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Residential Proximity to Mobile Phone Base Stations and Non-specific Health Symptoms- A cause for Concern?

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Abstract - The emergence and escalating popularity of the wireless communication technology is a matter of concern as exposure to radiofrequency radiations (RFR) emitted (900-1800MHz) from the mobile phone base stations can have public health implications. In this study from Amritsar city, 100 study participants, 50 (40.64±3.42y) residing near mobile phone base stations (sample group) and 50 (39.28±3.48y) with no nearby base stations (controls) were interviewed for non-specific health symptoms. The groups matched for age, gender, diet, education levels, socio-economic status and mobile phone usage. The sample/exposed group resided in two areas with power density measurements (226.04±63.02 μW/m^2, 392.88±60.51μW/m^2). Which were slightly higher (p=0.001) than at residences of controls (0.005±0.03μW/m^2). Prevalence of non-specific health complaints was higher in the exposed group: headaches (34.00% vs. 22.00%), blurred vision (16.00% vs. 6.00%) and skin (14.00% vs. 4.00%) and Cardiovascular (4.00% vs. 2.00%) problems. Other health symptoms included dizziness, depression, nausea, memory loss, tinnitus, loss of appetite, feeling of discomfort and bowel disturbances. These findings indicate that staying near mobile phone base stations with continuous radiofrequency radiations emittance can be detrimental as the non-specific health symptoms are early indicators of disease manifestation.

Keywords - 1.Radiofrequency radiations, 2.Power density, 3.Health effects, 4. Mobile communication.

INTRODUCTION

The increasing utility of cell phones and their widespread installed base stations for convenient communication is a matter of concern as exposure to radio-frequency radiationsemitted from the mobile phone base stations may prove hazardous to health of the general population. These electromagnetic radiofrequency radiations (RFR) fall in the range of 10 MHz-300GHz and the mobile (cell) phone technology use frequencies mainly between 800 MHz and 3 GHz and the cell tower antennas use a frequency of 900 or 1800 MHz, pulsed at low frequencies. These RFRs are generally known as microwaves (300 MHz-300 GHz). For CDMA (Code Division Multiple Access), antennas on cell towers transmit in the frequency range of 869-890 MHz while the range of 935-960 MHz is for the Global System for Mobile Communication(GSM-900) and 1805-1880 MHz for GSM-1800 with 2110-2170 MHz for 3G (Sivani and Sudarsanam, 2012).

As there is continuous increase in the user-base of cell phones, installation of mobile base stations is on the increase and India has 540,000 mobile phone base stations(DoT,2012). The International Agency of Research on Cancer (IARC, 2011) has stated that radiations in cell phone technology are "possibly carcinogenic". The continuous 24X7 emissions from mobile base installed near residential areas can impact the health of the residents. (Santini*et al*. 2002; Abdel-Rassoul*et al*., 2006; Gandhi *et al*.,2013;Gandhi *et al*.,2014). In the present study are reported non-specific health symptoms in those residing in areas with mobile phone base stations.

METHODOLOGY

A general survey by face-to-face interview method was used for carrying out this study. The study was approved by the Institutional Ethics Committee and written informed consent was given by all study participants (n=100) voluntarily. The ill-health effects with the personal details of some residents (n=50) staying in an area with a nearby mobile phone base station were documented on a specifically-designed proforma. Study participants comprising the control group (n=50) were healthy persons not staying in areas with mobile phone base stations and with no history of disease or any other exposure(s) during the past one year.

2.1 Study sites: A mobile base station (30m in height) erected in 2003 by Bharat Sanchar Nagar Limited (BSNL) on the roof-topof a double-storeyed building in a locality opposite the Guru Nanak Dev University (Kabir Park, Amritsar) was the residential site identified for the present study. The tower has four dish - and nine sectorial- antennas. The immediate next triple-storyed building has a Sify broadband internet connectivity (5MHz) tower which was erected in 2005 (~52mhigh) and has seven dish- and four sectorial-antennas.

2.2 Radiofrequency (RF) measurements: Using a hand-held RF analyser (Meco 9720 Electrosmog meter), the radiation frequency was measured at the 100 households from where sampling was done, i.e. 50 in Kabir Park (area with base station) and 50 from Adarsh Nagar and

Labh Nagar (with no nearby base stations). For each site, the best reading on the analyzer was recorded as the RF value.

