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Assessment of specific absorption rates of some commonly used mobile phones in Nigeria

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Introduction

As a result of fast technological advancement occurring in the nation following the introduction of Global System of Mobile Communication (GSM) in the year 2001, the sources of electromagnetic radiation in our immediate surroundings such as mobile phones and base stations, have increased [1-3]. Improved features and specifications especially video phones and different options from different operators have facilitated the mobile phone use and motivated the individuals to have multiple mobile phone lines.

As a result of these developments, individuals are presently exposed to more electromagnetic fields (EMFs) radiations. Scientific research about the effects of EMFs on health is substantial and are based on a large number of epidemiological, animal and in vitro studies. Epidemiological studies have focused on reported symptoms of headaches and heat sensation and on risk of brain tumours, cancer, breast cancers, or leukaemia [3,4,6-7]. Experimental studies have also assessed the effects of EMFs in human on electroencephalogram (EEG), cognitive functions, sleep quality index and reaction times and variability in heart rate. Animal experimental studies which allow more detailed or invasive investigations and also complementing these human studies, have been performed in rodents exposed to EMFs to study variation of neurotransmitters release, blood-brain barrier permeability, or vascular permeability [2,6-9]. The International Agency for Research on Cancer (IARC) under the umbrella of the World Health Organisation (WHO) has classified radiation from radiofrequency (RF) as possibly carcinogenic to humans (Group 2B), based on an increased risk for glioma, a malignant type of brain cancer, associated with wireless phone use [10]. To effectively quantify the effect of electromagnetic field transmitted by mobile phones on biological tissue, we bring in the concept of Specific Absorption Rate (SAR) which is expressed in W/kg. In the study by Kuster, SAR values measured from 16 mobile phones, ranged between 0.28 and 1.33 W/kg [11].

Various epidemiologic studies have been carried out on humans by taking into consideration, the importance of SAR value [11-14] and some studies have reported that since the dielectric properties varies in children, young adolescents and adults, the degree of exposure is also varies [2,5,7,16]. International Commission on Non-Ionizing Radiation Protection (ICNIRP) [6] and other reports indicate that there are very few reports about the susceptibility of children and adolescents to EMFs and there are also a limited number of biological studies [6,7,16]. This trend may be as a result of the developing state of the nervous systems of children and adolescents and as they drink more water, their brain tissues have greater conductivity and exposure to longer life expectancy. ICNIRP, Swedish Radiation Safety Authority reports and WHO suggest that experimental and epidemiological studies are required concerning childhood and adolescence period [6,16]. Presently in Nigeria, the factors considered by users when shopping for a mobile phone are usually about the camera, display, processor or battery, but little or no attention is paid to SAR specifications, which can affect human health. The objective of this study is to assess the specific absorption rates (SAR) of some commonly used mobile phones in Nigeria. Specifically, to carry out a comparison of the SAR values reported by the manufacturer and the measured values using an Electrosmog RF Meter.

Materials and Methods

A total of One hundred and Seventy three (173) mobile phones were used for this study. Electrosmog RF Meter (Model 9810 manufactured by MECO, USA) positioned 2cm from the mobile phone, was used to measure the Average Electric Field over a six-minute call duration for the different phones . The average electric field (E) was then inserted into equation (1) to obtain the Specific Absorption Rate (SAR) of the mobile phone.

$$SAR = \frac{\sigma E^2}{\rho}; \qquad (1)$$

where σ = Conductivity of the human brain tissue; E is the electric field and ρ is the Mass density of the human brain tissue.

The data measured and those reported in the manual of the phones or on the mobile phone website were entered into Microsoft Excel spreadsheet and later imported into the Statistical Package for Social Sciences (SPSS) version 22.0 for windows for data analysis. Descriptive Statistics such as frequency, percentages, mean, standard deviation as well as inferential statistics (one sample t-test; Analysis of Variance (ANOVA) using Tukey HSD *Post hoc* to separate means that were significant; χ^2 test of association.

Results and Discussion

The result shows that the mean reported SAR was highest in Brand D and least in Brand A brands. Similar results were observed in the mean SAR measured. Brand D mobile phones have significantly higher ($p<0.05$) reported SAR values than Brand A and Brand C phones. The mean difference between reported and measured SAR showed that Brand D mobile phones were higher than Brand C mobile phones. This implies that for Brand D mobile phones the measured values were lower than the reported value by the manufacturer; but Brand C phones reported higher SAR values. This difference in mean difference in SAR is statistically significant ($p<0.05$). The mean values for the different brands of mobile phones were lower than that of Kuster [11]. In the study carried out by Smythe and Costall [17] on 33 males and 29 females, they noted that in the exposure of mobile phone having a mean SAR of 0.79, and reported sex difference in the influence on the cognitive performance in the usage of mobile phones.

Also, the proportion of mobile phones above the reference level is statistically not significant ($\chi^2 = 7.115$; $p=0.068$) over the different products. The highest proportion was recorded in Brand C; while for Brand A, none of the mobile phones had SAR above the reference.

The mean SAR for the different products of mobile phones were significantly lower ($p<0.05$) than the reported SAR reference value of 1.6W/kg[6].

