

Awareness and Perception of Undergraduate Students towards Risk Associated with Wireless Electromagnetic Field Radiation Exposure in Enugu, South-East Nigeria: A Cross-sectional Study

EMEKA KEVIN MGBE¹, CHINENYE GLORY MGBE², CHUKS ENYEREIBE AJARE³, AMAKA OBIAGELI NNAMANJ⁴



ABSTRACT

Introduction: Use of telecommunication equipment (cell phone or mobile phone, tablets, walkie-talkie, ipads, ipods, android) has been on the increase globally. There is an estimate of over 145 million active subscribers on record in Nigeria. Hence, there is need for correct information about the associated risk of Electromagnetic Field (EMF) exposure of equipment so as to curb its debilitating effects.

Aim: To evaluate the level of awareness and perceived health risks of EMFs exposure (Radiation) among undergraduate students' of various discipline.

Materials and Methods: The Health Belief Model (HBM) was used with descriptive cross-sectional research design from March 2017 to November 2018 to evaluate awareness and perception of EMF radiation exposure. Structured questionnaire, focus group discussion and in-depth interviews with a predominantly 1-5 scale grading was applied for data collection. Data analysis was conducted using Statistical Package for Social Science (SPSS) version 14 with correlation coefficient (r) and Chi-square test (χ^2) of p-value <0.05 as significant.

Results: A total of 576 undergraduate students from six tertiary institutions in Enugu State, Eastern Nigeria were recruited for the study. A total of 43% were males while 57% were females. Even though majority (93.9%) of the respondents rightly defined the meaning of EMF as a wave that transmits energy through space or material medium, only 34.6% had significant awareness of the radiation effect of this equipment. About 82% of respondents kept their telecommunication equipment close to their body thereby increasing exposure to EMF. The correlation coefficient (r) is 0.806 and the p-value <0.05 shows that there is a high positive relationship between risk reduction strategies like use of hand-free/ear piece etc., and level of awareness among students. There was significant positive correlation between awareness of EMF radiation and faculty of studies as well between perceived EMF risk and year of study (Each p-value <0.05).

Conclusion: Increase in the level of health education is a key to reduction of risk of EMF exposure (Radiation) among undergraduate telecommunication equipment users and this invariably applies to the entire general population.

Keywords: Health, Health belief model, Telecommunication equipment

INTRODUCTION

The telecommunication industry is currently experiencing rapid growth on a global scale and recently in Nigeria, as a result of technological development which has enhanced the application of new information technologies and subsequently facilitated economic activities [1]. Mobile or cellular phones, ipads, ipods and android devices have become a necessity for many people globally. The ability to communicate with family, get assistance in emergencies, keep in touch with business associates, access to email are some of the reasons for the increasing importance of telecommunication equipment in developed and developing economies [2].

Mobile or cellular phones, ipads, ipods and android have gained immeasurable ground in the lives of students all over the world [3]. In many countries, half of the population use these devices and the market is growing rapidly. In 2014, the estimated global subscription was about 6.9 billion. In some parts of the world, telecommunication equipment is the most reliable or the only means of communication [4].

Closely related to the mechanism of function of telecommunication equipment is the emission of EMF by its antennae [5], classified by the International Agency for Research on Cancer as possibly carcinogenic to humans [4]. In many of the studies on EMF effects, it has been reported that people that used mobile phones, tablets,

walkie-talkies, ipads, ipods, android devices for upto an hour per day for over ten years had a significantly higher risk of brain cancer, neurosis, headaches, insomnia, dizziness, an increase in stress, lower bone density, possible adverse changes in brain activity and even sub-fertility in some men [4]. It was also observed that telecommunication equipment users expose their brains to higher mean intensities [6]. In a review of 23 studies involving 37,916 people, there is evidence linking telecommunication equipment use to an increased risk of tumours, especially if the phone had been used for 10 years or more [7]. In May 2011, the World Health Organisation (WHO) [8] warned, for the first time, that telecommunication equipment may cause cancer after reviewing 21 scientific studies from 14 countries [9].

The evolution of telecommunication equipment started in the mid-1980's with attraction of a small but reasonable number of subscribers [10]. With further development in late 1990's, there was introduction of digital network as well as entrance of additional network providers. This in turn fuelled increase in the number of subscribers in the market [11]. It is predicted that mobile communication will become the dominant technology for telephony and other applications like internet access [12]. In 2014, the estimated global subscription was 6.9 billion and in many parts of the globe, the cell phone is the reliable or the only means of telecommunication available [3].

In Nigeria, there is an estimate of over 70 million active subscribers on record [13]. This copious use of relatively new technology brings up the question of whether there are any health implications. There are conflicting findings and reports relating to possible adverse effects on human health and this has led to some serious concerns [5]. Given the huge population of cell phone users, it is paramount to investigate, understand, evaluate and monitor any possible public health implications [14]. Therefore, with the large population of phone users, there exists the potential for health complications of epidemic proportions, indeed a causative relationship between cancer and other documented adverse effects does exist.

