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Research

Awareness of specific absorption rate (SAR) value for mobile phone users in Southwestern Nigeria

[1*]Awe, O. O., [2]Oyelade, E. A., [3]Agbele, A. T., [1]Agunbiade, G. S., and [4]Akande, T. H.

[1]Department of Basic Science and Technology Physics Electronics Unit, Babcock University Ilishan-Remo Ogun State, Nigeria.

[2]Department of Science Education, Federal University of Lafia, Nigeria.

[3]Department of Basic Medical Sciences, Ekiti State College of Health Sciences and Technology, Ijero-Ekiti, Nigeria.

[4]Department of Physics, Ekiti State University, Ado Ekiti, Nigeria.

Corresponding author < aweo@babcock.edu.ng >

Abstract

Mobile phones are power radio devices that transmit and receive electromagnetic radiation in radio frequency region through an antenna. The radiation received from mobile phone depends on different factors: the distance of cell phone from the user and to the base station, duration of conversation, age of an individual and the value of Specific Absorption Rate (SAR) for a particular cell phone. SAR can be defined as a measure of energy which is absorbed per unit mass in the human body when it is exposed to Radio Frequency (RF), one of the non-ionizing radiation. To examine the knowledge and awareness of SAR value of mobile phone among the people living in southwestern Nigeria; the design employed is based on primary data from the respondents. The awareness on mobile phone SAR value among 300 different categories of mobile phone users across the six states of southwestern Nigeria was examined through a questionnaire that contains 25 items. The questionnaire has two sections: the first section records the socio-demographics profile of the respondents, while the second section was basically on the awareness on mobile phone SAR value and its health implications. The study utilized descriptive statistics and it was revealed that majority of the respondents (90 %) have not heard about mobile phone SAR value before this survey. The study further confirmed that most of the respondents (69.3 %) do not know or have access to their mobile phone SAR's value. The level of awareness of mobile phone SAR value and its health implications is very low and this call for concern. Furthermore, a reference level should be set for the country.

Keywords: Mobile phone, Health, Radiation, Specific Absorption Rate (SAR), Non-ionizing radiation

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Introduction:

In recent years, mobile telecommunication systems have grown significantly, to the point where more than a sixth of the world's population use mobile phones (Maier, 2006; NRPB, 2004). Mobile phones which are also known as cell phones or handsets have radically altered the way that people work, socialize, organize, and entertain themselves. The digital transmission and the global system for mobile communication (GSM), started in 1991 and includes new developments as data and image were transmitted. The third-generation mobile phones currently in the market offers additional services to the users such as fax, e-mail and Internet access (Organization, 2006; Sánchez, 2006). Mobile phones have become multimedia communication devices with a level of computing power seen in desktops only in some years back (Dubey, 2013).

This new communicating device is better than the previous one, they are handheld, the use is limited to areas where there is signal. Additional features like typing of text messages, sending voice note, surfing the internet, recording and playing of music, features for multimedia, video and camera features, personal and custom ringing tone, low and high graphics games, FM radio, push to talk (PTT), connectivity and transfer options such like Bluetooth and infrared these and many more user-friendly options embedded in the handset adds to the reasons of its acceptability (Dubey, 2013; Varshney, Malhotra, Sharma, & Aggarwal, 2018). Mobile phones can be referred to as time bomb to the health which are a part of our lives to such an extent that they are not just restricted to the elite but is also one of the most common gadgets owned by almost every individual (Dubey, 2013). Mobile phones were used by 1.85 billion people around the world in 2014, it would be 2.32 billion in 2017 and 2.87 billion in 2020 (Cha & Seo, 2018; Faromika & Agbele, 2015).

