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RESEARCH ARTICLE

SURVEY OF PEOPLE LIVING AT THE VICINITY OF CELLULAR BASE TRANSMITTING STATIONS IN AN URBAN AND A RURAL LOCALITY

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ABSTRACT

India has witnessed an unprecedented growth of wireless technology. This has lead to people living in close proximity to mobile phone base stations in densely populated metros. The aim of the study was to resort to a questionnaire-based survey of people (n=200) living around base stations in an urban and a rural locality in the state of Tamil Nadu, India. It was found that 49% of urban people lived around 6 or more base stations whereas it was less than 3 for 66% of the rural people ($p<0.001$); 76% of the rural people lived between 50-300 m of the base station, whereas 43% of the urban people lived within 50 to <10 m ($p<0.001$); 31% of the urban people were found facing the antenna, whereas 41% of the rural people were found living beneath the antenna of the base station ($p<0.001$); and 95% of the urban people used their mobile phones >20 minutes/day, whereas, it was 7% for the rural people ($p<0.001$). The rural people reported more non-specific symptoms (fatigue, difficulty sleeping, feelings of discomfort, difficulty in concentration, poor short-term memory, depression) when compared to the urban people. On the contrary, the urban people had more medical complications (gastrointestinal, ophthalmic, respiratory, endocrine, cardiovascular) than the rural people. Presence of electrical transformers was evident in the urban locality and very high-tension power lines in the rural locality. The authors concluded that constant monitoring of rising indoor and outdoor radiofrequency electromagnetic fields in India is essential under the prevailing conditions.

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INTRODUCTION

Mobile phones were introduced in India a decade ago. At many places in India and in the state of Tamil Nadu in particular, the cellular base transmitting stations (BTS) or more commonly called as the mobile or cell phone towers, which form the supporting infrastructure for mobile phones, are mounted on rooftops of hospitals, schools, residential and commercial buildings. The exposure, in the range of 30 kHz to 300 GHz, known as radiofrequency electromagnetic field (RF-EMF), belongs to the non-ionzing part of the electromagnetic spectrum. This is used in communication technologies, such as mobile telephony (2G, 3G, 4G and 5G in the pipeline), Wi-Fi, Bluetooth and radiofrequency identification (RFID) applications (ANSES 2013). The frequency utilized by mobile phones and base stations is between 800 MHz to 3 GHz. It is well known that ionizing radiations such as x-rays and gamma rays have sufficient energy to directly break chemical bonds, capable of damaging DNA, causing cancer and birth defects.

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There is a controversy though about the bioeffects caused by low-level, non-thermal RF-EMF, particularly from mobile phones, which have been termed as group 2B carcinogen by International Agency for Research on Cancer, part of World Health Organization, in 2011 (WHO-IARC 2011). The safety standards for RF-EMF exposure set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), adopted by India, have only taken into account the thermal and short-term effects and not the biological effects from long-term, low-level microwave exposure from mobile phones, base stations and many other wireless devices. A similar observation has been reported by Havas (2013), about Health Canada Safety Code 6, which protects the public from base station exposures based only on preventing a heating effect, averaged over six minutes and has not taken into consideration the long-term, non-thermal effects. The thermal and non-thermal effects were taken into account for 3 to 100 kHz and only the thermal effects for 100 kHz to 300 GHz. Evidence is mounting that a part of human population may be more susceptible to RF-EMF and develop a condition known as electro hypersensitivity syndrome (EHS).Typical exposure around a base station, in the direction of propagative of the

