

## Mobile phones usage and awareness of potential health risks from radiation emitted by mobile phones among medical students at Benue State University (BSU), Makurdi

Msuega Daniel Chia <sup>1, \*</sup>, Hameed Mohammad <sup>1</sup>, Teryima Joseph Iortile <sup>1</sup>, Kator Paul Iorpagher <sup>2</sup> and Aondoaseer Alexis Ugande <sup>2</sup>

<sup>1</sup> Department of Radiology, College of Health Sciences, Benue State University, Makurdi, Nigeria.

<sup>2</sup> Department of Radiology, Benue State University Teaching Hospital, Makurdi, Nigeria.

World Journal of Advanced Research and Reviews, 2022, 16(01), 557-571

Publication history: Received on 06 September 2022; revised on 12 October 2022; accepted on 15 October 2022

Article DOI: <https://doi.org/10.30574/wjarr.2022.16.1.1029>

### Abstract

The global increase in mobile phone (MP) usage in proximity to the human-body and proliferation of base stations has created potential health concerns about exposure to radiation emitted from these devices. This study aims to identify students who are knowledgeable about radiation emitted from MPs, assess their degree of awareness of the potential health risks from MP usage, and suggest precautionary and safety measures that can reduce or eliminate the health hazards of MP radiation. We prospectively evaluated medical students' knowledge of MP-emitted radiation, potential health risks, precautionary and safety measures at Benue State University (BSU), Makurdi, between May 13th and July 12th, 2022. Data was obtained through a well-structured questionnaire, analyzed using the Statistical Package for Social Sciences (SPSS) version 23 with a p value < 0.05. Results were presented in tables and figures. The study included 147 fourth-sixth year medical students, aged 20-38 years, male: female ratio 3:1, and mean age of 26.5±3.4. Knowledge of radiation emitted from MPs was high, 134(91.2%), especially among final year students. Similarly, 93 (63.3%) students were aware of potential health risks associated with MP usage, with some evidently experiencing the negative consequences. Many students ignored precautionary measures and continued making long phone-conversations 80(54.4%), putting MPs in their pockets 92(62.6%) and at their bed-head 77(52.4%), prompting crucial safety measures. Knowledge of radiation emitted by MPs was outstanding, with considerable awareness of potential health risks from MP usage. Important safety measures were proposed, even though the precautionary measures to minimize these risks were largely ignored.

**Keywords:** Awareness; Knowledge; Mobile phone; Potential health risks; Precautionary measures; Safety measures

### 1. Introduction

A mobile or cell phone is a gadget that transmits voice or data over a long distance across a network of specialized base stations or cell sites. Most mobile phones (MPs) have standard voice capabilities. The current services offered by MPs include bluetooth, infrared, text messaging, packet switching, gaming, video recording, e-mail, camera, multimedia message service (MMS), general packet radio service (GPRS), moving picture experts group layer-3 (MP3) player, and radio [1, 2].

The total number of MPs globally is predicted to reach 18.2 billion by 2025, from an initial 15 billion in 2021, up from just over 14 billion the year before [3]. Nigeria, with a population estimate of about 215 million in 2022, according to United Nations (UN) estimates, has more than 200 million mobile phone (MP) subscribers as of 2020, according to the Nigerian Communications Commission (NCC) [4,5]. It is nearly impossible to envision daily living without MPs in today's

\* Corresponding author: Msuega Daniel Chia

Department of Radiology, College of Health Sciences, Benue State University, Makurdi, Nigeria.

fast-paced and globalized society [6]. MP usage has grown to the point where, in some countries, the number of phone subscribers outnumbers the population [7]!

MP communication uses electromagnetic radiation in the radio frequency range of 100 to 2000 MHz. This has no ionization effect on the body and hence, not strong enough to directly damage deoxyribonucleic acid (DNA) or disrupt atomic structure; instead, it causes atoms to vibrate, which can make them to heat up. Furthermore, every MP has a specific absorption rate (SAR) rating with an upper limit of 1.6 W/kg, which is equal to 6 minutes (360 seconds) of daily MP usage for a person. According to SAR limit, an individual should not use a MP for more than 24 minutes (1440 seconds) per call. Sadly, the majority of MP users are ignorant of this information and engage in lengthy phone conversations without realizing the potential health hazards. They are also unaware that the radiofrequency energy absorbed by MP user is dependent on a variety of other related factors, such as the make, design specifications, network reception quality, and proximity to a base station antenna [8,9].

While MPs improve people's lives and economies, little is known about their possible health and environmental hazards [10]. The global increase in mobile phone (MP) use, their being used in close proximity to the human body, and proliferation of base stations, has raised potential health concerns about exposure to emitted microwaves from these devices [11] with people experiencing the negative effects from radiation exposure, such as cancer, cardiovascular problems, infertility, hearing impairment, eye problems, skin allergies, stress, traffic accidents, sleep disorder, withdrawal and depression, especially among young people[12].

However, there is no convincing scientific proof of the possibility of negative health consequences related to MP use based on research in the last decade or two [13,14]. Since the licensing of MP carriers in 2001, Nigeria has joined the league of nations where concerns about the health hazards, of MP use have become prominent. Many people have voiced their opinions, some of which have been proven to be incorrect based on scientific evidence [15]. However, in 2011, the World Health Organization (WHO) and International Agency for Research on Cancer (IARC) classified radiofrequency electromagnetic fields as potentially carcinogenic to humans following an elevated risk of glioma, a malignant brain tumor, linked to MP use [16]. More research into long-term, high MP use is required, given the public health implications of this classification and finding. In the absence of such data, it is critical to take precautionary and safety measures, such as using handsfree devices, texting, talking less on the phone, purchasing a lower radiation-emission phones, sleeping with the phone inches away, and using speaker phone, to reduce or eliminate potential health risks from MP radiation [16,17].

