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Health Hazardous of Specific Absorption Rate (SAR) of Mobile Phone Tower Waves

Mushtaq Ahmed Bhat [1]

Department of Physics Graphic Era University Dehradun (U. K)

Abstract: The physiological mechanism of mobile phone radiation related health effect is not well known. Mobile phone and their tower radiations affect human skin and blood. Those People who often talk on mobile phone handset or living near their tower have higher interaction with radiation. In this paper penetration of high frequency electromagnetic waves emitted from mobile phone tower into human skin and blood tissues was studied. The effect of specific absorption rate (SAR) was calculated at frequencies 800, 900, 1800 and 2450 MHz and effective radiated power from the mobile phone tower is taken as 20 Watts.

Keywords: Mobile Phone Tower, Electromagnetic Waves, Skin And Blood Tissues, Specific Absorption Rate.

I. INTRODUCTION

The measured rate at which energy is absorbed by the human body when exposed to a radio frequency (RF) electromagnetic field (EMF) is specific absorption rate (SAR). It is also defined as the power absorbed by the tissue per unit mass and is measure in watts per kilogram (W/kg). SAR is usually averaged either over the whole body or over a body tissue. The SAR is determined at the highest certified power level, the actual SAR level of the device while operating can be well below the maximum value. If we measure the specific absorption rate then mobile phone handset should be placed at the head in a talk position. Specific absorption rate value is then measured at the highest location of absorption rate in the entire head, which the mobile phone handset is often as close to their antenna as possible [1]. SAR values increase with the increase of conductivities of human body tissues and decreases with the increase of relative permittivity of human body tissues. Specific absorption rate describes the possible biological effects of RF fields. The high energy radio frequency field exposure causes thermal effects in biological tissues and generates high SAR values. This is called non-thermal effect. The effect of dielectric values of human body on SAR is frequency dependent and orientation of human body [2]. The maximum increase in temperature of human head tissue is due to specific absorption rate (SAR).

A number of countries have their own regulations for occupational exposure and general public exposure to radiofrequency electromagnetic radiation. For instance, the SAR limits adopted by Japan and South Korea are based on the ICNIRP limits [3] whereas those adopted by the USA and Canada are based on the ANSI/IEEE limits [4]. For USA, Australia and some other countries, certain devices operating within close proximity to human body such as mobile phone handsets and satellite phone handsets are required to have mandatory SAR compliance testing or evaluation. Although an international standard for SAR testing or evaluation is not yet available, the regionally recognized standards such as ANSI/IEEE 19925 and EN 50361 are used by some overseas countries [2]. Specific absorption rate values are dependent upon the size of the averaging volume. Comparisons between different measurements cannot be made without information averaging volume used. There is confusion and misunderstanding about the specific absorption rate values for mobile phones and other wireless system. In case of mobile phone, the rate of radiofrequency energy absorption by the body can be measured by specific absorption rate. SAR gives meaning for measuring the radiofrequency exposure of mobile phone waves within the safety guidelines set by the Federal Communications Commission [5].Many people consider that using mobile phone handset with a lower value of specific absorption rate is safer than the mobile phone handset having high specific absorption value. Actually specific absorption value is an important tool in checking the maximum possible exposure to radiofrequency energy from a particular model of mobile phone handset. A single value of specific absorption rate does not give complete information about the amount of radiofrequency exposure [6].

