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Potential Risk and Health Safety Analysis of Mobile Phones with Different Radition Levels Using SAR and Connect Value Measures in India.

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ABSTRACT

Mobile phones are become sixth finger of human beings. Latest statistical report reveals that the number of cell phone is greater than the human population in some countries. Cell phones emit radiofrequency in different ranges. There are many research works are conducted by scientists to identify the biological effects of the radiofrequency energy emitted by cell phones. While some researchers have reported biological changes associated with RF energy, these studies have failed to be replicated. This work proposed the study and analysis of radio frequency emission of Mobile phones based on SAR value and Connect value.

Keywords: Mobile phone, Radio frequency, SAR value, Connect value

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INTRODUCTION

India has rapid growth in wireless communication [1, 2]. The important reasons for unbelievable increase of mobile usage is growing population (especially youth (35 % of overall population)) and increase of smartphone penetration. It enables the mobile user to access many personal and public applications through hand hold device. The implementation of mobile technology [3] with Internet results sudden increase of digital communication among individuals and in social medium. Another important point is the ministry of information technology in India has taken much advancement in Telecommunciation development. Its regulatory bodies such as Telephone Regulatory Authority of India (TRAI) and Internet and Mobile Association of India (IAMAI) regularised call, sms and internet access rates at nominal costs. According to the data provided by Ministry of Communications and IT, India has nearly 7, 36,654 base transceiver stations in allover the country till 2012. The TRAI statistical report [3, 4] stated that there are 971 (up to 2014) million mobile subscribers in India. India is the second largest telephone user country and third largest internet user's country in the world. Whenever the technology grows, its defects and side effects will also be considered.

Need for Analysis

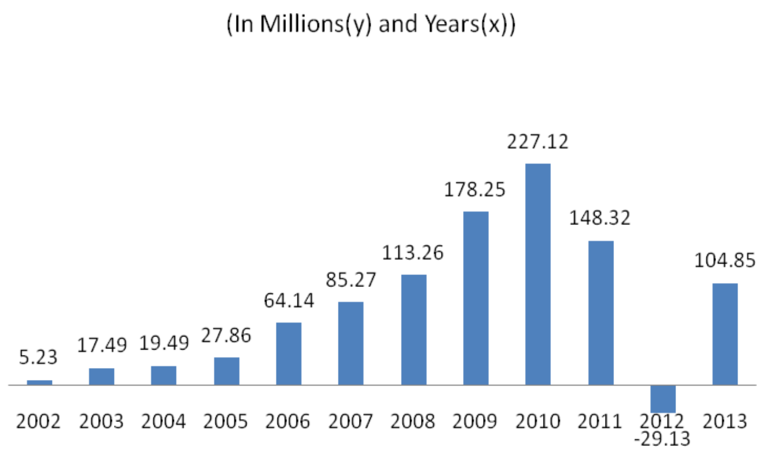
India is one of the largest and fastest growing telecom markets in the world. The population of India shows high potential value to the investors. The teledensity is nearly 75%. The following Table (1) illustrates the gradual increase of mobile subscriber additions (in millions) in India since January 2002.

Table 1: Annual addition of mobile users

Year	Annual Additions (In millions)
2002	5.23
2003	17.49
2004	19.49
2005	27.86
2006	64.14
2007	85.27
2008	113.26
2009	178.25
2010	227.12
2011	148.32
2012	-29.13
2013	104.85

There has been a rapid increase in the use of wireless communications devices and a great deal of research has been carried out to investigate possible biological or human health effects resulting from their use.

Figure 1: Mobile Subscriber Additions in India



The Telecom Regulatory Authority of India (TRAI) [4] was established in the year 1997, to regulate telecom services, mobile handsets, tariff fixation and revision for telecom.