lobe of radiation from the antenna, is considered to be a zone of high RF-EMF radiation. It is inversely proportional to the distance and thus, the radiation reduces as the distance increases (Kumar 2013). No other technology in the world has shown such an explosive growth as the mobile phone industry in its four-decade existence since the early 1970s, when the first cell phone call was made by a researcher from the Chicago-based Motorola Laboratory to the legendary AT&T Bell Laboratory, beating them in the process in making history. The ultrahigh frequency band of 300 MHz to 3 GHz was widely used for this purpose. In the presence of strategically placed base stations, these waves travel up to several kilometers, the power transmitted being low. Currently, with the use of smart phones and tablets skyrocketing, more data is clogging the airwaves and is set to exponentially grow in the future. The cellular communication technology has grown from First Generation (1G) where it was used only for making a phone call to the Second Generation (2G) with the addition of messaging and the Third Generation (3G) which enabled the smart phone wireless technology leading to web browsing, emailing, photo sharing and video downloading. This is followed by the Fourth Generation (4G) and Fourth Generation, Long Term Evolution (4G LTE), which enable much higher speed data transfer and connectivity, its availability only limited to large metropolitan areas around the world due to coverage issues. The 4G frequency bands include 700 MHz to 2.6 GHz. Although, the higher frequency bands have higher data capacity, enabling more people to connect at the same time in cities and densely populated areas, they cannot travel long distances and hence not useful in rural locations. The lower frequency bands can travel long distance and better penetrate walls of buildings and are ideal for rural locations. The cellular technologies mainly used in India include Global System for Mobile Communications (GSM) and Code Division Multiple Access (CDMA). Indian GSM subscriber base is the third largest in the world after China and Russia (DoT 2014).

With the advent of enormous increase in the use of mobile phones, a very large segment of society is regularly exposed to high levels of RF-EMF radiation through the placement of mobile phone towers, wireless buildings and even wireless cities. It is believed that people in cities alone are exposed to this non-ionising, non-thermal radiation constantly, and in the rural setting, the air is cleaner, but this technology has penetrated even the rural areas, as evidenced by the rural teledensity (TRAI 2014).It is believed by a section of scientific community that the modulated signals from the carrier microwaves resonate and stimulate vibrational cellular receptors, leading to biological effects. The aim of the study was to resort to an epidemiological survey of people living around base stations in an urban locality in Chennai city and a rural locality in the state of Tamil Nadu, India.

MATERIALS AND METHODS

A questionnaire was prepared and circulated among people dwelling at the vicinity of base stations in an urban locality (*n=100*) in Chennai and a rural locality (*n=100*) in Tamil Nadu. General questions included gender, marital status, age, diet, alcohol intake and cigarette smoking. Exposure conditions were determined by number and distance of cell phone towers, location of antenna on the towers and number of years of living near the cell phone towers. The presence of electrical transformers at less than 10 m, very high-tension electrical power lines at less than 100 m and television and radio transmitters at less than 1 km from the place of dwelling were also noted. Information on computer use for more than 2 hours per day and cell phone use for more than 20 minutes per day was sought along with 18 non-specific health symptoms and medical conditions of the people. The level of complaints for the frequency and severity of symptoms were expressed using a scale of 1=never, 2=sometimes and 3=frequent. The data were statistically analyzed using tools such as Chi-square test, t-test, discriminant analysis with F statistics and Duncan Multiple Range Test (DMRT), using software IBM SPSS, Version 17.

RESULTS

It was found that 49% of urban people lived around 6 or more base stations, whereas it was less than 3 for 66% of the rural people ($p<0.001$) (Fig. 1). As for distance from the base stations, 76% of the rural people lived between 50-300 m of the base station, whereas 43% of the urban people lived within 50 to <10 m ($p<0.001$) (Fig. 2). As for the location of base station antenna, 31% of the urban people were found facing the antenna, whereas 41% of the rural people were found living beneath the antenna of the base station ($p<0.001$) (Fig. 3).