Telecommunication equipment is low-powered radiofrequency transmitters, which work at frequencies between 450 and 2700 MHz with peak powers ranging from 0.1 to 2 watts. The power (and hence the radiofrequency exposure to a user) drop quickly with ever-increasing distance from the cell phone [3]. Power is transmitted only when the handset is turned on [15]. Use of Telecommunication equipment (tablets, walkie-talkie, ipads, ipods, android) 30-40 cm away from their body—for example when text-messaging, browsing, or using a “hands free” device—may have a much lower dose of exposure to radiofrequency fields than someone that holds the handset against the head [16].

Young people who are quick to catch on to fads and fashionable trends and who are likely to accumulate many years of exposure to this low frequency radiation seem to be at higher risk of exposure to harmful effects of telecommunication device use. It is therefore important to understand their level of knowledge about these risks and what protective measures they employ, if any, in their day to day use of these devices. Hence, the present study was done with the aim to create awareness of the same.

MATERIALS AND METHODS

A descriptive cross-sectional study was conducted from March 2017 to November 2018 to assess undergraduate students' awareness and knowledge of the effects of EMF exposure from mobile or cellular phone use (tablets, walkie-talkie, ipads, ipods, and android), perceived susceptibility and severity of the effects of EMF exposure, perceived barriers to information on the health effects of EMF exposure, and perceived self-efficacy to mitigate the health risks associated with EMFs exposure in Enugu, south-east Nigeria.

Qualitative and quantitative techniques were used to gather data from university students. Ethical clearance was obtained from the University of Nigeria Teaching Hospital Ethical Committee (Reference No; UNTH/CSA/329/OL.5). Informed written consent was obtained from research participants before the commencement of the research.

Enugu State has a population of 3,267,837 (National Population Commission, 2006) [17]. Enugu has 23 tertiary institutions which is the highest number in eastern Nigeria. Higher institutions also consist of people from different social and geographic background which invariably confers heterogeneity and spread to the research. Administratively, Enugu State has 17 Local Government Area (LGAs).

The study population included undergraduate students of Enugu State. A random sample of 576 undergraduate students was

selected from six institutions, based on one Federal University, one State University, one Private university, one Distance Learning University, one Polytechnic and one College of Education. A sample size of participants was calculated [18] and 'n' was calculated to be approximately 288, but a sample size of 576 undergraduate students was selected to have a better representative number of the population.

A multistage sampling technique was used to select the participants:

Stage 1: Stratification of the institutions into two categories: Universities and other tertiary institutions (Polytechnics, Colleges of Education and Monotechnics). Thus, University of Nigeria Nsukka (UNN), Enugu State University of Science and Technology (ESUT), Enugu State College of Education and Technology (ES CET), Institute of Management and Technology (IMT), Godfrey Okoye University (GOU), and National Open University of Nigeria (NOUN) were selected, respectively, in each of the categories [Table/Fig-1].

Stage 2: The selection of faculties was by simple random sampling. Three faculties were selected from each of the institutions. The basis of the choice of faculty was to get representation from different fields of study: social sciences, arts and biological/physical sciences.

The variables measured included certain socio-demographic characteristics such as age, gender, educational level, and years of cell phone usage. Other measures included awareness and knowledge, perceived susceptibility and severity, perceived barriers, perceived self-efficacy and mitigation of risk.

Measures

The major independent variables in the study were the demographic variables, predisposing factors such as levels of knowledge, awareness and all perception sub-variables. The dependent variables included practices and precautionary measures/risk reduction strategies.

A structured interviewer self-administered survey questionnaire was used to collect data from undergraduate students who used mobile phone. In addition, focus group discussions and in-depth interviews were conducted to gain qualitative understanding of perceived susceptibility, severity, barriers to the problem and perceived ability to carry out the recommended actions relating to telecommunication EMF.

Two data collection instruments were used for this study: 1) The first was the focus group discussion (FGD). The FGDs and in-depth interviews were conducted with carefully developed FGD/in-depth interview guide which contained diagnostic questions on some of the issues raised in the questionnaire study. This provides in-depth understanding on the socio-cultural risk factors of the people with respect to issues that affect the contacting of radiation from wireless telecommunication equipment. The focus group implemented was to uncover the experience, views and interpretation of events related to wireless telecommunication equipment user practices. Finding from the focus group discussions were incorporated in the development of the survey questionnaire.

Institutions in Enugu	Estimated student population	No. of faculties	Proportion of students to be selected from each institution	Number of students selected from each institution	Status
University of Nigeria Nsukka	28,202	15	$28202/80300 \times 576 = 202.2$	202	Federal University
Enugu State University of Science and Technology	16,236	7	$16236/80300 \times 576 = 117$	117	State University
Godfrey Okoye University	2,014	4	$2014/80300 \times 576 = 15.4$	15	Private University
National Open University of Nigeria	1,985	4	$1985/80300 \times 576 = 14.2$	14	Open and Distance Learning University
Institute of Management and Technology	30,000	6	$30000/80300 \times 576 = 215.1$	215	Polytechnic
Enugu State College of Education Technology	1,863	6	$1863/80300 \times 576 = 13.3$	13	College of Education
Total	80,300	42		576	

[Table/Fig-1]: Selected institutions in Enugu State and their sample size distribution.

