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Assessment of Electromagnetic Hypersensitivity Syndrome in Subjects Lived Near Mobile Phone Base Station: Gender Based Study

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Abstract

Background: Electromagnetic hypersensitivity syndrome (EHS) is subjective clinical signs and symptoms caused by exposure to the electromagnetic field.

Objective: To show the gender distribution of each category of EHS in people who lived near the mobile phone base station.

Patients and Methods: This cross-sectional study was performed in the College of Medicine, University of Diyala. A total number of 196 individuals (128 men and 68 women) lived within a 1500 m distance away from the mobile phone base station in the Diyala province in the North East of Baghdad-Iraq included in the study. The authors interviewed the participants and completed the EHS questionnaires.

Results: Participants reported high scores of sleep disturbances, anxiety, and mood fluctuation compared with other complaints. Men had significantly higher scores of transient deafness and migraine-like headache compared with women. There were no significant differences between men and women with subjective signs and symptoms related to the cardiovascular system or skin. Multi-variable linear regression data revealed a significant correlation (R=0.253) between the total scores of EHS with the age, distance from the base station, and the onset of the illnesses).

Conclusion: We conclude that men who lived in the vicinity of the mobile phone base station are significantly vulnerable to sleep disorder, anxiety, and fluctuation of mood induced by electromagnetic radiation.

Keywords: electromagnetic hypersensitivity syndrome; mobile phone base station; gender; central nervous system.

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Introduction

During World War II, the Soviet bloc countries reported that individuals exposed to microwave radiation frequently neurological and cardiovascular symptoms, including headache, fatigue, impaired memory, emotional liability, sleep disturbances, and dysfunction of cardiovascular homeostasis [1,2].In 1970, a report from the Soviet Union described these neurological symptoms among people working with radio and radar equipment and termed as a microwave syndrome [1]. The same symptoms were

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reported in individuals exposed to electromagnetic fields in Finn and linked these symptoms to the electromagnetic hypersensitivity syndrome (EHS) [1,2]. The World Health Organization does not categorize the electromagnetic hypersensitivity symptoms as a disease but classified the radio-electromagnetic fields as a potentially carcinogenic- category 2B [3]. Nowadays the common sources of electromagnetic waves include Wi-Fi access points, routers, and clients, wireless laptops, iPads, wireless and mobile phones, including their base stations, Bluetooth devices, and extremely low-frequency magnetic fields from net currents...etc. People who exposed involuntary to the electromagnetic field (EMF) are unaware of exposure because it has no physical properties e.g. color, odor, etc.[4].

A recent study found that about one-third of health careers, including hygienists, physicians, and general practitioners complained from psychosomatic symptoms which exaggerated the existing complaint and it may lead to health complaint [5]. The participants who exposed to EMF (0.2-6.0 V/m) complained of tension, tingling sensation, tightness in the chest, palpitation, malaise, and headache [6]. Some authors believed that these symptoms are to the source of RF-EMF, magnitude, and the characteristics of exposed people. Röösli et al. [7] found that the mobile phone base stations are the most common source (accounted 74%) of people complaining of symptoms including sleep disorder, headache, nervousness, fatigue, and concentration difficulties. The characteristics of the people who complained from symptoms associated with EMF exposure are female gender, old age, a highly-education level, and married [7]. The neuropsychiatric symptoms, including headache, fatigue, sleep disturbance are dose-response, therefore, the mobile stations as a source of RF-EMF can produce persistent symptoms because of the constant emission of radiation every day [8].

Previous studies showed that cell/mobile phone and base stations produced neuropsychiatry symptoms by a mechanism related to the activation of voltage-gated calcium channels in the brain, which ultimately producing an imbalance in the releasing of the neurotransmitters and enhancing the generation of oxidative free radicals leading [9]. Rats exposed to electromagnetic radiation daily showed an imbalance of releasing the excitatory (glutamate and aspartate) and inhibitory amino acids (gamma-aminobutyric acid) in the different sites of the brain [10]. Generation of reactive oxygen species linked with EMF-exposure is suggested as an associated factor of brain cancer in humans and in experimental studies [11]. Activation of nitric oxide synthase by electromagnetic field leads to overproduction of nitrative radicals, including nitric oxide and peroxynitrite, which involved in producing psychiatric disorders due to their damaging effects on the blood brain barrier [12,13]. Given the lack of data on the electromagnetic hypersensitivity syndrome in the general Iraqi population, we performed a pilot national survey among individuals lived nearby the setting of the base stations.

