

## **Delinquency of 4G communication on Human Health**

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**Abstract:** 4G communication is the visionary communication technology. It promises up to 1 Gbps of speed and will be a packet based network. Because of high speed our most of the applications will go wireless and average contact hours of an individual will be significantly increased. 4G works on higher band of frequency. The concern has been raised about the possibility that exposure to the radiofrequency (RF) fields from 4G user terminals or their base stations could affect people's health. Higher functionality handsets deliver more SAR and higher bracket of frequency add up possibly more risk. The WHO has classified mobile phone radiation on the IARC scale into Group 2B - possibly carcinogenic. This work demonstrates findings on this aspect and a detailed survey has been done and possible ways to reduce health risk are proposed.

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**Keywords:** 4-G communication, SAR, Radiation, WHO, IARC

### **I. INTRODUCTION**

Our life is completely dependent on wireless gadgets because most applications rely upon mobile networks and small wireless gadgets. Every wireless gadget works on electromagnetic. It means signal is transferred via electromagnetic radiation. This signal produces electromagnetic radiation in the form of thermal radiation that consists of ionizing radiation and non-ionizing radiation [1].

When using mobile phone, electromagnetic wave is transferred to the body which causes health problems. 4G/LTE provides a comprehensive and secure all-IP based mobile broadband solution to all kinds of mobile communication devices. WiMAX, HSPA+ and Long Term Evolution (LTE) have been the dominant technologies in this market. These technologies have been designed for higher speed, high bandwidth and higher frequency band.

Our concern for the health will be more pronounced because of higher contact hours, higher frequency band and higher radiation. RF energy is used in all sort of wireless telecommunication. More the frequency more the radiation.

4G has been the latest technology and hence it uses higher band in frequency spectrum allocated. RF energy is used in telecommunications services, including radio and television broadcasting, mobile communication, GPS devices, radio communications for police and fire departments, and satellite communications [2].

Non-communication sources of RF energy include microwave ovens, radar, and industrial uses. The complete electromagnetic spectrum consists of both ionizing and non-ionizing radiation [1]. Non-ionizing radiation does not carry enough energy to remove an electron from an atom or a molecule. Sources of non-ionizing radiation include microwaves, radio waves, cordless phones, wireless networks (wi-fi), power lines and MRIs [3].

### **II. CELL PHONE USE PATTERNS**

With the penetration of 4G technology, high end phone handset registered high selling. A smart-phone is defined as a cell phone that is capable of doing more than just phone. Users can email, search the web, edit documents, video call, check the weather, play online games, and perform many other functions. Smart phone leads to higher human contact hours because of its higher range of application support. Daily smart phone usage is jumped quite steeply. Figure 1 shows the survey conducted by various agencies regarding cell phone usage and also that average people sleep with smart phone is very high.

