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A case study of Cellular Base Stations in an Indian Metro (Chennai)

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Abstract

Cellular base stations are placed close to human dwellings in densely populated urban areas in several metros in India. As a result, people are exposed to constant, involuntary radiofrequency electromagnetic fields (RF-EMFs) from the antennas of the base stations. Due to the growing public concern surrounding this, a preliminary study is undertaken to survey the levels of non-ionizing radiation from the base stations in an Indian metro. Power density was measured using portable instruments at locations closer to the base stations at the vicinity of schools, hospitals and residential apartments in North, South, Central and West of Chennai city. Out of the locations surveyed, the radiofrequency electromagnetic field measurements were high in Central Chennai (57.1%) followed by South Chennai (25%). The measured values were then compared with the non-ionizing radiation standards and the levels at which bioeffects were seen in living systems. Among the locations surveyed, 99% of the power density measurements were less than half of the Indian standard and 50% were found to be more than 10 times the upper biological limit. Although adhering to the exposure limits set by International Commission on Non-Ionizing Radiation Protection, adopted by India, the RF-EMF radiation from the mobile base stations in most of the areas surveyed were above the biological limit at which bioeffects were observed.

Introduction

There is a growing concern about the potential health effects of low level, non-thermal, continuous, involuntary exposure of public to radiofrequency electromagnetic field (RF-EMF) from cellular base transmitting stations (BTS) or mobile phone towers, in densely populated Indian metros. Mobile services were launched in India in 1995 and it is one of the fastest growing mobile telephony industries in the world next to China. There are about 900 million mobile phone users in India with more than a billion handsets, connected through nearly 5.4 lakh towers. The electromagnetic energy spectrum includes extremely low frequency (ELF) with very long wavelengths to x-rays and gamma rays, which are the ionising radiations with very short wavelengths. Between these two extremes are the radio waves, microwaves, infrared rays, visible light and ultraviolet radiations. The radiofrequency part of the electromagnetic spectrum has frequencies in the range of 30 kilohertz (KHz) to 300 gigahertz (GHz) (Adey, 1981). Microwaves fall in the range between 300 MHz to 300 GHz. The exposure in the form of non-ionzing radiation from radiofrequency range of 800 MHz to 3 GHz of the electromagnetic spectrum is emitted by mobile phones and mobile phone towers. The public exposure of RF-EMF is high in the developed countries and is increasing at an alarming rate in the developing countries. The reason for this exponential growth, especially in India is because the telecom services turn out to be important drivers for development, delivery of public services such as education, health and integration of rural and urban areas. So much so, the World Bank has estimated that every 1% increase in tele-density results in a 3% increase in the rate of growth of gross domestic product (GDP) (MCIT, 2014).

According to a United Nations University study on sanitation in 2010, six of the world's seven billion people have mobile phones, but only 4.5 billion have proper access to sanitation and in the Indian context, about half of its 1.2 billion residents were mobile subscribers, but only 366 million people have access to toilets (UNU, 2010). Such is the penetration of this technology in India. Its benefits are manifold and as of now, the advantages clearly outweigh the disadvantages. Although from time immemorial, all living beings have been exposed to the natural electromagnetic radiation of the earth, sun and ionosphere, as well as the man-made EMFs, there is a sudden tremendous increase of RF-EMF in the environment in just over a decade. International Agency for Research on Cancer (IARC), which is a part of World Health Organization (WHO), in 2011, had termed the mobile phone radiations as group 2B carcinogen (WHO, 2014). The energy of a photon in the RF spectrum varies from 4.1 x10(-6) eV at 1 GHz to 1.2 x 10(-3) eV at 300 GHz. This is far less than the energy needed to ionise organic materials, which is approximately 5-10 eV (Stuchly 1979). Hence, there is a notion that this type of radiation cannot harm the populace.

