

Simplified Measurement on the Impact of Radiation by Mobiles

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Abstract: in fast growing world Mobile phone has become part of the human life. Specific Absorption is a measurement for the amount of Electromagnetic energy that has been absorbed by human tissue. Electromagnetic Radiation associated with Mobile Phones is always as an issue that has to be addressed for human safety, Particularly for children. More focus has been paid to induced SAR in the human head when exposed to EM Waves emitted from mobile Phone Antenna, but while using mobile phone the user gets exposed to a dangerous electromagnetic Radiations. ICNIRP Prescribed some guidelines for EM Exposure Level for Public. The Present paper is discuss the SAR Values of different Mobile Phones, Measured How much People are Aware of SAR Values are given as a survey. The study is compromised individuals that visited in the survey site. The awareness is assessed using structured questions and it was recorded to measure the awareness.

Keywords: EM exposure, ICNIRP, SAR, Socio-Demographic

I. INTRODUCTION

EMF effect on human body mainly depends on Frequency of EMF and Magnitude. Electronic gadgets are perceived as a fundamental components of every day life, The Portable terminal devices become the Part and parcel of Present Scenario, and the uses of those are expanding step by step. Electro Magnetic Field Radiated by antennas of Mobile Phone strongly Interact With Human Head and other Human body parts. The Most Immediate effect of Electromagnetic Radiation is Increasing of Temperature of Tissues. The Electromagnetic energy Absorbed by the tissue Converts into heat in the human body. When Electromagnetic energy hit the material generates heat and heating capacity is depends on energy of electromagnetic wave. in some Applications needs more antennas situated in a phone, it causes increasing of thermal heating is still challenging problem for safety and study of these unwanted health effects is most important topic in Recent Days. Although This Problem is Being Investigated for a longer time, still there is most Harmful Difficulty in the field.

Majority of The Research focused on Variation of the Specific Absorption Rate(SAR) and Power Density which treats to be suitable Parameter for Calculating the degree of absorption...The Distribution of RF Fields in in equal structures like human head is complicate and difficult to predict, because it is depends on number of factors Like Near

field or Far Field and Frequency of incident Fields and Dielectric Properties of the body

II. SAR

The Fields Penetrate short distances into the body at Radio Frequencies. The Energy of field is absorbed and transferred into the molecules, temperature rise arises due to friction o molecules. Generally it is opposite to Power Density (PD), it is used Measure the EMF Exposure in FAR Field Region.. especially body having highest water content results in high SAR Values.. The Reduction of SAR is an essential issue for the mobile phones and majority of research work is going on this aspect.

$$SAR = \frac{\sigma |E|^2}{\rho}$$

σ = Conductivity of tissue

E = RMS Value of Electric Field

ρ = Density of tissue

Specific Absorption Rate Limits for Different Countries

Table I: SAR Limits

Country	SAR Limit (W/Kg)
Japan	2.0(10 gram)
Korea	1.6(1 gram)
USA & Canada	1.6(1 gram)
EU	2.0(10 gram)
India	1.6(1 gram)

A. Mathematical Expression For SAR & Temperature Rise in Tissue

$$SAR = \frac{\text{Power Absorbed by human tissue}}{\text{Mass of the Tissue}} \quad (1)$$

Power absorbed by human tissue (P) = Voltage (V) * Current (I)

$$\text{Current density (J)} = \frac{\text{Current (I)}}{\text{Area (A)}}$$

$$\text{Current (I)} = \text{Current Density (J)} * \text{Area (A)}$$

$$\text{Electric Field} = \frac{\text{Voltage}}{\text{Length}} = \frac{V}{L}$$

$$\text{Voltage (V)} = \text{Electric Field (E)} * \text{Length (L)}$$

$$\text{Power Absorbed by tissue (P)} = V * I$$

$$P = E * L * J * A$$

Rearranging the equation

$$P = J * E * L * A$$

(Where J = Current Density, E = Electric Field, L = Length, A = Area)

Where Current Density (J) = Conductivity (σ) * Electric Field (E)

$$J = \sigma * E$$

$$P = \sigma * E * L * A$$

Revised Manuscript Received on December 13, 2019.

