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Measurement of the SAR Levels Near the Human Head for Different Types of Mobile Phone device

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ABSTRACT

With the increasing of mobile phones users during the last decades , the potential adverse outcomes from exposure to electromagnetic fields (EMF) emitted from different types of these mobile phones has also been increased. In this work the measurement of electric field (EF) emitted from different types of mobile phone have been conducted and the Specific Absorption Rate (SAR) had been mathematically calculated for different types of mobile phones in different ranges from the human head . The comparison of measured levels with the international radiation exposure ICNIRP indicate that they are lay within the standards limits .that means there is no negative effect on human health from the exposure to these radiations if the exposure is for a short and discontinues periods

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INTRODUCTION

With the increasing of mobile phone use as well as the accompanying growth of mobile base stations, there are a public concern on potential harmful effects caused by the everyday exposure to radio frequency (RF) electromagnetic fields (EMF) emitted from these devices. The RF-EMF emitted by mobile phones can be absorbed by the human skull to some extent, so the brain may be exposed to this radiation (Wiart J, Hadjem A, Wong MF, Bloch I. 2008). The use of mobile phones is not limited to adults only, children and are consider as a big group of mobile phone users.

The EMF are present everywhere in our environment, some visible (light), but most invisible to the human eye. They are an interaction between electric and magnetic forces. Natural sources of electric fields are produced by the local build-up of electric charges in the atmosphere associated with thunderstorms and the best known natural magnetic field surrounds the earth. But besides these natural sources, many man-made sources are present which generate EMF like x-rays, (high voltage) electricity and various kinds of high frequency radio waves which are used to transmit information (Centraal Bureau voor de Statistiek. 2008).

The official definition of RF is that it is a band in the EMF spectrum that lies in the frequency range of 3 kHz to 300 GHz. Part of this band is microwave (MW) radiation which is generally considered to be a subset of RF, and MW covers 300MHz to 300GHz (Kientega T, Coni El, Hadjem A, Gati A, Wong M, WiartJ, Richalo E, Picon O (2010).

There are different sources of RF exposure to which people may be exposed, but the source of interest for this research is exposure related to mobile phone signals. The first mobile phones available systems operate on a frequency between 450 and 900 MHz. The more recent third generation mobile phones make use of the Universal Mobile Telecommunication System (UMTS), which operates in the frequency of (1800-2600 MHz). New developments like future G4 phones, will work on much lower frequencies may be below the 50 MHz range (Krause CM, Pesonen M, Bjornberg C, Hamalainen H. 2007).

Biological Effects of Mobile Phone on Human Health:

Mobile phone exposure is localized at the head of an individual, and the RF-EMF emitted by the phone is absorbed through the skull to some extent, and the brain thereby exposed to this radiation. Potential effects of RF-EMF on the brain are therefore of a specific interest because this radiation may cause a heating effects to the human brain .

Microwave radiation is capable of producing heat, however, the rise in brain tissue temperature during exposure to RF-EMF from a mobile phone, is estimated to be very low (fractions of °C) For example, a

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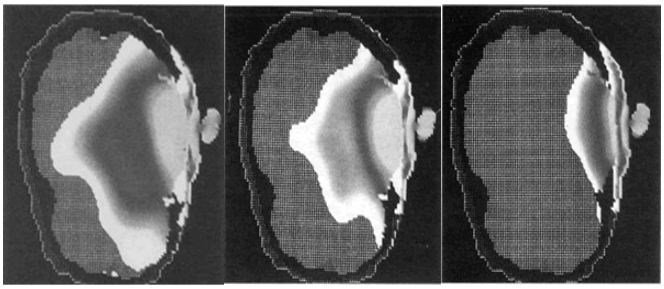
predicted worst-case brain temperature rise from use of different mobile phones (GSM/UMTS) is about (0.25°C) (Hung CS, Anderson C, Horne JA, McEvoy P. 2007|).



A : age 5-10 years B: age 10-15 years c : adults

Fig. (1): Thermal effect of mobile phone on human head (brain):

Literature Review:

A substantial research project recently concluded that future mobile phone systems would have less adverse EMC(electromagnetic compatibility) effects than present systems, and suggested some techniques for reducing the effects still further (Divan HA, Kheifets L, Obel C, Olsen J. 2008).