When mobile phones are in use, they transmit and receive radio frequency radiation (at frequencies in the microwave range of 900-1800 MHz) through an antenna. Recently, different researches have investigated whether health problems can be linked to cell phone use. In a research conducted by Tyagi *et al,* (2011), it was revealed that most people with higher exposure to radiation from mobile phone faced problems like headache, severe pain in the ear, blurring of vision, memory loss, itching, burning sensations, sleep disturbance, nausea, dizziness, and hypersensitivity exhaustion (Tyagi, Duhan, & Bhatia, 2011). Shubham & Supriya (2017) identified some factors that determine the extent of damage done to the brain by radiation from mobile phones. The factors are: (a) distance of cell phone from human body (b) distance from the cell phone tower (c) SAR value, (d) extent of conversation and (e) age of the person (Shubham, 2017). It was ascertained that, the closer a body is to the cell phone or base station, the higher the radiation absorbed by the body and the higher level of damage it can cause to the brain (Jemima & Hemanth, 2018). Likewise, the higher the SAR value of a phone, the more radiation it emitted and consequently pose more risk to the brain. Length of conversion has also been proved to be directly proportional to the amount of radiation that one gets from mobile phone. The brain of children and fetus have been claimed to be more affected by radiation emitted by mobile phone than adults because they have thinner skull and they are growing more rapidly, with more cell dividing capability, so that radiations disrupt a greater number of cells.

Hardell (2008) also reported that people who started mobile phone use before the age of 20 had a more than fivefold increase in glioma. Those who started using mobile phones when they were young were also five times more likely to develop acoustic neuromas (Hardell, 2008). The health effects of mobile phones might be more severe on

growing children and teenagers because a child's brain absorbs significantly more radiation than an adult's brain (Christ, Gosselin, Christopoulou, Kühn, & Kuster, 2010). Despite this, the popularity of cell phone use among young children keep rising especially now that covid-19 pandemic has turned most of teaching/learning processes in schools to virtual (Agbele & Oyelade, 2020). Both teens and young adults in school and college are also using mobile devices at school. Teachers and administrators use smartphone applications to take attendance, poll a classroom, and send out information about homework, exams, school events, and more. With all these, children will clearly have a much greater exposure to radiation from cell phones throughout their lives than adults (Lenhart, Ling, Campbell, & Purcell, 2010).

Governments in most developed countries and regions have comprehensive international safety guidelines in place, developed by independent scientific organizations and team of researchers, governing the exposure to non-ionizing radiation RF energy. There is need to design cell phones to operate within the stipulated reference level. Specific Absorption Rate or ratio (SAR) is an internationally agreed method of measuring radiation emitted by mobile phone. It is a measure of the rate at which radio frequency (RF) energy non-ionizing radiation is absorbed by the human body. A person who is text messaging, accessing the internet, or using a "hands-free" device will have lower exposure to RF energy than someone holding the phone against his or her head. Someone who stores the phone in a briefcase or purse will have far lower exposure than one who carries the device in a pocket (Wargo, Taylor, & Rabinowitz, 2012). The SAR varies by phone model and SAR for a specific model also varies according to the frequency (Wargo et al., 2012). Wireless connection and transfer of data, for example Bluetooth also emit radio frequency energy that can result into excitation. Bluetooth devices emit lower levels of RF radiation than cell phones and may reduce the amount of RF radiation exposure to the head (Bit-Babik et al., 2003), but may increase exposure to different parts of the body, including the testes and ovaries when a phone is kept in a pocket while in stand-by mode (Desai, Kesari, & Agarwal, 2009). SAR testing is required before mobiles phones get to markets or circulation in most countries. Table 1 below shows the recommended SAR value limit in some countries. In order to check SAR value on mobile phones, one can simply dial *#07#, check handset manual or visit the manufacturer's website.