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$$=E^2LA\sigma$$

Substituted in equation (1)

$$SAR = \frac{E^2\sigma}{\rho} \text{ (W/Kg)}$$

Power Per Unit Area(S) (poynting Theoram) = Electric Field(E)*Magnetic Intensity(H)

$$S=E*H$$

$$\text{Intrinsic impedance } (\eta) = \frac{\text{Electric Field } (E)}{\text{Magnetic intensity } (H)}$$

$$\eta = \frac{E}{H} \text{ (units: ohms)}$$

$$H = \frac{E}{\eta} \text{ (units: amperes/meter)}$$

$$S = E * \frac{E}{\eta}$$

$$SAR = \frac{S\eta\sigma}{\rho}$$

$$\text{Temperature Change } (\Delta T) = \frac{SAR * \Delta t}{C}$$

ΔT = Temperature Change of tissue

Δt = Exposure of Radiations(duration)

C=Tissue specific heat

Clearly SAR is Directly Proportional to $\frac{\Delta T}{\Delta t}$

III. SAR VALUES FOR SOME MOBILE MANUFACTURES (LTE)

Electrical Conductivity of human tissue is increases when frequency is increased, Mobile Terminal Engineers are trying hard to meet the safety limit for head SAR at high frequencies The SAR Value Measured at head having highest absorption Rates. The Long Term Evolution (LTE) offers High data Rates when Compared to GSM 900 and 1800 MHz,

Table II: SAR Values for Different Mobile Manufacturers

S. No	Mobile Manufacturer Name	SAR (Head) (W/Kg)	SAR (Body) (W/Kg)
1.	OPPO Realme1	1.4	0.909
2.	Redmi Note4	0.375	--
3.	MI A1	1.26	--
4.	Cool Pad Mega	0.574	0.982
5.	Samsung Galaxy	0.780	--
6.	Samsung J8	0.697	-
7.	Oppo	0.984	0.433
8.	Redmi Note7 Pro	0.962	0.838
9.	MI Note5 Pro	1.188	0.334
10.	Samsung M20	0.273	--
11.	VIVO V11(PRO)	1.2588	0.482
12.	MI Max	0.838	--
13.	Samsung J7 Nxt	0.610	--
14.	VIVO Y95	1.09	0.32
15.	Samsung J7	0.551	--
16.	OPPO F9 Pro	1.312	0.829
17.	Asus Lite	0.468	0.981
18.	Asus Zen Phone Max	0.454	0.274
19.	VIVO 1606	0.496	0.786
20.	Samsung J3	0.903	--
21.	MI Note 5	0.751	--
22.	Oppo Realme	1.132	0.569
23.	Honor 9	0.42	--
24.	Honor Play	1.10	--

25.	Vivo y69	1.212	1.31
26.	Redmi 4A	0.596	--
27.	Moto E4	0.500	0.914
28.	Realme3	0.976	0.261
29.	Oneplus	1.20	0.68
30.	Honor 7	1.23	--

Total number of Mobiles Verified for SAR=30

Table III: Analysis of the Head SAR Range (Graph)

