



(Print)

Section B

(Online)



Estd. 1989

JOURNAL OF ULTRA SCIENTIST OF PHYSICAL SCIENCES

An International Open Free Access Peer Reviewed Research Journal of Physical Sciences

website:- www.ultrascientist.org

Near field non-ionising electromagnetic radiation of cellular base stations in selected locations

BINDHU CHRISTOPHER*¹ and JOJO P. J.^{1,2}

¹Department of Physics, Fatima Mata National College(Autonomous), Kollam-691001, (India)

²Department of Applied Physics, The Papua New Guinea University of Technology, Lae, (Papua New Guinea)

Corresponding Author Email- bindhusubin@gmail.com

<http://dx.doi.org/10.22147/jusps-B/291105>

Acceptance Date 21st October, 2017, Online Publication Date 2nd November, 2017

Abstract

Cellular phone technology has made radical changes in global telecommunication scenario with exponential growth in cell phones and base towers. The effect of non-ionizing electromagnetic radiations on human health is a subject of serious concern with the enormous installation of base stations. With a view to study the near field areas of base stations, we selected certain locations in southern districts of Kollam and Trivandrum in Kerala state, India. We assessed the power density of radio frequency waves from mobile towers using a handheld pocket digital LCD microwave leakage radiation detector. The area near the mobile towers were divided into concentric circles, each with increasing radii of 5m maximum. The survey was carried out in various towns having large population. The power density and Specific Absorption Rate (SAR) rates were determined from the field measurements. The present study was conducted only to near field and ground level radiations.

Key words: tower radiation, exposure, near field radiation, SAR

Introduction

Wireless technology is based on extensive networks of base stations that connect the users through radio frequency signals. In recent years much attention has been paid to health entanglement of electromagnetic radiation, especially to human head, which is in the nearest proximity the EM field radiation from the transceiver hand set.⁽¹⁾In India more than 500 million cell phone users and nearly 0.44 million cell phone towers are there to meet the demand. The density of users and towers are alarmingly increasing even in small cities and villages. The advancement in mobile communication which facilitates users to access the Internet has further elevated unprecedented use of GSM.

Most of the countries have adopted the radiation norms as suggested by International Commission on Non-Ionizing Radiation Protection (ICNIRP). As per the ICNIRP, the power density for general public exposure zone should be less than $f/200 \text{ watt/m}^2$ for 400-2000 MHz band. Here f is the frequency used by the mobile operator in MHz^2 . In India cell phone towers emit significantly high frequency than the radio waves and it is nearly 1900MHz -2500MHz. When the frequency of radiation increases biological effect also increases.

Cell phone technology has grown exponentially without concerning about their disadvantages. With the recent explosive increase of use of mobile phone especially among the children, the scientific word worrying about the future. For this reason the World Health Organization (WHO) has recommended to undertake research students on this subject.³

Due to the development of large number of cell phone towers starts the debate on biological impact of mobile phone tower radiation. Most of the countries has adopted the radiation norms as suggested by ICNIRP. As per the ICNIRP, the value of power density at general public exposure zone should be less than $f/200 \text{ watt/m}^2$ for 400-2000 MHz band. Here f is the frequency used by the mobile operator in MHz^4 . Most of the people are believed that near to cell tower radiation rate is very large. So in this paper the Studies are limited to near field radiation and in the ground level.

The paper reports the results of investigations of power density of radio frequency waves from mobile towers near field area along the ground using handheld pocket digital LCD microwave leakage radiation detector.

For providing mobile services, telecom service providers establish base transceiver stations (BTSs), at suitable locations, as per their Radio Frequency (RF) Network Planning for proper coverage of the area and for meeting capacity requirements⁵. With the significant increase in the mobile phone usage, there was substantial increase in the number of towers. This would increase RF exposure rates in the biosphere. Health risk associated with RF exposure can be short term and long term. The short term effect of radiation are brain electrical activity, cognitive function, sleep disorders, increase heart rate, and blood pressure⁽⁶⁾. Long term effects include tinnitus, headache, dizziness, fatigue, sensation of warmth, memory loss, muscular problems and epidemiological effects including cancer and brain tumors^{7,8,9}.

In 2011 International Agency for Research on Cancer (IARC), France has classified RF radiation as possible risk for glioma, a malignant type of brain cancer associated with wireless phone use⁹. At the same time ICNIRP study has concluded that the exposure levels due to cell phone base stations are generally around one-tenth thousandth of the guideline levels¹⁰. WHO has classified mobile phone radiation on the IARC (International Agency for Research on Cancer) Scale into Group 2B – indicating a category possibly carcinogenic to humans¹¹.