In India, the antennas in a mobile phone network are mounted on ground-based masts and/or rooftop of existing buildings at a height of 15-50 m. A typical mobile phone tower is made of iron and steel. The antennas mounted on these towers are sectorial for 2G or 3G transmission, with a beam as wide as 180 degrees or as narrow as 60 degrees, radiating in a specific area. Directive parabolic dish antenna is used for long distance point-to-point communications. The cabin shelters and protects the network equipments, electrical supplies and the diesel generator. There are different types of mobile phone towers used by cellular operators in India and they include the macro cell, micro cell or pico cell. Categorization is based on the purpose of the site rather than in terms of technical constraints such as radiated power or antenna height. In India, macro cellular base station provides the main infrastructure for a mobile phone network and the antenna is mounted at a sufficient height to give a clear view over the surrounding geographical area. The maximum power for individual macro cellular base station transmitter is 20 watts. Antennas on mobile phone towers transmit in the frequency range of 869-890 MHz for CDMA, 935-960 MHz for GSM900, 1805-1880 MHz for GSM1800 and 2110-2170 MHz for 3G. Wi-Fi frequency range is 2.4 GHz, WiMAX is 2.5-3.3 GHz and 4G LTE is 2.99 GHz (Table 1) (Kumar, 2010; CPCB, 2010; TEC, 2012).

Table 1 Radiofrequency Sources in India

RF Source	**Operating Frequency**	**Transmission Power**	**Numbers**
AM Towers	540-1600 KHz	100 KW	197 Towers
FM Towers	88-108 MHz	10 KW	503 Towers
TV Towers	180-220 MHz	40 KW	1201 Towers
Cell Towers	800, 900, 1800 MHz	20 W	5.4 Lakh Towers
Mobile Phones	GSM-1800/CDMA GSM-900	1 W 2 W	900+ million
Wi-Fi	2.4-2.5 GHz	10-100 mW	Wi-Fi Hot Spots

Abbreviations: Wi-Fi, Wireless Fidelity; KHz, Kilohertz; MHz, Megahertz; GHz, Gigahertz; GSM, Global System for Mobile communications; CDMA: Code Division Multiple Access; W, Watt; KW, Kilowatt; mW, milliwatt.

The Indian metro chosen for the study is Chennai, which is the capital of the Southern Indian state of Tamil Nadu. It has an area of 426 sq.km and population of 48,00,000. The city has a wet and dry climate and the weather is hot and humid for most of the year. Mobile phone subscribers in Chennai is 1.15 crore. The teledensity in Chennai is nearly 200% with two mobile connections per person. GSM technology is widely used in Chennai under the Tamil Nadu circle (DoT, 2014; TRAI, 2014; Kumar, 2013). According to the committee set up by the Department of Telecommunication (DoT) in March 2012, to examine the issues relating to mobile phone towers, it was noted that in states such as Tamil Nadu and Karnataka, no permission was required for the erection of a tower (DoT, 2012). The infrastructure providers inform the state government and install the tower. Telecom Enforcement, Resource and Monitoring (TERM) Cells have been set up by the DoT to curb illegal activities in the telecom services and to resolve complaints received through the Public Grievance (PG) portal. According to TERM, the estimated number of towers in Chennai is 6650. At many places in India, Chennai in particular, the mobile phone towers are mounted on rooftop of the residential and commercial buildings as well as on the ground. According to the norms, for installation of mobile phone towers, the Standing Advisory Committee on Radiofrequency Allocations (SACFA) clearances are issued by the wireless monitoring organisation of DoT after getting no objection certificate (NOC) from defence and airport authorities considering aviation hazards, obstruction to line of sight of existing/planned networks and interferences, building owners and tenants, structural stability certificate from state/local bodies, clearance from fire safety department, as well as from Ministry of Environment and Forests (MOEF) for forest protected areas (Kumar, 2013; DoT, 2012; DoT, 2013).