Table 1: SAR value limit recommended by some countries

COUNTRY/REGION	ENDORSED SAR	SAR REGULATION
USA and Canada	1.6 W/Kg per 1 gram (Endorsed)	Compulsory
Australia	2.0 W/Kg per 10 gram (Endorsed)	Compulsory
EU	2.0 W/Kg per 10 gram (Endorsed)	Compulsory
Japan	2.0 W/Kg per 10 gram (Endorsed)	Compulsory
Korea	1.6 W/Kg per 1 gram	Compulsory
China	Report on request	Compulsory

Method of study

The awareness on mobile phone SAR value among 300 different categories of phone users across six States that make south-west Nigeria was examined through a questionnaire that contain 25 items. The questionnaire has two sections. First section records the socio-demographics profile such as age, sex, level of education, occupation etc. of the respondents while the second section was basically on awareness on mobile phone SAR value and its health implications. In order to get mobile phone's SAR value, respondents were instructed to dial *#07# on their phone, this should display SAR value. If no result displayed, they were hence instructed to check their mobile phones manual or login to the website of their mobile phone manufacturer and check if SAR value is declared. Descriptive statistics was used to analyzed and interpret the Data. Frequency counting and simple percentage were the quantitative statistics used. The statistical tool used was the Statistical Package for Social Sciences (SPSS) version 23.

Result and discussion

Table 2 represent the number of respondents per State in Southwest geopolitical zone of Nigeria. There are 300 total respondents, of which 90 (30 %) are from Lagos state, 49 (16.3 %) from Ogun State, 34 (11.3 %) from Oyo State, 31 (10.3 %) from Ondo State, 53 (17.7 %) from Osun State and 43 (14.3 %) from Ekiti State.

Table 3 is the result of SAR value test carried out by the respondents. It was observed that 2 (0.7%) respondents reported SAR value higher than 1.6 W/kg, the limit recommended by Federal Communication Commission of U.S.A. 90 respondents (i.e. 30 %) reported SAR value less or equal to 1.6 W/kg but majority 69.3% do not have access to their mobile phone SAR value. This is undesirable, because, if those phones are actually safe to use, why should the manufacturers hide their SAR values from users.

Table 4 presents awareness of SAR value across socio-demographics of sampled respondents. Out of total 300 respondents surveyed; 30 respondents are aware of the SAR value for mobile phone that is 10 % of total respondents. 18 Male respondents that is 6% are comparatively more aware about mobile phone SAR value than 12 female respondents that is 4%. This is line with the research conducted by (Dubey, 2013; Varshney et al., 2018). This might be attributed to the educational level of the male as compared to their female counterpart in the study area. The occupation with largest awareness level of SAR value are the engineers (37.5%) and scientists (23.8%). This is probably due to the reason that SAR is a scientific term which is related to their disciplines. Majority of the respondents who were aware of SAR value were in the age range (21 – 30) years 11.7% and (31 – 40) years 11.2 %. The results also revealed that respondents with awareness on SAR value were either undergraduate (4.5%), graduates (31.3%) or possesses higher degree (33.3%). This simply implies that education plays vital role in enhancing awareness among people.

Table 5 presents the frequency of phone usage among different categories of people. It is evident that large number of respondents in different categories used mobile phone for more than 3 hours every day. 45.6% of both gender, 59 % of people in different age groups, 50.7% of people with different occupations and 81.7% of people with different educational qualifications use phone for more than 3 hours per day.

The result of the research indicated that only 62 out of a total of 300 respondents had awareness of mobile phone SAR value before this survey. Majority of the respondents i.e. 270 (90%) have not heard anything about it. This call for a concern and there is need for serious campaigns on mobile phone SAR value's awareness and its health implications. Large number of respondents who have heard about SAR value were educated up to at least first degree. This is an indication that education cannot be overemphasized in people's awareness about something. "SAR"

is a scientific term, therefore, engineers and scientists claimed to be more aware about it than any other profession. The results of SAR value test conducted by the respondents indicated that most phone manufacturers fail to declare the SAR value. 69.3 % of the respondents could not assess their mobile phone SAR value, 30% had their SAR value less than or equal to 1.6 W/kg and 0.7% had their SAR value higher than 1.6 W/kg.