2) The second was survey questionnaire. Section A covered demographic characteristics of the participants (gender, age, ethnicity, educational level, course of study, number of phones). Section B focused on knowledge and awareness of cell phone EMF effects.

The questionnaire has been attached as an [Appendix].

Section C was on cell phone use. Section D was tailored to the component of the HBM framework. The health believe model entails, perceived susceptibility to EMF risks, perceived severity, perceived barrier and perceived benefits of adhering to precautions [19].

The Likert scale format with four response categories was used to elicit responses to the questions in the perception domain. The Telecommunication equipment Problem Usage Scale was reviewed and relevant sections adapted for this study [20]. The validity of the contents of the questionnaire and FGD was strengthened through review of literature and structured based on the objectives identified for the study and conceptual framework of the HBM. Furthermore, review of the instrument by colleagues was extensively undertaken to provide face validity. The reliability of the result of the questionnaire was ensured by assuring respondents that their status will be anonymous giving them freedom to answer the questions sincerely. The questions were in simple clear English language to avoid ambiguity.

Data Collection

a. Quantitative data

A uniform set of questionnaire was administered to undergraduate students from six selected tertiary institutions. The questionnaire sought information on the socio-demographic (background) characteristics of the respondents, knowledge and awareness, perceived susceptibility and severity, perceived barriers, perceived self-efficacy and mitigation of risk (HBM Frame work).

To ensure uniformity in the interpretation of concepts and recording of responses, the questionnaire was administered on one on one basis interviews with all the respondents. For this purpose, field assistants were recruited and trained for three days on the objectives and methods of the study.

b. Qualitative data

FGDs were conducted with 6-8 persons in a group in their classroom by the researcher and trained research assistants. The discussion was held with undergraduate males and females for 10 minutes and a note-taker was on hand to record important non-verbal expressions and reactions to issues raised by the facilitators of the FGDs. A total of twelve FGDs for six tertiary institutions were conducted in all (two per category of discussants and ensured information).

STATISTICAL ANALYSIS

Data analysis was conducted using the statistical package SPSS version 14. Computation involved frequency distributions, summaries of descriptive statistics, p-value of the Chi-square test and Correlation coefficient (2-tailed) at 0.05 level of significance was measured.

How can you rate your daily telecommunication equipment use	Institution						Total
	ESUT	IMT	UNN	ESCET	GOU	NOUN	
Less than 30 min % within institution	17.9%	29.8%	15.3%	23.1%	66.7%	28.6%	23.1%
30-60 min % within institution	23.9%	12.6%	15.3%	23.1%	20%	42.9%	17%
61-90 min % within institution	18.8%	12.1%	18.3%	15.4%	6.7%	7.1%	15.5%
More than 90 min % within institution	39.3%	45.6%	51.0%	38.5%	6.7%	21.4%	44.4%
Total	100%	100%	100%	100%	100%	100%	100%

[Table/Fig-3]: Daily telecommunication equipment use by institution.

RESULTS

A total of 576 undergraduate students from six tertiary institutions in Enugu State, Eastern Nigeria were recruited for the study. Out of 576 respondents, 82.2% carried their telecommunication equipment close to the body. Also, significant number of the respondents understood the meaning of EMF as a wave (34.1%), transmission of energy through space or material medium (34.8%) but about 6.1% of respondents still believed that EMF is a dangerous spell from evil spirit.

This study showed that 93.4% of the respondents were relatively addicted to their telecommunication equipment. It also showed that majority (46.5%) of the respondents had one telecommunication equipment. The study showed a higher percentage of 53.5% having more than one telecommunication equipment which translates to more exposure. Majority of the respondents 14.7% got the information about radiation from the internet and minority from health professional house visit (1.0%) and general practioners (6.5%).

A total of 576 undergraduate students were recruited for the study, 43.2% were males and 56.8% were females. The majority (84.2%) of the respondents were singles. A total of 91.3% of the respondents were Christians, 4.9% Muslims and 3.8% Traditional practitioners [Table/Fig-2].

Factors	N	%
Gender		
Female	327	57%
Male	249	43%
Age group		
Less than 15 years	2	0.3%
15-18 years	110	19.1%
19-24 years	351	60.9%
25-30 years	85	14.8%
31-35 years	27	4.7%
Above 35 years	1	0.2%
Marital status		
Single	485	84.2%
Married	78	13.5%
Divorce	10	1.7%
Separated	3	.5%
Religion		
Christianity	526	91.3%
Islam	28	4.9%
Traditional	22	3.8%

[Table/Fig-2]: Socio demographic characteristics.

In the study, out of 576 respondents recruited, 23.1% used their telecommunication equipment for less than 30 minutes daily while 17% used it for 30-60 minutes, 15.5% for 61-90 minutes. As much as 44.4% used theirs for more than 90 minutes daily [Table/Fig-3] while relatively less (40.1%) do significant texting, which is safer.

About 50% of respondents had used their phone for more than 2 years [Table/Fig-4].