II. CALCULATIONS OF PENETRATED ELECTRIC FIELD AND SPECIFIC ABSORPTION RATE (SAR)

If mobile phone tower is consider as point source, the radiation is emitted around are as spherical wave front of radius r. Let E_0 be the incident electric field and P is power of radiation around the transmission tower, then

[1] *Corresponding Author: dmbhat5979@gmail.com*

Radiating power per unit area is represented by.

$$\frac{P}{4\pi r^2} = \frac{1}{2}\varepsilon_0 E_0^2 c$$

$$E_0 = \left[\frac{P}{2\pi r^2 \varepsilon_0 c}\right]^{\frac{1}{2}} = \frac{7.746\sqrt{P}}{r} \quad \text{……..……} \tag{1}$$

Where ε_0 is the permittivity of free space and c the velocity of radiation

If the mobile phone tower of power radiates 20W power, the electric field can be calculated by

$E_0 = 34.641/r$ ……..……..…..…..…... (2)

Penetrated electric field inside the biological tissues can be calculated by the equation

$E_z = E_0 e^{(-z/\delta)}$ ……..……..…. (3)

Where E_z is the field inside the depth z, E_0 is the magnitude of field inside the boundary and δ is skin depth. For biological materials skin depth is given by

$$\delta = \frac{1}{\omega q} \text{……..……} \tag{4}$$

Where σconductivity of biological material and ω is is angular frequency of radiation.

Standard values

- At 2450 MHz , σ = 1.5919 W K^{-1} m^{-1} , skin depth δ = 28.808 mm,
- At 1800 MHz , σ = 1.232 W K^{-1} m^{-1} , skin depth δ = 28.808 mm,
- At 900 MHz , σ = 0.84465 W K^{-1} m^{-1} , of skin depth δ = 43.352 mm
- At 800 MHz ,σ = 0.80864 W K^{-1} m^{-1} , skin depth δ = 45.59mm,
- z= 0.1mm, 0.2mm, 0.3mm, 0.4mm and 0.5mm

The value of density ρ for blood=1060 kg m^{-3}, for skin=1070 kg m^{-3}

For frequency of EMW of 10 MHz–10 GHz its safe limit =0.4 W/kg [3].

Reference levels for general public exposure to time-varying electric fields with frequency (f**)** [3].

For frequency f=2450 MHz, E=68.059 V/m

For frequency f=1800 MHz, E=58.33 V/m

For frequency f=900 MHz, E=40.35 V/m

For frequency f=800 MHz, E=38.89 V/m

By Pointing vector theorem SAR can be define as

$$SAR = \frac{\sigma E_i^2}{\rho} \quad \text{…….……..……} \tag{5}$$

Where Ei is the field inside that material,σ is the conductivity of the material.

This relation shows that the rate of electromagnetic energy is converted into heat energy through well interaction mechanisms.

For frequency of EMW of 10 MHz–10 GHz its safe limit =0.4 W/kg [3]

III. RESULT AND DISCUSSION

For the calculation of SAR inside the body, the distance from mobile phone tower radiation are taken from 1m to 50 m for this study of skin, blood, tissues at four frequencies namely 800, 900, 1800 and 2450 MHz and power of radiation for mobile phone tower is taken 20W.

Table1. *SAR inside the skin due to the electromagnetic wave of 800 MHz frequency of mobile phone tower at depths 0.1 mm to 0.5 mm inside the body from 1 m to 50 m from the mobile phone tower.*

Distance from tower in (m)	SAR for skin at f=800 MHz				
	0.1	**0.2**	**0.3**	**0.4**	**0.5**
1	**0.901508**	**0.897562**	**0.893633**	**0.889722**	**0.885827**
5	0.03606	0.035902	0.035745	0.035589	0.035433
10	0.009015	0.008976	0.008936	0.008897	0.008858
15	0.004007	0.003989	0.003972	0.003954	0.003937
20	0.002254	0.002244	0.002234	0.002224	0.002215
25	0.001442	0.001436	0.00143	0.001424	0.001417
30	0.001002	0.000997	0.000993	0.000989	0.000984
35	0.000736	0.000733	0.000729	0.000726	0.000723
40	0.000563	0.000561	0.000558	0.000556	0.000554
45	0.000445	0.000443	0.000441	0.000439	0.000437
50	0.000361	0.000359	0.000357	0.000356	0.000354