S. No	SAR Range(W/Kg) for Head	Total No. of Mobiles	Percentage
1	0-0.4	06	20%
2	0.5-0.9	13	43.33%
3	1-1.6	11	36.66%

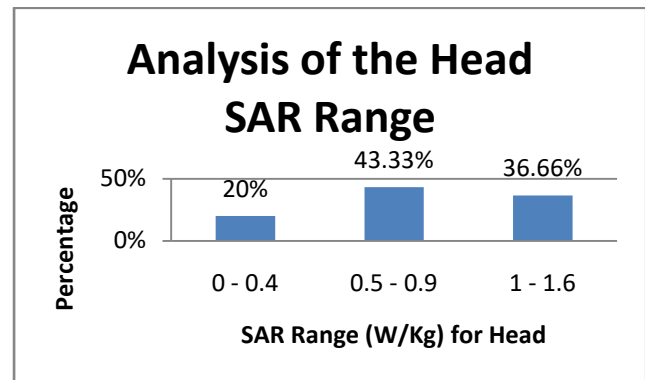


Fig. 1. Analysis of the Head SAR Range

IV. RESULTS & DISCUSSIONS

A. Socio-Demographic Profile:

Total Number of samples taken is 200 in the period of 3 Months. Maximum range of age group 17-50 years. Majority Respondents are in the age group 20-34 years is 148 members(74%),Male Respondents is 138 members(69%) and female Respondents are 62(31%),Most of the Respondents are students 115 members(57.5%) employees were 85(42.5%) and graduating students are 95(47.5%) and post graduates are 105(52.5%).

Table IV: Demographics of Respondents

Demographics	Total	%
Gender - Male	138	69%
Female	62	31%
Occupation		
Students	115	57.5%
Service (Employees)	85	42.5%
Education		
Under Graduation	95	47.5%
Post Graduates (Including Employees and Students)	105	52.5%
Age		
18-24 (students including Graduation and Post Graduation)	62	31%
25-29	32	16%
30-34	54	27%
35-39	26	13%

40-44	15	7.5%
45-50	09	4.5%
Greater than 55	02	1%

Graduation(95)+Post Graduation(20)	Male-10, Female-06		
Employees(85)	14	71	16.4%
	Male-11, Female-03		
Age	Female	male	12%
18-24 (62)	08	54	12%
25-29(32)	06	26	18.75%
30-34(54)	08	46	14.81%
35-39(26)	04	22	15.38%
40-44(15)	03	12	20%
45-50(09)	01	08	11%
Greater than 55 (02)	00	02	0%

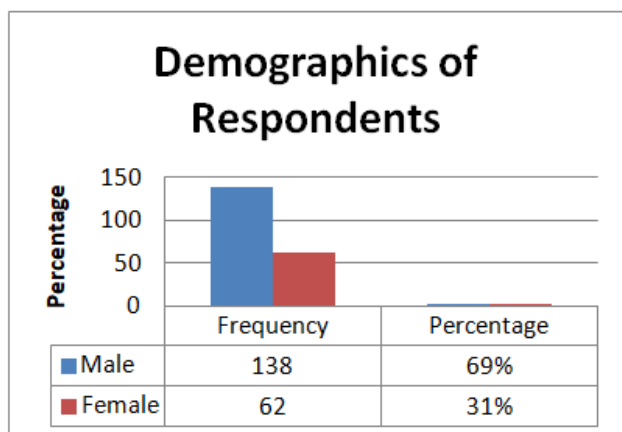


Fig. 2. Analysis of the Head SAR Range

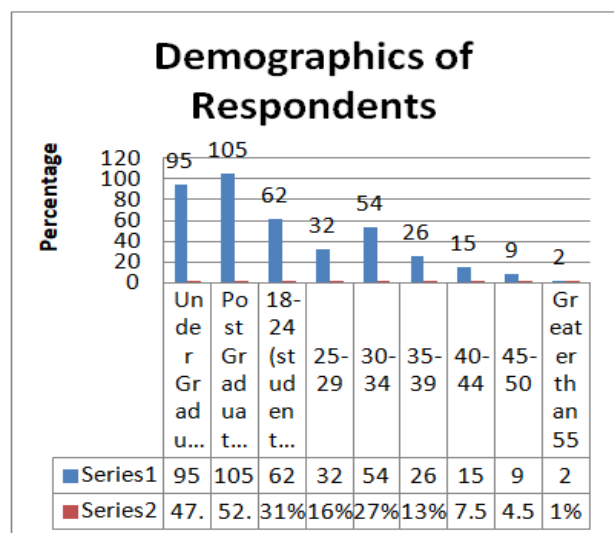


Fig. 3: Analysis of the Head SAR Range

B. Awareness of SAR Value:

Out of 200 samples only 30 members (15%) aware about SAR Value., out of which 14(total 85) (16%) members from service and 16(total 115) from students category(13%).Males are Comparatively aware than females .as only14% of mobile users are aware of SAR value, and safety limit for Mobile as per ICNIRP Guidelines. Generally in India People unaware of Mobile Phones hazards, SAR Value is the most important Parameter to be considered in buying a mobile Phone

