Review of the related literature

Use of cellular phone or mobile phone (MP) has increased exponentially as it became a part of every day life. With increase in cell phone communication, the number of cell towers getting installed is also increasing every day. The major area of concern about the increase in number is the radiation emitted by these base stations and their antennas. This is because, in contrast to mobile handsets, radiation by cell tower is emitted continuously and is more powerful at near by areas. In world, there are more than 6 billion mobile users and it has been estimated that with this rate of present growth the mobile number may cross world population by end of December 2014. In India mobile subscriber are 98 crores (which is 78% India’s population) and growing at 1.5 crores/month, second highest in world (TRAI, June 2012). India has total 7,36,654 base transceiver stations (BTS -2G GSM and CDMA & 3G Mobile Towers) while out of that only 96,212 BTSs have been installed to provide 3G mobile and data services in the country till the 30 November 2012.

All the transmitting towers, such as AM and FM towers, TV towers, cell towers, etc. emit RF/microwave radiation continuously. Also, Wi-Fi (wireless Internet), wireless computers, cordless phones and their base units, cell phones and all other wireless devices emit microwave radiation. A cell phone that is ON but not in use is also radiating. Mobile phones operate within the frequency band of 800 MHz, 900 MHz and 1800 MHz and the latest 3G technology works between 1900 –2200 MHz range. Computers and laptops operate within the frequency range of 1000 – 3600 MHz, and most Wi-Fi systems and some cordless phones operate around 2450 MHz, which is same frequency as that of a microwave oven. The growing use of wireless communication in the last decade has introduced concerns about health risks from so called man made electro smog. Various epidemiological and experimental studies have been carried out and the results have shown to have a close relation between biological effects and Electromagnetic radiation. Although level of radiation is below level of
exposure where thermal effects are induced in biological systems, there is intense debate about the impact of RF radiation on human health. [1].

Cell phone transmits 1 to 2 Watts of power. The most important parameter to assess human exposure is specific absorption ratio (SAR). SAR is a rate at which radiation is absorbed by human body per time by a particular mass of tissue. It is measured in units of watts per kg (W/kg) of tissue. Every mobile phone comes with a SAR rating (although some manufacturers try to hide it). Regulating agencies have set its maximum levels for handsets. Radiations depend on its design, antenna, how it is held and used. Institute of Electrical and Electronics Engineers (IEEE) Committee on Man and Radiation, national and international organizations have established safety guidelines for exposure to RF energy. Nowadays automatic positioning system, actual phones and head – like phantoms filled with appropriate tissue equivalent liquid is employed to measure the SAR for mobile phones [2]. Adheed Hasan Sallomi presented a theoretical method to calculate SAR in the human head exposed to microwave of frequency range used GSM 900 and GSM 1800 mobile phone [3]. Many national governments have established safety limits for exposure to various frequencies of electromagnetic energy based on SAR. In USA, SAR limit for cell phones is 1.6 W/Kg which is actually for 6 min. It has a safety margin of 3 to 4. Hence a person should not use cell phone for more than 18 to 24 minutes per day[4]. This information is not commonly communicated to people using mobile phone in India by mobile producer.

The biological effect of electromagnetic fields is dielectric heating which varies with the power and the frequency of the electromagnetic energy. If the heat generated is small, the body’s thermoregulatory mechanism can dissipate it without causing adverse effects. If the temperature exceeds this capacity, about 1 to 2 °C, tissue damage may occur. Electromagnetic fields can be considered as harmful to the health. Various devices such as radio and television broadcast stations, computers, microwave ovens, cellular phones, surveillance systems and communications satellites and navigational aids radiate electromagnetic energy during their normal operation. The pollution from man-made electromagnetic fields has increased so rapidly and uncontrollably that the biological consequences have paced up even at a faster rate [5].

It is well known that the EM fields penetrate deep inside the living tissue: consequently the biological systems get affected. It is believed that the association of electromagnetic fields
increases behavioral changes and health problems such as epilepsy, leukemia, cancer, brain tumor, Parkinson’s disease, fatigue, headache, and loss of appetite, decreased blood pressure, itching and alteration in the gene expression etc. Many scientists and physicians suggest a link between these disorders and long-term exposure to EMF [6]. Hence effects of EM fields on biological systems are a new and dynamic area for research and are a combination of biology and physics.

