

## Mobile Phone Base Stations Health Effects

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### Abstract

**Background:** The rapid increase of mobile telephony and the associated obvious presence of mobile phone base stations have raised concerns about possible non specific health symptoms (NSHS) caused by emitted microwaves, electromagnetic field (EMF), radiofrequency (RF) and radiofrequency electromagnetic radiations (RFR)

**Aims:** To investigate the health effects among the residence proximity to mobile phone base station in Baquba city.

**Materials and Methods:** A cross-sectional study from May 2010 till June 2010 of randomly selected inhabitants living in Baquba urban areas for more than one year near to (8 )selected base stations, (375) subjects (200 women and 175 men) were investigated and completed standardized questionnaires that focused on the relevant parameters.

**Result:** The results of the questionnaire survey reveal that people living in the vicinity of base stations report various complaints frequencies, Chi-square with Yates correction were used in relation to the sex, age and distance from mobile base stations, show significant ( $p < 0.05$ ) increase as compared to people living  $>300$  m or not exposed to base stations. In relation of sex; women complained mostly of nausea, headaches, men complain mostly of lowering of libido. In relation to age, in subjects older than 19 years, this study shows the existence of a greater sensibility for some NSHS symptoms such as headaches, fatigue, sleep disturbances, irritability, feeling of discomfort, dizziness, cardiovascular problems when comparisons are made between subjects living up to 300 m vs. subjects of the reference group. In relation to distance, the complaints are experienced in a significantly higher ( $p < 0.05$ ) by the subjects in the distance zones of  $< 10$  m to 300m from base stations. Up to 10m the symptoms are headaches, sleep disturbances, irritability, depressive tendencies, feeling of discomfort, loss of appetite, nausea, difficulties in concentration, , visual disturbances, lowering of libido. Significant differences ( $P < 0.05$ ) are observed up to 100 m from base stations for symptoms such as: headaches sleep disturbances, irritability, depressive tendencies, feeling of discomfort, difficulties in concentration, memory loss and lowering of libido. In the zone 100 m to 200 m from base stations, the symptoms of headaches, sleep disturbances, feelings of discomfort, feeling of discomfort, difficulties in concentration, memory loss are again experienced significantly more often ( $P < 0.05$ ) in comparison with the reference group. Beyond 200 m only the symptom of headaches, fatigue, sleep disturbances is reported at a significantly high frequency ( $P < 0.05$ ). There was significant increase in the prevalence of sleep disturbance, fatigue, feeling of discomfort among the inhabitants opposite to the station (20.8% versus 10.9%, 23.4% versus 9.8%, 26.0% versus 12.0%) ( $P < 0.05$ ) respectively.



## Conclusions:

1. This study shows that inhabitants living nearby mobile phone base stations are at risk for developing non specific health symptoms, the facing position appears to be the worst one for distances from cellular phone base stations < 100 m, so more research concerning the effects of radiofrequency radiation from base stations is indicated.

2. It is advisable that cellular phone base stations should not be sited closer than 300 m to populations, as a precautionary measure, siting of base stations should be such as to minimize exposure of neighbors.

**Recommendations:** Revision of standard guidelines for public exposure to RER from mobile phone base station antennas, regular assessment and early detection of biological effects among inhabitants around the stations are recommended.

**Keywords:** Base stations, non specific health symptoms (NSHS), (EMF) electromagnetic fields, (RF) radiofrequency, radiofrequency electromagnetic radiations (RFR).

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## Introduction

Use of mobile phones has increased dramatically in the last decade. A number of people cannot imagine a world without mobile communication anymore. Coeval with this development and with the increasing presence of mobile phone masts, concerns were raised about possible health risks from electromagnetic fields (EMF) emitted by mobile phones and base stations. The term Electromagnetic Hypersensitivity (EHS) was created for symptoms possibly related to EMF. However, the definition and diagnosis remains unclear and controversial, although experts of the WHO (WHO workshop on Electrical Hypersensitivity, defined the new term as Idiopathic Environmental Intolerance (Electromagnetic field attributed symptoms) or IEI-EMF, in order to substitute EHS [1]. According to the results gained in a number of experiments, a linear physiological dose-response relationship between EMF field density and the symptoms seemed to be unlikely for most of the people [2].