Latest survey report on 2016 collected the questionnaire details from the Civil Hospital, Karachi, Jinnah Medical Hospital, Karachi and Dow Medical University Hospital, Karachi, report as doctors believed that all wireless devices like cellular phones, laptop, wireless router, wireless earphone, cell telephone tower, Bluetooth devices and tablet PC are accountable for the development of diseases of brain tumor, male infertility, hearing function¹². In same year a reputed journal report showed the people who spend more than 50 minutes a day using a cell phone could have early dementia or other thermal damage due to the burning of glucose in the brain¹³. Another survey conducted on 2016 among the doctors report disease cause by mobile phone devices are Brain Tumor 74%, Male Infertility 37%, Heart Disease 45%, and Effect on Fetus 21%, Ear Hearing Function 80%, Alzheimer's disease 11% and Parkinson's disease 3%.¹⁴ Most recently in 2017 an environmental international publication report that maternal cell phone use during pregnancy may be associated with an increased risk for behavioral problems, particularly hyperactivity, inattention problems, in the offspring¹⁵.

We have estimated the SAR values for different age groups of human being for different vulnerable tissues from locations where the peak power densities observed during the study. The radiation absorbed rate

for adults is about 40%, while that of a 10 year child is about 60% while that for a 5 year old baby is about 80%¹⁶. Hence we calculated SAR values for different human tissues for adults, 10 year old child and 5 year old baby.

Methodology :

The experimental locations were divided into concentric circles, each with progressively increasing radius of 5m approximately. The study was carried out in cities namely Nedumangad, Karunagapally, Attingal, and Kollam and in rural areas of Parappil, Muthuvila and Mithirmala. In cities, density of mobile phones and towers are higher as compared with rural areas. Power densities were measured using a New Handheld Pocket Digital LCD Microwave Leakage Radiation Detector. The power density was estimated and hence the specific absorption rates for different tissues of the human body were estimated using the equation (1)¹⁷,

$$SAR = E_{rms}^2 \sigma / \rho \quad (1)$$

Where σ is the electrical conductivity and ρ the mass density of the respective tissue to whom the specific absorption rates are estimated. The values of electric conductivity and mass density of different tissue types used were adopted from the literature and are shown in the Table-1.

Table -1. Electrical conductivity of various type of human tissues^{18,19}

Tissue type	Electric current conductivity, σ (s/m) for 1800MHz	Mass density of each tissue (kg/m ³) ρ
Brain	0.92	1000
Blood	2	1057
Eye(corona)	2.32	1151
Fat	0.19	943
Skin	1.2	1125
Muscle	1.3	1090

Result and Discussion

Estimated power densities at different locations and distances from cell towers in the four cities are presented in the Table-2. The locations are Nedumangad (L1), Karunagapally (L2), Attingal (L3), and Kollam (L4). The height of all the mobile towers were nearly 50 m in each case.

Table -2. The estimated Power densities for the four cities at varying distances from tower

Location	Distance from the tower(m)	Power density(W/m ²)	Electric field(V/m)
L1	5	0.050	4.40
	8	0.045	4.20
	10	0.042	4.01
	11	0.040	3.92
	12	0.038	3.80
	13	0.030	3.41
	16	0.021	2.99
	18	0.015	2.55
	19	0.009	1.82
	20	0.004	1.42
	22	0.002	1.00

	25	0	0
	30	0	0
	35	0	0
L2	6	0.039	3.81
	10	0.026	3.23
	14	0.017	2.67
	15	0.010	1.93
	18	0.004	1.42
	21	0	0
	25	0	0
	30	0	0
	35	0	0
L3	5	0.052	4.48
	7	0.050	4.40
	10	0.049	4.25
	15	0.040	3.92
	20	0.018	2.55
	22	0.006	1.76
	25	0.002	1.00
	30	0	0
	35	0	0
L4	6	0.042	4.02
	8	0.040	3.92
	10	0.036	3.72
	13	0.022	3.20
	16	0.014	2.45
	18	0.010	1.93
	20	0.009	1.82
	22	0.003	1.02
	25	0	0
	30	0	0
	35	0	0

Using these data the SAR values for six vital human tissues for different age groups were estimated and are presented in the following table. Weighted mean for an age group of 40 years has also been presented.