Human head can absorb the radiation from mobile phone easily. This temperature is so called the thermal radiation where the human head temperature increase significantly as talking increased [7]. The arguments are made with respect to EMR exposure from Wi-Fi, cell towers and smart meters that due to distance, exposure to these wavelengths are negligible. However, many in vitro, in vivo and epidemiological studies demonstrated that significant harmful biological effects occur from non-thermal exposure [8, 9].

Neha Kumar et al reported various epidemiological studies and experimental studies which show significant biological effects far below the current standard [10]. The recent researches concerning the influence of the electromagnetic field on the living organisms have demonstrated that these influences had a different on intracellular phenomena, cells, organs and the organism itself. The research are conducted in order to elaborate new normative of the pollution sources and to implement new protection techniques of the human body against the electromagnetic field influence. The researchers also presented the results of the monitoring and diagnoses techniques based on electromagnetic radiation field and of ATP simulation. Christian P. Karger reviewed on the scientific literature addressing the issue of mobile phone and literature and suggested that special attention should be given to a possible association between mobile phone radiation and cancer [11].

Monika Atudori et al studied how electromagnetic map of three phase power line impacts over the electrical equipments, the surrounding environment and over the human body. The research concerning the effect of electromagnetic field on the living organism have demonstrated that these influences had a different impact on intracellular phenomenon, cells, organs and the organism itself. This research elaborated new formalities of the pollution sources and implemented new criterion techniques of the human body against electromagnetic field influence [12].
The most apparent biological effects of RF energy to living cells are mainly due to heating. While it is not certain that RF radiation generally poses any risk to human health, some reasons exist for being concerned about human health effects from cellular phones themselves. These concern exist because antenna of base stations of these phones deliver much of their RF energy to small portion of head [13]. Study of Ankur Mahajan et al had taken into account the adverse effects of the electromagnetic fields on the human body. After this study it was that electromagnetic fields are harmful and can have adverse effect on human body depending upon the intensity and frequency of EM field. It is always a good idea to avoid the unnecessary exposure to electromagnetic fields whenever possible. Though technology makes our life very comfortable but at the expense of our health, it is our first duty to save our life. Thus we should use technology wisely so that we can save ourselves as well as mother earth.

Electromagnetic pollution has various hazards like electrical hazards, fire hazards, biological hazards and DNA fragmentation [15,16]. Neha Kumar et al carried out measurements of radiation at various places near cell tower and observed that radiation level is high and suggested use of radiation shield to lower the amount of radiation [4]. Huber R, Treyer V, Borbely AA et al, investigated the effect of EMF vs. sham control exposure on waking regional cerebral blood flow (rCBF) and on waking and sleep electroencephalogram (EEG) in humans [17]. Genetic damage, reproductive defects, cancer, neurological degeneration and nervous system dysfunction, immune system dysfunction, cognitive effects, protein and peptide damage, kidney damage DNA damage and genotoxic effects have all been reported in the peer-reviewed scientific literature [18].

The sitting of cellular phone base stations and other cellular infrastructure such as roof-mounted antenna arrays, especially in residential neighborhoods, is a contentious subject in land-use regulation. Local resistance from nearby residents and landowners is often based on fears of adverse health effects. Despite reassurances from telecommunications service providers that international exposure standards will be followed, the resistance does not diminish. The reports and some epidemiology studies have found headaches, skin rashes, sleep disturbances, depression, decreased libido, increased rates of suicide, concentration problems, dizziness, memory changes, increased risk of cancer, tremors, and other neurophysiological effects in populations near base stations. Further epidemiology research that takes total ambient RFR
exposures into consideration is warranted. Symptoms reported today may be classic microwave sickness, first described in 1978. Nonionising electromagnetic fields are among the fastest growing forms of environmental pollution. Some extrapolations can be made from research other than epidemiology regarding biological effects from exposures at levels far below current exposure guidelines [19].