Mobile phones generally get better reception when used away from the main part of the body. Some mobile phones are designed to have a minimum separation from the body when in use, typically (15–25mm) depending on the mobile phone device. Standardized methods specified by the European Committee for Electrical Standardization (CENELEC) are used to test mobile phones in Europe. The limit for mobile phone use is the specific absorption rate (SAR) of 2 W/kg for the human head. Mobile phones are tested under worst case conditions, i.e. at the highest power level, e.g., 2 W peak power corresponding to 250 mW maximum time averaged transmitted power for GSM at 900 MHz. Maximum local SAR values averaged over 10 gram of tissue range typically between 0.2 and 1.5 W/kg, depending on the type of mobile phone(Krewski D, Glickman BW, Habash RWY, et al. 2007)

Standard limitation:

For a general public, Council Recommendation of 12 July 1992 on the limitation of exposure of the general public to electromagnetic fields fixes basic restrictions and reference levels to electromagnetic fields (EMFs). These and reference levels are based on the guidelines published by the International Commission on Non Ionizing Radiation Protection (ICNIRP) as shown in table (1). (Ahlbom A, Bergqvist U, Bernhardt JH, et al. 1998)

Table (1): SAR limits set by (ICNIRP) for general public exposure to EMF. (Ahlbom *et al*., 1998)

Mobile Model	SAR limit	FCC in USA and Canada		SAR ICNIRP guidelines
		SAR in free space	SAR on the body	
Nokia x6	1.6 W/kg	1.31 W/kg	1.13 W/kg	1.11 W/kg
Nokia 95	1.6 W/kg	0.42 W/kg.	0.60 W/kg.	0.58 W/kg.
Nokia 93	1.6 W/kg	0.68W/kg	1.14 W/kg	0.69 W/kg
Nokia 7230	1.6 W/kg	1.14 W/kg.	0.39 W/kg.	0.97 W/kg.
Nokia 73	1.6 W/kg	1.06 W/kg	0.59 W/kg	0.92 W/kg.

Methodology:

Measurement of SAR have been conducted in the following three steps :

1- Practical measurements of electric field emitted from mobile phone in a three positions (2cm, 10cm and 20cm) near human head

2- Mathematical calculation the value of SAR for five types of mobile phones devices in the three ranges .

3- Measurement of head temperature in relation with the exposure time

1- Practical Measurements:

The measurements of EF radiations emitted from mobile phone have been carried out for five types of mobile phone devices at three different ranges (0cm, 10cm, 20cm) by using a radiation survey meter model (Radio frequency EMF tester (480846) with digital display. This meter is a three-axis instrument, which can also read individual X, Y and Z axes. Frequency range is from 50 MHz to 3.5 GHz with high sensitivity (20 mV/m). Readings can be instantaneous, averaged or maximum .

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2- Mathematical Calculation:

SAR (Specific Absorption Rate) is the unit of measurement of the amount of Radio Frequency (RF) energy absorbed by the human body when using a mobile phone measured in units of watts per kg (W/kg) of tissue. SAR is determined at the highest certified power level in laboratory conditions (SSI'S Independent Expert Group on Electromagnetic Fields:2002).

SAR can be defined as :

$$SAR = \omega.\varepsilon_0.\varepsilon_r \frac{E^2}{2\rho} \quad (1)$$

Where :

ω : is the angular frequency .

ε_0 : is the permittivity of free space.

ε_r : is the imaginary part of the relative complex permittivity .

ρ : is the tissue density in kg/m^3 and

E : is the peak value of the total field inside the tissue material.

SAR value varies from point to point in the body because the electric field changes with the position and density of tissue .

RESULTS AND DISCUSSION

The practical measurements and mathematical calculations results are shown in tables (2,3) respectively, and the graphical representation of results is shown in figure (2) and the measurement of head temperature during exposure to EMF radiations emitted from mobile phone is shown in table (4) .The graph representation of the relationship between the head temperature and the exposure time is illustrated in figure (3).

From the results obtained, we can conclude the following :

- The first type of mobile phone type (Nokia X6) has a maximum electric fields strength of about (10.4V/m) which give a (SAR of about 0.34 W/Kg) which is far below the ICNIRP guidelines .
- The second device is the (Nokia 95) which has a maximum electric fields strength of about (11.2V/m) which give a (SAR of about 0.37 W/Kg) which is approximately equals about 63% of the limits set for this device by the ICNIRP (0.58 W/Kg) .
- The third model is the (Nokia 93) which has a maximum electric fields of about (12.8V/m) which give a (SAR of about 0.42 W/Kg) which also lie within the dangerous region (about 60%)of the limits set by the ICNIRP is device (0.69 W/Kg).
- The fourth type is the (Nokia 7230) which has a maximum electric fields strength of about (14.2V/m)which give a SAR of about (0.47) which is also lie within the dangerous region (about 48%) of the limits set by the ICNIRP for this device (0. 97 W/Kg) ..
- The last type is the (Nokia 73) which has a maximum electric fields strength of about (15.4V/m) which give a (SAR of about (0.51 W/Kg) which also lie within the dangerous region (about 55%) set by the ICNIRP for this device (0.92 W/Kg)
- Figure (3) shows that the head temperature raises with the increasing of exposure time .