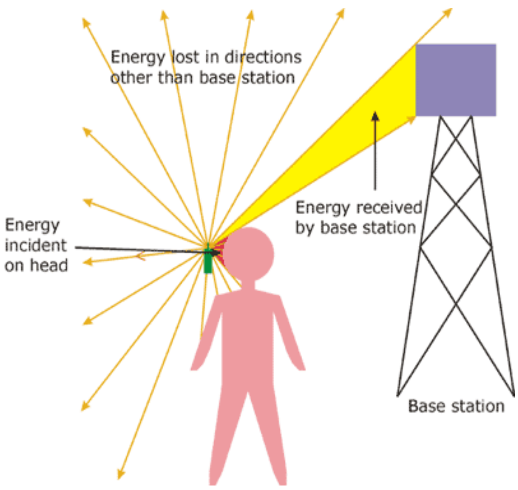
SPECIFIC ABSORPTION RATIO

Specific Absorption Rate [5] is an indicator for the amount of radiation that is absorbed into a head while using a cellular phone, the higher the SAR rating the more radiation that is absorbed into the head. A SAR value is a measure of the maximum energy absorbed by a unit of mass of exposed tissue of a person using a mobile phone, over a given time or more simply the power absorbed per unit mass. In the year 2012 ,TRAI [5,6] proposed the SAR value ranges from 0.0 W/kg as minimum and 1.6 W/kg as maximum where as exceeded SAR valued handsets are not recommended to sell and use.The SAR value is averaged over 1 gram of human tissue since it was 2 W/kg over 1 gram human tissue.

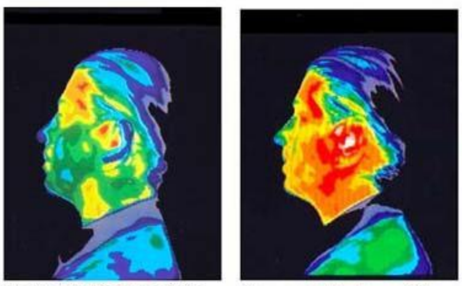
Energy transmission

	Postion	SAR 10g (W/Kg)
GSM 900	Head	0.338
	Body	0.749
DCS 1800	Head	0.092
	Body	0.753
WCDMA Band I	Head	0.136
	Body	0.751
WCDMA Band VII	Head	0.270
	Body	0.315

Radiation indications



Band and SAR Value



Thermographic Image of the head with no exposure to harmful cell phone radiation.

Thermographic Image of the head after a 15-minute phone call. Yellow and red areas indicate thermal (heating) effects that can cause negative health effects.

SAR Measures

SAR values [7] are usually expressed in units of watts per kilogram (W/kg) in either 1g or 10g of tissue. Absorption Rate is usually averaged either over the whole body or ever by an amount of sample volume from either 1 g or 10 g of tissue. The value cited is then the maximum level measured in the body part studied over the stated volume or mass.

$$\mathrm{SAR} = \int_{\mathrm{sample}} \frac{\sigma(\mathbf{r})|\mathbf{E}(\mathbf{r})|^2}{\rho(\mathbf{r})} d\mathbf{r}$$

Where σ is the sample electrical conductivity, **E** is the RMS electric field, ρ is the sample density.

SAR measures exposure to fields as radio waves ranges from 100 kHz to 10 GHz and it is commonly used to measure power absorbed from mobile phones and other devices. The value will depend heavily on the geometry of the part of the body that is exposed to the RF energy and on the exact location and geometry of the RF source. Thus tests must be made with each specific source, such as a mobile phone model, and at the intended position of use.When measuring the SAR to a mobile phone the phone is placed at the head in a talk position. The SAR value is then measured at the location that has the highest absorption rate in the entire head, which in the case of a mobile phone is often as close to the phone's antenna as possible. Based on the RF, various governments have defined maximum SAR levels for RF energy emission. The limitation of SAR value can vary in different countries. Most of the countries are following the limitations of United States and European stantdards. Federal Communication Commission (FCC) [8] a body of United States of America standardized SAR values for phones sold level at or below 1.6 watts per kilogram (W/kg) taken over the volume containing a mass of 1 gram of tissue that is absorbing the most signal. Commité Européen de Normalisation Électrotechnique (CENELEC) [9] a body of European Union SAR limit is valu limit is 2 W/kg averaged over the 10 g of tissue absorbing the most signal. In India Telecommunication Engineering center (TEC) a division of Indian government initially followed CENELEC standard and later switched in to FCC standards. The important thing is SAR values are heavily dependent on the size of the averaging volume. Without information about the averaging volume used, comparisons between different measurements cannot be made.