Table -3. The estimated SAR for vital human tissues for different age group

Age group	Mean Specific Absorption Rate of different part of human body (mW/Kg)					
	Brain	Blood	Eye	Fat	Skin	Muscle
Adult	2.37±0.74	5.40±0.44	4.63±0.50	0.46±0.02	2.44±0.25	2.72±0.26
10 year old child	3.55±0.34	8.10±0.65	6.94±0.75	0.69±0.04	3.66±0.45	4.08±0.37
5 year old child	4.74±0.45	10.08±0.87	9.26±1.00	0.92±0.05	4.88±0.52	5.44±0.50
Weighted mean	3.55±0.29	7.86±0.66	5.73±0.75	0.69±0.04	3.66±0.41	4.08±0.38

India has adopted the most stringent international norms towards the standards for mobile phones as well as mobile towers. All handsets shall comply with the SAR values of 1.6 W/kg averaged over 1 gram of human tissue. Department of Telecom is supposed to ensure that the exposure limits for radio frequency fields (1800 MHz) from mobile towers be 0.1 to 0.92 Watt per square meter. From the figures in the table-3, it is clear that the people living near the mobile towers in the study regions especially children are exposed to radiation with higher specified rates, especially outdoors. It can be seen that for the range 0 to 18 m distance from the tower the estimated figures of SAR exceed the limit, especially for blood and cornea for the children. In general, from about 18 m from tower the absorption rate is found to decrease gradually. 20 m and farther SAR values were found within the limit. Further detailed investigations are necessary since the exposure to radiations have cumulative effect over the years. The figure 1 shows the distribution of dose rate for different human tissues resulting from the exposure to mobile radiations.

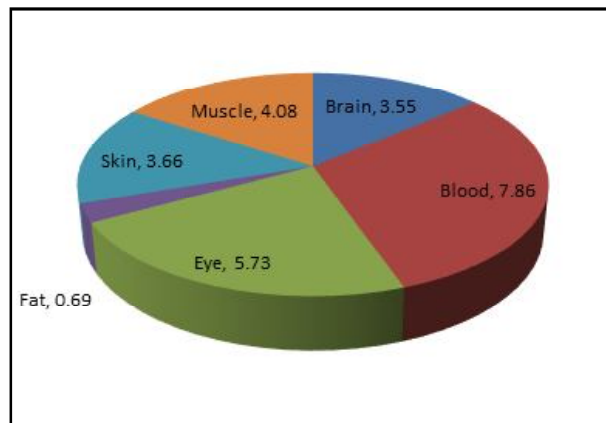


Figure 1: Distribution of SAR values in mW/Kg for different human tissues from mobile radiations

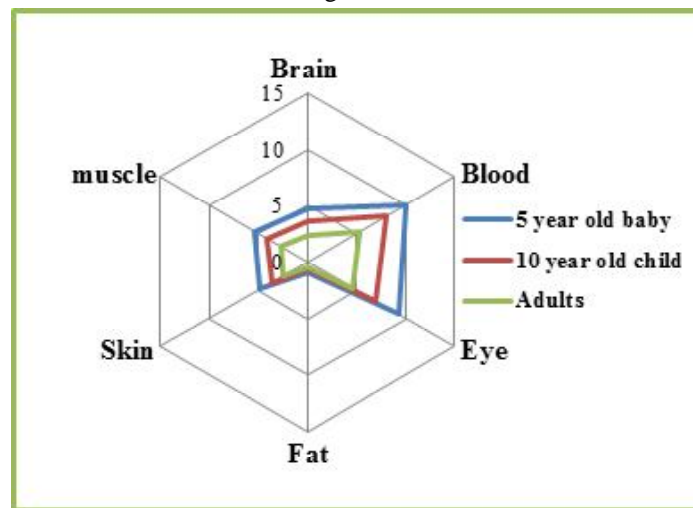


Figure 2 Comparison of SAR values for different human tissues with age groups.

From the figure 1, it is evident that eye gets the maximum exposure followed by blood tissues taking a share more than 50% from mobile radiation. Figure 2 depicts the comparison of exposure to different age groups and

tissue types. The specific absorption rate of mobile tower radiations almost double for 5 year old baby and is about 50% higher to 10 year old children as compared with the adults to the vital organs studied.

Conclusions

The results of the study indicate that the people living near mobile towers are exposed to elevated levels of non-ionising radiation originating from the mobile base stations, particularly for the range of 0 to 18 m distance from the tower. The estimated figures of SAR exceed the limit for children, especially for blood and cornea. It can be concluded that lower age groups are more prone to the effects of mobile tower radiation. In general, beyond 18 m from tower the absorption rate is found to decrease gradually. 20 m and farther SAR values were found within the permitted limit. There is a 'radiation zone' between 0 to 18m from tower where the specific absorption rates are high. The biological impacts of non-ionizing radiations generally do not have a linear dose-response relationship. Experiments have proved that larger absorption rates to the human beings do not necessarily induce a larger biological effect to a specific tissue. Therefore, higher SAR does not necessarily relate to enhanced biological response or health hazard. SAR in point of fact refers to thermal effects of electromagnetic radiation. Majority of the recorded biological impacts from non-ionizing electromagnetic radiation are non-thermal. In the wake of reports of cytogenetic damage in human tissues by the prolonged use of mobile phones only a detailed investigation can lead to an acceptable conclusion towards the direct health effect.