2.3 Statistical analysis: The categorical demographic variables of sample (those residing near mobilr phone base stations) and the control (in areas with no base stations) groups were assessed by the Chi-squared (χ^2) analysis whereas on the continuous variables of age and power density (mean±S.E.M.), the Student's t-test was applied. The p value of ≤0.05 was considered for determining the significance. The statistical analysis was done using SPSS (version 16) for Windows.

RESULTS

The general demographic characteristics of the individuals residing in the vicinity of mobile phone base stations and controls are given in Table 1. The sample (n=50; 40.64±3.42y) and the control (n=50; 39.28±3.48y) participants matched for age, gender, diet, education, socio-economic status and daily mobile phone usage, duration of mobile phone use. All participants were mobile phone users with no drinking or smoking habits. The occupations differed but there were no occupational exposures. The group of individuals had been residing near the mobile phone base stations and the internet tower for 5-16y; most of the males (80.00%) and females (92.00%) had been residing for 5-10y. Residence of females were at 50-100m from base station, with 28.00% males residing at a distance of 50-100m, 24.00% at a distance of 101-150m from base station, 36.00% at 151-200m and 52.00% at 201-250m. The residences either faced the towers (34.00%) or were besides (28.00%), behind (20.00%) and even beneath (18.00%) the towers. Both the groups matched for mobile phone usage. The power density at residences near towers was very highly (p=0.001) significantly increased (309.46±44.85µW/m^2)in comparison to that in residential areas of control group (0.005±0.003µW/m^2).

The health effects reported by the sample and the control group participants is presented in Table 2. In comparison to controls, the exposed group had more cases with headaches (34.00% *vs.* 22.00%), blurred vision (16.00% *vs.* 6.00%),skin problems (14.00% *vs.* 4.00%) and cardiovascular problem (4.00% *vs.* 2.00%). The other health effect reported by sample group included dizziness, depression, nausea, memory loss, tinnitus, loss of appetite, feelingof discomfort and bowel disturbance. Only irritability (4.00%) and fatigue (2.00%) were reported by control participants. A significant (p=0.01) increase incases of headaches was observed in females (56.00%) in comparison to males (52.00%) residing in vicinity of mobile phone base station.The health effects stratified as function of power density values among the sample group participants revealed no difference in occurrence of symptoms with increase in power density (Table 3) though the non specific health symptoms were significantly increased from those in controls.

DISCUSSION

According to the Telecom Regulatory Authority of India (TRAI,2014), by the end of February 2014 there were more than 903.36 million cell phone users in India (Verma*et al.*, 2012) and nearly 5,40,000 cell phone towers to meet the communication demand (DoT, 2012). The installed base stations have been a cause of debate over the emittance of RFR as these can cause health disturbances. The results of the present study also showcase the same.

The health complaints as a host of non-specific health symptoms in residents from proximity to cell base station, could well be early indicators of the adverse health effects and disease-causation. Studies from other parts of the world are also in accordance to the results in the present study. Non-specific health symptoms reported in those staying near mobile phone base station include headaches, dizziness, blurred vision, sleep disturbances, irritation, lack of concentration, fatigue, loss of appetite, memory loss and skin problems (Santini*et al.*, 2002; Hutter*et al.*, 2006; Abdel Rassoul*et al.*, 2006). In a study from France, symptoms such as irritation, depression, loss of memory were reported to be more prevalent among residents within 300m distance from mobile phone base station (Santini*et al.*, 2002). Also the females complained more of nausea and headaches whereas the males reported about decreased libido at a distance of 50-100m from a base station.

Another study from Spain observed significant correlation of health effects viz. discomfort, irritability, headaches, fatigue, loss of appetite, sleep disturbances, difficulty in concentration with the measured power density values (Navarro *et al.*, 2003). Neurological complaints have been observed to be significantly increased in individuals residing under the base station in Egypt (Abdel Rassoul*et al.*, 2006) and also at a distance of about 100m; and in those with residences facing base station, there was reported increased prevalence of sleep disturbances and fatigue in Baquba area of Iraq (Alazawi, 2011).