Typical locations where the public is exposed to are at the ground level beneath or beside the antenna and in the terraces and balconies of buildings facing the antenna mounted on towers in the adjacent buildings. According to the Ministry of Communication and Information Technology (MCIT), about 500 000 mobile phone towers consume 4 billion litters of diesel per year, to maintain backup power supply for the high-power radiating antennas. This in turn leads to more than 6 million tons of carbon dioxide emissions per year. According to the noise monitoring undertaken by the Delhi Pollution Control Committee (DPCC), the diesel generators installed for the mobile phone towers contribute 1 dB to 8 dB to the ambient noise level (CPCB, 2010). Even though the antennas mounted on these towers radiate less power vertically down, the distance between the antennas and the top floor of the adjacent building is usually a few meters, so the radiation level in the top two floors of nearby buildings remains high. Some antennas are directly mounted in balconies of residences and lodges and windows of apartments and commercial establishments. Consequently, people are found living and working in close proximity of merely 10 m and sometimes, even less than 5 m from the antenna. In 2008, Government of India adopted the guidelines developed by International Commission on Non-Ionizing Radiation Protection (ICNIRP) for RF-EMF from mobile phone towers (ICNIRP, 1998). Since, the cellular GSM (Global System for Mobile communications) services were being operated at 900 MHz and 1800 MHz frequency band in India, the permissible power density was 4500 mW/sq.m for 900 MHz and 9200 mW/sq.m for 1800 MHz. On 1 September 2012, India adopted 1/10th of this ICNIRP standard (DoT, 2013). According to the Bioinitiative Report, the existing public safety limits set by ICNIRP did not sufficiently protect the healthy population and the sensitive subpopulation against long-term bioeffects from such chronic low-intensity exposures. Hence, new biologically relevant safety limits had to be adopted, as current research on mobile phone towers have reported bioeffects in the range of 0.01 to 0.5 mW/sq.m (Table 2) (Bioinitiative Report, 2012).

The present preliminary study is intended to measure RF-EMF radiation in different zones of Chennai city, particularly from mobile phone towers located near schools, colleges, hospitals, residential apartments as well as commercial establishments.

Materials and Methods

Power density measurements were carried out using two instruments as per recommendations of the Telecommunication Engineering Centre (TEC). The first instrument was a portable, handheld, broadband meter to detect RF-EMF radiation at a given spot. It accurately detected the cumulative radiation in the range of 800 MHz to 4 GHz, which covered the frequency used by most modern communication systems (900 MHz, 1800 MHz 2450 MHz). The radiation levels were indicated by three LEDs (Light Emitting Diodes) as Green, Yellow and Red. The power density measurement range was given in power ratio in decibels (dBm) and microwatts per square meter (μW/sq.m), which was converted to mW/sq.m. If only Green LED lighted up, it implied safe level of radiation, as power received was less than -30 dBm (0 to 0.0706 mW/sq.m). If yellow LED lighted up, it implied caution level of radiation, as power received was between -30 to -15 dBm (0.0706 to 26.19 mW/sq.m). If red LEDs lighted up, it implied high level of radiation, as the power received was greater than -15 dBm (>26.19 mW/sq.m).Power density measurements were also performed using a second instrument, which was a digital, triaxial, hand-held, RF-EMF Strength Meter. The power density measurement was given in microwatts per centimeter squared (µW/sq.cm), which was converted to mW/sq.m. The measuring instrument covered a wide range of frequencies from 50 MHz to 3.5 GHz and specific frequencies of 900 MHz, 1800 MHz and 2.7 GHz. The measuring range was 0 µW/sq.cm to 3.093 mW/sq.cm. The number of locations covered were 106 in four zones of Chennai, namely, North, Central, West and South. In all four zones, measurements were carried out in areas accessible to the public. Locations closer to schools and hospitals at the vicinity of a mobile phone tower were purposely chosen. Other areas included were children's daycare centers, playgrounds, and residential apartment complexes. The spot measurements were carried out between the peak hours of 11 am to 1 pm for a period of six months. Statistical tool/software IBM SPSS, Version 17, was used and the results were tabulated. These measurements were compared to the RF-EMF radiationstandard adopted by India and biological standard at which bioeffects were seen.