We predict that less than half of the BSU medical student population would be aware of the hazards of MP use. Thus, forming a basis for our study, which aims to identify students who are knowledgeable about radiation emitted from MPs, assess their degree of awareness of the potential health risks from MP usage, and suggest precautionary and safety measures that can reduce or eliminate the health hazards of MP radiation in our environment.

---

## 2. Material and methods

### 2.1. Materials

This was a 3-month prospective study aimed at evaluating the medical students' knowledge of MP-emitted radiation, potential health risks as well as precautionary and safety measures at Benue State University (BSU), Makurdi, between May 13th and July 12th, 2022, 2022. Makurdi, the capital of Benue State, is situated between latitudes 7.3 and 8.32 degrees. In 2016, the city and its environs had an estimated population of 365,000 people [18].

BSU has approximately 163 students in their 4th-6th year of study. They received 170 questionnaires. A response rate of 90.2 % was recorded from the 147 completed questionnaires returned.

The inclusion criteria were MP users who were medical students at BSU's College of Health Sciences and were of sound mind and willing to participate in the study.

The exclusion criteria were medical students that were mentally challenged, visually impaired or those who were unwilling to participate in the study. Those without MPs or who were not directly enrolled at BSU but registered at other universities, such as students on exchange programs, or students from other faculties at BSU were equally exempted.

## 2.2. Methods

All participants signed a term of free and informed consent before taking part in the research. Codes were used instead of participants' names. The questionnaire was piloted prior to actual data collection and all necessary corrections were made.

The eventual assessment instrument was a well-structured self-reporting questionnaire consisting of six sections (A-F), which were delivered to the respondents by the researchers themselves. Section A contains socio-demographic information of the respondents such as age, gender, and year of study at BSU, with a guide on how to respond to this segment. Section B includes 5 background inquiries and a completion checklist about the use of mobile phones. Section C looks at the students' responses on enquiries about knowledge of radiation emitted from mobile phones in a "yes" or "no" answer segment. Section D is 15 items' catalogue of potential health risks posed by radiation emitted from MPs. The following awareness 4-point "Linkert" rating scale was used to respond to all items under this heading: Highly Aware (HA) = 4 points, Aware (A) = 3 points, Slightly Aware (SA) = 2 points, and Unaware (UA) = 1 point, with a consecutive range of 1.00 - 1.75, 1.76 - 2.5, 2.51 - 3.25 and 3.26 - 4.00 [19], which is used to classify the final predominant response-unaware, slightly aware, aware or highly aware depending on the average mean of the rating. Section E contains 4 questions, the answers to which, determines how successfully precautionary measures were being followed in order to mitigate the negative effects of MP use. Section F contains information on safety measures that could be adopted to reduce or eliminate the potential health effects of MP radiation and is made-up of 9 items, with a step-by-step approach on how to respond to this segment of the questionnaire.

## 2.3. Data Analysis

The data was analyzed using the statistical package for social science (SPSS) version 23 software, 2015 (IBM, New York City, USA) and Microsoft Excel 2017. The data for quantitative variables were presented as means and standard deviations, while data for categorical variables were presented as frequency tables and figures. P value  $\leq 0.05$  was used to determine statistical significance.

## 3. Results

**Table 1** Distribution of socio-demographic information of respondent (n=147)

Variable	Frequency	Percentage (%)
<b>Age group (years)</b>		
15-20	1	0.7
21-25	60	40.8
26-30	70	47.6
31-35	13	8.8
36-40	3	2.0
Total	147	100
<b>Gender</b>		
Male	107	72.8
Female	40	27.2
Total	147	100.0
<b>Year of study at BSU</b>		
4 <sup>th</sup>	55	37.4
5 <sup>th</sup>	51	34.7
6 <sup>th</sup>	41	27.9
Total	147	100.0

Recruited for the study were a total of 147 medical students at Benue State University (BSU), Makurdi, made up of 107(72.8%) males and 40 (27.2%) females. A good number, 55 (37.4%) of the students were in their 4th year of study, followed by 51 (34.7%) in the 5th year, with the final (6th) year students having the least number of 41(27.9%). Their ages ranged from 20 to 38 years, with a mean age of 26.5±3.4 years, median age of 26.0 and 27 as the modal age. The predominant age range is the 26-30, with 70(47.6%) students, followed by the 21-25 age range, with 60(40.8%). The least number, 1(0.7 %) was from the 15-20 age range as shown in table 1.

Table 2 provides a background to the participants' responses to inquiries about MP usage, in which all 147(100%) respondents own and make use of MPs, with a male to female ratio (M: F) of nearly 3:1. Sixty-seven (62.6%) males and 30 (75.0%) females have at least one MP. Sixty-one (41.5%) students have used MP for 6–10 years, with only 3(2.0%) having used the device for under one year. A good number, 65 (44.2%) of students used both ears to received calls, whereas 62(42.2%) and 20(13.6%) others make use of only the right and left ear, respectively. The 3 most popular MP brands were Techno, Infinix and Samsung with a consecutive frequency of 46(31.3%), 22(15.0%) and 15(10.2%). Among the males, 34(31.8%), 14(13.1%) and 9(8.4%) commonly make use of Techno, Infinix and Samsung consecutively, while 12(30.0%), 8(20.0%) and 6(15.0%) females frequently use the same 3 brands.