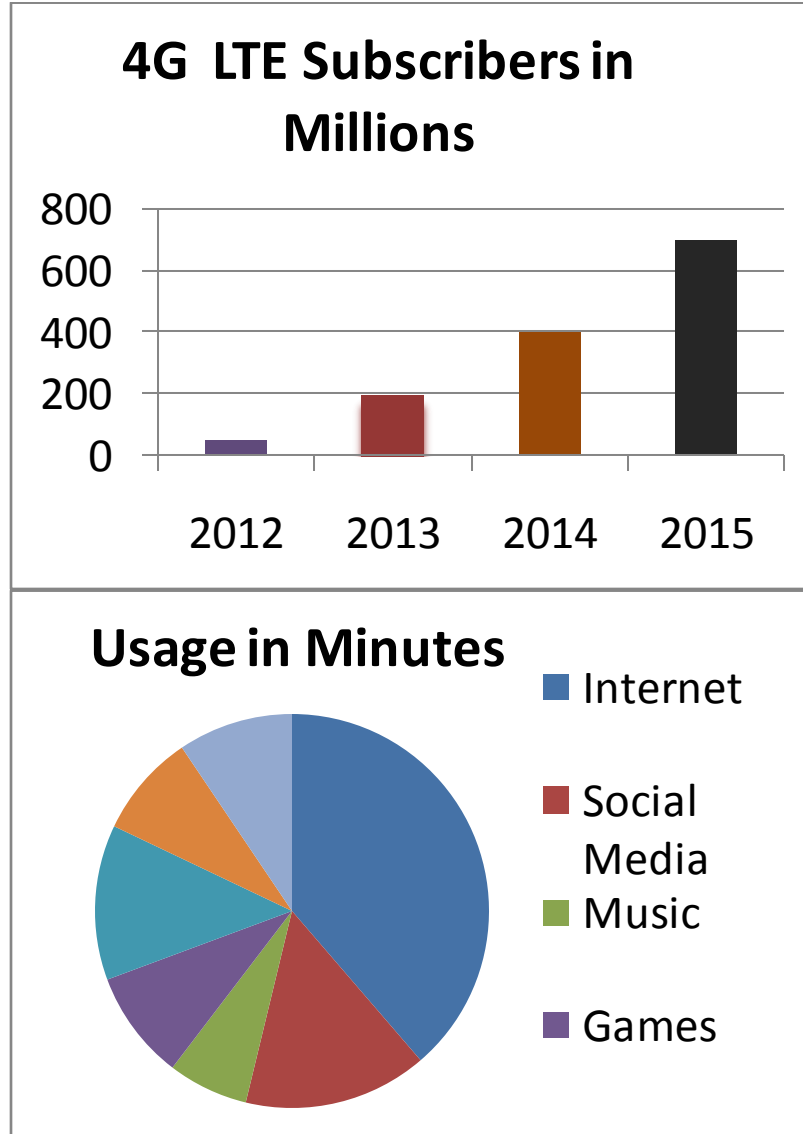


Figure 1: Rise of 4G subscriber and usage [4]

It means lots of unnecessary hours increase in contact with phone. Studies suggest that age group of 30-49 years and 18-29 years sleeps with smart phone every single night and exposes themselves unnecessarily to radiation [5].

### III. RADIOFREQUENCY (RF) EXPOSURE FROM 4G CELL PHONES

Cell phone networks worldwide use the Ultra High Frequency (UHF) portion of the RF spectrum for transmission and reception. It allows the transmission of large amounts of digital data over a wide spectrum of frequency bands with very low power for a short distance. Most cell phones used in 2011–2012 operate at frequencies between 450 and 2700 MHz and it will increase, with peak powers in the range of 0.1 to 2 watts. The radiofrequency exposure to a user decreases rapidly with increasing distance from the phone [6]. Specific Absorption Rate (SAR): Exposure to RF energy is determined by the Specific Absorption Rate (SAR), a measure of the rate at which energy is absorbed by the body when exposed to radiofrequency.

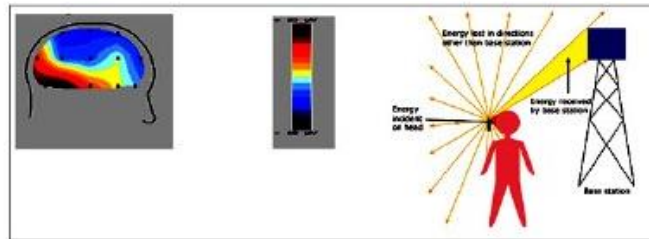
It is defined as the power absorbed per mass of tissue, measured in watts per kilogram (W/kg).The SAR is commonly

used to measure power absorbed during MRI scans and from mobile phones. The FCC's allowable SAR limit for the head is 1.6 W/kg (measured where the absorption rate is highest, which in the case of a mobile phone is often close to the phone's antenna) [7]. For exposure of other parts of the body from cell phones, partial-body SAR limits have been established to control absorption of RF energy. SAR for electromagnetic energy can be calculated from electric field within the tissue as following where  $\rho$  is sample conductivity and  $\sigma$  is sample density [8].

$$SAR = \int_{\text{sample}} \frac{\sigma(r)|E(r)|^2}{\rho(r)} dr$$

#### IV. HEALTH RISKS BY RF RADIATION

Part of the radio waves emitted by a mobile telephone handset is absorbed by the human head. The radio waves emitted by a 3G/4G handset can have a peak power of 2 watts. The influence of the weak EM radiations on human can be realized as sequence of events which includes exposure to EM radiations which when absorbed modulates the biological field patterns, accumulation of energy and information into the body fluid, change in the functional activities of cell which finally results into some disease. Figure shows the level of electrical activities generated in brain. The voltage level ranges from blue to red and represents electrical activities ranging from minimum to maximum.



