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ORIGINAL ARTICLE

Health effects of living near mobile phone base transceiver station (BTS) antennae: a report from Isfahan, Iran

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Abstract

Background: In recent years, by tremendous use of mobile phone telecommunication, growing concern about the possible health hazards has increased greatly among public and scientists. The mobile phone exposure has been shown to have many effects upon the immune functions, stimulating hormones, mammalian brain, sperm motility and morphology, and neurological pathologies syndrome. The aim of this study was to find out the psychological and psychobiological reactions of the people who are living near mobile phone base transceiver stations (BTS) antenna, in Isfahan, Iran. *Materials and methods*: A cross-sectional study on 250 randomly selected inhabitants (133 women and 117 men) was performed from October 2012 till November 2012. The inhabitants were requested to complete a standardized questionnaire that focused on the relevant psychological and psychobiological reactions parameters. A computer program (SPSS version16.0, Chicago, IL) was used for statistical analysis using the Chi-square test with Yates correction. All the data were tested using a criterion level of $p < 0.05$. *Results*: The results showed that most of the symptoms such as nausea, headache, dizziness, irritability, discomfort, nervousness, depression, sleep disturbance, memory loss, and lowering of libido were statistically significant in the inhabitants living near the BTS antenna (<300 m distances) compared to those living far from the BTS antenna (>300 m). *Conclusion*: It is suggested that cellular phone BTS antenna should not be sited less than 300 m from populations to minimize exposure of neighbors.

Keywords

Electromagnetic field, human effects, microwave radiation, mobile phone BTS

History

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Introduction

In recent years, use of mobile phone telecommunication has drastically increased the amount of human exposition from the microwaves (MWs) radiation in everyday life. Because it became impossible to imagine a world without mobile communication, a growing concern about the possible health hazards have increased greatly among public, even in those who do not use such phones (Repacholi, 2001).

In this regard, the World Health Organization (WHO) established a project to assess environmental and health effects of Electro Magnetic Field (EMF) in the frequency of 0 to 300 Giga Hertz (GHz) (Dasdag et al., 2003; Hamblin et al., 2006). The mobile phones technology uses 880 and 900 MHz frequency range (Valberg et al., 2007). Accordingly, the term Electromagnetic Hypersensitivity (EHS) was created for symptoms possibly related to EMF. However, the definition and diagnosis remains controversial (Hansson et al., 2006).

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The emitted microwaves have been shown to have many effects upon the immune functions (Repacholi, 2001), stimulating hormones (Fattahi-asl et al., 2012, 2013; Shahbazi-Gahrouei et al., 2012), mammalian brain (de Tommaso et al., 2009), sperm motility and morphology (Agarwal et al., 2009) and neurological pathologies syndrome (Leszczynski et al., 2002).

According to the results gained in a number of experiments, for most of the people, a linear physiological dose-response relationship between EMF field density and the symptoms seemed to be unlikely (Roosli, 2008). Diem et al. reported DNA single- and double-strand induced breaks due to 1800 MHz RF-EMF exposure at 1.2 W/kg SAR (Diem et al., 2005). Nittby et al. have investigated that albumin extravasation enhanced in the rats due to exposer to mobile phones at 12 mW/kg SAR (Nittby et al., 2009). Ammari et al. investigated the effects of a chronic GSM 900 MHz exposure on glia in the rat brain (Ammari et al., 2008). While Rubin et al. found no differences between people with EHS and controls with regard to psychopathological diagnoses (Rubin et al., 2008). Gurisik et al. also found no significant differences between RF-exposed cells and sham-exposed in any of the conditions examined or assays (Gurisik et al., 2006). Lee et al. reported that 1763 MHz RF radiation alone did not reflect any stress response (Lee et al., 2006).

Yuasa et al. investigated that the 30 min pulsed EMF field emitted by a mobile phone no has short-term effects on the human somatosensory evoked potentials (Yuasa et al., 2006).

In Isfahan, mobile phone base transceiver station (BTS) antennas are mostly found ubiquitously, especially near or on homes, hospitals, shops, daycare centers. However, there is a same story worldwide. As the exposure from these base stations is regarded as being low power, nevertheless, their output is continuous (Khurana et al., 2009).