So, from the discussion above, we can see that the maximum emitted electric field is from the mobile phone type (Nokia 73) and the minimum is from the mobile phone type (Nokia 95) which give a low SAR (0.58 W/Kg) .All the SAR levels are below the standard limit levels .

Table (2): Practical measurementsresults of electric field near the human head **.**

Mobile model	Electric field (V/m) at 0 cm		Electric field (V/m) at 10 cm		Electric field (V/m) at 20 cm	
	Max	Average.	Max.	Average.	Max.	Average.
Nokia x6	10.4V/m	7.6V/m	5.2V/m	3.8V/m	1.4V/m	0.8V/m
Nokia 95	11.2V/m	8.4V/m	6.3V/m	4.8V/m	1.7V/m	1.1V/m
Nokia 93	12.8V/m	10.2V/m	6.8V/m	5.2V/m	2.1V/m	1.5V/m
Nokia 7230	14.2V/m	11.6V/m	7.4V/m	6V/m	2.6V/m	1.8V/m
Nokia 73	15.4V/m	12.8V/m	8.2V/m	6.8V/m	2.8V/m	1.9V/m

Table (3): Mathematical calculationsresults of (SAR) near the humanhead**.**

Mobile phone	SAR At ocm (max.)	SAR At 0cm (average)	SAR At 10cm(max.)	SAR At 10cm (average)	SAR At 20cm (max.)	SAR At 20cm (average)	Standard limits
Nokia x6	0.34	0.25	0.17	0.12	0.04	0.02	1.11
Nokia 95	0.37	0.28	0.21	0.16	0.05	0.03	0.58
Nokia 93	0.42	0.34	0.22	0.17	0.07	0.05	0.69
Nokia 7230	0.47	0.38	0.27	0.2	0.08	0.06	0.97
Nokia 73	0.51	0.42	0.27	0.22	0.09	0.06	0.92

Table (4): Head temperature raises with increasing of exposure time.

Exposure time (minute)	Head Temperature (^{o}c)
0 - 5	0 - 0.2
5 - 10	0.2 - 0.4
10 - 15	0.4 – 0.9
15 - 20	0.9 – 1.3
20 - 25	1.3 – 1.7

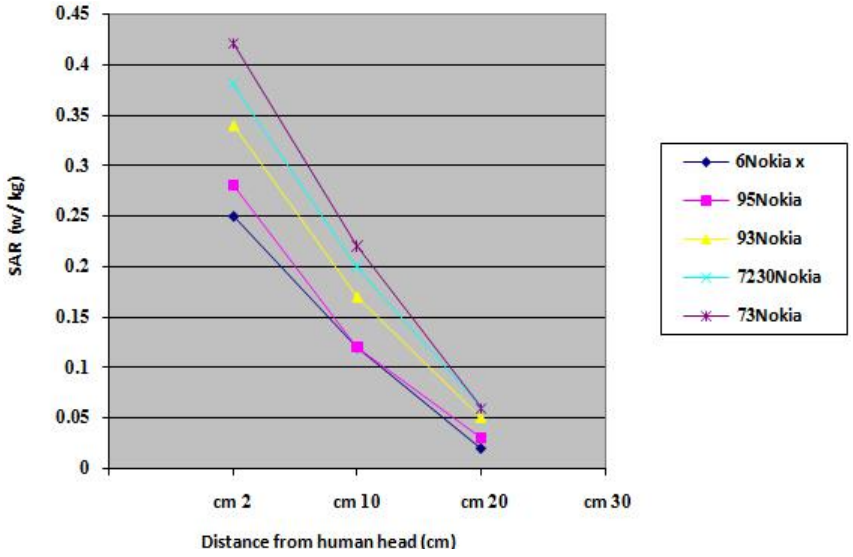

Fig. (2): SAR levels for five types of mobile phones at three ranges from the human head.