It was observed that majority used their telecommunication equipment in full bar (60%) [Table/Fig-5].

About 46% of respondents were concerned about the radiation effects from their telecommunication equipment [Table/Fig-6].

There was a significant relationship between student's perception and pattern of EMF and their gender [Table/Fig-7].

Percentage of duration the respondents have been using telecommunication equipments	Institution						Total
	ESUT	IMT	UNN	ESCET	GOU	NOUN	
Less than one month % within institution	0.9%	6.5%	1%	Nil	6.7%	14.3%	3.5%
1 month-1 year % within institution	41%	61.4%	42.1%	23.1%	40%	Nil	47.60%
2-4 years % within institution	25.6%	14.4%	14.4%	30.8%	6.7%	42.9%	17.5%
5-7 years % within institution	16.2%	9.3%	6.9%	23.1%	13.3%	14.3%	10.4%
8-10 years % within institution	16.2%	5.6%	35.6%	Nil	33.3%	21.4%	19.3%
More than 10 years % within institution	Nil	2.8%	Nil	23.1%	Nil	7.1%	1.7%
Total	100%	100%	100%	100%	100%	100%	100%

[Table/Fig-4]: Percentage of duration the respondents had been using telecommunication equipment.

Signal strength of telecommunication equipment used by the respondent	Percentage (%)
Full (Four) bars	60%
Three bars	24%
Two bars	11.3%
One bars	4.7%
Zero bar	Nil
Total	100%

[Table/Fig-5]: Analysis of signal strength of telecommunication equipment used by the respondents

In the study, there was a significant relationship between perception of EMF risks and students' level in school ($p=0.003$). This implies that perception of EMF risks varies with the year of study, which may be explained by increased exposure to information with longer stay in school [Table/Fig-8].

The faculty of medical lab and health administration/mgt had the highest level of awareness while Biological sciences had the least level of awareness [Table/Fig-9].

The correlation coefficient is 0.806 and the p -value <0.05 shows that there is a high positive relationship between risk reduction strategies and level of awareness among students [Table/Fig-10].

How worried in getting radiation from their telecommunication equipment?	Institution						Total
	ESUT	IMT	UNN	ESCET	GOU	NOUN	
Very much worried % within institution	52.1%	56.3%	30.2%	46.2%	46.7%	50%	45.7%
A little worried % within institution	33.3%	34%	34.7%	30.8%	40%	21.4%	33.9%
Not worried at all % within institution	14.5%	9.8%	35.1%	23.1%	13.3%	28.6%	20.5%
Total	100%	100%	100%	100%	100%	100%	100%

[Table/Fig-6]: How worried in getting radiation from their telecommunication equipment.

Responses to questionnaire			Gender		Total
			Male	Female	
Perception and Pattern of EMF	Strongly disagree	Count	Nil	92	92
		Expected count	52.2	39.8	92
		% within gender	Nil	36.9%	16%
	Disagree	Count	1	104	105
		Expected count	59.6	45.4	105
		% within gender	0.3%	41.8	18.2
	Neutral	Count	95	44	139
		Expected count	78.9	60.1	139
		% within gender	29.1%	17.7%	24.1%
	Agree	Count	151	9	160
		Expected count	90.8	69.2	160
		% within gender	46.2%	3.6%	27.8%
Strongly agree	Count	80	Nil	80	
	Expected count	45.4	34.6	80	
	% within gender	24.5%	Nil	13.9%	
Total	Count	327	249	576	
	Expected count	327	249	576	
	% within gender	100%	100%	100%	

Analysis	Value	df	p-value
Pearson Chi-square	414.820 ^a	4	<0.001
Likelihood ratio	533.787	4	<0.001
Linear-by-linear association	365.569	1	<0.001
N of valid cases	576		

[Table/Fig-7]: Relationship between Students' Perceptions of EMF and their gender using Chi-square test.

^a0 cells (.0%) have expected count less than 5. The minimum expected count is 34.58

DISCUSSION

With increased use of telecommunication equipment in the developing countries like Nigeria, there is a great concern over the adverse effects of the EMF. This becomes particularly worrisome because all the respondents in the study possessed at least one telecommunication equipment. This also supports the NCC data that there are 145 million active subscriptions in Nigeria with a population of 190 million [13]. A similar study done in Saudi Arabia [9] shows that 77% had one telecommunication equipment as 23% had more than one. In contrast, the study showed a higher percentage of 53.5% having more than one telecommunication equipment which translates to more exposure.

Perception of EMF risk and students level	Level (Year of study)				Total
	100 level	200 level	300 level	400 level	
Strongly disagree % within level	14.3%	17.9%	10.5%	24.8%	16%
Disagree % within level	14.3%	21.4%	18.4%	17.8%	18.2%
Neutral % within level	21.4%	17.9%	23.8%	25.7%	24.1%
Agree % within level	42.9%	28.6%	29.2%	24.3%	27.8%
Strongly agree % within level	7.1%	14.3%	18.1%	7.4%	13.9%
Total	100%	100%	100%	100%	100%

[Table/Fig-8]: Relationship between students perception of EMF risk and students level in school (Year of study).
p=0.003

The duration of the use of telecommunication equipment was much higher in our respondent that is 44.4% for more than 90 minutes as against 5% in Saudi Arabian medical students [9]. The more usage by the respondents in this study may be due to a wider cross section of students as against only medical students in Saudi Arabian who by reason of their course of study should be exposed to more health related information.