The aim of this study was to find out the psychological and psychobiological reactions of the people who are living near mobile phone BTS Antenna. On the other hand, the influence of inhabitants' exposure conditions to BTS antenna such as the distance, length of time living near the antenna and the influence of sex and age of subjects was aimed.

In addition, finding the relation between the parameters that are often connected with EHS, such as daily use of mobile phone, self-estimated distance between home and the next mobile phone base station, EMF-health concerns, EHS, and psychological strain and psychobiological stress parameters was the second aim.

Materials and methods

A cross-sectional study on 250 randomly selected inhabitants (133 women and 117 men) was performed to determine the prevalence of health effects among subjects living near mobile phone BTS antenna at Isfahan, in October 2012 till November 2012. Among the 250 questionnaires studied, 133 were women (41 years ± 18) and 117 were men (50 years ± 22).

The inhabitants were selected if they had been living near the BTS antenna for more than one year (Liakouris, 1998). Study protocol was in accordance with those in Spain (Navarro et al., 1992; Linde and Mild, 1997; Lotz et al., 1994) and Iraq (Alazawi, 2011).

The inhabitants were requested to complete a standardized questionnaire that focused on the relevant parameters, such as headaches, sleep disturbances, fatigue, depressive tendencies, irritability, feeling of discomfort, difficulties in concentration, loss of appetite, nausea, memory loss, visual disturbances, hearing disturbances, dizziness, cardiovascular problems and lowering of libido (Alazawi, 2011).

The questionnaire was consisted of age and sex of the subjects, distance from BTS antenna (less than 10 m, 10–50 m, 50–100 m, 100–200 m, 200–300 m, more than 300 m) and the location in relation to the antennas (facing, beside, behind, in the case of antennas placed on rooftops). In addition, the exposure conditions of subjects were defined as the length of time living near the BTS antenna (less than 1 year, 1–2 years, 2–5 years, more than 5 years).

At this work, the level of complaints for the studied symptoms was expressed by the study participants using a scale of: 0 = never, 1 = sometimes, 2 = often and 3 = very often.

To avoid the variability inherent to the study, participants living near the electrical transformers (at less than 10 m) and/or high tension electric power lines (at less than 100 m) were neglected from the study.

A computer program (SPSS version16.0, Chicago, IL) was used for statistical analysis using the Chi-square test with Yates correction. All the data tested using a criterion level of $p = 0.05$.

The obtained results were analyzed concerning the frequency of the complaints experienced in relation to responses with 0 (=never). Results were compared with the frequency of complaints of the reference group (subject exposed at >300 m) for incidences of distance, sex and age. The comparisons were done with the frequency of complaints expressed by subjects exposed up to 300 m for length of exposure (comparison to <1 year), for location of subjects (comparison of locations among themselves) and for sex and age.

All data were collected based on self administered questionnaire filled by the study participants.

Results

The results among the 250 questionnaires showed that most of the symptoms, such as nausea, headache, dizziness, irritability, discomfort, appetite loss, depression, sleep disturbance, memory loss difficulty in concentration, lowering of libido, were statistically significant in the exposed group.

Tables 1 and 2 show frequency of inhabitant symptoms of people living near mobile phone BTS antenna according to their gender and age, respectively. Frequency of symptoms according to distance from mobile phone BTS antenna is presented in Table 3. Table 4 demonstrates the symptoms of inhabitants who are living under and opposite to the mobile phone BTS antennae.

Discussion

In this work, the psychological and psychobiological reactions of the people who are living near mobile phone BTS antenna were studied. The results showed the fact that health symptoms are reported by people at distances up to 200 m to 300 m from mobile phone base stations antenna. It means that a significant increase in the frequency of complaints in relation to the reference group

Table 1. Frequency of symptoms according to inhabitant genders living near mobile phone BTS antennae.