**Table 2** The study subjects` responses to inquiries about mobile phone usage

Mobile phone usage	Frequency			Percentage (%)		
	Male (n=107)	Female (n=40)	M+F (n=147)	Male(M)	Female(F)	M+F
Do you use mobile phone?						
Yes	107	40	147	100.0	100.0	100.0
No	0	0	0	0.0	0.0	0.0
Total	107	40	147	100.0	100.0	100.0
<b>How many mobile phones do you have?</b>						
One	67	30	97	62.6	75.0	66.0
Two	35	10	45	32.7	25.0	30.6
Three	4	0	4	3.7	0.0	2.7
Four	1	0	1	0.9	0.0	0.7
Total	107	40	147	100.0	100.0	100.0
<b>How long have you been using mobile phone (years)?</b>						
≤1	2	1	3	1.9	2.5	2.0
1-5	23	7	30	21.5	17.5	20.4
6-10	41	20	61	38.3	50.0	41.5
11-15	35	9	44	32.7	22.5	29.9
16-20	5	3	8	4.7	7.5	5.4
21-25	1	0	1	0.9	0.0	0.7
Total	107	40	147	100.0	100.0	100.0
<b>Which ear is used to answer calls?</b>						
Left	18	2	20	16.8	5.0	13.6
Right	44	18	62	41.1	45.0	42.2
Both ears	45	20	65	42.1	50.0	44.2
Total	107	40	147	100.0	100.0	100.0

<b>Which phone brands?</b>						
Techno	34	12	46	31.8	30.0	31.3
Infinix	14	8	22	13.1	20.0	15.0
Samsung	9	6	15	8.4	15.0	10.2
Itel	6	5	11	5.6	12.5	7.5
Redmi	7	1	8	6.5	2.5	5.4
iPhone	4	1	5	3.7	2.5	3.4
Xiaomi	5	0	5	4.7	0.0	3.4
Others	27	8	35	25.2	20.0	23.8
Total	106	41	147	100.0	100.0	100.0

Of the 147 students, 134(91.2%), M: F ratio of almost 3:1 was knowledgeable about the emitted radiation from MPs, while 13(8.8%) were not, as shown in table 3A and B.

**Table 3A** Distribution of respondents based on positive knowledge of the emitted radiation by mobile phones

<b>Knowledge of the emitted radiation by mobile phones</b>						
YES						
	Frequency			Percentage (%)		
Respondents` year of study	Male(M)	Female(F)	M+F	Male(M)	Female(F)	M+F
4th	36	14	50	33.6	35.0	34.0
5th	30	15	45	28.0	37.5	30.6
6th	30	9	39	28.0	22.5	26.6
Total	96	38	134	89.6	95.0	91.2

**Table 3B** Distribution of respondents based on negative knowledge of the emitted radiation by mobile phones

<b>Knowledge of the emitted radiation by mobile phones</b>						
NO						
	Frequency			Percentage (%)		
Respondents` year of study	Male(M)	Female(F)	M+F	Male(M)	Female(F)	M+F
4th	4	1	5	3.7	2.5	3.4
5th	5	1	6	4.7	2.5	4.0
6th	2	0	2	1.9	0.0	1.4
Total	11	2	13	10.3	5.0	8.8

Ninety-three (63.3%) students were aware of the potential health risks associated with MP usage; 30 (20.4%) highly aware, 40 (27.2%) aware, and 23 (15.7%) slightly aware. The successive ranges of 1.00 - 1.75, 1.76 - 2.5, 2.51 - 3.25 and 3.26 - 4.00 (unaware, slightly aware, aware, highly aware) and the average mean of 2.7, which falls within the 2.51-3.25 range is suggestive that the predominant response is "aware". The 3 most potential health risks, to which the predominant response was "highly aware" are the eye problems, increased risks of road traffic accident (RTA) and

headaches with a frequency of 61(41.5%),61(41.5%) and 49(33.3%) whereas pimples were the least item, as shown in table 4.

**Table 4** Distribution of the awareness of potential health risks posed by radiation emitted from mobile phones (MPs)

Potential health risks of using MPs	Highly aware		Aware		Slightly aware		Unaware		Mean
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	
Eye problems	61	41.5	61	41.5	16	10.9	9	5.4	1.8
Increased RTA risks	61	41.5	50	34.0	11	7.5	25	17.0	2.0
Headaches	49	33.3	53	36.1	26	17.7	19	12.9	2.1
Hearing impairment	43	29.3	57	38.8	23	15.6	24	16.3	2.2
Cancer	34	23.1	65	44.2	35	23.8	13	8.8	2.2
Stress	32	21.8	52	35.4	18	12.2	45	30.6	2.5
Sleep disorder	28	19.0	45	30.6	27	18.4	47	32.0	2.6
Infertility	27	18.4	31	21.1	20	13.6	69	46.9	2.8
Dizziness	19	12.9	43	29.3	27	18.4	58	39.5	2.8
Infection	17	11.6	19	12.9	24	16.3	87	59.2	3.2
Overheating of organs	17	11.6	36	24.5	23	15.6	71	48.3	3.0
Prostate malignancy	16	10.9	26	17.7	21	14.3	84	57.1	3.2
Heart problems	15	10.2	28	19.0	28	19.0	76	51.7	3.1
Skin allergies	14	9.5	26	17.7	25	17.0	82	55.8	3.2
Pimples	11	7.5	12	8.2	21	14.3	103	70.1	3.5
Average	30	20.4	40	27.2	23	15.7	54	36.7	2.7

Table 5 shows distribution of the awareness of potential eye problems posed by radiation emitted from mobile phones (MPs) according to year of study and gender. A total of 147 respondents from the 4th- 6th grades were polled, with a M: F ratio of nearly 3:1. A total of 39 (36.5%) males and 22 (55.0%) females were highly aware of the potential eye problems associated with MP use. The highest number of male participants who were highly aware came from the 5th grade 15(14.0%), whereas the highest number of female respondents 9(22.5%) came from both the 4th and 5th grades. Eight (7.5%) men and 1 (2.5%) woman were completely unaware, with the 5th grade having the most utterly clueless students 5(3.4%).

A M:F ratio of nearly 3:1 was found among those who were highly aware of the potential increased risk of road traffic accidents (RTAs) from usage of mobile phones (MPs), with the highest male18(16.8%) and female 8(20.0%) participants in the 5th grade, whereas another 2:1 M:F ratio was unaware according to year of study and gender, with the 4th grade students 15(10.2%) most ignorant as depicted in table 6.

Headache, as a potential health risk was not a strange feature from MP usage as attested to by 32(30.0%) males and 17(42.5%) females, who were highly aware, even though 19(12.9%) others made up of 15(14.1%) males and 4(10.0%) females were unaware as noted in table 7.