On the other hand, Rubin et al. did not see any differences between people with EHS

and controls regarding psychopathological diagnoses. Therefore, simple psychopathological explanations are inadequate [3].

Empirical evidence indicates that EHS and EMF-related symptoms, mostly unspecific symptoms, are associated with a variety of psychological and psychobiological mechanisms and parameters. The present study intends to find out how people, who believe that a mobile phone base station is very close to their home, react psychologically and psychobiologically. Furthermore, we wanted to detect how the parameters that are often connected with EHS are related to each other: Self-estimated distance between home and the next mobile phone base station, daily use of mobile phone, EMF-health concerns, EHS, and psychological strain and psychobiological stress parameters.

Mobile phone base stations are now found ubiquitously in communities worldwide. They are frequently found near or on shops, homes, schools, daycare centers, and hospitals. The radiofrequency (RF)

electromagnetic radiation from these base stations is regarded as being low power; however, their output is continuous. This raises the question as to whether the health of people residing or working in close proximity to base stations is at any risk [4].

## Materials and Methods

A cross-sectional study carried out in May 2010 till June 2010 to determine the prevalence of health effects among randomly selected inhabitants living in Baquba urban areas for more than one year near to (8) selected base stations, (375) subjects (175 women and 150 men) were investigated and completed standardized questionnaires that focused on the relevant parameters (headaches, fatigue, sleep disturbances, irritability, depressive tendencies, feeling of discomfort, loss of appetite, nausea, difficulties in concentration, memory loss, visual disturbances, hearing disturbances, dizziness, cardiovascular problems, lowering of libido).

A questionnaire was sent to people wishing to participate in the study. Subjects about the existence of a study on people living near cellular phone base stations. The questionnaire was filled out by subjects without the presence of a person in charge of the study and was returned to a person responsible for the study.

General questions pertained to age, sex and estimated distances from base stations (less than 10 m, 10-50 m, 50-100 m, 100-200 m, 200-300 m, more than 300 m) and their location in relation to the antennas (facing, beside, behind, beneath in the case of antennas placed on rooftops). The exposure conditions of subjects were also defined by the length of time living in the neighborhood of base stations (less than 1 year, 1-2 years, 2-5 years, more than 5 years).

Participants were asked to indicate the presence or not of electrical transformers (at less than 10 m). High or very high tension electric power lines (at less than 100 m), radio and television transmitters (at less than 4 km). The questionnaire sought information on computer use (more than 2 hours per day) and cellular telephone use (more than 20 minutes per day).

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.

Among the 375 questionnaires studied, 200 came from women (45 years  $\pm$ 20) and 175 from men (47 years  $\pm$ 19). Fifteen symptoms referenced were found in the questionnaire; premature menopause, concerned only women were excluded.

The results obtained, concerning the frequency of the complaints experienced in relation to responses with 0 = never, were analyzed by the Chi-square test with Yates correction. Results were compared with the frequency of complaints of the reference group (subject exposed at > 300 m or, living in the vicinity of nonoperating base stations) 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. A  $P < 0.05$  was considered significant. We are presenting here the results tallied with: (1) the influence of subjects' exposure conditions to base stations (distance, length of exposure location in relation to the antennas, other electromagnetic factors) and (2) the influence of sex and age of subjects. Data were entered into a personal computer and analyzed using SPSS Version 16.

## Result

A cross-sectional study on health effects of mobile phone base stations have been performed. All of them focused of unspecific symptoms of ill health. Symptoms were collected based on self administered questionnaire filled in by the study participants. Exposure assessment was based on self estimated distance to the base station or spot measurements.