Symptoms	Women ($N = 133$), N (%)	Men ($N = 117$), N (%)	p Value
Memory loss	33 (24.8)	30 (25.6)	0.9
Visual disturbances	11 (8.2)	7 (6)	0.61
Headaches	91 (68.4)	57 (48.7)	0.02
Feeling of discomfort	41 (30.8)	31 (18)	0.15
Nausea	37 (27.8)	14 (12)	0.03
Hearing disturbances	24 (18)	7 (9.4)	0.12
Nervousness	29 (21.8)	20 (17.1)	0.49
Fatigue	77 (57.9)	52 (44.4)	0.36
Sleep disturbances	80 (60.1)	53 (45.2)	0.34
Irritability	41 (30.8)	21 (17.9)	0.15
Depressive tendencies	47 (35.3)	35 (29.6)	0.62
Loss of appetite	13 (9.7)	3 (2.5)	0.06
Dizziness	13 (9.8)	9 (7.7)	0.66
Cardiovascular problems	16 (12)	9 (7.7)	0.41
Lowering of libido	11 (8.2)	29 (24.8)	0.009

Table 2. Frequency of symptoms according to inhabitant ages living near mobile phone BTS antennae.

Age (year)	≤18 years		19–39 years		40–59 years		≥60 years	
Symptoms	Exposed	Non-exposed	Exposed	Non-exposed	Exposed	Non-exposed	Exposed	Non-exposed
Memory loss	4.1	3.7	14	12.9	30	29.1	45.7	40
Visual disturbances	4.5	3.9	10.3	6.7	17.9	13.3	23.5	18.5
Headaches	23.2	33.6	37.8*	10	43.2*	23.6	34.3*	18.7
Feeling discomfort	1.6	1.3	18.5*	8	27.3*	13.4	29.9*	10.3
Nausea	1.3	0.7	8.1	8.7	7.1	7	10	12.5
Hearing disturbances	5.4	4	9.7	8.3	20.2	17.1	3[illegible]	33.3
Nervousness	17.6	15.7	29.3	26.5	31.1	28.7	33.8	30.5
Fatigue	23.4	13.3	30.8*	15.2	40*	21.5	47.2*	20
Sleep disturbances	12	8	34.7*	14.3	40.8*	18.4	43.6*	19.4
Irritability	10	6.4	30.8*	12	33.6*	12.8	35.1*	3
Depressive tendencies	6.6	3.3	13.3	7.2	16.7	9.7	3[illegible]	24
Loss of petite	6.6	5.3	10.7	9.3	10.6	7.9	3.5	13.2
Dizziness	4.7	2.7	9	5.7	14.7	11.6	25.9*	11.2
Cardiovascular problems	0	0	4	1.3	16.5*	0	27*	9.9
Lowering of libido	1	0	2. 7	2	23.7	19.3	40	39.9

*Significance difference ($p < 0.05$).

Table 3. Frequency of symptoms according to inhabitant distances from mobile phone BTS antennae.

	Exposed					Non-exposed
Symptoms	<10 m	10–50 m	50–100 m	100–200 m	200–300 m	>300 m
Memory loss	20*	19.4*	21.3*	16.4*	8	3.5
Visual disturbances	17*	14.7	13.9	3.3	2.1	2.7
Headaches	33.7*	32.6*	26.9*	20.1*	19.9*	9.6
Feeling of discomfort	20*	17*	9*		5.9	1.3
Nausea	11	6.7	4.[illegible]	2.6	2.9	0
Hearing disturbances	21.7	10	10	6.6	7.3	5.7
Nervousness	26.7*	25.7*	2[illegible]	17.7*	5.7	4.7
Fatigue	50.5	3[illegible]	[illegible]	40	28.3*	6.7
Sleep disturbances	36.7*	3[illegible]*	31.2*	31.1*	21.5*	8.3
Irritability	23.9*	25	6.7*	21.1	13.3	10.7
Depressive tendencies	12	14	[illegible]	3.6	2.4	1.7
Loss of appetite	1[illegible]*	[illegible]	4	5	1.6	0
Dizziness	12.8	10.7	7.2	3.3	3.3	0
Cardiovascular problems	6.5	8	5	2	3.9	0.7
Lowering of libido	8.3*	9.3*	8.1*	5.7	3.1	1.3

*Significance difference ($p < 0.05$).

Table 4. Inhabitant symptoms for people who are living under and opposite to the mobile BTS antennae.