It has been reported that there were cross-sectional association between high compared to low mobile phone use and stress, sleep disturbance, and symptoms of depression for men and women. High frequency of mobile phone use at baseline was a risk factor for mental health outcome at one year follow-up among young adults. The risk for mental health is greatest for mobile users [20, 21]. Increased blood-brain barrier permeability and oxidative damage, which are associated with brain cancer and neurodegenerative diseases, have been found. Changes associated with degenerative neurological diseases such as Alzheimer's, Parkinson's have been reported. Other neurological and cognitive disorders such as headaches, dizziness, decreased memory and attention, autonomic nervous system dysfunction, decreased reaction times, sleep disturbances and visual disruption have been reported [22, 23]. The data was collected by A.A. Ayeni et al. on effect of GSM phone radiation on human health, especially in connection with human heart in Nigeria. In the analysis carried out, it has been found that the elderly ones, basically of age 40 years and above, showed a slight decrease of about 1.4% in pulse rate after exposure. Even though this just barely above 1%, it is advisable that this age group should avoid keeping phone anywhere close to their heart as this may further put stress on their ageing hearts [24].

Results of the study of Ryszard Andrzejak et al demonstrated that the call with a mobile phone may influence heart rate variability and change the autonomic balance. The increase in the parasympathetic tone concomitant with the decrease in the sympathetic tone measured indirectly by analysis of heart rate variability was observed during the mobile telephone call. It had been interpreted that changes in heart rate variability during the call with a mobile phone could be affected by electromagnetic field [25].

It has been found that there lies a tangible congruence of the result of statistical analysis based on an extensive survey all over Bangladesh on different level of mobile users with the hazards [26]. Some investigators had done a simple but elaborate measurement of the
sensitivity of human health due to the radiation of mobile phone tower and mobile phone while using it. The possible risks by radio frequency electromagnetic field exposure of the human body are a major concern for the society. If exposure is sufficiently intense, it can cause biological effects. The increasing use of mobile phone in our environment is one of the reasons why many scientists believe some disease rates are on the rise. It is scientifically proved that the radiations by the mobile phones affect especially the brain of human being and it will give them the difficulty to cope up with their systematized daily course of action and soon cause health injury [27, 28].

The initial case-control studies of brain tumours and mobile phone use was conducted in Sweden during 1994 – 1996 [29, 30, 31]. In these studies, details were taken about the intensity and duration of mobile phone use, preferred side (ear) of use, phone type (analogue or digital), and hand-held or hands-free. A similar second larger study a few years later by the same authors was carried out [32]. It involved 1,303 cases (half of all brain tumours diagnosed 1997 - 2000) along with controls. Ipsilateral use of analogue phones was received widespread public attention; their interpretation is not straightforward because of related to temporal tumours and analogue phone use was associated with acoustic neuroma [32, 33]. Furthermore, studies of mobile phone risks have methodological difficulties. In order to summaries the current state of knowledge, the epidemiological aspects about the effect of mobile phone on human health have been reviewed [34].

The neurological effects that are caused by EM field that is radiated from MP are also reported. The heart rate variability (HRV) is taken as a measure of neurological effects as automated nervous system modulates the HRV. The nonlinear parameters to quantify the MP radiation effects on HRV include approximate entropy, capacity dimension and correlation dimension. The result analysis showed that there was no evidence that MP have clinical effects on ANS (autonomic nervous system). This study was conducted with a rather small number of test persons and test lasted for relative small time indicating that the statistical significance of study was limited. To increase the statistical significance requires increasing both number of participants and time over which the measurements are taken [35]. A number of studies investigating the effect of mobile phone on human body have been done by number of investigators by examining heart rate variability, BP, when MP is kept on pericardium. Using 12 lead ECG machine, electrocardiogram (ECG) was recorded when MP is off, on and in ringing
tone. Statistical analysis was done using paired ‘t’ test. It has been observed that there is no statistically significant difference in the BP, HR, P wave distribution, QT dispersion. Studies concluded that the MP on hemodynamic and cardiac activity when it is positioned on the chest in the immediate proximity to heart does not cause cardiac dysfunction. The limitation of the study was that number of cases included in the study was relatively low [36].