In our study 375 individuals (200 women and 175 men) filled in a questionnaire on 15 unspecific symptoms of ill health. Symptoms frequency was asked on a 4 level scale (never, sometimes, often, and very often). Questions were asked about fatigue, irritability, headaches, nausea, loss of appetite, sleep disturbances, depressive tendencies, feeling of discomfort, difficulties in concentration, memory loss, visual disturbances, hearing disturbances, dizziness, Lowering of libido and cardiovascular problems. Frequency of symptoms was cross tabled with self estimated distance of the residence from a base station (<10 m, 10-50 m, 50-100 m, 100-200 m, 200-300 m, >300

m). Frequency of the complaints experienced in relation to responses with 0 (=never), were analyzed by means of chi-square test with Yates correction taking the group of people living at least 300 m from the next base station as reference group. Each symptom was statistically significantly more frequent than in the reference group in at least one exposure category.

Most of the symptoms were statistically significantly more frequently observed in the exposed group (headache, irritability, nausea, appetite loss, discomfort, sleep disturbance, depression, memory loss difficulty in concentration, dizziness, lowering of libido).

### Sex

When the men/women comparison is made for all subjects exposed at a distance up to 300 m, women complained mostly of nausea, headaches, men complain mostly of lowering of libido; show significant ( $p < 0.05$ ) (table1). On the contrary, for the subjects of the reference group, there appears to be no significant difference related to sex in the frequency of complaints reported for the different symptoms.

**Table 1:** Frequency of symptoms according to sex.

Symptoms	Women (N=200), N (%)	Men (N=175), N (%)	p-value
Headaches	136(68.5)	85(28.8)	0.02
Fatigue	116(58.2)	78(45.5)	0.36
Sleep disturbances	120(60)	80(46)	0.34
Irritability	62(30.8)	31(18.2)	0.15
Depressive tendencies	70(35.7)	52(30)	0.62
Feeling of discomfort	62(30.5)	31(18)	0.15
Loss of appetite	20(10)	5(3)	0.06
Nausea	56(28)	21(12)	0.03
Difficulties in concentration	44(22)	30(17)	0.49
Memory loss	50(25.6)	45(26.6)	0.90
Visual disturbances	16(8)	11(6.4)	0.61
Hearing disturbances	36(18)	16(9)	0.12
Dizziness	20(10)	14(8)	0.66
Cardiovascular problems	24(12)	14(8.4)	0.41
Lowering of libido	16(8)	44(25)	0.009

## Age

Significant differences are observed in relation to the age of the subjects (from 18 to >60 years) for symptoms such as fatigue, irritability, headaches, sleep disturbances, feeling of discomfort, dizziness, cardiovascular problems when comparisons are made between subjects

living up to 300 m vs. subjects of the reference group. For subjects younger than 18 years of age, there is no significant difference in the frequency of symptoms between subjects living at up to 300 m vs. subjects of the reference group (Table 2).

**Table 2.:** Frequency of symptoms according to age.

Symptoms	Age(year)							
	≤18 years		19-39 years		40-59 years		≥60 years	
	Exposed	Non exposed	Exposed	Non exposed	Exposed	Non exposed	Exposed	Non exposed
Headaches	34.9	50.5	56.7*	15	64.8*	35.4	51.5*	25.1
Fatigue	35.1	20	46.2*	22.8	60*	32.2	70.8*	30
Sleep disturbances	18	12	52*	21.4	61.2*	27.6	65.4*	29.1
Irritability	15	9.6	46.2*	18	50.4*	19.2	52.7*	26
Depressive tendencies	9.9	4.9	20	10.8	25	14.5	45.2	36.8
Feeling discomfort	2.5	2	27.8*	12	41*	20.1	44.8*	15.5
Loss of petite	10	7.9	16	14	15.9	11.9	20.2	19.8
Nausea	2	1	12.2	13	10.6	10.5	15	18.7
Difficulties in concentration	26.4	23.5	44	39.7	46.7	43	50.7	45.8
Memory loss	6.2	5.6	21	19.3	45	43.6	68.6	60
Visual disturbances	6.8	5.9	15.4	10	26.8	20	35.3	27.8
Hearing disturbances	8.1	6	14.5	12.5	30.3	25.6	45	50
Dizziness	7	4	13.5	8.6	22	17.4	38.8*	16.8
Cardiovascular problems	0	0	6	2	24.8*	0	40.5*	14.8
Lowering of libido	1	0	4	3	35.5	29	60	59.9

\* - (P < 0.05) significance difference in comparison to nonexposed subjects for Non Specific Health Symptoms