In a study from Amritsar city, 26.54% of 113 residents had health complaints from residing (50-300m) near a base station for four to ten years (Gandhi *et al.*,2013). Power density measurements were significantly higher in the two areas with base stations (11.49±0.17 W/m2, 11.18±0.13 W/m^2) in comparison to areas with no stations (0.04±0.00 W/m^2). Headaches were significantly increased in areas with high power density and in those residing adjacently to the base stations. Mobile phone usage, SAR value of mobile sets and power density also influenced health complaints (Gandhi *et al.*,2013).In an another survey of 150 study participants from 17 areas of Amritsar city with 32 mobile phone base stations with power density ranging from 1.295 to 2.514µW/m^2 a pleothara of non-specific health symptoms were also reported(Gandhi *et al.*,2014) within an area of 250m of various base stations, 60% complained of headaches,33.33% of bowel disturbance, 23.33% of blurred vision,22.66% of tinnitus,20.66% of sleep disturbances,14.00% of dryness of mouth, lack of

concentration and irritability,11.33% of nausea, 8.00% of skin problems,6.66% of dizziness, 5.33% of depression,4.66% of tremors, 3.00% of fatigue, movement difficulties and memory loss 2.00% of loss of appetite and 1.00% of cardiovascular problems.In an another study from India, Kumar (2010)though reported no health symptoms, but cancer incidences from exposure to RFR radiation (power density 0.1 W/m^2 = 100,000 $\mu W/m^2$) in a duration of two to three years in Mumbai have been reported.

The results of the present study and of other studies from India and abroad are a cause for concern from exposure to mobile phone base stations as these non-specific health effects are indications that such exposures affect the well-being and may also predispose the populace to disease manifestation. Many of these non-specific symptoms are early indicators of chronic and acute diseases (Michaelson and Lin, 1987; Kennedy *et al.*, 2012).Headaches imply problems in respect of neurological disorders (Genuis and Lipp, 2011) while blurred vision is an early manifestation of cataracts since the region near the eyes has limited blood supply that cannot dissipate the heat (Eid *et al*.,2013). Cognition effects, slower reflexes and memory loss are also known effects of RFR (Luria *et al*.,2009; Hareuveny *et al*.,2011).Fatigue as a non-specific symptom is also associated with neurological problems (Genuis and Lipp, 2011) and its presence in those with RFR exposure has also been documented (Santini *et al*.,2003). Sleep disturbances are associated with effects on the autonomic nervous system, systemic hemodynamics, cardiac and endothelial functions and coagulation problems (Wolk *et al*.,2005).Complaints about sleep disturbances from people staying near base stations have also been reported in studies from Spain (Gómez-Perretta *et al*.,2013), France (Santini *et al*., 2002), Austria (Hutter *et al*.,2006) as well as in the present study. The absence of such symptoms in controls adds weightage to these symptoms having manifestation from RFR exposure. Therefore, stronger adherence to existing guidelines for not siting mobile phone base stations in residential areas is required to safeguard human health.

Table 1: General Characteristics of Individuals Residing in the vicinity of Mobile Phone Base Stations and of Controls

Characteristics	**Category**	**Sample Group n (%)**			**Control Group n (%)**			**χ^2 Value**	**P value**
		Females	**Males**	**Total**	**Females**	**Males**	**Total**		
Age(y)	18-45	13(52.00)	16(64.00)	29(58.00)	14(56.00)	17(68.00)	31(12.40)	0.02	0.838
	46-73	12(48.00)	09(36.00)	21(42.00)	11(44.00)	08(32.00)	19(38.00)		
Diet	Veg	11(44.00)	04(16.00)	15(30.00)	18(72.00)	07(28.00)	25(50.00)	3.37	0.066
	Non - Veg	14(56.00)	21(84.00)	35(70.00)	07(28.00)	18(72.00)	25(50.00)		
Education	Illiterate	-	-	-	01(4.00)	-	01(2.00)	5.05	0.409
	Middle	-	-	-	01(4.00)	-	01(2.00)	-	-
	Matric	02(8.00)	02(8.00)	4(8.00)	01(4.00)	01(4.00)	02(4.00)		
	Senior secondary	06(24.00)	06(24.00)	12(24.00)	05(20.00)	05(20.00)	10(20.00)		
	Graduate	12(48.00)	12(48.00)	24(48.00)	09(36.00)	09(36.00)	18(36.00)		
	Post graduate	05(20.00)	05(20.00)	10(20.00)	08(32.00)	08(32.00)	16(32.00)		
Occupation	Service class	06(24.00)	06(24.00)	12(24.00)	9(36.00)	09(36.00)	18(36.00)	7.20	**0.027**
	Business class	01(4.00)	01(4.00)	02(4.00)	04(16.00)	04(16.00)	08(16.00)		
	Teachers	18(72.00)	18(72.00)	36(72.00)	12(48.00)	12(48.00)	24(48.00)		
[a]Socio-economic Status	Upper	25(100.00)	04(16.00)	29(58.00)	25(100.00)	04(16.00)	29(58.00)	4.42	0.109
	Upper middle	-	21(84.00)	21(42.00)	-	17(68.00)	17(3.00)		
	Lower middle	-	-	-	-	04(16.00)	04(8.00)		
Time since residing/working in the vicinity of the base station(y)	5-10	23(92.00)	20(80.00)	43(86.00)	-	-	-	0.66	0.41
	11-16	02(8.00)	05(20.00)	07(14.00)	-	-	-		
Distance from mobile phone base station (m)	50-100	25(100.00)	07(28.00)	32(64.00)	-	-	-	-	-
	101-150	-	06(24.00)	06(12.00)	-	-	-		
	151-200	-	09(36.00)	09(18.00)	-	-	-		
	201-250	-	03(52.00)	03(6.00)	-	-	-		
Location with respect to base station	Facing	09(36.00)	08(32.00)	17(34.00)	-	-	-	-	-
	Besides	03(12.00)	11(44.00)	14(28.00)	-	-	-		
	Behind	04(16.00)	06(24.00)	10(20.00)	-	-	-		