**Table 5** Distribution of the awareness of potential eye problems posed by radiation emitted from mobile phones (MPs) according to year of study, and gender

Awareness /Year of study	Frequency			Percentage (%)		
	Male (n=107)	Female (n=40)	M+F (n=147)	Male	Female	M+F
<b>4th year</b>						
Highly Aware	10	9	19	9.4	22.5	12.9
Aware	20	5	25	18.7	12.5	17.0
Slightly Aware	8	0	8	7.5	0.0	5.4
Unaware	2	1	3	1.9	2.5	2.0
Total	40	15	55	37.5	37.5	37.3
<b>5th year</b>						
Highly Aware	15	9	24	14.0	22.5	16.3
Aware	11	4	15	10.3	10.0	10.2
Slightly Aware	4	3	7	3.7	7.5	4.8
Unaware	5	0	5	4.7	0.0	3.4
Total	35	16	51	32.7	40.0	34.7
<b>6th year</b>						
Highly Aware	14	4	18	13.1	10.0	12.2
Aware	17	4	21	15.9	10.0	14.3
Slightly Aware	0	1	1	0.0	2.5	0.7
Unaware	1	0	1	0.9	0.0	0.7
Total	32	9	41	29.9	22.5	27.9

**Table 6** Distribution of the awareness of potential increased risk of road traffic accidents (RTAs) posed by radiation emitted from mobile phones (MPs) according to year of study, and gender

Awareness /Year of study	Frequency			Percentage (%)		
	Male (n=107)	Female (n=40)	M+F (n=147)	Male	Female	M+F
<b>4th year</b>						
Highly Aware	10	4	14	9.4	10.0	9.5
Aware	17	4	21	15.9	10.0	14.3
Slightly Aware	4	1	5	3.7	2.5	3.4
Unaware	9	6	15	8.4	15.0	10.2
Total	40	15	55	37.5	37.5	37.3
<b>5th year</b>						
Highly Aware	18	8	26	16.8	20.0	17.7
Aware	8	6	14	7.5	15.0	9.5
Slightly Aware	4	1	5	3.7	2.5	3.4

Unaware	5	1	6	4.7	2.5	4.1
Total	35	16	51	32.7	40.0	34.7
<b>6th year</b>						
Highly Aware	17	4	21	15.9	10.0	14.3
Aware	11	4	15	10.3	10.0	10.2
Slightly Aware	1	0	1	0.9	0.0	0.7
Unaware	3	1	4	2.8	2.5	2.7
Total	32	9	41	29.9	22.5	27.9

**Table 7** Distribution of the awareness of potential headaches posed by radiation emitted from mobile phones (MPs) according to year of study and gender

Awareness/Year of study	Frequency			Percentage (%)		
	Male (n=107)	Female (n=40)	M+F (n=147)	Male	Female	M+F
<b>4th year</b>						
Highly Aware	8	5	13	7.5	12.5	8.8
Aware	17	7	24	15.9	17.5	16.3
Slightly Aware	10	1	11	9.4	2.5	7.5
Unaware	5	2	7	4.7	5.0	4.8
Total	40	15	55	37.5	37.5	37.3
<b>5th year</b>						
Highly Aware	16	9	25	15.0	22.5	17.0
Aware	7	6	13	6.5	15.0	8.8
Slightly Aware	7	0	7	6.5	0.0	4.8
Unaware	5	1	6	4.7	2.5	4.1
Total	35	16	51	32.7	40.0	34.7
<b>6th year</b>						
Highly Aware	8	3	11	7.5	7.5	7.5
Aware	14	2	16	13.1	5.0	10.9
Slightly Aware	5	3	8	4.7	7.5	5.4
Unaware	5	1	6	4.7	2.5	4.1
Total	32	9	41	29.9	22.5	27.9

Table 8 depicts the precautionary measures for reducing the negative consequences of cell phones usage. More than half, 89 (60.5%) of the students lived far away, while 58 (39.5%) lived close to mobile base stations which are associated with electro-hypersensitivity. A disturbing proportion of the students 80 (54.4%) spend an unacceptable long time on MP conversations as against a combined 67 (45.6%) others who spend comparably shorter period on calls (minute/day). We noted the day and night-time habits of keeping MPs in the pocket and near the head by the majority, 92 (62.6%) and 77 (52.4%) students respectively. Whereas 82 (76.6%) males chose to keep MPs in their pockets most of the times during the day, 28 (70.0%) females preferred to keep theirs in the handbag.