Table 2 Indian RF-EMF Standards and Biological Limits

Indian Standards and Biological Limits	**Power Density in mW/m^2**	**Comments**
Old Indian Guidelines	4500 for 900 MHz 9200 for 1800 MHz	Adopted ICNIRP 1998 guidelines
New Indian Guidelines 1 September 2012	450 for 900 MHz 920 for 1800 MHz	Reduced to one-tenth of ICNIRP guidelines
New Indian Guidelines 1 August 2013	1000 for 3G and 4G	Guidelines doubled by Department of Telecommunication (DoT)
Range at which health problems have been observed	1 - 0.5	Bioinitiative Report 2007
Range at which health problems have been observed	0.5 - 0.01	Bioinitiative Report 2012
Safe power density level for long-term continuous exposure	For 100 years - < 0.1 For 10 years - < 1 For 1 year - < 10	Girish Kumar, 2010

Abbreviations: mW/m^2, milliwatt per square meter; G, generation; MHz, megahertz, ICNIRP, International Commission on Non-Ionizing Radiation Protection; DoT, Department of Telecommunication.

Results

Data obtained from the first instrument was tabulated (Table 3). Since P value was less than 0.05, there was a significant association between the four zones of Chennai and RF-EMF radiation at 5% level. According to column percentage, zones denoting highest radiation in the red or high levels were in Central Chennai at 57.1%, followed by South Chennai at 25%, West Chennai at 17.9% and North Chennai at 0%. Zones showing caution level or yellow included Central Chennai at 41.1%, West Chennai at 28.8%, South Chennai at 16.4% and North Chennai at 13.7%. Zones showing safe level or green include West Chennai at 60% and South Chennai at 40%. No indication of safe levels in North or Central Chennai from the locations surveyed. In the present survey, using the second instrument, out of 106 readings across four zones of Chennai, namely North, Central, West and South, 51 readings were found to be above 5 mW/sq.m. Hence, among the locations surveyed, 50% were found to be more than 10 times the upper biological limit of 0.5 mW/sq.m and 99% of the locations were less than half (225 mW/sq.m) of Indian standard. One particular location in West Chennai showed a power density of 450 mW/sq.m when surveyed (Figure 1).

Table 3 Chi-Square test for association between four zones of Chennai and the levels of RF-EMF radiation

Four Zones of Chennai	**Yellow (caution)**	**Red (high)**	**Green (safe)**	**Chi-Square**	**P-value**
North	(100.0) [13.7]	(0.0) [0.0]	(0.0) [0.0]	12.451	0.047*
Central	(65.2) [41.1]	(34.8) [57.1]	(0.0) [0.0]		
West	(72.4) [28.8]	(17.2) [17.9]	(10.3) [60.0]		
South	(57.1) [16.4]	(33.3) [25.0]	(9.5) [40.0]		

Note:
1. The value within ( ) refers to Row Percentage
2. The value within [ ] refers to Column Percentage
3. * Denotes significance at 5% level
4. Green = < -30 dBm = 0 to 0.0706 mW/sq.m
   Yellow = -30 to -15 dBm = 0.0706 to 26.19 mW/sq.m
   Red = > -15 dBm = > 26.19 mW/sq.m and above

Overall mean for all four zones was 26.64 mW/sq.m (Table 4). There was a significant difference at 1% level between Indian and biological standards and RF-EMF radiation in all four zones of Chennai. In the North and West zones, there was a significant difference at 1% level when compared to the Indian standard, whereas it was not significant when compared to the biological standard. In the case of Central and South zones, there was a significant difference at 1% level between both Indian and biological standards.