	Beneath	09(36.00)	-	09(18.00)	-	-	-		
Mobile Phone usage	User	25(100.00)	25.00(100.00)	50(100.00)	25(100.00)	25(100.00)	50(100.00)	0.010	0.920
Duration of mobile phone usage (y)	≤5	11(44.00)	14(56.00)	25(50.00)	12(48.00)	13(52.00)	25(50.00)	0.04	0.840
	>5	14(56.00)	11(44.00)	25(50.00)	13(52.00)	12(48.00)	25(50.00)		
Daily mobile phone usage (hours)	≤0.5	13(52.00)	15(60.00)	28(56.00)	18(72.00)	19(76.00)	37(74.00)	2.81	0.090
	>0.5	12(48.00)	12(48.00)	22(44.00)	07(28.00)	06(24.00)	13(26.00)		
SAR (W/kg)	≤0.83	15(60.00)	13(52.00)	28(56.00)	13(52.00)	02(8.00)	15(30.00)	5.87	**0.015**
	>0.83	10(40.00)	12(48.00)	22(44.00)	12(48.00)	23(72.00)	35(70.00)		
Power Density ($\mu W/m^2$)	0.00-0.01	-	-	-	0.005±0.003	0.005±0.003	0.005±0.003	-	**0.001**
	0.01-960.30	226.04±63.02	392.88±60.51	309.46±44.85	-	-	-		

[a]Kumar *et al.*(2012); *Students' t-test; p values <0.05 are significant

Table 2: Health Effects Reported by Individuals Residing in the Vicinity of Mobile Phone Base Station and by Controls