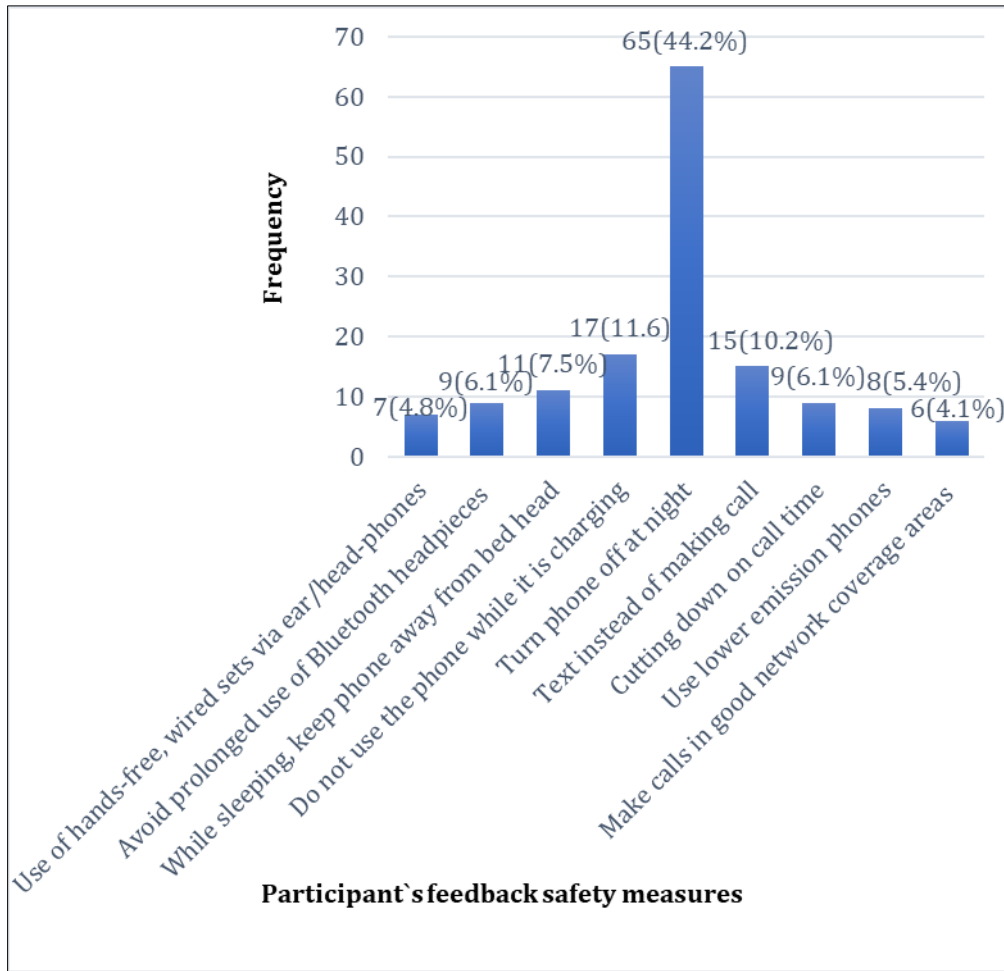
**Table 8** Distribution of precautionary measures needed for reducing the negative effects of cell phone usage (n=147)

Mobile phone usage and precautionary measures	Frequency			Percentage (%)		
	Male(M)	Female(F)	M+F	Male(M)	Female(F)	M+F
<b>What is the distance from your mobile base stations?</b>						
Close	44	14	58	41.1	35.0	39.5
Far away	63	26	89	58.9	65.0	60.5
Total	107	40	147	100.0	100.0	100.0
<b>How long do you make phone call (Minute/day)?</b>						
0-10	17	9	26	15.9	22.5	17.7
11-20	29	12	41	27.1	30.0	27.9
≥20	61	19	80	57.0	47.5	54.4
Total	107	40	147	100.0	100.0	100.0
<b>Where do you keep your phone during the day?</b>						
Pocket	82	10	92	76.6	25.0	62.6
Hand-bag	16	28	44	15.0	70.0	29.9
Hand	6	2	8	5.6	5.0	5.4
Table	2	0	2	1.9	0.0	1.4
Pocket, bag, table	1	0	1	0.9	0.0	0.7
Total	107	40	147	100.0	100.0	100.0
<b>Where do you keep your phone at night (Power On)?</b>						
Near my head	57	20	77	53.3	50.0	52.4
Away from my head	50	20	70	46.7	50.0	47.6
Total	107	40	147	100.0	100.0	100.0

Figure 1 demonstrates the participants' feedback on safety measures that can be adopted to reduce the deleterious effects of MP usage, the 3 most important of which are to turn phone off at night 65(44.2%), avoid using phone while it is charging 17(11.6%) and to, if possible, text instead of calling 15(10.2%), with a consecutive M: F ratio of 4:1, 5:1 and 2:1. The least adopted feedback on safety measures 6(4.1%) was to make calls in good network coverage areas.

**Table 9** The distribution of Pearson's correlation (r) between selected variable (n=147)

Variable	Pearsons's correlation(r)	P-value
Age vs knowledge about emitted radiation from phone	-0.007	0.937
Gender vs knowledge about emitted radiation from phone	-0.083	0.319
Year of study vs knowledge about emitted radiation from phone	-0.053	0.527
Duration of phone use vs cancer risk	0.026	0.759
Duration of phone use vs risk of eye problems	-0.070	0.399
Duration of phone use vs risk of headache	0.031	0.706



**Figure 1** Participants’ feedback on safety measures that can be adopted to reduce the deleterious effects of mobile phones (n=147)

Table 9 reveals that no statistically significant correlation existed between age, gender and year of study with knowledge about emitted radiation from phone ( $r=-0.007, p=0.937$ ), ( $r=-0.083, p=0.319$ ), ( $r=-0.053, p=0.527$ ). There was also no statistically significant correlation between duration of phone use and cancer risk ( $r=0.026, p=0.759$ ), duration of phone use and risk of eye problems ( $r=-0.070, p=0.399$ ), and duration of phone use with risk of headache( $r=0.031, 0.706$ ).

#### 4. Discussion

The knowledge of radiation emitted from MPs was outstanding, with affirmative responses from 134 (91.2%) students, indicating that the 4th–6th year medical students at BSU were highly informed. When compared to other researchers [1, 6], our percentage was higher. In contrast, Maduka et al [2] reported that 338 (94.0%) students were knowledgeable about the radiation emitted by MPs, which is a slightly higher percentage level of knowledge than in our study. This knowledge is crucial because majority of medical students use MPs to communicate about their families, finances, and education. These communication benefits could become a source of distraction to a few students, who fail to recognize the link between excessive MP use and the negative socio-educational vices like examination malpractices, fighting, theft, use of alcohol and narcotics [20].