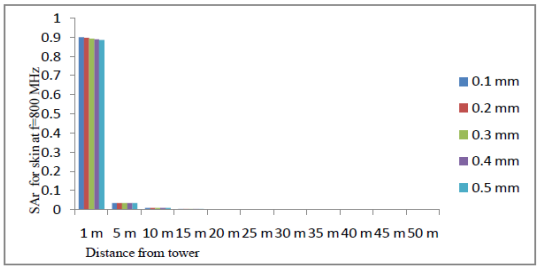

Fig1. *The variation of SAR in W/Kg for skin (tower) at frequency 800 MHz.*

Table2. *SAR inside the skin due to the electromagnetic wave (900 MHz) of mobile phone tower at depths 0.1 mm to 0.5 mm inside the body from 1 m to 50 m from the mobile phone tower.*

Distance from tower in (m)	SAR for skin at f=900 MHz				
	0.1	**0.2**	**0.3**	**0.4**	**0.5**
1	**0.941441**	**0.937108**	**0.932794**	**0.928501**	**0.924227**
5	0.037658	0.037484	0.037312	0.03714	0.036969
10	0.009414	0.009371	0.009328	0.009285	0.009242
15	0.004184	0.004165	0.004146	0.004127	0.004108
20	0.002354	0.002343	0.002332	0.002321	0.002311
25	0.001506	0.001499	0.001492	0.001486	0.001479
30	0.001046	0.001041	0.001036	0.001032	0.001027
35	0.000768	0.000765	0.000761	0.000758	0.000754
40	0.000588	0.000586	0.000583	0.00058	0.000578
45	0.000465	0.000463	0.000461	0.000459	0.000456
50	0.000376	0.000375	0.000373	0.000371	0.00037

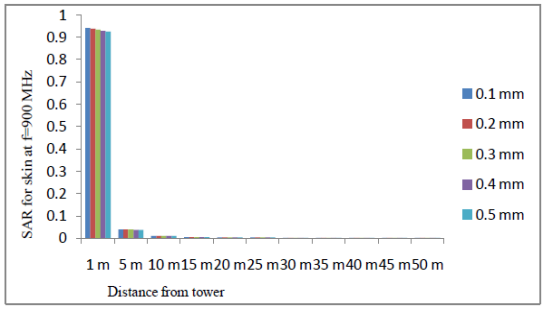

Fig2. *The variation of SAR in W/Kg for skin at frequency 900 MHz*

Table3. *SAR inside the skin due to the electromagnetic wave (1800 MHz) of mobile phone tower at depths 0.1 mm to 0.5 mm inside the body from 1 m to 50 m from the mobile phone tower.*

Distance from tower in (m)	SAR for skin at f=1800 MHz				
	0.1	**0.2**	**0.3**	**0.4**	**0.5**
1	**1.369984**	**1.360506**	**1.351093**	**1.341745**	**1.332463**
5	0.054799	0.05442	0.054044	0.05367	0.053299
10	0.0137	0.013605	0.013511	0.013417	0.013325
15	0.006089	0.006047	0.006005	0.005963	0.005922
20	0.003425	0.003401	0.003378	0.003354	0.003331
25	0.002192	0.002177	0.002162	0.002147	0.002132
30	0.001522	0.001512	0.001501	0.001491	0.001481
35	0.001118	0.00111	0.001103	0.001095	0.001088
40	0.000856	0.00085	0.000844	0.000838	0.000833
45	0.000677	0.000672	0.000667	0.000663	0.000658
50	0.000548	0.000544	0.00054	0.000537	0.000533

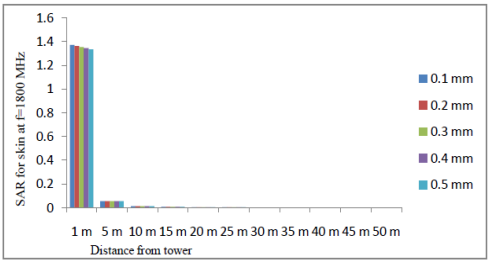

Fig3. *The variation of SAR in W/Kg for skin at frequency 1800 MHz.*

Table4. *SAR inside the skin due to the electromagnetic wave (2450 MHz) of mobile phone tower at depths 0.1 mm to 0.5 mm inside the body from 1 m to 50 m from the mobile phone tower.*