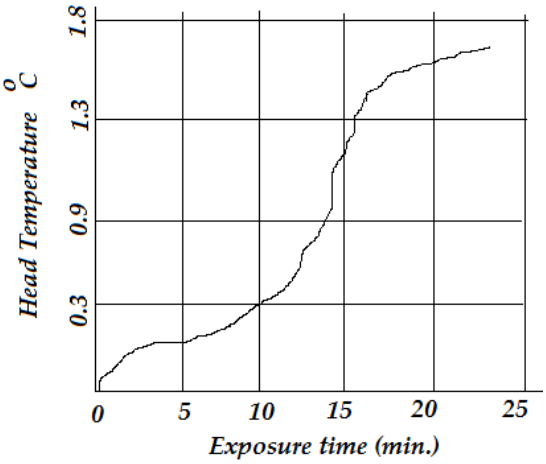

Fig. (3): Human head temperature increases with increasing the time exposure.

Recommendations:

- Present scientific information does not indicate the need for any special precautions for use of mobile phones. If individuals are concerned, they might choose to limit their own or their children's' RF exposure by limiting the length of calls, or using "hands-free" devices to keep mobile phones away from the head and body.
- Obey local restrictions on mobile phone use to avoid EMF interference: Mobile phones may interfere with certain electro medical devices, such as cardiac pacemakers and hearing aids. In hospital intensive care departments mobile phone use can be a danger to patients and should not be used in these areas. Similarly mobile phones should not be used in aircraft as they may interfere with its navigation systems.
- Providing information: An effective system of health information and communications among scientists, governments, industry and the public is needed to raise the level of general understanding about mobile phone technology and reduce any mistrust and fears, both real and perceived. This information should be accurate, and at the same time be appropriate in its level of discussion and understandable to the intended audience
- Do not usemobile phonesonlywhen absolutely necessary.
- Prevent the using ofmobile phoneby the children less than 16years old and pregnant women

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Conclusion:

Mobile phones and their base stations transmit and receive signals using electromagnetic waves (also referred to as electromagnetic radiation or fields, or radio waves). Electromagnetic radiation is emitted by many natural and man-made sources and plays a very important part in our lives. The aim of this research was measurement evaluation of EMF effect by mobile phone onhuman head phantom. This phantom is real model of human tissue and we were interested in specific absorption rate (SAR). Our measurements showed that this maximum value was not exceed the standard exposure limits values . from the all results obtained ,we can come to fact that conclusion that there is no negative effect on human health from exposure to these radiations if the exposure is for a short and discontinues periods .

List of abbreviations:

(EMR) : Electromagnetic Radiation .
(EMF) : Electromagnetic Field .
(GSM) : Global System For Mobile .
(ICNIRP) : International Commission On Non Ionizing Radiation Protection .
(RF) : Radio Frequency .
(SAR) : Specific Absorption Rate.
(UMTS) : Universal Mobile Telecommunication System .
(WHO) : WORLD Health Organization .

REFERENCES

Ahlbom, A., U. Bergqvist, JH. Bernhardt, Guidelines for limiting exposure to timevarying electric, magnetic, and electromagnetic fields (up to 300 GHz). Health Physics, 1998, 74: 494-521.

Centraal Bureau Voor De Statistiek, De DigitaleEconomie, 2008. Den Haag: Centraal Bureau Voor de Statistiek, 2008.

Divan, HA., L. Kheifets, C. Obel, J. Olsen, 2008. Prenatal and postnatal exposure to cell phone use and behavioral problems in children. Epidemiology, 19: 523-529.

Hung, CS., C. Anderson, JA. Horne, P. McEvoy Mobile phone 'talk-mode' signal delaysEEG-determined sleep onset. Neuroscience Letters. 2007; 421: 82-86.

Kientega, T., El. Coni, A. Hadjem, A. Gati, M. Wong, J. Wiart, E. Richalo, O. Picon, 2010. Multiple Plane Waves Exposure Analysis, Abstract No.P-B-63, BEMS 32nd AnnualMeeting, Seoul, Korea, 2010, pp: 14-18.

Krause, CM., M. Pesonen, C. Bjornberg, H. Hamalainen, Effects of pulsed and continuous wave 902 MHz mobile phone exposure on brain oscillatory activity duringcognitive processing. Bio electro magnetics. 2007, 28: 296-308.

Krewski, D., BW. Glickman, RWY. Habash, Recent advances in research on radiofrequency fields and health: 2001-2003. Journal of Toxicology and Environmental Health - Part B: Critical Reviews. 2007, 10: 287-318.

SSI'S Independent Expert Group on Electromagnetic Fields, 2002. Health Council of the Netherlands, Mobile Phones, An Evaluation of Health Effects. 2002, No. 2002/01E, ISBN, 90-554-9411-9.

Wiart, J., A. Hadjem, MF. Wong, I. 2008. Bloch Analysis of RF exposure in the head tissues of children and adults. Physics in Medicine and Biology, 53: 3681-3695.