The sociodemographic distribution of the students using MPs at BSU shows that, majority 55 (37.4%) of them were from the 4th grade. This re-affirms the findings of another study [21], in which the majority of the respondents, 67 (56.0%) were from the lowest grade. This may just be a coincidence necessitating further research. Again, we observed that medical students between 26-30 years were habitual MP users 70(47.6%). This collaborated findings by Gandhi et al [22], who also observed a similar trend with individuals below 30 years. This could be explained by the fact that internet connectivity via the MP is gradually replacing traditional textbooks because it enables easy access to study resources and provides timely solutions to students’ academic problems [23]. MPs have thus, become a crucial and

integral part of daily life for the majority of young people [24]. Gender-wise, majority 107(72.8%) of our respondents were men, compared to 40 (27.2%) who were women. Other researchers also found male predominance [21, 22, 25]. In contrast, Sharma et al [26] and Maduka et al [2] reported female preponderance. More research is needed to understand the inconsistent prevalence of MP addiction in both sexes [27]. However, it could be explained by the fact that men and women use MPs differently. While females use them primarily for social contact, messaging and networking, males use them more diversely, with text messaging, voice calls, and gaming. As compared to men, women use MPs at higher rates of problematic dependence and abuse [27, 28]. We found no statistically significant correlation between age, gender or year of study with knowledge about emitted radiation from MP ( $p=0.319-0.937$ )

In our current research, all the 147 students own and use MPs, similar to findings in other studies [26, 29, 30]. This is because MP has benefitted student academically and even saved lives of many by shortening the reporting and response time following road traffic accidents (RTAs). The use of the device has grown to a point where, in some countries, the number of phone subscribers outnumbers the population [7]. According to our index study, 97(66.0%) students had at least one MP, 45(30.6%) had two, and 1(0.7%) student, a male, had 4 MPs. In another survey [26], 44(34.0%) students had two mobile phones, and 5(4.0%) had more than two. From among the various MPs brands in our study, Techno was preferred by 46(31.3%) students, followed by Infinix 22(15.0%) and then Samsung 15(10.2%). This contradicted other surveys [1, 22], in which the dominant brand was Nokia. One center [23] had most of its students predominantly using android phones, as against iPhones, by 115(56.6%) others in another center [31]. This is most likely due to the satisfaction that MPs provide, with a preference for brands that enable easy access to relevant medical educational applications regularly used by medical students to improve their academic experiences [32]. This study revealed that most of the students 61 (41.5%), with a M: F ratio of 2:1 have been using MP for 6-10 years, followed by 44(29.9%) others for 11-15years, while 1(0.9%) student, a male has been using the device for 21-25 years. Our findings were comparable to a previous study [30], in which a number of students 97 (42.4%) had been using MPs for 4-6 years. Gandhi et al [22], reported comparably shorter duration of phone use. The number of our students 65(44.2%) who answered phone calls from both ears, was more than those who received the call from the right 62(42.2%) or left ear 20(13.6%). We compared our findings to another study [22], which reported that 15 (15.0%) respondents used both ears to answer phone calls, whereas 54(54.0%) used their right ear and 31(31.0%) used their left ear. MP users are 30% more likely to develop brain tumors, primarily acoustic neuromas, on the same side of the head as the MP was commonly used [22, 33].

Ninety-three (63.3%) of our students were aware of potential health hazards associated with MP usage, with some evidently experiencing the negative effects. The first 6 self-reported most potential health risks attributed to electromagnetic fields (EMFs) in our survey, to which the predominant response was “highly aware” were eye problems, increased risks of RTAs, headaches, hearing impairment, cancer and stress. The 3 top potential health risks that our students were completely “unaware” of included pimples 103(70.1%), infection 87(59.2%) and prostate malignancy 84(57.1%). In their separate studies, Pendse et al [21] and Schreier et al [34] also reported these symptoms. Other researchers [11, 12], identified these symptoms as of potential health concern because of the expanding global use of MPs, their positioning close to the human body, and the proliferation of base station antennas. In terms of public awareness, MP Service providers bear a substantial amount of responsibility for always minimizing risks by prioritizing precautionary measures. Children, in particular, must be informed and educated about these devices [9].

But for more than half 89(60.5%) of our participants who were staying far away from the base station antennas, many students disregarded precautionary measures to mitigate the negative consequences of MP use and continued making long phone-conversations 80(54.4%), putting MPs in their pockets 92(62.6%) and at their bed-head 77(52.4%). Even though all MP users are within the coverage range of various types of mobile base stations, individuals who live within one kilometer of the base stations are 1.88 times more at risk than those who live further away [35]. Despite the considerable awareness of the potential health risks, our students were unconcerned and did not limit their MP usage, most likely because they saw the habit as an essential part of everyday life. Some of them even believe that minimizing a phone call when it came from someone important is disrespectful. Others simply can't keep it short and simple, while the remainder are seduced by MP Service providers' offers that the longer you chat, the less you pay [1]. We also found it curious that while males chose to keep MPs in their pockets 82(76.6%) most of the times during the day, females preferred to keep theirs in the handbag 28(70.0%). Our findings were in consonant with previous reports [6, 36, 37]. The position of the MP during the day is a lesser risk factor. Respondents who kept their MP in their bag were 0.26% less vulnerable than those who kept their MP in their pocket. Whereas, participants who keep their MP mode on and away from their heads at night were 0.75% less at risk than those who keep their MP mode on and near their heads at night [35].

As regards feedback on safety measures that can be adopted to reduce or eliminate the deleterious effects of MP usage, our participants adopted the following 9-point action plan. These were to turn off MP at night, avoid using phone while

it is charging, text instead of calling, keep phone away from bed head while sleeping, cutting down on call time, avoid prolonged use of bluetooth headpieces because they emit radio-waves, use lower emission phones, use of hands-free, wired sets via ear/head-phones and to make calls in good network coverage areas. In a study by Maduka et al [2], 86 (23.9%) participants adopted some safety measures, while 274 (76.1%) did not. All were, however aware of the possible health effects of radiation emitted by MPs. The safety measures adopted by the 86 (23.9%) respondents were comparable to ours. Our findings were also consistent with those of a previous study by Al-Muhayawi et al [38]. The user manuals that come with MPs typically include safety tips, advising users to keep their phones about 5-25mm away from their bodies and heads. It is noteworthy to limit exposure, because MP radiation is harmful to the brain, reproductive, and immunological systems, particularly in children who are more radiosensitive [39].

There was no statistically significant correlation between age, gender, or study year and knowledge of emitted radiation from phones ( $p=0.319-0.937$ ). We also found no statistically significant correlation between duration of phone use and cancer risk, risk of eye problems, and headache ( $p=0.399-0.759$ ).