## Distance

In comparison with the reference group, the complaints are experienced in a significantly higher way by the subjects located in the distance zones of < 10 m to 300m from base stations. Certain symptoms are experienced significantly more often (P<0.05) only in the immediate, vicinity, of base stations (up to 10m) and not beyond that; are headaches, sleep disturbances,

according to age group experienced by 375 people (200 women + 175 men) in relation to their distances from mobile phone base stations (<300 m vs. >300 m)

irritability, depressive tendencies, feeling of discomfort, loss of appetite, nausea, difficulties in concentration, memory loss, visual disturbances, lowering of libido. Significant differences (P < 0.05) are observed up to 100 m from base stations for symptoms such as: headaches, sleep disturbances, irritability, depressive tendencies, feeling of discomfort, difficulties in

concentration, memory loss and lowering of libido. In the zone 100 m to 200 m from base stations, the symptoms of headaches, sleep disturbances, feeling of discomfort, difficulties in

concentration, memory loss are again experienced significantly more often ( $P < 0.05$ ) in comparison with the reference group. Beyond 200 m only the symptom of headaches, fatigue, sleep disturbances is reported at a significantly high frequency ( $P < 0.05$ ) (Table 3).

**Table 3:** Frequency of symptoms according to distance from mobile phone base stations..

Symptoms	Exposed					Non exposed
	<10 m	10-50m	50-100m	100-200m	200-300m	>300 m
Headaches	50.5*	48.9*	40.4*	30.1*	29.9*	14.4
Fatigue	75.8	62	60	60	42.5*	10
Sleep disturbances	55*	55.2*	46.8*	46.6*	32.2*	12.4
Irritability	35.9*	38.7*	40*	31.7	20	16.1
Depressive tendencies	20.5*	21.6*	12*	5.4	3.6	2.5
Feeling of discomfort	30*	25.5*	30*	12.5*	8.8	2
Loss of appetite	20.8*	10.2	6	7.5	2.4	0
Nausea	16.5*	10	6.7	3.9	4.4	0
Difficulties in concentration	40*	38.5*	35*	26.5*	8.6	7
Memory loss	30*	29.1*	32*	24.6*	12	5.3
Visual disturbances	25.5*	22	20.9	5	3.2	4
Hearing disturbances	32.6	15	15	9.9	11	8.5
Dizziness	19.2	16	10.8	5	5	0
Cardiovascular problems	9.8	12	7.5	3	5.8	1
Lowering of libido	12.5*	14*	12.2*	8.5	4.6	2

\*( $P < 0.05$ ) significance difference in comparison to non exposed subjects for Non Specific Health Symptoms

Table 4 shows that there was significant increase in the prevalence of sleep disturbance, fatigue, feeling of discomfort among the inhabitants

experienced by 375 people (200 women + 175 men) in relation to their distances from mobile phone base stations (<300 m vs. >300 m)

opposite to the station vs. the inhabitants under the station (20.8% versus 10.9%, 23.4% versus 9.8%, 26.0% versus 12.0%) ( $P < 0.05$ ) respectively

**Table 4:** Symptoms among inhabitants living under and opposite to the mobile base station.

Symptoms	Inhabitants (n = 375)		x2	P-value	OR [95% CI]
	Opposite the station (N = 192), N (%)	Under the station (N = 183), N (%)			
Headaches	40 (20.8)	20 (10.9)	2.73	>0.05	2.91 [0.85–10.47]
Fatigue	45(23.4)	18(9.8)	4.56	<0.05	2.50[1.07–5.88]
Sleep disturbances	60 (31.3)	16(8.7)	3.92	<0.05	3.75 [1.01–15.09]
Irritability	64 (33.3)	28 (15.3)	1.53	>0.05	2.14 [0.7–6.74]
Depressive tendencies	36 (18.8)	32 (17.5)	0.10	>0.05	0.84 [0.25–2.75]
Feeling of discomfort	50(26.0)	22(12.0)	3.93	<0.05	2.27[1.01–5.15]
Loss of appetite	42(21.8)	35(19.1)	0.10	>0.05	1.20[0.55–2.61]
Nausea	40(20.8)	33(18.0)	0.12	>0.05	1.21[0.55–2.66]
Difficulties in concentration	36 (18.8)	20 (10.9)	0.12	>0.05	1.48 [0.4–5.71]
Memory loss	48 (25.0)	48 (26.2)	0.26	>0.05	0.69 [0.24–1.99]
Visual disturbances	48 (25.0)	28 (15.3)	0.16	>0.05	1.43 [0.45–4.65]
Dizziness	39 (20.3)	28(15.3)	0.07	>0.05	0.99 [0.29–3.38]