Table 2: Number of Respondents in South West Nigeria

REGION	FREQUENCY	PERCENT	VALID PERCENT	CUMULATIVE PERCENT
Lagos State	90	30.0	30.0	30.0
Ogun State	49	16.3	16.3	46.3
Oyo State	34	11.3	11.3	57.7
Ondo State	31	10.3	10.3	68.0
Osun State	53	17.7	17.7	85.7
Ekiti State	43	14.3	14.3	100.0
Total	300	100.0	100.0	

Table 3: Result of SAR Value Test

	FREQUENCY	PERCENT	VALID PERCENT	CUMULATIVE PERCENT
NO RESULT	208	69.3	69.3	69.3
SAR value than or equal to 1.6 W/kg	90	30.0	30.0	99.3
SAR Value greater than 1.6 W/kg	2	0.7	0.7	100.0
Total	300	100.0	100.0	

Table 4: SAR Awareness

	YES	%	NO	%
Gender				
Male 148 (49.3%)	18	12	130	87.8
Female 152 (50.7 %)	12	7.9	140	46.7
Total 300(100%)	30	10	270	90
Age				
11-20 Years 11(3.7%)	0	0	11	100
21-30 Years 102 (34%)	12	11.7	90	90
31-40 Years 98 (32.7%)	11	11.2	87	87
41-50 Years 51 (17%)	4	7.8	47	47
51-60 Years 27 (9%)	2	7.4	25	25
61-70 Years 11 (3.7%)	1	9.1	10	10
Total 300(100%)	30	10	270	90

Occupation				
Students 118 (39.3%)				
Business/Trading 42 (14%)	15	12.7	103	87.3
Journalists 11 (3.7%)	0	0	0	100
Teachers/Lecturers 39 (13%)	1	9.9	10	90.9
Engineer 8 (2.7%)	4	10.3	35	89.7
Scientists 21 (7%)	3	37.5	5	62.5
Technicians 17 (5.7%)	5	23.8	16	76.2
Farmer 10 (3.3%)	1	5.9	16	94.1
Retired 6 (2%)	0	0	10	100
Others 28 (9.3%)	0	0	6	100
Total 300(100%)	1	3.6	27	96.4
	30	10	270	90
Education				
< Secondary 6(2%)	0	0	6	100
Secondary 28 (9.3)	0	0	28	100
Undergraduate 200(66.7)	9	4.5	191	95.5
Graduate 48 (6%)	15	31.2	33	68.8
Postgraduate 18(6%)	6	33.3	12	66.7
Total 300(100%)	30	10	270	90

Table 5: Frequency of Phone Usage Per Day

	Less Than 1 hour	**Between 1-2 Hours**	**Between 2-3 hours**	**More than 3 hours**
Gender				
Male 148 (49.3%)	12 (8.1%)	34 (23%)	39 (26.4%)	63 (42.6%)
Female 152 (50.7 %)	17 (11.2%)	28 (18.4%)	33 (21.7%)	74 (48.7%)
Total 300(100%)	**29 (9.7%)**	**62 (20.7%)**	**72 (24%)**	**137 (45.6 %)**
Age				
11-20 Years 11(3.7%)	1 (9.1%)	2 (18.1%)	2 (18.1%)	6 (54.5%)
21-30 Years 102 (34%)	10 (9.8%)	11 (10.7%)	13 (12.7%)	68 (66.7%)
31-40 Years 98 (32.7%)	8 (8.2%)	7 (7.1%)	9 (9.2%)	74 (75.5%)
41-50 Years 51 (17%)	6 (11.8%)	9 (17.6%)	21 (41.2%)	15 (29.4%)
51-60 Years 27 (9%)	3 (11.1%)	4 (14.8%)	8 (2.96%)	12 (44.4%)
61-70 Years 11 (3.7%)	2 (18.1%)	3 (27.3%)	4 (36.4%)	2 (18.2%)
Total 300(100%)	**30 (10%)**	**36 (12%)**	**57 (19%)**	**177 (59%)**