Group	**Sample Group n(%)**					**Control Group n (%)**						**P value**
†Power Density	309.46±44.85					0.005±0.003						**0.001**
Health Effects	**Females**	**Males**	**Total**	**X^2 value**	**P value**	**Females**	**Males**	**X^2 value**	**P value**	**Total**	**X^2 value**	-
Headaches	14(56.00)	03(12.00)	17(34.00)	5.88	**0.01**	04(16.00)	07(28.00)	0.364	0.546	11(22.00)	0.89	0.340
Dizziness	-	**01(4.00)**	**01(2.00)**	-	-	-	-	-	-	-	-	-
Depression	**02(8.00)**	-	**02(4.00)**	-	-	-	-	-	-	-	-	-
Nausea	**01(4.00)**	-	**01(2.00)**	-	-	-	-	-	-	-	-	-
Blurred vision	05(20.00)	03(12.00)	08(16.00)	0.125	0.72	02(8.00)	01(4.00)	0.000	1.000	03(6.00)	1.45	0.220
Sleep disturbance	03(12.00)	-	06(12.00)	0.167	0.68	01(4.00)	02(8.00)	0.000	1.000	03(6.00)	0.444	0.500
Irritability	-	-	-	-	-	01(4.00)	01(4.00)	0.50	0.47	02(4.00)	-	-
Fatigue	-	-	-	-	-	-	01(4.00)	-	-	01(2.00)	-	-
Lack of concentration	01(4.00)	02(8.00)	03(6.00)	0.000	1.000	02(8.00)	-	-	-	02(4.00)	0.000	1.000
Memory loss	-	**02(8.00)**	**02(4.00)**	-	-	-	-	-	-	-	-	-
Tinnitus	**01(4.00)**	-	**01(2.00)**	-	-	-	-	-	-	-	-	-
Loss of appetite	**02(8.00)**	**1(4.00)**	**03(6.00)**	0.000	1.000	01(4.00)	-	-	-	01(2.00)	0.250	0.617
Feeling of discomfort	-	**1(4.00)**	**03(6.00)**	-	-	-	-	-	-	-	-	-
Bowel disturbance	**01(4.00)**	-	**01(2.00)**	-	-	-	-	-	-	-	-	-
Dryness of mouth	**02(8.00)**	-	**02(4.00)**	-	-	-	-	-	-	-	-	-
Skin problems	04(16.00)	03(12.00)	07(14.00)	0.000	1.000	01(4.00)	01(4.00)	0.50	0.47	02(4.00)	1.77	0.18
Movement disturbance	**01(4.00)**	-	**01(2.00)**	-	-	-	-	-	-	-	-	-
Cardiovascular problem	**02(8.00)**	-	**02(4.00)**	-	-	01(4.00)	-	-	-	01(2.00)	0.00	1.000
Irritability	-	-	-	-	-	01(4.00)	-	-	-	-	-	-
Discomfort	-	-	-	-	-	01(4.00)	-	-	-	-	-	-

p value in bold (p=0.01) is significant
Figures in bold indicate significant occurrence of non-specific health symptoms as a function of RFR (power density) exposure † Students' t- test

Table 3: Health effects as Function of Power Density in Individuals Residing in the Vicinity of a Mobile Phone Base Station

Health Effects	**Power Density**									**χ^2 value**	**p value**
	≤200μW/m²					**>200μW/m²**					
	Females	**Males**	**Total**	**χ^2 value**	**p value**	**Females**	**Males**	**Total**	**χ^2 value**	**p value**	
Headaches	07(28.00)	-	07(14.00)	-	-	07	03(12.00)	10(20.00)	0.900	0.342	0.235	0.627
Dizziness	01(4.00)	-	01(2.00)	-	-	-	-	-	-	-	-	-
Depression	01(4.00)	-	01(2.00)	-	-	01(4.00)	-	01(2.00)	-	-	0.500	0.479
Nausea	-	-	-	-	-	01(4.00)	-	01(2.00)	-	-	-	-
Blurred vision	03(12.00)	02(8.00)	05(10.00)	0.000	1.000	02(8.00)	01(4.00)	03(6.00)	0.000	1.000	0.125	0.723

Sleep disturbance	01(4.00)	01(4.00)	02(4.00)	0.500	0.479	02(8.00)	02(8.00)	04(8.00)	0.250	0.617	0617	0.683
Lack of concentration	01(4.00)	-	01(2.00)	-	-	-	02(8.00)	02(4.00)	-	-	-	-
Memory loss	-	-	-	-	-	-	02(8.00)	02(4.00)	-	-	-	-
Tinnitus	01(4.00)	-	01(2.00)	-	-	-	-	-	-	-	-	-
Loss of appetite	01(4.00)	-	01(2.00)	-	-	01(4.00)	01(4.00)	02(4.00)	0.500	0.479	0.000	1.000
Feeling of discomfort	-	-	-	-	-	-	01(4.00)	01(2.00)	-	-	-	-
Bowel disturbance	-	-	-	-	-	01(4.00)	-	-	-	-	-	-
Dryness of mouth	01(4.00)	-	01(2.00)	-	-	01(4.00)	-	01(2.00)	-	-	0.500	0.479
Skin problems	02(8.00)	01	03(6.00)	0.000	1.000	02(8.00)	02(8.00)	04(8.00)	0.250	0.617	0.000	1.000
Movement disturbance	-	-	-	-	-	01(4.00)	-	-	-	-	-	-
Cardiovascular problem	01(4.00)	-	01(2.00)	-	-	01(4.00)	-	-	-	-	-	-

Significance at $p \leq 0.05$

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