}{n}\right)\left(\Sigma Y^2 - \frac{(\Sigma Y)^2}{n}\right)}} \quad (1)$$

Where:

r = Coefficient of correlation
X = Average amount of the radiation measured
Y = Period of exposure to GSM RF radiation
n = The number of terms (Ezeowu, 1990)

RESULTS AND DISCUSSION

The analysis of the results were done by determining the coefficient of correlation and graphical analysis in other to establish the fact that whether exposure to GSM base station has effect or no effect on human health for a long period of time. The coefficient of correlation of each is indicated under the table calculated from Eq. 1.

Point-to-point microwaves antenna transmit and receive microwave signals across relatively short distance from a few 10th of kilometer to 48 km or more (Kelly, 2005). Theses antenna are usually circular in shape and are normally found mounted on a supporting tower as depicted in Fig. 1-3. They are always place at a considerable height to provide clear and unobstructed Line of Sight (LOS) path between both ends of a transmission path or link. Theses antennas have a variety of uses, such as transmitting voice and data message and serving as link between broadcast or cable TV studios and transmitting antennas. The RF signal from these antennas travel in a directed beam from a transmitting antenna to a receiving antenna and dispersion of microwave energy outside of the relatively narrow beam is minimal and in addition this antenna transmit usually very low power levels, usually on the order of a few watts or less. The measurement were taken at ground level and the average amounts of radiation measured in this study are 1.87 μSv h^{-1}, for GLO, 2.26 μSv h^{-1} for MTN and 1.48 μSv h^{-1} for ZAIN at 100 m,