### *Limitation of study*

Our research was constrained by a number of factors. Chief among them was the disruption of academic activities at our institution brought on by the ongoing strike action by the academic staff union of universities (ASUU). As a result, we were unable to obtain comparable results from all medical students as anticipated, particularly from the 1st–3rd year medical students. Again, as a cross-sectional study, we could only observe participants at one point in time. Therefore, it was impossible for us to trace the effect of time on the changes in the participants' knowledge of emitted radiation from MP, potential health risks of MP use, or safety precautions undertaken to reduce the negative repercussions. Furthermore, because our research was limited to a single public medical institution, the results may not be generalizable to other locations or populations.

---

## **5. Conclusion**

MPs have not only improved global communication, particularly in developing countries, but they have also saved lives by dramatically shortening both the notification and response times during emergencies in several RTAs. Many parents rely on these gadgets to communicate with their children as they commute to and from school, during social engagements, or sporting activities. These, as well as other benefits of MPs, are plausible. However, several studies have also highlighted the negative consequences of MP use, such as headaches, neurological disorders, skin cancer, eye problems, brain tumors, and auditory problems. Different opinions have been expressed on this matter, some of which have been proven to be incorrect based on scientific evidence. However, given that both the WHO and IARC have identified radiofrequency electromagnetic fields as potentially carcinogenic to humans, it is crucial to take safety precautionary measures to reduce or eliminate exposure to radiation from MP usage. Some of these measures, which are quite beneficial to humanity includes sleeping with the phone placed inches away, talking less on the MP, use of handsfree devices, purchasing lower radiation-emission phones, texting and using speaker phones. However, more research is needed, particularly in third world countries where only a few studies have been conducted, to reconcile the conflicting claims of health hazards from MP use and also to provide clear rules and guidelines regarding the radiation exposure thresholds permissible from MP use.

### *Recommendations*

The recommendations are directed at individuals, phone manufacturers/service providers and governments, based on reports by Chukwu et al.

- Role of Individuals

Perpetual MP users must learn how to use their devices safely in order to avoid its direct contact with the human body and to use hands-free products and gadgets. MPs should never be used while driving or in poor signal locations since a weak base station signal causes MPs to raise their broadcast power. Children should be shielded from excessive radiofrequency (RF) exposure.

- Role of Manufacturers/Service Providers

MP manufacturers should fund research on RF fields in universities, just as is being done in sports and social activities. They should also provide consumers with a user manual outlining the potential health risks of RF energy, as well as

meet public health safety standards and improve network services, as erratic services increase the amount of RF emission from handsets.

- Role of Government

Apart from an outright ban on the importation of fairly used phones, which allows manufacturers to dump devices that failed routine tests elsewhere, local, state, and federal governments have a duty to give advice on all pertinent radiation issues, including rules and standards for MP safety. They are also responsible for informing the general public and the media about the health and safety implications of electromagnetic radiation.

---

## Compliance with ethical standards

### *Acknowledgments*

We are grateful to the managements of Benue State University (BSU) and Benue State University teaching hospital (BSUTH), Makurdi for enabling us to undertake this research. We are especially grateful to the 4th-6th year medical students who enthusiastically participated in the study and availed us with their knowledge of emitted radiation from MPs and awareness of potential health risks from these devices.

### *Disclosure of conflict of interest*

Such information was not provided by the authors. There was no research funding.

### *Statement of ethical approval*

The protocols were reviewed and approved by the institution's Health Ethical Committee: No. BSUTH/MKD/HREC/2022/191, effective May 2022.

### *Statement of informed consent*

All participants signed a term of free and informed consent before taking part in the research.

---

## References

- [1] Kumar LR, Chii KD, Way LC, Jetly Y, Rajendran V. Awareness of mobile phone hazards among university students in a Malaysian medical school. *Health*. 2011;3(7):406-415
- [2] Maduka BU, Anakwue AM, Abonyi EO, Onwuzu S, Umekwe CN, Uzo EC. Assessment of awareness of possible health effects of radiation emitted by mobile phones among University of Nigeria Enugu campus students. *S. Afr. Radiogr*. 2021; 1:28-32
- [3] Number of Mobile Devices Worldwide 2020-2025 | Statista. March 16, 2022. Available from: <https://www.statista.com/statistics/245501/multiple-mobile-device-ownership-worldwide/>.
- [4] Nigeria Population 2022 (Demographics, Maps, Graphs). March 16, 2022. Available from: <https://worldpopulationreview.com/countries/nigeria-population>.
- [5] Onaleye T NCC Stats: Nigeria Now has over 200 million Mobile Subscribers. March 16, 2022. Available from: <https://technext.ng/2020/10/05/ncc-stats-nigeria-now-has-over-200-million-mobile-subscribers/>.
- [6] Michael SH, Hui TC, Khalid ES, Quan LJ, Meganathan A. A Study on Mobile Phone Cleaning Practices and Knowledge of Microbial Contaminants. *Int. J. Biomed. Clin. Sci*.2020;5(3): 295-307.
- [7] Samkange-Zeeb F, Blettner M. Emerging aspects of mobile phone use. *Emerg. Health Threats J*. 2009; 2(5):1-8
- [8] Acheampong OK, Biya-Sambian S, Kingsley DD. Effects of radiofrequency radiation from mobile phones on health: a review. *Glob Sci J*.2020;8(12),1926-1935.
- [9] Chukwu GU, Eluwa NN, Kanu GI. Health implications emanating from electromagnetic radiation through the use of cell phones: a case study of Aba-south LGA of Abia state, Nigeria *Int. J. Innov. Environ. Stud. Res*.2016; 4(3):12-23.
- [10] Mani R. Do mobile phones cause more harm than good? *Open J. Soc. Sci*.2019; 7: 198-205.