SAR Limitations

Today SAR is the commonly used standardized measure for Radio Frequency emission in mobile phones. Although mobile phones are sold with SAR values, the transmission rate, body heat, and device heat emission values are not considered. The increase of device heat can also cause increase in radiation. The heat of human body may also vary with respect to person and environment.These states that SAR value is not alone a sufficient measure. The world health organization [10, 11] investigated and classified the cause of radiation of human body is based on its exposure levels. It states the distance between the device and human body. Based on that, the health effects [10,12], may either short-term or long-term.The short term effect leads to tissue heating, head ache and cause electro magnetic hyper sensitivity.The long term effect leads to nervous damage in brain, cause of tumor. However there is no strong proof is available that the mobile radiation causes cancer but the epidermological studies evident that after introduction of mobile phone in 1990s, there is a sudden increase of cancer disease compare with the consistent growth cause of cancer to animals.Several studies are intiated to get the proof of cancer risk exposure for using mobile phones. This work focuses to improve the standards of RF energy measures and ensuring the consistency to monitor the RF emission values. To improve the SAR value measure, additional testing features should be included.

Connect Value

The Connect value is introduced by a german magazine [13] based on Metcalfe's law [14] which states that the value of a telecommunications network is proportional to the square of the number of connected users of the system (n^2) The connect value is a new measurement which includes different factors besides SAR. It is called as Connect radiation value. This value consists not only of the SAR value but also the effective power and transmisssion features. Its important features are mobile heat emission [15] and transmission power. When these two factors are added with SAR value the consistent radiation of mobile phone can be identified. According to connect value, the amount of radio frequency RF emission [16] can be positive and negative. The negative indication shows that the device has no increase of radiation at the time of mobile transmission. A negative value in the comparisons means that the value is lower than the average value. A positive value indicates an above average radiation load of the particular phone. The table shows various speed and technology used in electromagnetic ware transmission.

Table 2: Various Transmission Technologies

Spectrum	Technology	Speed
2G	GSM	9.6 kbps or HSCSD (multiple)
2.5G	GPRS	9.6 kbps or HSCSD (multiple)
3G	UMTS	384 kbps
3.5G	HSDPA	14 Mbps
4G	LTE	100 Mbps

Electromagnetic radiation] consists of electrical and magnetical radiation. This radiation exists in many different frequencies. Low frequencies are often found in computers and electrictronic equipment. High frequencies are often found in mobile phones.The value is the most effective transmission power in relation to the SAR value. Therefore purhcase of least connect valued handsets gives less radiation. It is unclear of which exact features the value consists.

ANALYSIS AND MODEL COMPARISIONS

There are various technologies are widely used in mobile communications. For analysis, the GSM technology is taken because it is highly used by the network providers in India. The table 3 and 4 shows nearly 10 handset models [17] each with SAR and connect value from lower to higher values respectively.

Table 3:
Samsung Mobiles with Low SAR and Connec

Producer	Model	SAR Value	Connect Value
Samsung	Galaxy Note II N7100	0.17	-0.8
Samsung	Galaxy Note N7000	0.26	-0.76
Samsung	Galaxy Beam	0.28	-0.63
Samsung	Galaxy 551	0.38	-0.63
Samsung	S5550	0.6	-0.61
Samsung	Wave 533	0.32	-0.59
Samsung	Galaxy S3	0.34	-0.54
Samsung	Galaxy S2 i9100	0.34	-0.53
Samsung	E2370	0.41	-0.5
Samsung	i9000 Galaxy	0.24	-0.5