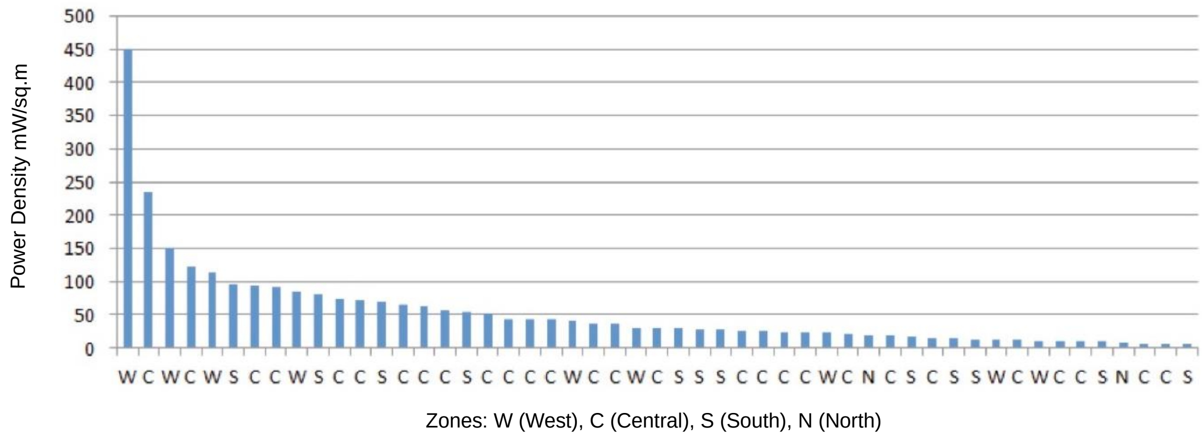

Figure 1. Power density measurements across four zones of Chennai

Table 4: T-test for significant difference between RF-EMF radiation level in four zones of Chennai and Indian and biological standards

Zones of Chennai	Mean	SD	Indian Standard P-value	Biological Standard P-value
North	4.31	5.74	<0.001**	0.065
West	31.39	88.65	< 0.001**	0.071
Central	30.02	43.14	< 0.001**	< 0.001**
South	23.32	28.58	< 0.001**	0.002**
Overall	26.64	55.79	< 0.001**	<0.001**

Note: ** Denotes significance at 1% level

Discussion

The RF-EMF radiation exposure from both mobile phones and their towers may have possible thermal/non-thermal effects. Excessive mobile phone usage leads to temperature release at the site of ear lobes. The mobile phone is a weak source of RF signal, but it is very close to human body, whereas the more powerful mobile phone tower is at the far end. Electromagnetic radiation from a source spreads around the vicinity and creates an electromagnetic field (EMF). The intensity of EMF is strongest at the source and becomes weaker as distance increases. Hence, distance plays a vital role followed by time factor of exposure duration. According to the cumulative RF-EMF measurements, Central Chennai being the commercial hub, with considerably lesser green cover and a dense cluster of mobile phone towers, had increased electrosmog, followed by South Chennai, which is the Information Technology (IT) hub, although with a considerable green cover. Mean power density was the highest in the West zone of Chennai followed by the Central zone. North Chennai is a thriving trade and commerce centre, with many industrial establishments and lesser green cover. West Chennai has well-planned townships, less congestion and increased green cover, although commercial activities are on the rise currently. Vegetation is known to reduce the signals from the base stations, but buildings do not appreciably diminish signal transmission.

An independent cellular tower study in 2010 to assess the cumulative emissions within the 800 to 2000 MHz band of frequency, which included both GSM and CDMA (Code Division Multiple Access) technologies, at 180 areas in New Delhi, using carefully calibrated equipment, as per the DoT prescribed procedure in line with the ICNIRP specifications were carried out by leading experts from the Indian Institute of Technology-Madras (IIT-M), Chennai, Thiagarajar College of Engineering (TCE), Madurai and Centre of Excellence in Wireless Technology (CEWiT), Chennai. It revealed that cumulative measurement levels of radiation from base stations in Delhi were 100 times below international safety guidelines and in compliance with the limit set by ICNIRP (1998). The independent study was commissioned by the Cellular Operators Association of India (COAI) and Association of Unified Telecom Service Providers of India (AUSPI) as a proactive measure to address public health and safety issues (Announcement Economy, 2010). According to the 2012 Bioinitiative Report, the power density at which bioeffects were seen was in the range of 0.5 to 0.01 mW/sq.m. Safe radiation levels for long-term continuous exposure were postulated (DoT, 2013; ICNIRP, 1998; Bioinitiative Report, 2007; Bioinitiative Report, 2012; Bioinitiative Report, 2014).

A measurement of public exposure to RF-EMF in the living environment in areas around base stations were carried out in Salzburg, Austria, in cities and towns at 100 sites and rural areas at 102 sites from 1997 to 1999. Dosimeter measurements were carried out in Australia for 24 hours at 14 different locations; at 118 locations at 17 sites in UK; and in Canadian schools (Thuróczy, 2002). A similar study in Chandigarh city in India was performed to measure RF-EMF radiation near schools and hospitals (Dhami, 2011). The results of these varied studies indicated that although adhering to standards, the power densities were found to be much higher than the biological limit at which effects were noticed. The RF-EMF values around mobile phone towers were measured in two cities in Malaysia and it was found to be less than 1% of the maximum permissible exposure and within the international limits, although the number of mobile phone towers in the city was increasing (Ismail *et al*., 2010). In another study, the real-life exposure of the general public to 3G base station radiation in environment was measured during a period of one day and concluded that it was higher during daytime than at night due to the traffic demands (Mahfouz *et al*.,2011).