**Figure 2. Effect of electromagnetic radiation in human brain [9]**

Some symptoms of radiation exposure are chronic fatigue, hyperactivity, cramps, stiffness, hyperventilation, Rigid left shoulder etc [10]. Exposure to RF radiation could cause a wide range of health effects, including behavioural changes, effects on the immunological system, reproductive effects, changes in hormone levels, headaches, irritability, fatigue, and cardiovascular effects [11].

4G radiations are non-ionizing radiation, with long wavelength and low frequency, do not break chemical bonds, but has sufficient energy to move electrons and heat body tissue, leading to biological effects at certain doses. Except for optical radiation, there is little data on the quantitative relationships between exposures to different types of non-ionizing radiation and effects on human health [12]. Referring to IARC cancer group, it is very clear that cellular mobile falls into the Group 2A which is possibly carcinogenic. Nervous system is the area which is likely to be suffered from radiation. Minor effects on brain activity have been found.

Examples of effects in humans include impaired cognitive performance after exposure to a pulsed electromagnetic field and slower response times to spatial working memory tasks when exposed to RF from a standard GSM cellular phone placed next to the head of male subjects. Several research studies have examined the effects of RF-EMF on the male reproductive system [13].

Semen exposed to RF electromagnetic waves emitted from cell phones had higher levels of damaging free radicals, lower sperm motility, lower sperm viability, and possibly greater oxidative stress [14]. Researchers have studied the potential of

RF-EMFs to cause changes in a cell's genetic material (DNA) and/or to damage the genome. "Genotoxic" substances can potentially cause genetic mutations or cellular damage that can contribute to the development of cancerous tumours.

Many ocular effects on eye lenses and epithelial cell are studied. The addictive nature of cell phones has concerned psychologists for years. Recently, psychologists have warned that Smartphone users are especially at risk for becoming addicted to their devices. In a recent study, user checks their phones 34 times a day [15].

## V. RESULT

In this work detailed survey is made on link between wireless gadget's electromagnetic radiation and health risk. It is discussed below in various findings derived.

### Findings 1

Instrument like SARLITE [16] checks SAR level instantly on every condition in field. We observed that SAR level increases in following conditions.

1. BTS power reduces to user terminal. More distance from it or poor coverage area or elevation.
2. High end phone used with enhanced capability of high speed internet and other wireless technologies.
3. As frequency band increases loss increases. So, 4G may suffer from higher loss as compared to 3G.

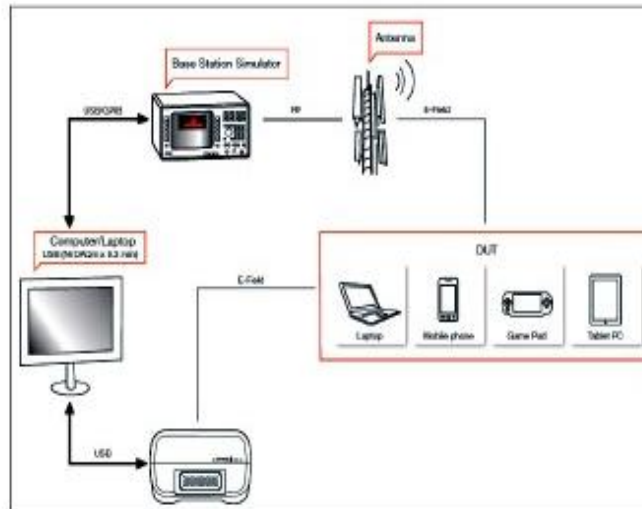


Figure 4: SAR measurement experimental setup [16]

SAR measures exposure to fields between 100 kHz and 10 GHz. Surveying various handsets and its SAR declared by manufacturers it is very clear that high end mobiles and higher frequency model carry more SAR value on theoretical ground [17].

### Findings 2

In experiments where plankton has been exposed to WIFI and/or 3G/4G radiation the plankton dies or is deformed within several days. With WIFI it takes about 96 hours, with 3G about 72 hours and with 4G it occurs within 48 hours [19]. EEG machine is used to capture the brain activity here under three conditions: without cell phone, while using cell phone and while using high-end 4G smart phone.