- [11] Samuel OA, Emmanuel R, Abraham EO. Awareness of the Possible Hazards of Electromagnetic Waves Radiation among Mobile Phone Users in Bosso, Niger State, Nigeria. *Eng Technol. J.* 2017; 4(5): 65-69.
- [12] Rupavate S. Addicted to your phone? Here's how it's affecting your health,2016. March 16, 2022. Available from: <https://www.thehealthsite.com/diseases-conditions/10-health-hazards-of-mobile-phones-139726/>.
- [13] US food and drug administration (FDA). Scientific evidence for cell phone safety. March 16, 2022. Available from: <https://www.fda.gov/radiation-emitting-products/cell-phones/scientific-evidence-cell-phone-safety>.
- [14] Abeshu MA, Geleta B. Physical Health Hazards of Mobile Phone Use. *Health Care: Current Reviews.* 2015;2(3):1-2.
- [15] Abdus-salam A. Elumelu T, Adenipekun A. Mobile phone radiation and the risk of cancer; a review. *Afr J Med Med Sci.*2008;37(2):107-118.
- [16] The WHO/International Agency for Research on Cancer (IARC) press release 2011. IARC classifies radiofrequency electromagnetic fields as possibly carcinogenic to humans. March 16, 2022. Available from: [https://www.iarc.who.int/wp-content/uploads/2018/07/pr208\\_E.pdf](https://www.iarc.who.int/wp-content/uploads/2018/07/pr208_E.pdf).
- [17] Eight ways to reduce the health risks from mobile phone radiation. March 16, 2022. Available from: <https://www.thejournal.ie/eight-ways-to-reduce-the-health-risks-from-mobile-phone-radiation-147571-Jun2011/>.
- [18] Makurdi. March 16, 2022. Available from: <https://en.wikipedia.org/wiki/Makurdi>.
- [19] Watrin M. What is the significance of a 4-point scale? August 31,2022. Available from: <https://www.researchgate.net/post/What-is-the-significance-of-a-4-point-scale>.
- [20] Ling R. *The Mobile Connection: The Cell Phone's Impact on Society.* San Francisco: Morgan Kaufmann.2004.
- [21] Pendse N, Zagade T. Knowledge and Attitude Regarding Health Hazards of Mobile Phone Users among the Junior College Students. *Int. J. Sci. Res.* 2014; 3(5): 554-561.
- [22] Gandhi G, Singh A, Singh P. Mobile Phone Users: Another High Health Risk Group .2005. *J. Hum. Ecol.,* 17(1): 1-8
- [23] Rohilla R, Rohilla J, Rohilla A, Singh K. Academic use and attitude of the 1st year medical students toward smartphones in a North Indian city. *Digit Med* 2016; 2:13-15
- [24] Media PA. Most children own mobile phone by age of seven, study finds. September 07,2022. Available from: <https://www.theguardian.com/society/2020/jan/30/most-children-own-mobile-phone-by-age-of-seven-study-finds>.
- [25] Sharma N, Advani U, Sharma L, Jain M, Sharma K, Dixit AM. Pattern of mobile phone usage among medical students. *Int J Acad Med* 2019; 5:118-23.
- [26] Sharma N, Sharma P, Sharma N, Wavare RR. Rising concern of nomophobia amongst Indian medical students. *Int J Res Med Sci.* 2015;3(3):705–707.
- [27] Chen B, Liu F, Ding S, Ying X, Wang L, Wen. Gender differences in factors associated with smartphone addiction: a cross-sectional study among medical college students. *BMC Psychiatry.* 2017; 17 (341):1-9
- [28] Gutiérrez JD, De Fonseca FR, Rubio G. Cell-phone addiction: a review. *Front. Psychiatry.* 2016; 7(175):1-15.
- [29] Gupta N, Garg S, Arora K. Pattern of mobile phone usage and its effects on psychological health, sleep, and academic performance in students of a medical university. *Natl J Physiol Pharm Pharmacol.* 2016; 6(2):132-139
- [30] Thapa K, Pokharel R, Sigdel R, Rimal PS. Pattern of Mobile Phone Use among Students of an Institution. *J Nepal Med Assoc* 2018;56(209):522-26
- [31] Payne K, Wharrad H, Watts K. Smartphone and medical related App use among medical students and junior doctors in the United Kingdom (UK): a regional survey. *BMC Med Inform Decis Mak.* 2012;12(121):1-11.
- [32] Singh K, Sarkar S, Gaur U, Gupta S, Adams OP, Sa B et al. Smartphones and educational apps use among medical students of a smart university campus. *Front. Commun.*2021;6:1-9
- [33] Lonn S, Ahlbom A, Hall P, Feychting M. Mobile phone use and the risk of Acoustic Neuroma. *Epidemiology.* 2004;15: 653-659.
- [34] Schreier N, Huss A, Rösli M. The prevalence of symptoms attributed to electromagnetic field exposure: a cross-sectional representative survey in Switzerland. *Praventiv Med.* 2006; 51:202–209

- [35] Ferdous J. Mobile Phone Usage and Awareness of Health Hazards among the Adolescents in Sylhet City. *Imp. J. Interdiscip. Res.* 2017;3(11): 2454-1362,
- [36] Anuradha SN, Arunkumar S, Mekhanayakee, Shyen WY, Arwintharao. Study on awareness of microbial contamination through mobile phones. *Asian Pac. J. Health Sci.*, 2016; 3 (4):313-323
- [37] Lopez VA, Liew JY, Pahirulzaman KK, Sim KY. A study of microbial distribution and cell phone hygiene awareness at Universiti Malaysia Kelantan, Jeli Campus. *Songklanakarin J. Sci. Technol.* 2020;42 (1):65-72.
- [38] Al-Muhayawi HS, Eldeek B, Abubakr H, BenKuddah R, Zahid A, Abukhashabah H. The Impact of Medical Education on Saudi Medical Students' Awareness of Cell Phone Use and its Health. *Life Science Journal*, 2012; 9 (3):1-6
- [39] Mobile phone safety tips, September 09,2022. Available from: <https://cellsafe.com.au/mobile-phone-safety-tips/>