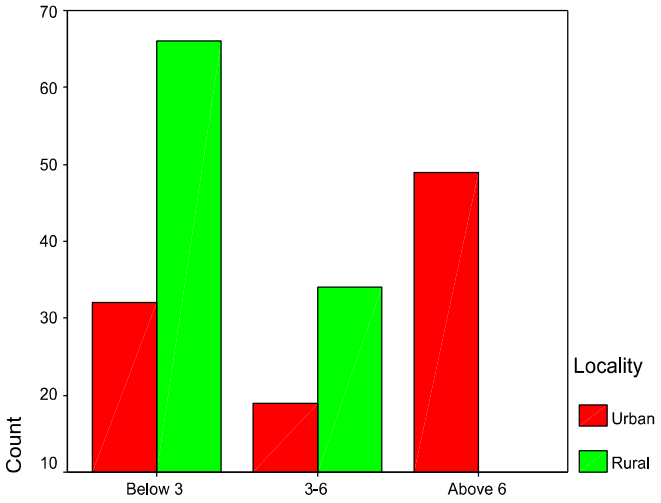

Figure 1. Number of cell phone towers in urban and rural localities

In the urban locality, 48% of the people lived between 1-5 years near the base stations, >5 years (36%) and <1 year (16%). As for the rural people, 73% lived near the base stations between 1-5 years, >5 years (20%) and <1 year (7%) ($p<0.001$). It was found that 72% of the urban people used the computers 2 hours/day, whereas none of the rural people used the computers ($p<0.001$). As for mobile phone use, 95% of the urban people used their mobile phones >20 minutes/day, whereas, it was 7% for the rural people ($p<0.001$) (Fig. 4). There was a significant association between some of the 18 non-specific symptoms and locality of the people around base stations (Table 1).