According to Shandala and Vinogradov (1983), there will be high electromagnetic radiation near a re-emitting element such metal-coated devices such as wires, pipes, playground equipments, cranes, power transmission lines, and metal fences. An invisible ocean of electromagnetic waves from cell towers among others, travelling at the speed of light, can be reflected and refracted by metal appliances, rain, snow, glass and conductive materials. RF-EMF radiation (835 MHz, 915 MHz, 1900 MHz and 2450 MHz) from mobile phone towers was higher at a closer distance from the mobile phone base station than farther away. The peak in power density values was observed at a distance of 40 meters for most of the antenna orientations (Kaur and Dhami, 2012). According to Tanwar, (2006), in the over-exuberance of the speed of network roll out and covering the full population for good communication range, structural stability, heritage protection and radiation health effects have been neglected. The general public was being continuously exposed to EMF leading to have permanent effect on human health and behavior. The average threshold value for non-thermal biological effects was found to be 1 mW/sq.m. Two of the most important factors were the distance and the direct line of sight to the antenna. At the typical mobile phone base station distance of about 250 m in cities, with direct line of sight, the observed levels were in the range of 0.2 mW/sq.m, with the maximum value exceeding 100 mW/sq.m (Haumann *et al*., 2002).

Mantiply *et al.,* (1997), measured and reported common sources and levels of RF in the environment. Areas near mobile phone base stations on the ground were found to be from 0.03 to 0.3 mW/sq.m. Ambient radiofrequency exposures in cities and suburbs in the 1990s were found to be below 0.03 mW/sq.m. Ambient radiofrequency power density measurements in 12 large cities in Sweden were roughly ten times higher than in the United States for equivalent measurement in locations, which were carried out by Mantiply in 1978, when no mobile phone service existed in the US. The total mean value of 26 measured sites in the study showed a power density of 0.5 mW/sq.m. An office location with a mobile phone base station at a distance of 300 feet was 1000 mW/sq.m. A train station with indoor antennas revealed a power density of 30 mW/sq.m. Both indoor and outdoor ambient radiofrequency power density measurements were highly variable and depended on the location of the transmitting antennas. Within the first 100 to 300 feet, power density levels were found to be 0.1 to 30 mW/sq.m. Elevated radiofrequency power density levels from a major wireless antenna site can be detected 1000 feet away. Power density levels away from wireless antenna sites measure between 0.01 mW/sq.m to 0.00001 mW/sq.m (Sage, 2000). Mobile phone base stations are being incorporated into stealth designs, such as church steeples, water tanks, trees and flag poles called as stealth installations and they produce elevated radiofrequency levels in nearby areas where people are ignorant about their presence. The power density levels of RF-EMF radiation decrease with distance. If a mobile phone tower is situated at 100 m from a school, the RF-EMF radiations are much more in that area than a school, which is situated at more than 500 m. Metal objects, cement walls and clay tiles obstruct RF-EMF radiation. The orientation of the antenna plays an important role, as the area facing the tower antenna will have more radiation compared to the one on the back side of it and right below it (Dhami, 2011).