About half of the respondents have had telecommunication equipment for less than 1 year while just less than 50% have had it for 2-10 years. This is relatively small compared to that of the study done by Huber R et al., in which 75% of the children between 7-15 years already own telecommunication equipment [22]. This invariably translates to less exposure for our respondents.

About 60% of the respondents make use of their telecommunication equipment when signal strength is the strongest (Full Bar). This means that since signal strength is inversely proportional to emissions, a

How much do you know about telecommunication equipment radiation?	Faculty						Total
	Biological sciences	Political science and Business admin	Medical lab and Health admin/Mgt	Accounting and library education	Social sciences	Law	
Nothing At All	22.2%	15.3%	7.4%	7.7%	Nil	7.1%	13.2%
A little	38.5%	42.3%	37.1%	61.5%	66.7%	42.9%	40.8%
Neutral	12.8%	7.9%	11.4%	23.1%	20.0%	35.7%	11.5%
Much	18.8%	18.1%	17.3%	7.7%	6.7%	7.1%	17.2%
Very much	7.7%	16.3%	26.7%	Nil	6.7%	7.1%	17.4%
Total	100%	100%	100%	100%	100%	100%	100%

[Table/Fig-9]: Chi-square test for relationship between Awareness and Faculty (Discipline of study).
p=0.0001

Correlations

		Self efficacy 2	Level of awareness of EMF
Self efficacy 2	Pearson correlation	1	0.806**
	p-value		<0.001
	N	576	576
Level of awareness of EMF	Pearson correlation	0.806**	1
	p-value	<0.001	
	N	576	576

[Table/Fig-10]: Correlation between risk reduction strategies and level of awareness among students.
**Correlation is significant at the 0.01 level (2-tailed)

Interestingly, majority of respondents (about 93.9%) got the proper definition of EMF while few 6.1% believe it to be a spell from evil spirit. This higher level of knowledge may not be unconnected to the high level of education of the respondents compared to the general public. Majority of the respondents 14.7% got the information about radiation from the internet and minority from health professional house visit (1.0%) and general practitioners (6.5%). This implies that the respondents' information might be wrong because the major source (internet) does not create room for interactions and questions unlike the information obtained directly from health professionals' visit and general practitioners whereby the respondents would be opportune to interact and also ask question on one on one basis.

This result showed a higher percentage 59.9% use their telecommunication equipment for making calls as against 40.1% that do more of texting. It therefore implies that there is high exposure to EMF because in texting the phone is about 15 cm away from the body unlike phone calls in which there is close contact to the body. This study showed that 93.4% of the respondents were relatively addicted to their telecommunication equipment because they claimed they can't do without their telecommunication equipment and they spent at least 90 minutes on calls daily. This is more than the study by Khan MM in which 27.5% were addicted to their telecommunication equipment [21].

greater part of the respondents are relatively safe from EMF effects. It is alarming to note that up to 54% of the respondents showed little or no concern about the radiation effects of telecommunication equipment in spite of their high level of education compared to the general population. This implies that a lot of awareness needs to be inculcated.

The study also showed that there was a significant relationship between students' perception and pattern of EMF and their gender. This is particularly important because Sandrini L et al., observed that the specific absorption rate (WBA-SAR) of female is more than that of the male because of a thicker subcutaneous fat layer [23].

The study showed high positive correlation coefficient(r) relationship between risk reduction strategies and level of awareness among students (0.806 and the p-value <0.05), awareness of susceptibility of effects of EMF (0.950 and the p-value <0.05) and awareness of severity (0.931 and the p-value <0.05). This implies that with improved education on adverse health effects of telecommunication equipment, respondents are more likely to take steps to mitigate of risk.

For the HBM perceived susceptibility and perceived benefit, the study showed that the overall mean rating of the respondents with regards to perceived susceptibility is (2.97) and perceived benefit (2.9395) is below the criterion mean of 3.0. This implies that most of the respondents do not perceive themselves as being susceptible to radiation as well as perceived benefit.

The significant correlation between level of awareness and risk reduction strategies among students implies that there is willingness to change behaviour to reduce risk of EMF exposure. Therefore, effort should be made by all stake holders to properly educate the populace so as to mitigate the risk as shown by this study.

Limitation(s)

The study was carried out among the educated class who by inference are exposed to more information; their response may not give a true picture of the general population that are illiterates.

CONCLUSION(S)

Undergraduate students are one of the active users of telecommunication equipment with all the students having at least one form or the other. Even though they have higher level of education exposure compared to the general population, they still show little or no concern about the radiation effects. The situation is made worse by their high level of addiction which translates to more exposure. This implies that there is a lot of awareness that needs to be created. The HBM is therefore an ideal model to evaluate and manage radiation risk associated with use of EMF equipment. Its recommended to carry out a similar research on telecommunication equipment producers and wireless network providers and compare with the view from the present study for a more comprehensive evaluation.