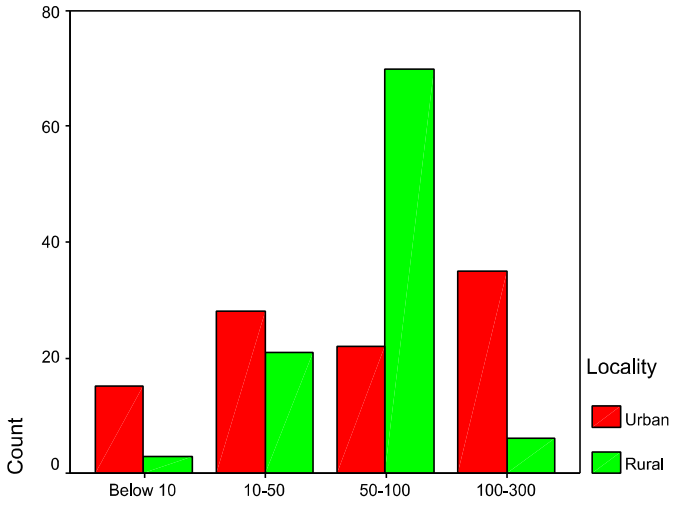

Figure 2. Distance from cell phone towers in urban and rural localities

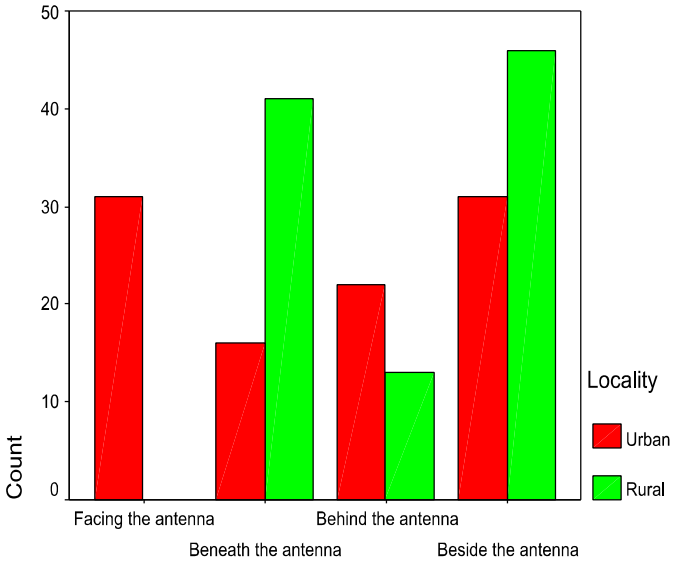

Figure 3. Location of cell tower antennae in urban and rural localities

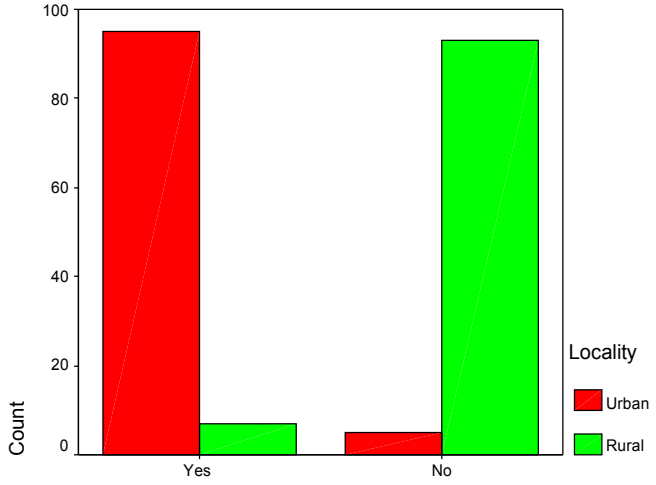

Figure 4. Cell phone use (>20 min/day) in urban and rural localities

There was a significant association between the some of the medical conditions and dwelling of the people around the cell phone tower (Table 2). More than one medical condition was found in 67% of the urban people living around the cell phone towers, whereas 75% of the rural people living around the cell phone towers had no medical conditions ($p<0.001$). Based on the responses, discriminant analysis was carried out to distinguish between people in the rural and urban localities living around the cell phone towers (Table 3).

The tests of equality of group means measure each independent variable's potential before the model was created. Wilks' lambda, the F statistics and its significance level were presented. Out of 18 variables, six variables were significant at 1% level (loss of appetite, difficulty sleeping, depression, feelings of discomfort, hearing disruption, joint pain and problems) ($p<0.001$). Three variables (visual disruption, dizziness, loss of libido) were significant at 5% level. Wilks' lambda was another measure of a variable's potential. Smaller values indicated the variable was better at discriminating between groups. This suggested that non-specific symptom of feelings of discomfort was found the most followed by depression, difficulty sleeping, loss of appetite, joint pain/problem, hearing disruption, dizziness, loss of libido, and visual disruption. On one-way urban data, based on Duncan Multiple Range Test (DMRT), there was a significant association between number of years living near the cell phone tower and overall medical conditions in the urban locality ($p<0.001$). No medical conditions were found in 75% of the people who were living for less than one year near the cell phone tower. One medical condition was found in 37.5% of the people living for 1 to 5 years near the cell phone tower, followed by to 3 to 5 medical conditions in (27.8%) of the people living near the cell phone tower for more than 5 years. There was also a significant association between the presence of electrical transformers, very high tension electrical power lines and radio and television transmitters and the distance of the cell phone towers, location of antenna and number of years living near the cell phone tower ($p<0.001$). From 50 m to <10 m of the cell phone tower, there were electrical transformers and no radio or television transmitters. Within 50-300 m, there were very high-tension power lines and radio and television transmitters. Also very high-tension power lines were found facing the antenna of the cell phone tower and electrical transformers were found beside the antenna of the cell phone tower. It was found that 41.7% of the people living near the cell phone towers for more than 5 years were also at the vicinity of very high tension power lines and 35.4% living for 1 to 5 years were also at the vicinity of electrical transformers.

In one-way rural data, based on Duncan Multiple Range Test (DMRT), there was a significant difference between numbers of years living near the cell phone tower and overall severity of non-specific symptoms in the rural locality surveyed ($p<0.001$). There was a significant difference between living less than 1 year near the cell phone tower and living 1 to 5 years and above, with respect to overall severity of non-specific symptoms in the rural locality. There was an association between number of years living near the cell phone tower and the presence of electrical transformers, high tension power lines and radio and television transmitters with respect

Table 1. Non-specific symptoms found in people living at the vicinity of cell phone towers

Symptoms	Urban (n=100)	Rural (n=100)
Fatigue ($p<0.001$)	58%	83%
Irritability ($p<0.05$)	61%	74%
Loss of appetite ($p<0.001$)	40%	68%
Difficulty sleeping ($p<0.001$)	46%	82%
Depression ($p<0.001$)	55%	79%
Feelings of discomfort ($p<0.001$)	47%	82%
Difficulty in concentration ($p<0.05$)	69%	80%
Short-term memory loss ($p<0.05$)	64%	80%
Visual disruption ($p<0.05$)	48%	30%
Hearing disruption ($p<0.001$)	50%	27%
Dizziness ($p<0.001$)	43%	21%
Join pain/problem ($p<0.001$)	47%	21%
Chest pain ($p<0.05$)	19%	8%
Loss of libido ($p<0.05$)	-	6%

Table 2. Medical conditions found in people living at the vicinity of cell phone towers