It has been noticed that there was significant difference between heart rate during talking in comparison with HR during ringing and resting in both the genders. There was a significant decrease of TP segment in comparison with TP segment during ringing and talking in males. Where as in case of females there was significant difference in TP segment. Further the results indicated that there was no significant difference in that of females in any of these three stated conditions. The results of these study indicated that constant use of MP may cause harmful effect on heart [37]. In other study, exposure to EMR led to a significant decrease in sperm motility. The results of semen analysis between the control and EMR group exposure showed statistically significant changes in the sperm motility. Since all the environment factors, except the exposed EMR levels were the same for control and exposed group, it is concluded that there is effect of EMR on sperm motility. In addition to these acute adverse effects of EMR on sperm motility, long term EMR exposure may lead to behavioral or structural changes of the male sperm cell. These effects may be observed later in life and should be investigated more seriously[38].

In one study by BhagyalaxmiKodavanji et al selected 37 healthy male volunteers of 10-24 yr age group. Their consent is taken before experiment. Their physical examination including BP, BMI, HR respiratory rate was done. They were grouped in two: mobile users for more than 1 year and non mobile users. The autonomic activity was assessed by recording ECG and calculating heart rate. The HRV was analyzed both by time domain and frequency domain. Statistical analysis was performed using students unpaired t test. In time domain analysis HRV showed no statistically significant difference in between two groups. But in frequency domain, significant difference is observed concluding that mobile users had a higher sympathetic tone and lower parasympathetic tone as compared to mobile non user.[39].
Fatma et al conducted an experiment on 110 adult rats of both sexes. Group I included rats exposed to cell phone EMF for 4 weeks; and group II includes rats exposed to EMF for 8 weeks. All rats are subjected to measurements of SBP, ECG recordings. The change in absolute and relative cardiac weight, changes in plasma rennin activity, changes in plasma calcium were also noted. It is concluded that long term exposure of cell phone EMF increase the liability for hypertension reflected on ECG and cardiac weights [40].

Thorat et al reported that the electromagnetic field (EMF) generated by mobile phones (MP) may have an influence on the autonomic nervous system and modulates the function of circulatory system. To evaluate the effect on cardiac electrical activity, the variation in heart rate was examined. To compare the variation in heart rate due to mobile phone radiation in MP users and non MP users, total 53 completely healthy male subjects were selected for the study and divided into two groups as MP users and non MP users. Heart rate was assessed by recording ECG in lead II in supine position of the body before, during and after 5 min when mobile phone ring was stopped. Descriptive statistics was done and presented using tables and graphs, including mean values for continuous data to discuss the results. Comparison of outcome parameters was calculated with significance test. This study suggested that MP radiation have no statistically significant influence on the variation in the heart rate. The study concludes that MP has no effect on heart rate, cardiac electrical activity and therefore on autonomic nervous system[41].

Many investigators suggested measures to follow in using various mobile phone technologies [26, 34, 42] and suggested rules framed by different international organization [43]. Some of the results showed that children are more affected as compared with adults hence children must be educated about less use of cell phones [44]. Because Mobile phones are designed exclusively for communication, users can restrict it for communication instead of using as MP3 player or as camera to avoid unnecessary exposure to radiation emitted by cell phone [45].

The word Geopathic is derived from two Greek words: “geo” means “of the earth” and “pathos” means “suffering” or “disease”. The word “geopathic” literally means suffering or disease of the earth. Energies from earth at specific locations which have an ability or power to change the function of normal body which working, are often known as negative energies. Geopathic Stress is the Earths vibrations which rise up through the Earth and are distorted by weak electromagnetic fields created by subterranean running water, certain mineral concentrations, fault lines and underground cavities. The vibration distorted becomes abnormally high and
harmful to living organisms. The significant difference in the physical parameters noticed lead to the conclusion that the GS zone exerted different influence on the normal functioning of the human body especially changes in BP and HR. The common effects of GS zone observed include feeling run-down and exhausted, depression, nervousness, headaches, tingling in arms and legs etc. depending upon age group. As a result, different retardation of immune system and other organ may occur. Though GS doesn’t cause any serious illness, it can be predicted that it may lower immune system and one’s ability to fight off virus and bacteria[46].