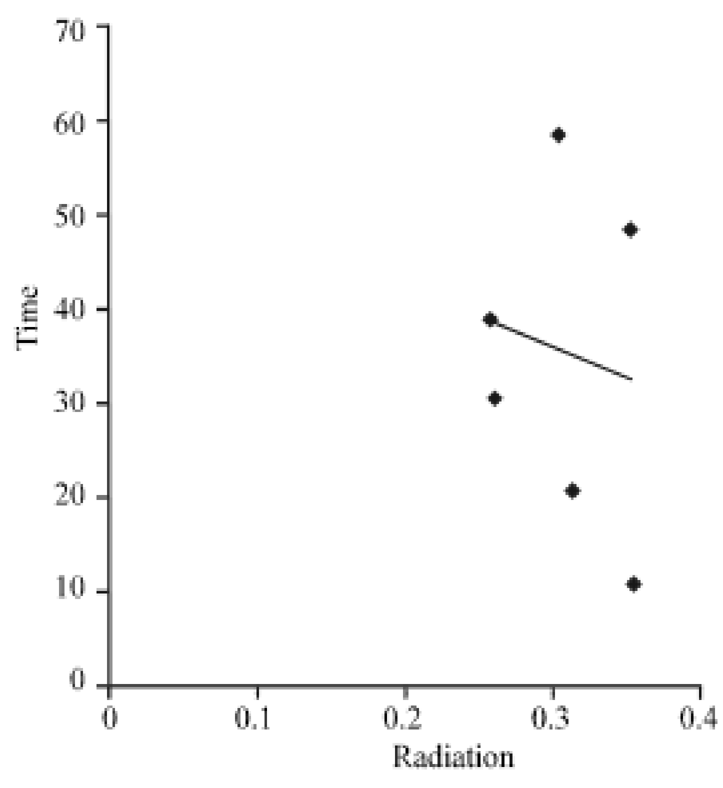

Fig. 4: Analysis of radiation from GLO GSM mask at 100 m

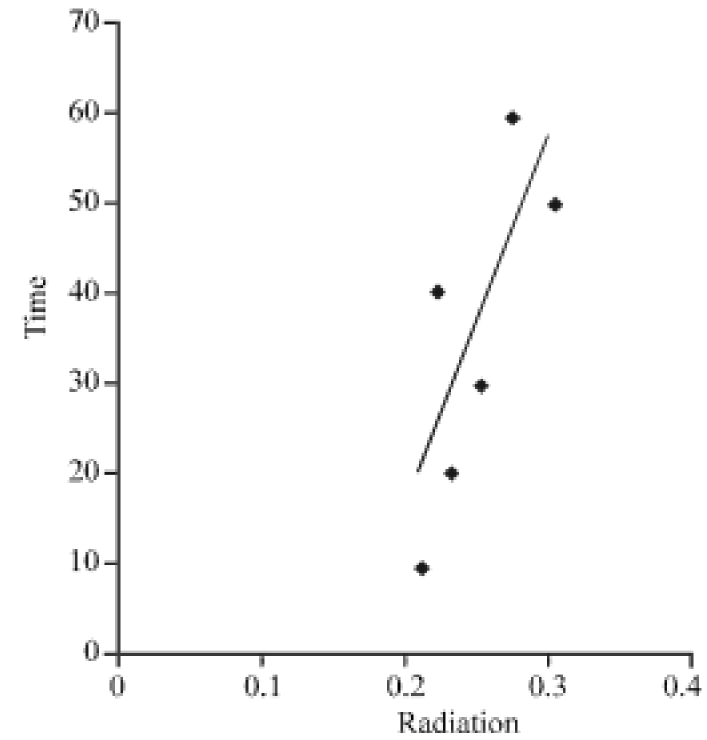

Fig. 5: Analysis of radiation from GLO GSM mask at 200 m

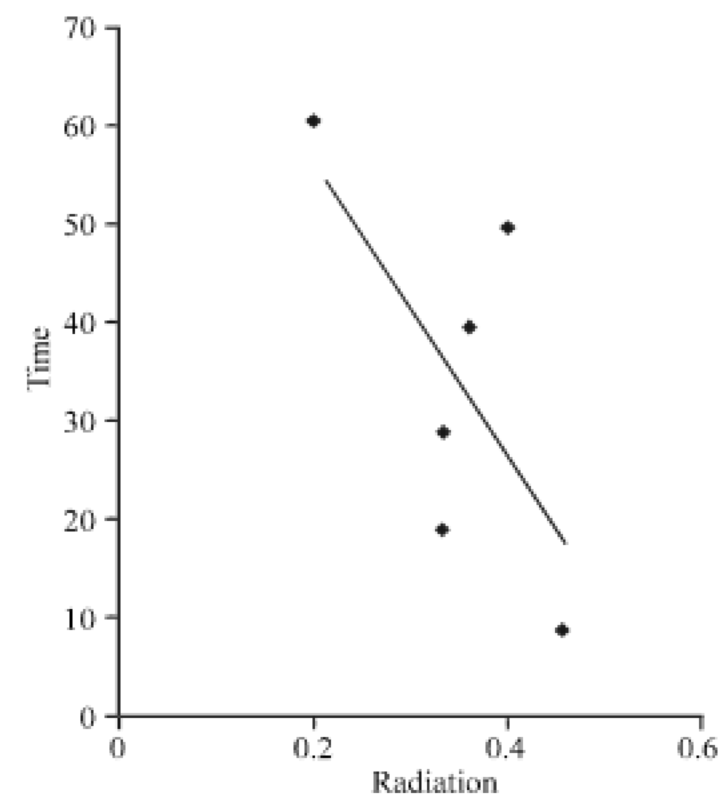

Fig. 6: Analysis of radiation from MTN GSM mask at 100 m

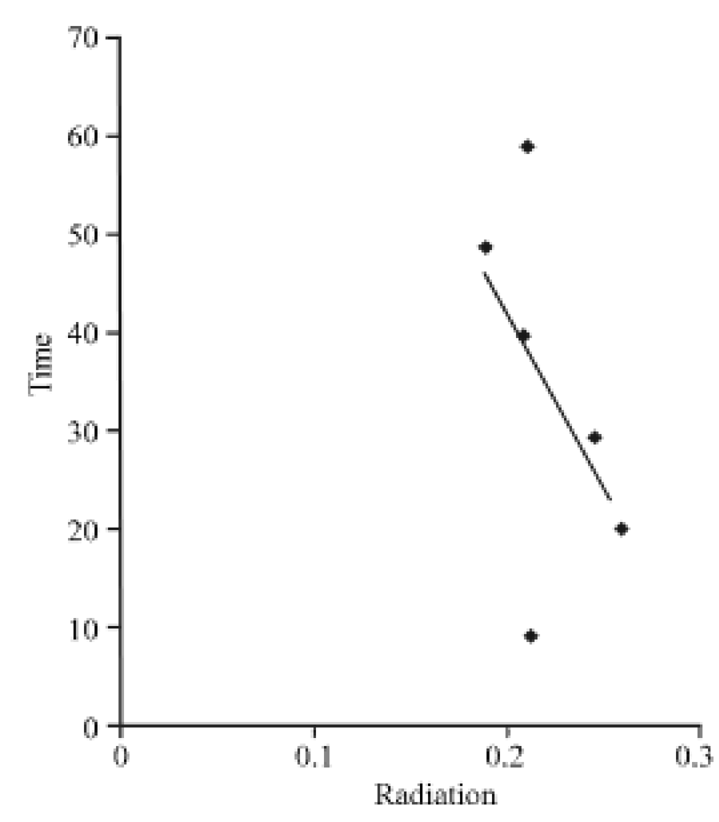

Fig. 7: Analysis of radiation from MTN GSM mask at 200 m

1.50 μSv h^{-1} for GLO and 1.32 μSv h^{-1} for MTN and 1.37 μSv h^{-1} for ZAIN at 200 min 3.5 h each. Theses measurements show that ground level power densities due to microwave directional antenna are normally a thousand times below recommended safety link (Thomas *et al*., 2007). Moreover, as added margin of safety, microwave towers shown in Fig. 1-3 are in accessible to the general public because of its considerable height. Significant exposure from these antennas could only occur in the unlikely event that an individual has to stand directly in front of the antenna and very close to the antenna for a long period of time.

The analysis of the results in Fig. 4-9 shows that there is an insignificant, negative and scattered