Symptoms	Urban (n=100)	Rural (n=100)
Blood pressure ($p<0.05$)	5%	16%
Cardiovascular problems (palpitations, Arrhythmias, shortness of breath) ($p<0.001$)	9%	-
Respiratory problems (allergies, asthma, Sinusitis) ($p<0.001$)	25%	-
Gastrointestinal problems (stomach pain, Ulcer, gastroesophageal reflux) ($p<0.001$)	42%	1%
Endocrine problems (swollen lymph nodes, Enlarged thyroid, testicular/ovarian pain) ($p<0.001$)	10%	1%
Ophthalmic problems (eye pain and Burning, eye pressure, deteriorating vision, Floaters, cataracts) ($p<0.001$)	28%	4%

Table 3. Discriminant Analysis - F tests of equality of group means

Symptoms	Wilks' Lambda	F value	P value
Fatigue	0.986	2.840	0.094
Irritability	0.996	0.750	0.387
Headaches	0.999	0.296	0.587
Nausea	0.997	0.503	0.479
Loss of appetite	0.948	10.845	0.001**
Difficulty sleeping	0.927	15.571	0.001**
Depression	0.925	16.129	0.001**
Feelings of discomfort	0.900	22.028	0.001**
Difficulty in concentration	1.000	0.053	0.819
Memory loss (short-term)	0.985	2.967	0.087
Skin problems	0.996	0.795	0.374
Visual disruption	0.980	4.000	0.047*
Hearing disruption	0.966	7.045	0.009**
Dizziness	0.968	6.549	0.011*
Join pain/problem	0.951	10.106	0.002**
Chest pain	0.988	2.373	0.125
Loss of libido	0.972	5.651	0.018*

Note: ** Denotes significance at 1% level and *denotes significance at 5% level

Table 4. Discriminant Analysis Classification Results

Locality	Predicted Group Membership		Total
	Urban	Rural	
Urban	79 (79.0%)	21 (21.0%)	100
Rural	20 (20.0%)	80 (80.0%)	100

Note: 1.79.5% of original grouped cases correctly classified 2. The value within bracket refers to row percentage

to the rural locality surveyed ($p<0.001$). It was found that 43.8% of the rural people who lived between 1 to 5 years near the cell phone tower were also in the presence of electrical transformers and 45% living for more than 5 years were also in the presence of very high tension power lines. Table 4 shows the practical results of using the discriminant model. Of the cases used to create the model, 79 of the 100 cases of urban locality (79%) were classified correctly and 80 of the 100 cases of rural locality (80%) were classified accordingly. Overall, 79.5% of the cases were classified based on their locality.

DISCUSSION

In a metro like Chennai, in the Tamil Nadu, India, it is very common to see clusters of cell phone towers within 300 m and cell phones are used extensively by people, as confirmed by the urban teledensity. Lifestyle, general health and welfare of people living at the vicinity of cell phone towers were assessed in this urban landscape in comparison to a rural locality in Tamil Nadu. A study in Spain found that most exposed people had a higher incidence of fatigue, irritability, headaches, nausea, loss of appetite, sleeping disorders, depression, discomfort, difficulties concentrating, memory loss, visual disorders, dizziness and cardiovascular problems. The authors recommended a maximum exposure of 0.001 mW/sq.m (Oberfeld *et al*. 2004).