REFERENCES

- [1] The Nigerian Communications Commission, (2014). Quarterly Summary of Telephone Subscribers in Nigeria. (NCC).
- [2] Billieux J, Philippot P, Schmid C, Maurage P, De Mol J, Van der Linden M. Is dysfunctional use of the mobile phone a behavioural addiction confronting symptom- Based versus process-based approaches. *Clin Psychol Psychother.* 2015;22(5):460-68.
- [3] WHO, (2014). Electromagnetic Field and Public Health: Mobile phones. Geneva. World Health Organization. <https://www.who.int/news-room/fact-sheets/detail/electromagnetic-fields-and-public-health-mobile-phones>. Last accessed on 28 April 2020.
- [4] WHO, (2014). Electromagnetic Field and Public Health: Cautionary Policies. Geneva. World Health Organization.
- [5] Hardell L. World Health Organization WHO. Radio frequency radiation and health- A hard nut to crack (Review). *Int J Oncol.* 2017;51(2):405-13.
- [6] Cherry N. Cell phone radiation poses serious biological and health risks. 2001. Available from www.neilcherry.com.
- [7] Myung SK, Woong JU, McDonnell DD, Lee YJ, Kazinets G, Cheng CT, et al. Mobile phone use and risk of tumors: A meta-analysis. *J Clin Oncol.* 2009;27(33):5565-72.
- [8] Rööslä M, Frei P, Mohler E, Hug K. Systematic review on the health effects of exposure to radiofrequency electromagnetic fields from mobile phone base stations. *Bulletin of the World Health Organization.* 2010;88:887-96F.
- [9] Baan R, Grosse Y, Secretan BL, Ghisssassi FE, Bouvard V, Talaa LB, et al. Carcinogenicity of radiofrequency electromagnetic fields. *Lancet Oncol.* 2011;12(7):624-26.
- [10] Fransman M. Evolution of the telecommunications industry into the internet age. *Communications and Strategies.* 2001;43(1):01-56. DOI-10.4337/9781781950654.00012.
- [11] SCENIHR, (2015). Scientific Committee on Emerging and Newly Identified Health Risks: Potential health effects of exposure to electromagnetic fields (E.M.F): http://ec.europa.eu/health/scientific_committees/emerging/docs/scenih_r_o_041.pdf, accessed August 14, 2015.
- [12] Wainwright PR. Thermal effects of radiation from cellular telephones. *Phys. Med Biol.* 2000;45(8):2363-72.
- [13] The Nigerian Communications Commission, (2010). Quarterly Summary of Telephone Subscribers in Nigeria (NCC).
- [14] Institute of Electrical and Electronics Engineers (IEEE) (2005). IEEE standard for safety levels with respect to human exposure to radio frequency electromagnetic fields, 3 kHz to 300 GHz, IEEE Std C95.1.
- [15] The Global Development Research Center (GDRC), (2000). EU's Communication on Precautionary Principle. Kobe, Japan, The Global Development Research Center, (<http://www.gdrc.org/u-gov/precaution-4.html>, accessed 30 August).
- [16] INTERPHONE Study Group. Brain tumour risk in relation to mobile telephone use: results of the interphone international case-control study. *Int J Epidemiol.* 2010;39(3):675-94.
- [17] National Population Commission (NPC), (2006). Nigeria National Census: Population Distribution by Sex, State, LGAs and Senatorial District: Census (Vol. 3). Population and Development Review. 2007;33(1): 206-10.
- [18] Araoye MO. Sample size determination. *Research methodology with statistics for health and social sciences.* 1st Ed. Ilorin: Nathadex Publishers; 2003:115-120.
- [19] Eisen M, Zellman GL, McAlister AL. A health belief model-social learning theory approach to adolescents' fertility control: Findings from a controlled field trial. *Health Educ Q.* 1992;19(2):249-62.
- [20] Takao M. Problematic mobile phone use and big-five personality domains. *Indian J Community Med.* 2014;39(2):111-13.
- [21] Khan MM. Adverse effects of excessive mobile phone use. *International Journal of Occupational Medicine and Environmental Health.* 2008;21(4):289-93.
- [22] Huber R, Schuderer J, Graf T, Jütz K, Borbély AA, Kuster N, et al Radio frequency electromagnetic field exposure in humans: Estimation of SAR distribution in the brain, effects on sleep and heart rate. *Bioelectromagnetics.* 2003;24(4):262-76.
- [23] Sandrini L, Vaccari A, Malacarne C, Cristoforetti L, Pontalti R. RF dosimetry: A comparison between power absorption of female and male numerical models from 0.1 to 4 GHz. *Phys Med Biol.* 2004;49(22):5185-201.