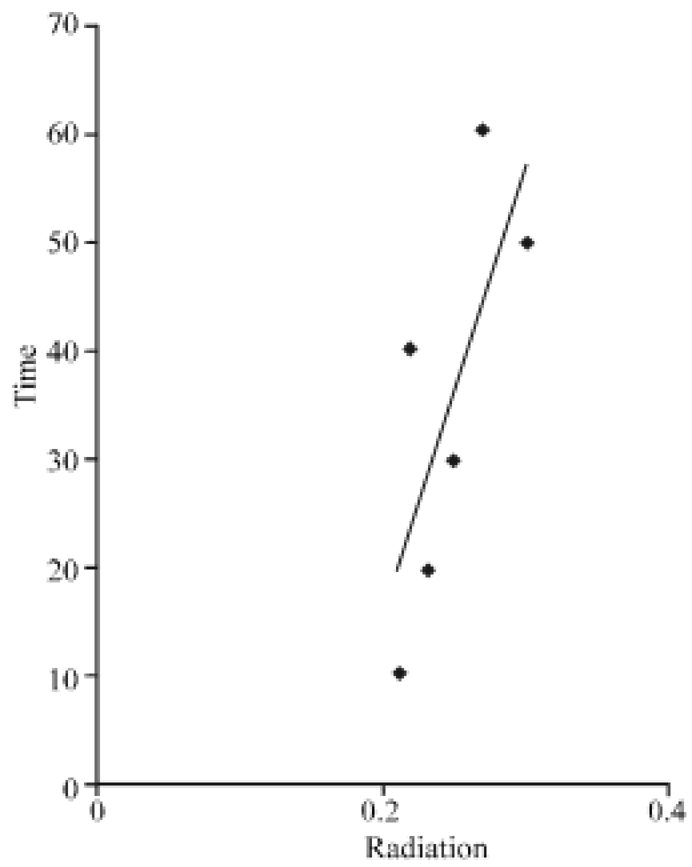

Fig. 8: Analysis of radiation from ZAIN GSM mask at 100 m

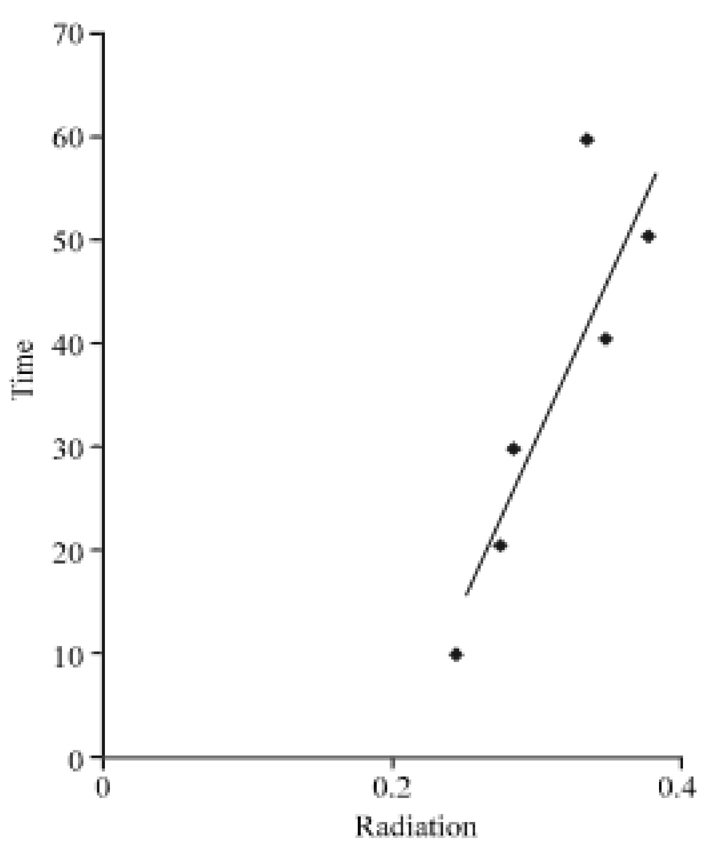

Fig. 9: Analysis of radiation from ZAIN GSM mask at 200 m

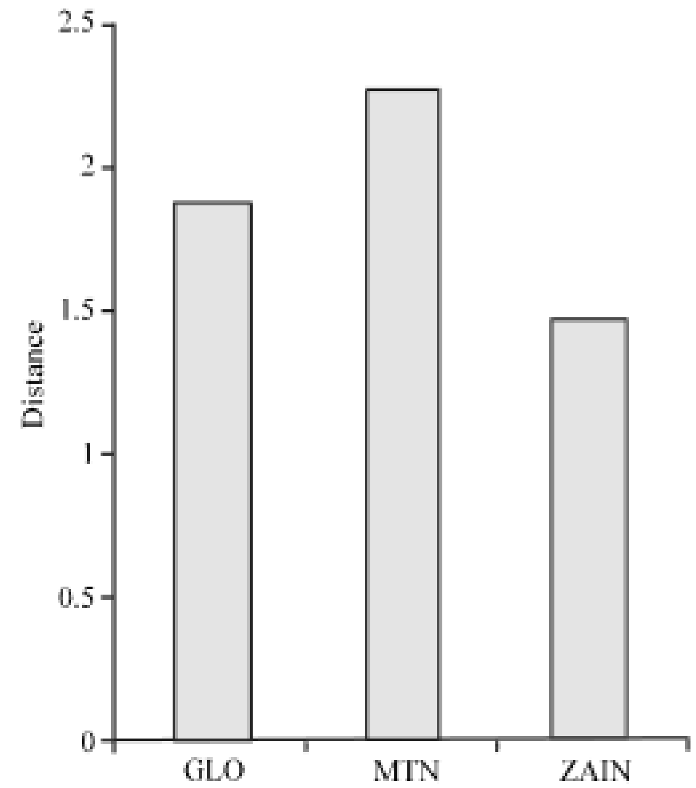

Fig. 10: Total radiation measured at 100 m

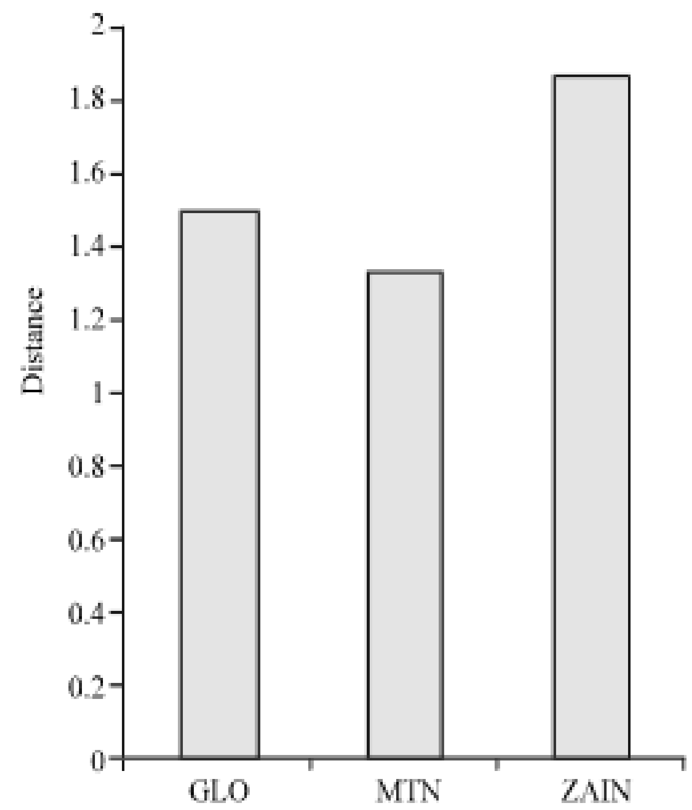

Fig. 11: Total radiation measured at 200 m

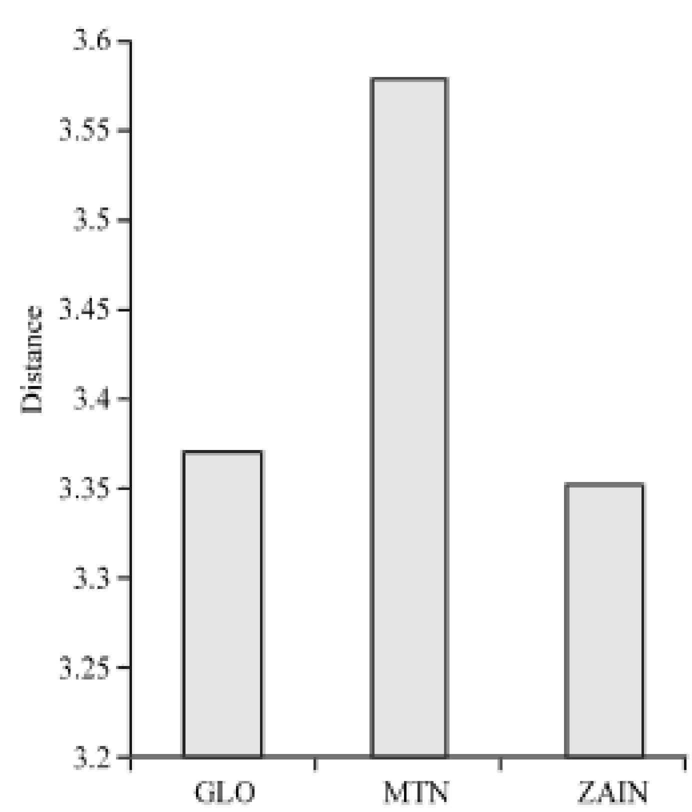

Fig. 12: Total amount radiation measured at 100 and 200 m

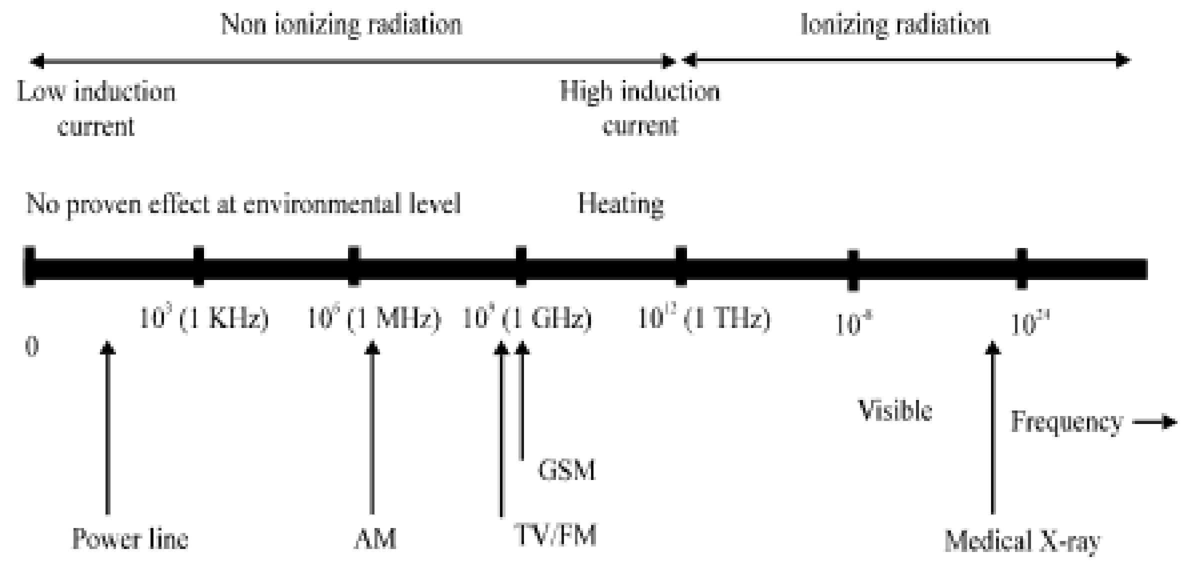

Fig. 13: Non Ionizing and Ionizing radiation spectrum (PTRHA, 1947)

correlation between exposure of RF radiation, human health and long time of period, with coefficient of correlation of 0.008, 0.004, 0.27, -0.0027, 0.039 and 0.048. The analysis in Fig. 10 also shows that at 100 and 200 m the average amount of radiation measured from MTN mask is higher than that of GLO and ZAIN mask with Zain (2005) the lowest, however this is still far below safety level. Figure 11 and 12 shows that from the measurements the greater the distance the magnitude of the field reduces, the amount of the radiation is reduce by 0.37, 0.94 and 0.39 for GLO, MTN and ZAIN, respectively. The measurements also shows that at 1000 m (1 km) the radiation disappears completely meaning at that point no amount of radiation can be detected (0 radiation). In Fig. 13 frequency spectrum that indicated GSM frequency position.

CONCLUSION

The purposed of this study is to put an end to the great debate among Nigerian citizen that RF of GSM mask no effect on human health. The measurement were carried out carefully with precision and the results obtained and analyzed established that GSM RF has no correlation or effect on human health because the low power emission has no sufficient ionization energy to destroy any part of cell in human body.

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