### Findings 3

N=47 studies conducted at Brookhaven National Laboratory whole 2009. It was aimed to find if acute cell phone exposure affected regional activity in the human brain. Project evaluated the effects in healthy participants (N = 47) of acute cell phone exposures on brain glucose metabolism, measured using PET with injection of fluorodeoxyglucose (18FDG).

Brain glucose metabolic activity is a more proximal marker of neuronal activity than measures of CBF, which reflects vascular as well as neuronal components. Because exposure to RF-EMFs from cell phones is well localized and is highest in brain regions closest to the antenna, they hypothesized that the effects on brain metabolism would be greatest in inferior and anterior brain regions, the regions that would be exposed to the highest RF-EMF amplitude for the cell phone model used in this study.

Result provides evidence that the human brain is sensitive to the effects of RF-EMFs from acute cell phone exposures. The findings of increased metabolism in regions closest to the antenna during acute cell phone exposure suggest that brain absorption of RF-EMFs may enhance the excitability of brain tissue.

**Findings: 4 Proposed Regulations :**

Following standards can be proposed to limit human exposure to cell phone radiation exist listed below.

- Government should regulate the content used in making of cell phones.
- Producer and users should take the accountability on disposal of cell phone waste because antenna, loudspeaker, cell phone, BTS all are radiating.
- Cell phone radiation should have pre-Market emissions testing.
- Low cost RF measurement devices to be developed to measure cumulative exposure.
- SAR values, Radiation level should be made public.
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- Cell site design and installation should have stricter norms.

**Findings 5**

Author	Research
Khurana (2009) Australia [18]	“ There is adequate epidemiologic evidence to suggest a link between prolonged high end frequency phone usage and development of an ipsilateral brain tumor. ”
Han YY (2009) Pittsburgh Cancer Institute [19]	“ Usage of Long time cell phone have found an increased risk of ipsilateral acoustic neuroma “
Kundi (2008) Medical University Vienna, Austria [20]	“ The overall evidence speaks in favor of an increased risk, but its magnitude cannot be assessed at present because of insufficient information on long term use “

Deiuliis et al.62 [21]	Extensive use of high frequency mobile phone in both the power density and frequency range has clear implication on males of reproductive age by potentially affecting both their fertility and the health.
Agarwal (2009)[13]	“ Radio frequency electromagnetic waves emitted from cell phones may lead to oxidative stress in human semen. Keeping the cell phone in a trouser pocket in talk mode may negatively affect spermatozoa and impair male fertility

**Table 1: Survey on health risk & Cellular Communication**

**Findings: 6 Proposed way to reduce health risk due to 4G radiation:**

1. It is highly recommended to reduce talk time. If longer talks are unavoidable hands free kits should be used. EEG clearly suggest that this way the possible damage can be reduced.
2. It is recommended that current regulations for cell phones concerning exposure of the population to RF radiation be extended to other devices (e.g. laptops, tablet computers, baby monitors, etc.).
3. Use of a wired ear-piece/microphone hands-free accessory, texting rather than talking, keeping the phone a distance from the body, and placing your thumb between the phone and ear could prove beneficial.
4. Reduction in talk time is highly recommended.
5. There should be distance with smart phone while sleeping.
6. Usually a phone in an area with good reception will transmit at much lower levels than in an area with poor reception like a lift or deep within a large building.
7. Use of an earthing sheet, which should be put on bed and connect to a ground by means of a wire. All the accumulated radiation in the body is immediately fed to ground.

**VI. CONCLUSION**

Technological advancements in multiplexing techniques, cell design, MIMO, turbo code etc. will definitely make 4G communication works at promised 1 Gbps speed. This speed will come up with high frequency band deployment and much higher contact hours of human to smart phone. Higher the frequency band more the radiation and higher the configuration of smart phone higher the SAR.

Hence health risks shown in this work will be more pronounced. Few regulations are suggested that can help average user to avoid unnecessary radiation exposure. Many unorthodox ways can be used to reduce radiation but smart usage of smart phone will be the most effective way to reduce radiation from world most promising technology.

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