PARTICULARS OF CONTRIBUTORS:

1. Department of Radiation, University of Nigeria Teaching Hospital, Enugu, Nigeria.
2. Department of Health Science, National Open University of Nigeria, Enugu, Nigeria.
3. Department of Radiation, University of Nigeria Teaching Hospital, Enugu, Nigeria.
4. Department of Radiation, University of Nigeria Teaching Hospital, Enugu, Nigeria.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Chinenye Glory Mgbe,
Ph.D, Department of Health Science, National Open University of Nigeria,
Enugu, Nigeria.
E-mail: chinenyemgbe@yahoo.com

AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: Dec 07, 2019
- Manual Googling: May 06, 2020
- iThenticate Software: Jul 26, 2020 (15%)

ETYMOLOGY: Author Origin

Date of Submission: **Dec 06, 2019**
Date of Peer Review: **Jan 10, 2020**
Date of Acceptance: **May 08, 2020**
Date of Publishing: **Jul 01, 2020**

Questionnaire on Awareness and Perception of Undergraduate students towards risks associated with Wireless Electromagnetic Fields Exposure (Radiation) in Enugu, South-East

SECTION A: Tell us about yourself

1. **Gender:** a. Female () b. Male ()
2. **Age in years:** a. Less than 15 () b. 15-18 () c. 19-24 () d. 25-30 () e. 31-35 () f. Above 35 ()
3. **Marital status:** a. Single () b. Married () c. Divorced () d. Separated ()
4. **Which institution?**
5. **Which faculty?**
6. **Which department?**
7. **Course of study**.....
8. **Level:** a. 100 L () b. 200 L () c. 300 L () d. 400 L () e. 500 L () f. 600 L ()
9. **Religion:** a. Christianity () b. Islam () c. Traditional () d. Others (specify)_____

SECTION B: This section is on use of wireless telecommunication equipment (mobile or cell phone, Ipad, ipod, android, etc..)

10. Do you use Telecommunication equipment? a. Yes () b. No ()
11. Which type of telecommunication equipment do you use?: a. Mobile or cell phone () b. Ipad () c. ipod () d. Android ()

12. Which Network(s) do you use?

Network	Yes	No
a. MTN		
b. ETISALAT		
c. GLO		
d. AIRTEL		
e. Others (Specify)		

13. How many Telecommunication equipment do you have? a. One () b. Two () c. Three () d. More than 3 ()

14. How can you generally rate your daily Telecommunication equipment use?

- a. Less than 30 min () b. 30-60 min () c. 61-90 min () d. More than 90 min ()

15. How many minutes do you spend in talking on your Telecommunication equipment per day?

- a. Less than 30 min () b. 30-60 min () c. 61-90 min () d. More than 90 min ()

16. How many minutes do you spend in listening to music in your Telecommunication equipment per day?

- a. Less than 30 min () b. 30-60 min () c. 61-90 min () d. More than 90 min ()

17. How many text messages do you send or receive per day?

- a. 1-10 () b. 11-20 () c. 21-30 () d. Over 30 ()

18. How long have you been using your Telecommunication equipment?

- a. Less than one month () b. 1 month-1 year () c. 2-4 years () d. 5-7 years () e. 8-10 years () f. More than 10 years ()

19. Do you use your Telecommunication equipment when it has:

Signal Strength	Yes	No
a. Full (four) bar		
Three bars		
Two bars		
One bar		
No bar		

20. Where do you carry your Telecommunication equipment?

Where?	Yes	No
a. In the breast pocket of your blouse/shirt/jacket?		
b. On the waist?		
c. Side pocket of blouse/shirt/jacket?		
d. In purse or bag?		
e. Other (Specify) _____		

21. Have you felt any of these symptoms/conditions ever since you started using Telecommunication equipment?

Symptoms/Conditions	Yes	No
a. Headache		
b. Fatigue		
c. Sleeplessness		
d. Facial dermatitis		
e. Memory disturbances		
f. Impaired concentration		
g. Sensation of warmth behind/around the ear		
h. Academic distraction		
i. Others (Specify) _____		

S/N	Question	Yes	No
22	Do you turn on your Telecommunication equipment only when you need to use it?		
23	Do you use hand-free/ear piece?		
24	Do you use Bluetooth?		
25	Do you text while walking?		
26	Do you read on your Telecommunication equipment?		
27	Do you slow down when texting on your Telecommunication equipment during walking?		
28	Do you slow down when answering a call on your Telecommunication equipment during walking?		
29	Do you use your Telecommunication equipment away from the antenna?		
30	Do you place your fingers up behind the earpiece to press it to your ear when answering a call or listening to music?		

31	Do you keep 15 mm away from the body while making calls?		
32	Do you use approved casing on Telecommunication equipment?		
33	Do you use your Telecommunication equipment as alarm clock?		
34	Do you hold your Telecommunication equipment away from your body when switching it on?		
35	Do you hold your Telecommunication equipment away from your body immediately after dialing until you hear the person answer?		
36	Do you hold your Telecommunication equipment near or in front of your eyes while it is on?		
37	Do you use Telecommunication equipment while wearing metal glasses?		
38	Do you clip your Telecommunication equipment on your belt while using a hand-free kit?		
39	Do you keep the Telecommunication equipment away from your body when it is not in use?		
40	Do you think your sleeping quality worsen with increased use of Telecommunication equipment?		
41	Do you think you are becoming addicted to increased use of Telecommunication equipment?		