Table V: Awareness of SAR Level

Demographics		Awareness		Percentage
		Aware	unaware	
Male	(138)	21	117	15%
Female	(62)	09	53	14%
Education				
Graduation(95)		10	85	10%
		Male-8, Female-02		
Post Graduation(105)		20	85	19%
		Male-13, Female-07		
Occupation				
Students(115)		16	99	13%

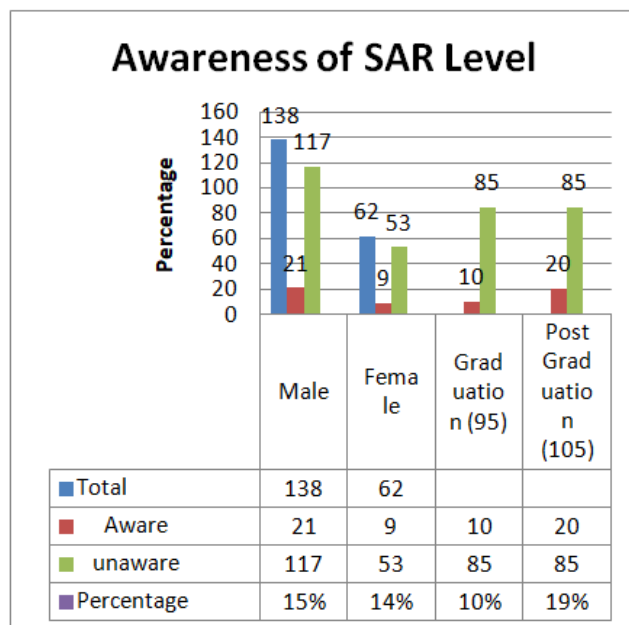


Fig. 4. Analysis of the Head SAR Range

V. RESEARCH ON SAR REDUCTION & ADVERSE EFFECTS OF SAR

Lot of research has been done across the world and many of the techniques and methods are adopted to Reduce the SAR Reduction, but still it is challenge to many of the researchers .Jeong-Haelee et.al[2] designed a Artificial Magnetic Conductor integrated with PIFA to reduce the Specific Absorption Rate. Amirhossein et.al[3]Proposed a Microstrip Patch antenna to reduce Specific Absorption Rate with the help of metal case , Produces 0.52.0.25W/Kg on human head at 0.9 and 2.4 Ghz Respectively. P.R.Arul Jenshiya et.al.[4] Proposed antenna with FR-4 Material as Substrate to Reduce the SAR Value (0.00109W/Kg) for 1g of tissue. .Jalal Khan et.al[5] designed an array of antennas operating in K-band at 28 and 38 Ghz,it gives 0.37 nd 1.34 W/kg for 5G mobile handheld Device. PVY Jayasree et.al[12] modeled a human brain in HFSS and Measured the SAR Values on Skin and Brain(0.95 W/Kg and 0.75 W/Kg) with use of Germanium or Leather as a shield between Mobile antenna and human brain and result taken at different thickness of the shield(0.1 cm and 0.2 cm).

A .Adverse Effects:

Exposure to EMF from Various sources like Mobile Phones , base stations and high voltage Power lines lead to Adverse health effects. With Increase of SAR Values The Common Biological Effect are eye Irritation and cataracts, Fatigue and exhaustion, Anxiety, Sleep disruption and depression and Serious Biological Effects with increasing of SAR Values are Brain Tumors, Alzheimer's disease ,Parkinson's disease, eye cancer, leukemia, Disturbances in Brain Nervous system it leads to bleed in Brain .

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