Distance from tower in (m)	SAR for skin at f=2450 MHz				
	0.1	**0.2**	**0.3**	**0.4**	**0.5**
1	**1.766415**	**1.75045**	**1.73463**	**1.718952**	**1.703417**
5	0.070657	0.070018	0.069385	0.068758	0.068137
10	0.017664	0.017505	0.017346	0.01719	0.017034
15	0.007851	0.00778	0.007709	0.00764	0.007571
20	0.004416	0.004376	0.004337	0.004297	0.004259
25	0.002826	0.002801	0.002775	0.00275	0.002725
30	0.001963	0.001945	0.001927	0.00191	0.001893
35	0.001442	0.001429	0.001416	0.001403	0.00139
40	0.001104	0.001094	0.001084	0.001074	0.001065
45	0.000872	0.000864	0.000857	0.000849	0.000841
50	0.000706	0.0007	0.000694	0.000687	0.000681

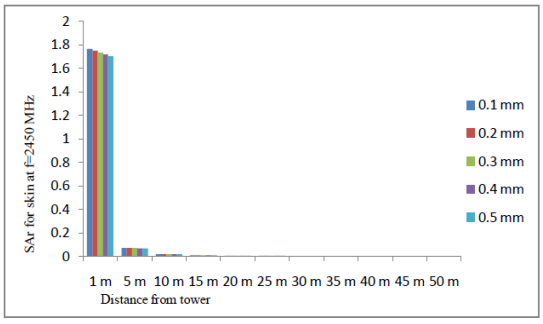

Fig4. *The variation of SAR in W/Kg for skin at frequency 2450 MHz*

Table5. *SAR inside the blood due to the electromagnetic wave (800 MHz) of mobile phone tower at depths 0.1 mm to 0.5 mm inside the body from 1 m to 50 m from the mobile phone tower.*

Distance from tower in (m)	SAR for blood tissue at f=800 MHz				
	0.1	**0.2**	**0.3**	**0.4**	**0.5**
1	**1.678806**	**1.667201**	**1.655676**	**1.644231**	**1.632865**
5	0.067152	0.066688	0.066227	0.065769	0.065315
10	0.016788	0.016672	0.016557	0.016442	0.016329
15	0.007461	0.00741	0.007359	0.007308	0.007257
20	0.004197	0.004168	0.004139	0.004111	0.004082
25	0.002686	0.002668	0.002649	0.002631	0.002613
30	0.001865	0.001852	0.00184	0.001827	0.001814
35	0.00137	0.001361	0.001351	0.001342	0.001333
40	0.001049	0.001042	0.001035	0.001028	0.00102
45	0.000829	0.000823	0.000818	0.000812	0.000806
50	0.000671	0.000667	0.000662	0.000658	0.000653

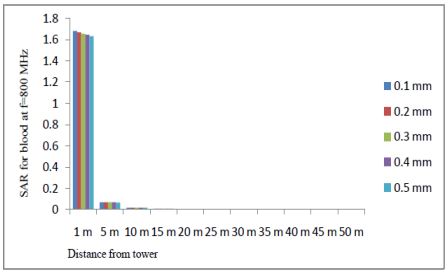

Fig5. *The variation of SAR in W/Kg for blood at frequency 800 MHz.*

Table6. *SAR inside the blood due to the electromagnetic wave (900 MHz) of mobile phone tower at depths 0.1 mm to 0.5 mm inside the body from 1 m to 50 m from the mobile phone tower*