Occupation					
Students	118 (39.3%)	8 (6.8%)	27 (22.9%)	35 (29.7%)	48 (40.7%)
Business/Trading	42 (14%)	3 (7.1%)	7 (16.7%)	11 (26.2%)	21 (50%)
Journalists	11 (3.7%)	0 (0%)	2 (18.2%)	2 (18.2%)	7 (63.6%)
Teachers/Lecturers	39 (13%)	2 (5.1%)	3 (7.7%)	11 (28.2%)	23 (59%)
Engineer	8 (2.7%)	0 (0%)	1 (12.5%)	2 (25%)	5 (62.5%)
Scientists	21 (7%)	1 (4.8%)	2 (9.5%)	4 (19%)	14 (66.7%)
Technicians	17 (5.7%)	1 (5.9%)	2 (11.8%)	3 (17.6%)	11 (64.7%)
Farmer	10 (3.3%)	1 (10%)	2 (20%)	2 (20%)	5 (50%)
Retired	6 (2%)	1 (16.7%)	2(33.3%)	2 (33.3)	1 (16.7%)
Others	28 (9.3%)	3 (10.7%)	3 (10.7%)	5 (17.9%)	17 (60.7%)
Total	**300(100%)**	**20 (6.7%)**	**51 (17%)**	**77 (25.7%)**	**152 (50.7%)**
Education					
< Secondary	6(2%)	2 (33.3%)	2 (33.3%)	1 (16.7%)	1 (16.7%)
Secondary	28 (9.3)	2 (7.1%)	7 (25%)	8 (28.6%)	11 (39.2%)
Undergraduate	200 (66.7)	0 (0%)	1 (0.5%)	4 (2%)	195 (97.5%)
Graduate	48 (6%)	7 (14.5%)	5 (10.4%)	6 (12.5%)	30 (62.5%)
Postgraduate	18(6%)	1 (5.6%)	3 (16.7%)	6 (33.3%)	8 (44.4%)
Total	**300(100%)**	**12 (4%)**	**18 (6%)**	**25 (8.3%)**	**245 (81.7%)**

Conclusion

In Nigeria, most people just buy mobile phone and start using them without the knowledge of their health implications. One important thing to consider while buying mobile phone is the SAR value. It is therefore the responsibility of every Nigerian to buy phones that will not deteriorate their health or cost them their life. To minimize radiation received from mobile phones, the following should be observed as suggested by (Shubham, 2017): while using the mobile phone, keep phone at speaker mode, with phone at hand's away or use a wired handset; similarly, turn off handset when not in use; try as much as possible to use the phone when the signal strength is full, as high amount of radiation is emitted when signal strength is poor. In addition, don't use the phone inside elevators, cars as well as in airplanes as it emits more radiation in an enclosed metal space. Also, imbibe the habit of using the SMS instead of call, as the phone is farther from the body, the safer it becomes. Furthermore, when at home, or wherever it is possible, use wired landline as it emits less amount of radiation.

Recommendations

The following recommendations are made based on the findings of this research work:

i. Like in some developed countries such as U.S.A, Germany, China, India etc., there should be a regulatory body that will monitor and set a reference limit for SAR value in Nigeria
ii. All manufactured or imported mobile phones should be tested and thoroughly checked to ensure that they are in compliance with SAR reference limit. Also, SAR value information of the mobile phones should be available on the manufacturer's websites and in the handset manual.
iii. With the current admiration of mobile phone use among the youths, and therefore potentially longer lifetime exposure, further studies that will cover more region are required to fill the gaps in the knowledge and awareness regarding safety measures against harmful effects of radiations emitted by mobile phones.
iv. Finally, it is recommended that people should use mobile phones as minimum possible and avoid giving them to

children as the re effect is more on them.

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