According to Swicord and Balzano, (2008), there were 781 papers in the WHO-EMF Health Project database, reporting research effects of RF-EMF from 0.1 to 100 GHz on animals. Majority employed laboratory rodents (mice and rats) in the range of 900 MHz to 2.5 GHz. There was only one paper dealing with dosimetry. In an investigation on inhabitants living near mobile phone towers in Egypt, it was found that they were at a risk for developing neuropsychiatric and neurobehavioral problems. Microwave measurements of power density as low as 6 mW/sq.m showed strong correlation with symptoms like depressive tendency, fatigue and insomnia in humans (Abdel-Rassoul *et al.,*2007). According to an article in Wall Street Journal (2014), six engineers on examining more than 5000 mobile phone tower sites across US, found that 1 in 10 of the sites violated Federal Communication Commission's rules placed for protection of workers from excessive RF-EMF radiation and absence of barricades and signs preventing people from getting too close to the towers (Dugan and Knutson, 2014). According to the Cellular Telecommunications and Internet Association, the antennas placed in more than 300 000 locations, such as rooftops, parks and stadiums, have doubled since 10 years ago. (CTIA, 2014). India has tightened the rules, and as per TERM, if a site fails to meet the EMF criterion on testing, there is provision of levying a penalty of Rs. 5 lakh per Base Transmitting Station (BTS) per service provider. Service providers must meet the criterion within one month of the report of TERM cell in such cases, after which the site will be shut down. The sites against which there were public complaints would also be tested by TERM Cell of DoT. The cost of the testing shall be borne by the service provider. As for the structural safety of the towers, some state governments and municipal corporations have formulated their guidelines and issued instructions to regulate erection of mobile phone towers (MCIT, 2014; CPCB, 2010; TEC 2012).

Various guidelines have been set by DoT (2012) after examination of the report of the departmental committee on mobile phone towers. The installation of mobile phone towers in narrow lanes are prohibited to avoid the risk caused by earthquake or wind-related disaster. No towers are allowed within the premises of schools or hospitals, as children and patients are more vulnerable to RF-EMF. Instead, low wattage, indoor device solutions are to be introduced. The general public should be cautioned against accessing the mobile phone tower. Wire fencing, locking doors to the terraces and putting up warning signs, which are clear, visible and identifiable, that read "Danger Radio Frequency (RF) Radiation, Restricted Area, Don't Enter" are mandatory. Service providers must possess and maintain Structural Stability Certificate (SSC), every 5 years, from certified structural engineers or from Indian Institute of Technologies (IITs), National Institute of Technologies (NITs) or any other government-recognized institution. Installation should be avoided on structurally unsafe buildings. The design, fabrication, material and erection of mobile phone towers and the buildings should conform to relevant Bureau of Indian Standards (BIS) provisions in the relevant areas, incorporating earthquake/cyclone resistant features. There should be consistent inspection of existing buildings and towers in seismic zones by structural engineers in order to ensure that these are compliant. The DoT website should display the details of buildings and towers with status such as self-certified, TERM Cell-certified or not certified (DoT,2014; TRAI, 2014; Kumar, 2013; DoT, 2012; DoT, 2013).

Although with mobile telephony, the advantages clearly outweigh the disadvantages, one must pay attention to their bioeffects on biosystem and ecosystem. Humans are bioelectrical systems and the environmental over-exposures to artificial EMFs can interact with fundamental biological processes in the human body. The future of this technology is ubiquitous computing. Hansmann (2003) explains the concept of the Internet of Everything (IOE), also known as the Internet of Things or Machine-to-

Machine (M2M) as the concept of linking billions of devices wirelessly through Bluetooth, Wi-Fi, ZigBee, Cellular, Radio Frequency Identification (RFID) and many other wireless technologies. People will live in an electronic environment, which will be responsive to their everyday needs. The devices will grow smaller and will be integrated into the environment. The technology will become invisible in such a way that everyone will only know how it works and will not be able to see it. Mobile phone use is under the control of the individual, whereas people found living as close as 10-50 m facing the antenna of the mobile phone tower, are exposed to long-term, low-level, non-thermal RF-EMF radiation. People should be made aware of the rules, regulations and precautions related to the placement of mobile phone towers, especially in densely populated metros. Measures need to be taken to carry out extensive dosimetry study with sophisticated sensitive equipments to assess the level of increasing electrosmog in the environment of human habitation all through.

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Authors' contributions: Sivani Saravanamuttu (Ph.D. Research Scholar) performed the case study, data analysis and is the corresponding author of manuscript. Vivek Singh (Research Scholar) and Robinson Khumukcham (Research Scholar) were responsible for data collection and measurement. Sudarsanam Dorairaj, (Professor) contributed to editing, correction of manuscript and overall guidance.

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