Distance from tower in (m)	SAR for blood tissue at f=900 MHz				
	0.1	**0.2**	**0.3**	**0.4**	**0.5**
1	**1.725856**	**1.713497**	**1.701226**	**1.689043**	**1.676947**
5	0.069034	0.06854	0.068049	0.067562	0.067078
10	0.017259	0.017135	0.017012	0.01689	0.016769
15	0.00767	0.007616	0.007561	0.007507	0.007453
20	0.004315	0.004284	0.004253	0.004223	0.004192
25	0.002761	0.002742	0.002722	0.002702	0.002683
30	0.001918	0.001904	0.00189	0.001877	0.001863
35	0.001409	0.001399	0.001389	0.001379	0.001369
40	0.001079	0.001071	0.001063	0.001056	0.001048
45	0.000852	0.000846	0.00084	0.000834	0.000828
50	0.00069	0.000685	0.00068	0.000675	0.000671

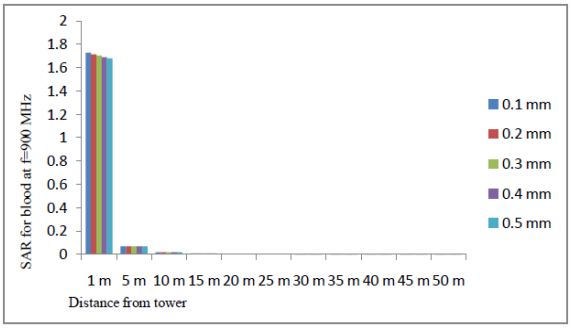

Fig6. *The variation of SAR in W/Kg for blood at frequency 900 MHz.*

Table7. *SAR inside the blood due to the electromagnetic wave (1800 MHz) of mobile phone tower at depths 0.1 mm to 0.5 mm inside the body from 1 m to 50 m from the mobile phone tower.*

Distance from tower in (m)	SAR for blood tissue at f=1800 MHz				
	0.1	**0.2**	**0.3**	**0.4**	**0.5**
1	**2.287148**	**2.264728**	**2.242528**	**2.220546**	**2.19878**
5	0.091486	0.090589	0.089701	0.088822	0.087951
10	0.022871	0.022647	0.022425	0.022205	0.021988
15	0.010165	0.010065	0.009967	0.009869	0.009772
20	0.005718	0.005662	0.005606	0.005551	0.005497
25	0.003659	0.003624	0.003588	0.003553	0.003518
30	0.002541	0.002516	0.002492	0.002467	0.002443
35	0.001867	0.001848	0.00183	0.001812	0.001795
40	0.001429	0.001415	0.001401	0.001388	0.001374
45	0.001129	0.001118	0.001107	0.001097	0.001086
50	0.000915	0.000906	0.000897	0.000888	0.000879

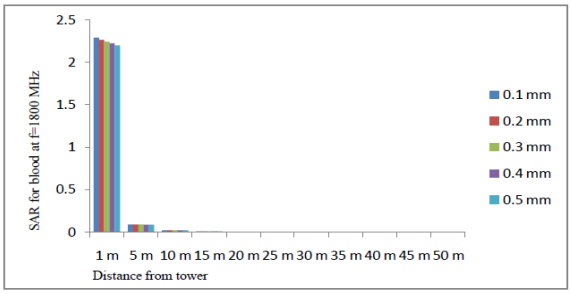

Fig7. *The variation of SAR in W/Kg for blood at frequency 1800 MHz.*

Table 8. *SAR inside the blood due to the electromagnetic wave (2450 MHz) of mobile phone tower at depths 0.1 mm to 0.5 mm inside the body from 1 m to 50 m from the mobile phone tower.*