Accordingto a studyon the effect of a cell phone tower on human subjects, skin disease and hair loss were found to be common, along with marked incidences of diabetes, cardiac and respiratory problems among people who lived within 50-100 m of cell phone towers, besides cancer, epilepsy and insomnia were also insignificant (Chandran *et al*. 2012). Also, among the people who were surveyed in Chennai for this study, cancer, diabetes, impotency, infertility, premature menopause, sterility, miscarriage, Alzheimer, Parkinson, epilepsy, stroke or seizures were not noted either in urban or rural localities. In the urban locality, people lived at a distance of less than 50 m, facing the antenna of 6 or more base stations. Wireless device use was higher in the urban locality than the rural locality, where more people lived at a distance of 50 to 300 m in the presence of less than 3 base stations. The non-specific symptoms of the urban people were limited when compared to the rural people. On the contrary, the urban people had more medical conditions than the rural people. Presence of electrical transformers was evident in the urban locality. People living longer near the EMF emitters in the urban locality had more medical conditions and in the rural locality, had more non-specific symptoms. An independent case study in Mumbai found that people living within 50 to 300 m radius were in the high radiation zone and more prone to ill-effects of electromagnetic radiation, especially people in the 6th, 7th and 8th directly facing and at similar height as four mobile phone towers placed at the roof of the opposite building (Kumar 2010). According to a Brazilian study, mortality rates and relative risk of cancer were higher for the residents living within 500 m from the base station compared to the average mortality rate of the entire city. Among the people who lived away from the base station, a decreased dose-response gradient was noted (Dode *et al*., 2011). Unlike the Scandinavian countries, which were the early manufacturers and adopters of this technology, India, Chennai in particular, has a long way to go, but there has been an unprecedented explosive growth in mobile telephony and wireless devices. In an investigation in Naila, Germany, it was found that the proportion of newly developing cancer cases was significantly higher among people who lived for 10 years within 400 m of a cell phone tower site which was in operation from 1993 in this area, compared to the people living outside this area. This investigation was carried out between 1994-2004 and 1000 case histories of patients were surveyed between this period. After five years of being at the vicinity of a cell phone tower, from 1999-2004, the relative risk of getting cancer had trebled for the residents of the area compared to the inhabitants of Naila outside the area (Eger *et al*., 2004).

In Netanya, Israel, an epidemiological assessment was done to determine whether the incidence of cancer cases among individuals exposed to a cell phone transmitter station in comparison with people who lived away from it. Cancer incidences were significantly higher ($p<0.001$) in this area with eight cases of cancer being reported in one year, women being more affected than men. Hence, an association between increased incidence of cancer and living in proximity to a cell phone tower was established (Wolf and Wolf 2004). A study by Santini *et al*., (2002), was carried out to compare the complaints of people living at a certain distance from cellular base station. It showed a significant ($p<0.05$) increase when compared to people living greater than 300 m or not exposed to base station, within 300 m for tiredness, 200 m for headache, sleep disturbance and discomfort, 100 m for irritability, depression, loss of memory, dizziness and libido decrease. Women significantly more than men ($p<0.05$) complained of headache, nausea, loss of appetite, sleep disturbance, depression, discomfort and visual perturbations (Santini *et al*. 2002).

According to Hyland, (2000), urban electromagnetic contamination, also known as the electrosmog, pulsated waves in the frequency of 900 and 1800 MHz interfered with the nervous system of living beings. There was prevalence of neuropsychiatric complaints among people living near base stations (Hyland 2000). In 2008, the Austrian Department of Health found a higher risk of cancer among people living within 200 m of a mobile phone base station and that cancer risk rose with increasing exposure, reaching 8.5 times the norm for people most exposed (Abdel-Rassoul *et al*. 2007). Higher exposure combined with sensitive, developing brain tissue leave children at a greater risk for cell phone radiation. Radiation exposures are higher for children than adults because children have thinner skulls, and their brains have higher water and higher ion (charged particle) content. These factors enhance radiation penetration. Researchers in the United States, France, and Japan have reported that a child's brain absorbed twice the amount of radiation compared to that of an adult (Rosenberg 2013). Research reported headaches, concentration difficulties and behavioural problems in children and adolescents, and sleep disturbances, headaches and concentration problems in adults. Radiofrequency Radiation Sickness Syndrome is a systemic human response to chronic low-intensity radiofrequency exposure, identified in the 1950s by Soviet medical researchers who named it neurotic syndrome (Liakouris 1998).