SECTION C: Knowledge and Awareness

42. Do you know about Telecommunication equipment radiation? a. Yes () b. No () c. Not sure ()

43. If Yes, where did you get your information?

Information	Yes	No
a. Internet		
b. Educational TV		
c. Book and Magazine		
d. Family and Friends		
e. Newspaper/Flyers/Brochures		
f. Health protective Agency		
g. GP (General Practitioner)		
h. Mega phone/Public announcement		
i. Church/Mosque/other religion venue		
j. Mobile phone/Text Message		
k. House visits by health professional		
l. Others (please specify) _____		

S/N		1 Nothing at all	2 A little	3 Neutral	4 Much	5 Very much
44.	How much do you know about Telecommunication equipment radiation?					

45. Which of these helps you understand what electromagnetic field (radiation) from telecommunication equipment is?

Meaning	Yes	No
a. A mixture of energy?		
b. Dangerous spell from evil spirit?		
c. Transmission of energy through space or material medium?		
d. A wave?		
e. Other (Specify) _____		

46. How worried are you about getting radiation from your telecommunication equipment?

a. Very much worried () b. a little worried () c. Not worried at all ().

47. Would you like to learn more about telecommunication equipment and radiation?

a. Yes () b. No () c. Not Sure ()

48. How would you rate your health check-up during the past 12 months?

a. Poor () b. Fair () c. Good () d. V. Good () e. Excellent ().

SECTION D: Radiation and health belief

S/N	Perceived susceptibility	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
49	Using telecommunication equipment will lead me to getting radiation hazard.					
50	Answering call without earpiece will expose me to radiation.					
51	Carrying telecommunication equipment in my breast pocket and waist will expose me to radiation.					
52	Using telecommunication equipment while wearing metal glasses like eye glasses will expose me to radiation.					
53	Clipping my telecommunication equipment on my belt while using an earpiece will expose me to radiation.					
54	Telecommunication equipment radiation emitted from one person's mobile phone will affect people nearby.					
55	I am addicted to using telecommunication equipment.					

S/N	Perceived Severity	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
56	Having telecommunication equipment radiation will have adverse health effect on my life and family					
57	Having telecommunication equipment radiation will have adverse effect like loss of concentration on my study.					
58	Having telecommunication equipment radiation will have adverse effect on my income.					
59	Thought of having radiation hazard scares me.					
60	Having telecommunication equipment radiation will have adverse effect on my emotion.					
61	Having telecommunication equipment radiation will increase my health issue like high blood pressure.					
62	Having telecommunication equipment radiation can transform to active cancer.					
63	Having telecommunication equipment radiation will expose me to health effects like memory disturbances.					
64	Having telecommunication equipment radiation will expose me to facial dermatitis.					
65	Having telecommunication equipment radiation will expose me to hearing problem.					
66	Having telecommunication equipment radiation will expose me to impaired concentration.					
67	Having telecommunication equipment radiation will expose me to headache.					
68	Having telecommunication equipment radiation will expose me to unpleasant sensations such as a burning feeling on the fingers and tingling in the ears.					
69	Having telecommunication equipment radiation will expose me to mood swing after receiving a call or text message.					

S/N	Perceived barrier	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
70	Using ear piece/ear devices make me uncomfortable.					
71	Using ear piece/ear devices is not convenient.					
72	Using ear piece/ear devices is an added stress to me.					
73	Using ear piece/ear devices is an added cost to me.					
74	Putting my phone on speaker mode makes my conversation unconfidential.					
75	Keeping my telecommunication equipment 15 mm away from my body makes it difficult to access.					
76	I can't do without my telecommunication equipment.					
77	I do have fear of missing out without my telecommunication equipment.					

S/N	Perceived benefit	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
78	Not having a radiation hazard is beneficial					
79	Using ear piece/ear devices will prevent radiation hazard.					
80	Keeping telecommunication equipment away from my body when it is not in use will prevent radiation hazard.					
81	Using an approved casing for my telecommunication equipment will prevent radiation hazard.					
82	Using Bluetooth technology will reduce the possible health risk.					
83	Using my telecommunication equipment in speaker mode will reduce exposure to radiation emissions.					

S/N	Self-efficacy	Highly can do (70-100)	Moderately can do (30-60)	Cannot do at all (0-20)
84	I will use hand-free/ear phone on my telecommunication equipment while receiving calls.			
85	I will switch on my telecommunication equipment only when necessary.			
86	I will use Bluetooth in receiving calls.			
87	I will make my calls short always.			
88	I will use my telecommunication equipment when it has strong signal.			
89	I will stop texting while walking.			
90	I will use approved casing for my telecommunication equipment.			
91	I will hold my telecommunication equipment away from my body when switching it on and immediately after dialing until I hear the person answer.			
92	I will not carry my telecommunication equipment in the breast pocket of my blouse, shirt or jacket.			
93	I will keep my telecommunication equipment away from my body when it is not in use.			
94	I will place my fingers up behind the earpiece to press it to my ear.			
95	I will clean my telecommunication equipment before use.			
96	I will stop using my telecommunication equipment while driving.			