Distance from tower in (m)	SAR for blood tissue at f=1800 MHz				
	0.1	**0.2**	**0.3**	**0.4**	**0.5**
1	**2.840951**	**2.805926**	**2.771332**	**2.737165**	**2.703419**
5	0.113638	0.112237	0.110853	0.109487	0.108137
10	0.02841	0.028059	0.027713	0.027372	0.027034
15	0.012626	0.012471	0.012317	0.012165	0.012015
20	0.007102	0.007015	0.006928	0.006843	0.006759
25	0.004546	0.004489	0.004434	0.004379	0.004325
30	0.003157	0.003118	0.003079	0.003041	0.003004
35	0.002319	0.00229	0.002262	0.002234	0.002207
40	0.001775	0.001754	0.001732	0.001711	0.001689
45	0.001403	0.001386	0.001369	0.001352	0.001335
50	0.001136	0.001122	0.001108	0.001095	0.001081

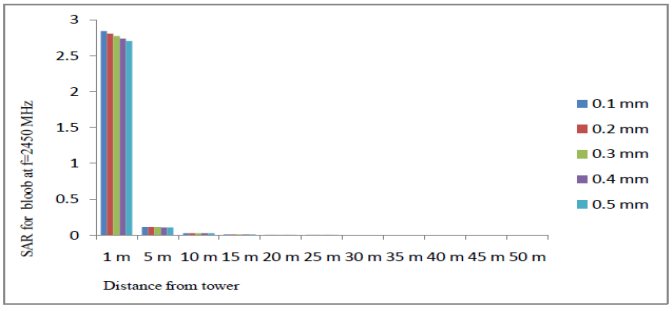

Fig8.*The variation of SAR in W/Kg for blood at frequency 2450 MHz.*

IV. CONCLUSIONS

According to some International agencies International Commission of Non-Ionizing Radiation Protection and World Health Organization, the specific absorption rate (SAR) becomes harmful after 0.4 W per kg of the body weight and for person of weight 76 kg, the safe limit of specific absorption rate is 120 W/kg. It means that SAR may be harmful for the tissue life of the human being, if their values become greater than 120 W/kg. Bold data in tables shows harmful effect.

Table 1 represents specific absorption rate (SAR) for skin tissues due to EMW of frequency 800 MHz This shows that the value of SAR decreases as the distance is increased. After comparing the data it is found that at 800 MHz frequency of mobile phone tower SAR is harmful for the life of the skin tissues up to 1m distance from the body till 0.5 mm depth.

Table 2 represents SAR for muscle tissues due to EMW of frequency 900 MHz After comparing the data it is found that at 900 MHz frequency of mobile phone tower SAR is harmful for the life of the skin tissues up to 1m distance from the body till 0.5 mm depth.

Table 3 represents SAR for skin tissues due to EMW of frequency 1800 MHz It is found that at 1800 MHz frequency of mobile phone tower SAR is harmful for the life of the skin tissues up to 1m distance from the body till 0.5 mm depth.

Table 4 represents SAR for skin tissues due to EMW of frequency 2450 MHz The value of SAR decreases as the distance is increased. After comparing the calculated data it is found that at 2450 MHz frequency of mobile phone tower SAR is harmful for the life of the skin tissues up to 1m distance from the body till 0.5 mm depth.

Table 5 represents SAR for bone tissues due to EMW of frequency 800 MHz From this it is found that at 800 MHz frequency of mobile phone tower SAR is safe for the life of the blood tissues up to 1m distance from the body till 0.5 mm depth.

Table 6 represents SAR for blood tissues due to EMW of frequency 900 MHz This shows that at 900 MHz frequency of mobile phone tower SAR is safe for the life of the blood tissues up to 1m distance from the body till 0.5 mm depth.

Table 7 represents SAR for blood tissues due to EMW of frequency 1800 MHz . This shows that the value of SAR decreases as the distance is increased. After comparing the data it is found that at 1800 MHz frequency of mobile phone tower SAR is safe for the life of the blood tissues up to 1m distance from the body till 0.5 mm depth.

Table 8 represents SAR for blood tissues due to EMW of frequency 2450 MHz This shows that the value of SAR decreases as the distance is increased. After comparing the data it is found that at 2450 MHz frequency of mobile phone tower, SAR is safe for the life of the blood tissues up to 1m distance from the body till 0.5 mm depth.

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