The clinical manifestations accepted by Russian medicine include elevated lymphocyte counts, protozoan intestinal diseases, dermographism - psoriasis, eczema, inflammatory and allergic skin problems, neurological - diseases of the peripheral nerves and ganglia among males, reproductive - problems during pregnancy, childbirth, tumors - benign among men, malignant among women, hematological changes, mood alterations - irritability, depression, loss of appetite, functional deficits - concentration difficulties and refractive eye problem. The Centre for Climate Change and Adaptation Research, Anna University, using PRECIS, a climatic modeling system, had found that Tamil Nadu will experience an increase in temperature, nearly by 3.4 degree Celsius by the end of the century (CCC&AR 2013). The report also suggested that life would be very hard to live in the urban areas where the temperature may exceed 45 degrees Celsius. Consequently, birds, bats and other animals would migrate from these sites. Chennai's maximum temperature will increase by 0.9 degree Celsius and that of the neighboring districts by 1 degree Celsius over the next 30 years. Public safety standards are 1,000 to 10,000 or more times higher than levels now commonly reported in mobile phone base station studies to cause bioeffects. Mobile phone radiation-induced changes in stress protein(s) hsp27 expression/activity might eventually lead to increase in the permeability of blood-brain barrier. At power density of 20,000 mW/m2, when the rats were placed in a warm air environment, where their brain was made hyperthermic, blood brain barrier permeability changes were induced (Merritt 1978). The landmark investigation by Havas (2008), led to the conclusion that there was a third type of diabetes called brittle diabetes or Type 3 diabetes, caused by transient electromagnetic fields or dirty electricity, generated by electronic equipment and wireless devices, and that exposure to electromagnetic pollution from kHz to GHz may account for higher plasma glucose levels, contributing to the misdiagnosis of diabetes (Havas 2008). Studies link an elevated risk of cancer to cell phone use. The authors concluded that their results support the previous findings concerning a possible association between heavy mobile phone use and brain tumors, especially gliomas and temporal tumours for occupational use and urban cell phone use. Vertigoordizzinesswas one of the complaints frequently made by people who were hypersensitive to RF radiation emitted by cell phones. There were investigations on the acute effects of RE-EMF on auditory perception and hearing deterioration using standard audiometry (Hardell *et al*. 2007; INTERPHONE Study 2011; Sadetzki *et al*. 2008; Coureau 2014). Carpenter (2010), concluded from his analysis that cordless phones increased both exposure levels and disease by about the same magnitude as cell phones do and that the use of either resulted in an increased risk of gliomas. Cordless phones emit RF-EMF radiations, frequency being 900 MHz to 2 GHz inside the premises even when the phone is not in use, similar to a cell phone tower radiation 24/7. Due to the surmounting research on the ill-effects of RF-EMF radiation, the Federal Communications Commission, USA, in June 2012 was advised to review its exposure limits set in 1990s, especially for children and cell phones (IAC 2013).

People who were electrohypersensitive reported a sensitivity to cell phone tower-like signals (Eltiti *et al*. 2007; Furubayashi *et al*. 2008), signals from cell phones (Kwon *et al*. 2008), and mobile phone symptoms especially related to hearing (Bamiou *et al*. 2008; Hillert *et al*. 2008). According to a postal survey, increasing number of people in Japan have electrohypersensitive syndrome (EHS), due to chronic nervous system arousal, with the main symptoms being dizziness, ringing in the ears, fatigue, headaches and sleeplessness. Moreover, 85.3% had to take measures to protect themselves from EMF, such as moving to low EMF areas or buying low-EMF electric appliances. EHS persons were suffering not only from their symptoms, but also from economical and social problems (Kato and Johansson 2012). Pritchard *et al*. (2013), point to the fact that there was a steady increase in auto-immune diseases, motor neuron diseases, dementia, cancer, infertility, and asthma from 1979 to 2010, more women being affected than men in UK and USA, pointing to lifestyle and environmental influences augmented due to electropollution. Hagström *et al*. (2013), carried out a survey in Finland where 206 self-diagnosed electrohypersenstive (EHS) Finns replied to a questionnaire and 81% were women. Before EHS onset, the most common health complaints were allergies at 35%. During the acute phase of EHS the most common symptoms were nervous system related, such as stress 60%, sleeping disorders 59% and fatigue 57%. The sources most often triggering EHS were personal computers 51% and mobile phones 47%; 76% reduced their exposures to RF-EMFs or avoided completely, which helped them in their partial or full recovery. The best treatments for EHS were dietary change 69%, nutritional supplements 68% and increased physical exercise 62%. The official treatment recommendations of psychotherapy 3% and medication 4% were not significantly helpful. The avoidance of RF-EMF radiations effectively removed or lessened EHS symptoms.