Acknowledgement

The authors wish to thank Dr. Wilson Neto (Principal), Dr. Kochuthresia T C (Former H.O.D), Prof. Vimala V (H.O.D Physics Department) Fatima Mata National College (Autonomous), Kollam, to provide all the facilities to do the research work. Without their support this research work could not have been possible.

References

1. Adel Z. ElDein, Alaeddin Amr, specific absorption rate induced in human heads of various sizes when using a mobile phone; proceedings of the world congress on Engineering 2010vol I WCE 2010, June 30-July 2, 2010, London, UK.
2. R Ktchen Microwave radiation safety hand book; Second edition book chapter 3, pp-47-85, (2001).
3. "Information paper On Effects of Electromagnetic Field Radiation from Mobile Towers and Handsets"- Information paper No. 01/2014-QoS-by telecom Regulatory authority of India (TRAI)
4. ICNIRP guidelines for limiting exposure to time varying electric, magnetic and electromagnetic fields (up to 300 GHz). published in: health physics 74 (4): 494 522; (1998).
5. Richa Chitranshi, Dr. Rakesh Kumar Mehrotra, Praksh Pancoli ; Analysis of Cell Tower Radiation, RF Safety and Practical Realization of Compliance Distance- - International Journal of Scientific and Research Publications, Volume 4, Issue 4, April 1 ISSN 2250-3153 (2014).
6. World Health organization (WHO) media centre electromagnetic fields and public health "mobile phones <http://www.who.int/mediacentre/fact sheets/fs193/en/index.html>. (2011).
7. Chia S E Chia HP & Tan J S-prevalence of headache among head held cellular telephone users in Singapore. A community study, Environ Helth prespect (USA), 108(11), pp1059-1062 (2000).
8. Oftedal G Wilen G Sandstorm M & Mild K H symptoms experience in connection with mobile phone use occup Med (UK. 50(4) pp 237-245 (2000).
9. <http://www.emfrf.com/rf-radiation-levels-from-cellular-towers/Scientific Study: RF Radiation Levels From Cellular Towers By Peter Sierck> - January 27, 2015. Accessed on 11/10/2017.
10. International agency of research on cancer IARC classifies radiofrequency electromagnetic fields as

- possibly classifies radiofrequency electromagnetic fields as possibly carcinogenic to human, press release No 2008, Lyon, France, 31 May 2011, WWW.iarc.fr/en/media-centre/pr/2011/pdfs/pr208_E.pdf.
11. ICNIRP - International Commission on Non-Ionizing Radiation Protection - Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz), Health Phys, 1 Sep (2012).
 12. Suhag AK, Larik RS, Mangi GZ, Khan M, Abbasi SK, *et al.* (2016) Impact of Excessive Mobile Phone Usage on Human. *J Comput Sci Syst Biol* 9: 173-177. doi:10.4172/jcsb.1000235.
 13. Mosa Moradi, Nasrollah Naghdi, Hamidreza Hemmati, Majid Asadi-Samani, Mahmoud Bahmani *Electron Physician*. 2016 May; 8(5): 2452–2457. Published online 2016 May 25. doi: 10.19082/2542
 14. Suhag AK, Larik RS, Mangi GZ, Khan M, Abbasi SK, *et al.* (2016) Impact of Excessive Mobile Phone Usage on Human. *J Comput Sci Syst Biol* 9, 173-177. doi:10.4172/jcsb.1000235
 15. Birks L, Guxens M, Papadopoulou E, Alexander, *et al.*, Maternal cell phone use during pregnancy and child behavioral problems in five birth cohorts. *Environment International*. Published online April 7, 2017. (2017).
 16. O M P Gandhi, L.Lloyd Morgan. “Exposure limits: The underestimation of absorbed cell phone radiation, especially in children “–*Electromagnetic Biology and medicine* ISSN 1536-8378, DOI-10.3109/153668378.2011/22827/pp 1-18/2011.
 17. Richa Chitranshi, Prakash Pancholi “Analysis of Cell Tower Radiations & Practical Realization of Compliance Distance”- *International Journal of Scientific and Research Publications*, Volume 3, Issue 5, 1 ISSN 2250-3153 (May 2013).
 18. Teerapot Wessapan, Phadungsak Rattanadecho ; “Aqueous Humor Natural Convection of the Human Eye induced by Electromagnetic Fields”: In the Supine Position - *Journal of Medical and Bioengineering* Vol. 3, No. 4, (December 2014).
 19. Kari Jokela, Dariusz Leszczynski, Wendla Paile *et al.* Radiation safety of handheld mobile phones and base station- *-S T U K - A 1 6 1* (January 1999).