## Discussion

This study gives evidence of the fact that health symptoms are reported by people at distances up to 200 m to 300 m from mobile phone base stations. The significant increase in the frequency of complaints in relation to the reference group (people exposed at >300 m or not exposed) goes in the direction of the observation found in an Australian governmental report, which had signaled that at 200 m from a base station, some people exposed in their homes are complaining of chronic fatigue and sleep disturbances [5,6,7].

Our results agree with those of a Spanish preliminary study on people living in the vicinity of cellular phone base stations.

Where 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 vs. subjects at a distance > 250 m [7,8,9,10].

The number of reported symptoms is higher close to base stations, and that number decreases with increased distance from them, in relation to the fact that some symptoms such as nausea, loss of appetite, visual disturbances, and are no longer experienced in a significant way beyond 10 m.

Symptoms such as fatigue, headaches, and sleep disturbances, which are experienced significantly at considerable distances from base stations, exhibit no notable decrease in

the percentages of complaints experienced with increased distance. But the measurements of electromagnetic fields in the neighborhood of cellular phone base stations show a reduction in strength over distance [11,12,14].

One could expect that human sensitivity to electromagnetic waves is such that increased distance from cellular phone base stations has no significant effect on certain non specific health symptoms up to a distance of 200 to 300 m (difference in receptors sensibility to microwaves). It is also possible that the measurements of electromagnetic fields found around base stations may not be the true representation of population's exposure. In fact, different parameters are likely to interfere to modify the measurements and in particular fluctuations in emission strengths relating to the number of calls handled by base stations, the reflection of electromagnetic waves, etc. [15]. No significant decrease was observed 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). This result shows that there is no acclimation of subjects to microwave bioeffects with duration of exposure.

This study shows that 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. On comparing exposed inhabitants living in the building under the station with those opposite the station regarding symptoms, there was significant increase in the prevalence of sleep disturbance, fatigue, feeling of discomfort among the inhabitants opposite to the station

(20.8% versus 10.9%, 23.4% versus 9.8%, 26.0% versus 12.0%) ( $P < 0.05$ ) respectively. This could be explained by the fact that the concrete roof can soak up to 5–30% of the radiation from the antennas, so the levels of radiation in the building under the station may be lower than opposite and pose fewer hazards. This result can be related to the fact that antennas emit microwave at a higher level in front than in other directions [12].

The results obtained demonstrate the greater sensitivity of women for two of the studied non specific health symptoms. One earlier study related to cellular phones users demonstrated an increase in women's sensitivity for the symptom of sleep disturbances [13]. This sex-related difference is parallel to the particular sensitivity of women to electromagnetic fields [10,13]. The results obtained in this study also show the existence of a greater sensibility for some non specific health symptoms, in relation to age, in subjects older than 20 years. This sensibility is particularly high in subjects older than 60 years. This last result agrees with the greater sensibility of the elderly to radiofrequencies [17].

## Conclusion

This study shows that inhabitants living nearby mobile phone base stations are at risk for developing non specific health symptoms, the facing position appears to be the worst one for distances from cellular phone base stations < 100 m, so more research concerning the effects of radiofrequency radiation from base stations is indicated. As a precautionary measure, sitting of base stations should be such as to minimize exposure of neighbors. From these results and in applying the precautionary principle, it is advisable that cellular phone base stations should not be sited closer than 300 m to populations and most significantly because



exposed people can have different sensitivities related particularly to their sex and their age.

## Recommendation

Revision of guidelines for public exposure to RER from mobile phone base station antennas, regular assessment and early detection of biological effects among inhabitants are recommended.

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