The BioInitiative Report (2012; 2014), prepared by 29 research scientists from 10 countries, such as Sweden, USA, India, Italy, Greece, Canada, Denmark, Austria, Slovac Republic and Russia state that exponentially increasing RF-EMF exposures are deleterious to the biosystem and ecosystem. There was substantial evidence that EMF could cause inflammatory reactions, allergy reactions and change normal immune function at the current public safety standards. Medical conditions were successfully treated using EMFs at levels below the current public safety standards, proving another way that the body recognised and responded to low-intensity EMF signals. Moreover, these treatments were controlled for a specific time period, unlike the RF-EMF exposure in the environment, terming it as the biggest biological experiment. Continuous exposure could result in diminished capacity for thinking, judgment, memory, learning, and control over behaviour.

Drugs used in medical treatments and prevention of disease cannot be given without a prescription, especially to children, yet they are being exposed to constant EMFs in the environment as well as through the addictive use of wireless devices. Not only on humans, but the effects of electromagnetic fields (EMF) on animals, especially cows, often found grazing near cellular base stations, show EMF susceptibilities and respond to environmental exposures of a broad range of frequencies and properties (Fedrowitz 2014).
Being a bioelectrical system, the human heart and brain is regulated by internal bioelectrical signals. According to veteran EMF researcher, Dr. Neil Cherry, New Zealand, a water-filled upright human is a sizeable antenna and since all moving electrons generate electrical current, all those electromagnetic waves inundating our everyday lives pass into our bodies, where they each generate an electric current. These induced electric currents change the charge on which our complex bioelectrical body, brain and heart network operates to maintain our health and vitality. Every RF-EMF transmission, according to him, disrupts cells directly (Cherry 2001). According to the Seletun Scientific Statement (2011), low-intensity, non-thermal RF-EMF exposure-related health effects were demonstrated at levels significantly below existing standards and that new, biologically based public exposure standards were urgently needed to protect public health world-wide. EMR exposures should be reduced now rather than waiting for proof of harm before acting (Fragopoulou 2010). According to Sage and Carpenter, (2009), physics and engineering communities must work in tandem with biology and medical community to convince the national and international bodies to set biologically-based standards for safe RF-EMF exposure (Sage 2009).

As each new technology replaces the other, the cell phone devices and their towers need to keep pace with such rapid development. In order to expand the capacity, there are multiple antennas on cell phone towers and better coordination between devices in order to sustain the surge in mobile traffic. Super-high frequency bands from 10 GHz to 30 GHz and extremely-high frequency bands from 30 GHz to 300 GHz, also known as millimeter waves, are beginning to be exploited as well in the future Fifth Generation (5G) technology. The use of millimeter wave at 60 GHz was demonstrated by the Indian scientist, J. C. Bose to send the first-ever wireless telegraph, which travelled 23 m, in Kolkata in 1895. This technology is currently being used for radar and radio telescopes. There are competing technologies like Wi-Fi and WiMAX. Wi-Fi stands for Wireless Fidelity, which provides a wireless local area network coverage within 50-100 m, frequency bands being 2.4 to 5 GHz. WiMAX stands for Worldwide Interoperability for Microwave Access, which have the capability to travel up to 50 kilometers to provide broadband wireless access, frequency bands being 2 to 11 GHz and 10 to 66 GHz, where a computer inside the building will communicate with a tower outside the building (Banerji and Chowdhury 2013; Rappaport *et al*. 2014).

The Indian Telecommunications Industry is one of fastest growing markets in the world and it is responsible for India's significant economic growth. The populations around the world are exposed to a complex mix of electromagnetic fields, which have been steadily increasing from the time of World War II, from extremely low electromagnetic fields of the high tension power lines and electrical transformers to the wireless technologies and their supporting networks. Some countries are completely moving away from wired phones to exclusive wireless phones. This marvelous technology is an enabler, driving many improvisations for mankind. In the future, the conventional cell phone towers are set to be replaced by smaller cluster of cells, known as heterogeneous networks, which will be placed indoors to provide faster connectivity at lower power. There needs to be a constant monitoring of this non-thermal, low-level electromagnetic fields in future and epidemiology surveys of people living in close proximity to the cell phone towers.

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