Table 4:
Sony Mobiles with Low SAR and Connect Values Values

Producer	Model	SAR Value	Connect Value
SonyEricsson	Xperia Play	0.36	-0.67
SonyEricsson	Xperia X2	0.9	-0.53
SonyEricsson	Hazel	0.68	-0.44
SonyEricsson	Xperia Mini Pro	0.46	-0.2
SonyEricsson	Xperia X8	0.84	-0.13
SonyEricsson	Xperia Pro	0.88	-0.1
SonyEricsson	Xperia Arc S	0.66	0.03
SonyEricsson	Xperia Arc	0.66	0.06
SonyEricsson	Xperia Mini	0.78	0.09
SonyEricsson	Vivaz pro	1.03	0.09
SonyEricsson	Xperia Mini	0.78	0.09

Similarly tables 5, 6 and 7 shows the different SAR and Connect values.Note that some of the models are having high SAR value with negative connect values. This states that the priority must give to connect value along with SAR value.

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Table 5: Sony Ericcsion Mobiles with Low SAR and Connect Values

Producer	Model	SAR Value	Connect Value
SonyEricsson	Xperia Play	0.36	-0.67
SonyEricsson	Xperia X2	0.9	-0.53
SonyEricsson	Hazel	0.68	-0.44
SonyEricsson	Xperia Mini Pro	0.46	-0.2
SonyEricsson	Xperia X8	0.84	-0.13
SonyEricsson	Xperia Pro	0.88	-0.1
SonyEricsson	Xperia Arc S	0.66	0.03
SonyEricsson	Xperia Arc	0.66	0.06
SonyEricsson	Xperia Mini	0.78	0.09
SonyEricsson	Vivaz pro	1.03	0.09
SonyEricsson	Xperia Mini	0.78	0.09

Table 6: Blackberry Mobiles with Low SAR and Connect Values

Producer	Model	SAR Value	Connect Value
RIM/Blackberry	Curve 3G	1.09	-0.58
RIM/Blackberry	Blackberry Torch 9860	0.92	-0.3
RIM/Blackberry	Torch 9800	0.91	-0.17
RIM/Blackberry	Blackberry Bold 9780	1.15	-0.03
RIM/Blackberry	Blackberry Bold 9900	0.77	0.05
RIM/Blackberry	Storm2 9520	1.02	0.18
RIM/Blackberry	Blackberry Torch 9810	0.97	0.29
RIM/Blackberry	Blackberry Curve 9790	1.47	0.36
RIM/Blackberry	Pearl 3G	1.38	0.76
RIM/Blackberry	Blackberry Curve 9360	1.47	1.15

Table 7: Nokia Mobiles with Low SAR and Connect Values

Producer	Model	SAR Value	Connect Value
Nokia	E7-00 (RM-626)	0.56	-0.26
Nokia	6700 Slide	0.91	-0.26
Nokia	E5 (RM-634; RM-632)	0.88	-0.24
Nokia	3710 Fold (RM-509)	0.95	-0.19
Nokia	Lumia 920 (RM-820)	0.7	-0.12
Nokia	500	1.18	-0.08
Nokia	X7 (RM-707)	0.94	-0.02
Nokia	Lumia 710 (RM-803)	1.3	-0.02
Nokia	X3 (RM-540)	0.73	0
Nokia	E6-00 (RM-609)	1.14	0.05
Nokia	2710 Navigation Edition	0.73	0.07
Nokia	2690	0.66	0.13
Nokia	C7-00 (RM-675)	0.73	0.14
Nokia	C3-01 Touch and Type	1.18	0.17
Nokia	7230	0.97	0.18
Nokia	C6-00 (RM-612)	1.05	0.28
Nokia	5230	1.1	0.28
Nokia	2730 classic	1.02	0.3

RESULTS AND DISCUSSION

From the analysis, the results show all the mobile manufactures have low SAR valued modles and vice versa. Inorder to measure transmission rate and power, the connect value is used with SAR. The addition of connect values denotes that some of the devices with least SAR value requires more power and needs high transmission to transmit and receive the signals. For further work all the models are compared and most least connect valued mobile phones are listed in Table (8).