	Inhabitants ($N = 375$)				
Symptoms	Opposite the station ($N = 128$), N (%)	Under the station ($N = 122$), N (%)	χ^2	p Value	OR [95% CI]
Headaches	27 (21.1)	13 (10.6)	2.73	>0.05	2.91 [0.85–10.47]
Fatigue	30 (23.4)	12 (9.8)	4.56	<0.05	2.50 [1.07–5.88]
Sleep disturbances	40 (31.3)	11 (9)	3.92	<0.05	3.75 [1.01–15.09]
Irritability	43 (33.6)	19 (15.6)	1.53	>0.05	2.14 [0.7–6.74]
Depressive tendencies	24 (18.8)	21 (17.2)	0.10	>0.05	0.84 [0.25–2.75]
Feeling of discomfort	33 (25.7)	15 (12.3)	3.93	<0.05	2.27 [1.01–5.15]
Loss of appetite	28 (21.9)	23 (18.8)	0.10	>0.05	1.20 [0.55–2.61]
Nausea	27 (21.1)	22 (18.0)	0.12	>0.05	1.21 [0.55–2.66]
Nervousness	24 (18.8)	13 (10.7)	0.12	>0.05	1.48 [0.4–5.71]
Memory loss	32 (25.0)	32 (26.2)	0.26	>0.05	0.69 [0.24–1.99]
Visual disturbances	32 (25.0)	19 (15.6)	0.16	>0.05	1.43 [0.45–4.65]
Dizziness	26 (20.3)	19 (15.6)	0.07	>0.05	0.99 [0.29–3.38]

(people exposed at >300 m or not exposed) was existed. The findings were in agreement with those reported by the Australian governmental report, which had indicated that at 200 m from a base station some people exposed in their homes are complaining of chronic fatigue and sleep disturbances (Australian Report, 1996; Bielski, 1994; Dabis et al., 1992). Moreover, the number of reported symptoms is higher close to base stations and decreases with increased

distance from them. This is in agreement with those of a Spanish preliminary study, in which symptoms as irritability, headaches, nausea and sleep disturbances are experienced in a significantly higher way by the subjects located at a distance up to 150 m versus subjects at a distance >250 m (Dabis et al., 1992; Linde and Mild, 1997; Loomis et al., 1994).

It should be noted that some symptoms such as nausea, loss of appetite, visual disturbances are no longer experienced in a significant way beyond 10 m. Furthermore, symptoms such as headaches, sleep disturbances and fatigue were experienced significantly at considerable distances from BTS and exhibit no notable decrease with increased distance. However, the measurements of electromagnetic fields in the neighborhood of cellular phone base stations show a reduction in strength over distance (Petersen and Testagrosa, 1992).

This study showed no significant decreases in the frequency of symptoms in relation to the length of time living in the neighborhood of base stations (from <1 year to >5 years). Meanwhile, for some distances and for some symptoms, the facing location is the worst position, especially for distances of <100 m from cellular phone base stations. This finding was in agreement with that reported by Peterson et al., in which radiofrequency electromagnetic fields associated with cellular radio cell-site antennas were studied (Petersen and Testagrosa, 1992).

The results obtained here demonstrate the greater sensitivity of women for two of the studied nonspecific health symptoms. In accordance, one earlier study related to cellular phones users demonstrated an increase in women's sensitivity for the symptom of sleep disturbances (Santini, 1998). This sex-related difference is parallel to the particular sensitivity of women to electromagnetic fields (Loomis et al., 1994).

More accurate follow-up studies are needed for the evaluation of the effects of the BTS antennae. The results here should be confirmed in larger series and places by considering more psychological and psychobiological reactions.

On the basis of these results, it can be believed that mobile phone BTS antenna may have health effects on inhabitants living near the stations (<300 m distances).

Therefore, placing of base stations should be such as to minimize exposure of neighbors. It is suggested that mobile phone base stations should not be sited closer than 300 m to populations because exposed people can have different related sensitivities particularly to their gender and their age.

However, the evaluation of the possible effects of BTS antennae and the emitted MWs on the living organism is a complex process that needs the combined contributions of many scientific regulations.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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