Testing the level of agreement between measured and reported SAR values, the study shows that the overall mobile phones and for Brand C Phones reported values are significantly higher ($p<0.05$) than the measured SAR values as indicated by the negative signs in the mean difference column. This goes to show that the reported SAR by these mobile phones manufacturers is less than the actual SAR on measurement as reported by Sandström et al that there should have been lesser SAR values [18].

Conclusion

This study however revealed that the measured and reported values of SAR are within range as there was no significant difference in the manufacturer's reported SAR value and our measured SAR value; except for Brand C mobile phones which had significantly higher measured value than the value reported in their user's manual. Although the mean measured values for the different mobile phones were below the reference value set by the FCC, some Brand C phones had values higher than the reference value. It should be a matter of concern for users and the government, that some of these mobile phones being imported into the nation, have such high SAR values which may pose a health risk to users. It is therefore recommended that the government sets up a regulatory body to monitor the type of phones been imported into the country, and to ensure that such phones actually meet the reported SAR on the phone user

manual. Another recommendation is that phone users should amidst other factors consider the SAR of the phone before buying so as to minimise the risks.

References

[1] Ajiboye, J.O., Ajiboye, J.O., Adu, E.O., & Wojuade, J.I. (2007). Stakeholders' Perceptions of the Impact of GSM on NigeriA Rural Economy: Implication for an Emerging Communication Industry, Journal of Information Technology Impact, 7(2), pp. 131-144.

[2] Otto,M.,& Mühlendahl, K.E., (2007). Electromagnetic fields (EMF): Do they play a role in children's environmental health (CEH)?, *International Journal of Hygiene and Environmental Health*; 210 (5): 635-644.

[3] IEGMP,Mobile Phones and Health. (2000). *Report of Independent Expert Group on Mobile Phones*, Chairman, Chilton WS, IEGMP,.

[4] Söderquist, F., Hardell, L., Carlberg, M.,& Mild, H., (2007). Ownership and use of wireless telephones: a population-based study of Swedish children aged 7-14 years. *BMC Public Health*.7:105.

[5] World Health Organisation (2002). Establishing a Dialogue on Risks from Electromagnetic Fields Radiation and Environmental Health Department of Protection of the Human Environment, WHO, Geneva, Switzerland.

[6] International Commission on Non-Ionizing Radiation Protection (ICNIRP). (2009). Exposure to high frequency electromagnetic fields, biological effects and health consequences (100 kHz-300 GHz). Available from:URL:http://www.icnirp.de/documents/ RF Review.pdf

[7] Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR). Possible effects of Electromagnetic Fields (EMF) on Human Health. (2009). Avaliable from:URL:http://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scenihr.

[8] World Health Organization (2006). WHO Research Agenda for Radio Frequency Fields. Available from:URL: http://www.who.int/peh-emf/research/ rf_research_ agenda_.pdf.

[9] Andrzejak, R., Porebal, R., Poreba, M., Derkacz, M.,Skalik, R.,Gac, P.,Beck, B., Steinmetz-Beck, A.,& Pılecki, W. (2008). The Influence of the Call with a Mobile Phone on Heart Rate Variability Parameters in Healthy Volunteers. *Industrial Health*. 46: 409–417.

[10] WHO/International Agency for Research on Cancer (IARC), IARC classifies radiofrequency electromagnetic fields as possibly carcinogenic to humans, Press release No: 208, 31 May (2011).

[11] Kuster, N., (1997). Swiss tests show wide variation in radiation exposure from cell phones. Microwave News Nov/Dec. 1–11,249-257.

[12] Smythe, J.W.,& Costall, B., (2003). Mobile phone use facilitates memory in male, but not female subjects. Neuroreport 14: 243-246.

[13] Regel, S.J., Gottselig, J.M., Schuderer, J., Tinguely, G., Rétey, J.V., Kuster, N., Landolt, H.P.,& Achermann, P., (2007a). Pulsed radio frequency radiation affects cognitive performance and the waking electroencephalogram. Neuroreport, 28 18(8):803-807

[14] Regel, S.J., Tinguely, G., Schuderer, J., Adam, M., Kuster, N., Landolt, H.P.,& Achermann, P.,(2007b). Pulsed radiofrequency electromagnetic fields: dose-dependent effects on sleep, the sleep EEG and cognitive performance. *J Sleep Res*, 16(3):253-258.

[15] Sun, W., Shen, X., Lu, D., Fu, Y., Lu, D.,& Chiang, H.,(2011). 1.8-GHz radiofrequency radiation induces EGF receptor clustering and phosphorylation in cultured human amniotic (FL) cells. *Int J Radiat Biol*. Nov 18: 1-6.

[16] WHO. Health effects research needs. In; Research Agenda for Radiofrequency Fields. (2010). Geneva, Switzerland. 12-22.

[17] Smythe, J.W.,& Costall, B., (2003). Mobile phone use facilitates memory in male, but not female subjects. Neuroreport 14: 243-246.

[18] Sandström, M.,Wilen, J.,Oftedal, G.,& Mild, KH.,(2001). Mobile phone use and subjective symptoms experienced by users of analogue and digital mobile phones. Occup. Med. 51: 25-35.