Table 8: Different Model Mobile Phones with Low SAR and Connect Values

Producer	Model	SAR Value	Connect Value
Samsung	Galaxy Note II N7100	0.17	-0.8
Samsung	Galaxy Note N7000	0.26	-0.76
SonyEricsson	Xperia Play	0.36	-0.67
Samsung	Galaxy Beam	0.28	-0.63
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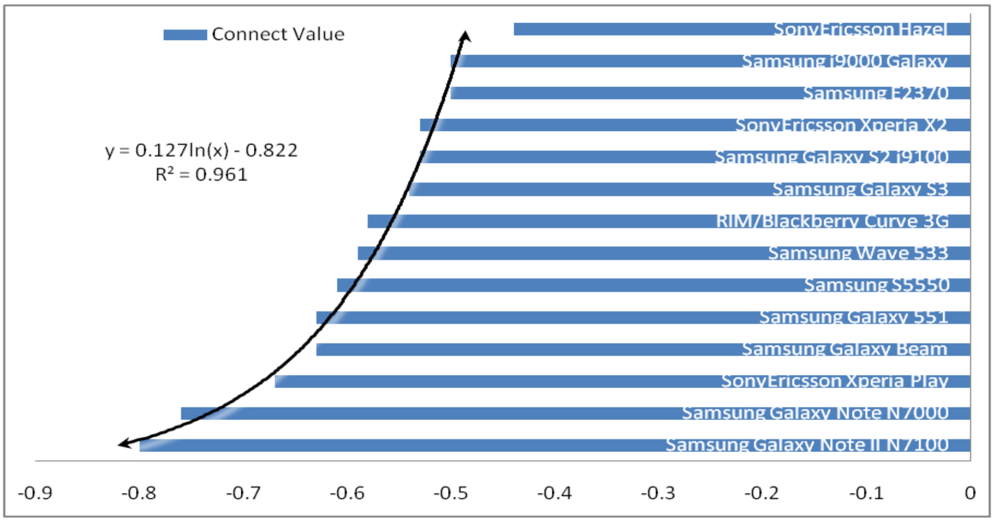
Samsung	Galaxy S2 i9100	0.34	-0.53
SonyEricsson	Xperia X2	0.9	-0.53
Samsung	E2370	0.41	-0.5
Samsung	i9000 Galaxy	0.24	-0.5
SonyEricsson	Hazel	0.68	-0.44

From the above anaylis, among mobile devices, over 50% of the Samsung mobiles achieved very SAR value as well as Connect value. The other mobile devices are also very closer to Samsung.

Figure 2: Connect Value of Mobile Phones



The aim of the work is not to identify the best brand rather finding the least SAR with Connect value model mobile phones. From the year 2013 onwards, the Indian government implemented FCC regualations for manufacturing mobile phones. But the regulations have no measures for transmission rate and power.

Fortunately most of the mobile devices manufactures are adhering connect values. Only few manufactures are selling mobiles without SAR and connect values.

From the detailed study, the findings are given as suggestions From detailed study, some of the important findings should be noticed

- The government has to consider transmission rate and power emission measure are mandetary feature for selling mobile phones
- The radiation limitation standards must be revised with SAR and Connect value or with any standardised electro magnetic measures
- The mobile handset manufacturer must display SAR value with power emission and transmission rate possibly
- Inorder to maintain the consistency of radiation level in handsets, the maximum usage hours must be noticed.
- The government must educate and promote about SAR and connect values before going to buy the handset.
- The government must take necessary steps for health risk analysis with respect to the use of mobile handsets

CONCLUSION

A large number of studies have performed to asses about potential health risk due to mobile phones. Till now there is no remarkable results obtained. Mobile technology is a new field and its age is just 15 years. It takes longer time to get postivie or negative results. This study focused to expose the effects and radiation measures of mobile phones. The SAR and Connect value measures and its limitations are discussed with various models of different brands. This investigation shows that the government has to take health care initiatives as well as continuos update of standards for mobile devices.

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