Patients and Methods

This study was conducted in the Department of Physiology-Medical Physics

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in the College of Medicine at the University of Diyala in Baqubah-Diyala, Iraq from January 2020 to December 2020. The Institutional Scientific Committee approved the study and a signed consent form was obtained from each participating prior to inclusion in the study. The eligibility for the study included both sexes aged ≥ 12 years who were apparently healthy subjects. The criteria of exclusion included hypertension, diabetes mellitus, neurological illness, acute febrile infections, pregnancy, and nursing mothers. The authors recruited the participants who lived within a distance of 1500 meters from the mobile station location and interviewed them to complete the Electromagnetic Hypersensitivity Questionnaire (EHQ) [14].This questionnaire included health based signs and symptoms that covered neurodegenerative, skin, auditory, headache, cardiorespiratory, cold, allergy-related symptoms, and stress domains. Each sign or symptom was scored using six- options Likert-type scale responses that ranged from 0 (not at all a problem) to 5 (serious problem). A total number of 196 participants (128 men and 68 women), aged 12-67 years and with a history of 3.2 years (median) exposure to the mobile station radiation, were included. The score of each health problem which the participants did not experience was considered zero (0).

Statistical Analysis

The results were expressed as number, percentage, median, range, and mean ± SD. A comparison between men and women was achieved by using a two independent sample, a two-tailed t-test, and a multivariable linear regression to calculate the correlation between the total score of EHS with the age, the distance of the base station, and the onset of symptoms. A probability (p) of ≤ 0.05 is the limit of significance. The statistical analysis was done by using the Statistical Package for Social Sciences (SPSS) (version 20, IBM Corporation, USA).

Results

Table (1) shows that there was a non-significant difference between men and women in age, the onset of signs and symptoms, the distance of the base station exposure, and the number of subjects required medications to alleviate the signs and symptoms. Women expressed health hazards of base stations within significantly shorter period, and a significantly high frequency of their family members complained of the adverse effects of base stations Table (1). Table (2) shows that the scores of the sleep disorder, anxiety, and mood swinging amounted to the highest scores. Men were significantly having the highest score of their complaints of transient deafness and migraine headache compared with women, whereas the other hypersensitivity electromagnetic symptoms and signs did not show a significant difference between men and women. The score of the palpitation was higher than other cardiovascular complaints and there were no significant differences between men and women Table (2). Dryness and coldness of the skin were scored higher than other dermatological complaints and men did not have a significantly different score from the corresponding values of women Table (2). Table (3) shows that about one-third of total participants were complaining of anxiety, sleep disorder, mood swinging, and tension headache. The mean of the total score did not

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significantly higher in men than women Figure (1). Multivariable linear regression between total scores of the electromagnetic hypersensitivity syndrome (as the dependent variable) and the age (year), the distance of base stations (m), and the onset of subjective illness (as independent variables) showed a significant positive correlation (R=0.253, F=4.353, p=0.005) Figure (2). The R^2 is 0.064, which means that the total scores of EHS can be predicted at 6.4% of subjects.

Table(1): Characteristics of the patients

Characteristics	**Men (n=128)**	**Women (n=68)**	**Total (n=196)**	**P value**
Age (year)				
Mean ± SD (Median)	32.9±14.3 (26)	29.1±12.3(24)	31.6±13.7	0.057
Minimum-Maximum	24-37	12-67	12-73	
Duration of exposure (year; median)	3.2	3.1	3.2	1.000
Duration of signs and symptoms (year)	2.38±1.5 (2)	2.0±1.15(2)	2.23±1.41(2)	0.033
Onset of signs and symptoms (year)	1.44±0.88(1)	1.43±1.03(1)	1.44±0.93(1)	0.926
Other member of family involved	23(18.0)	24(35.3)	47(24)	0.007
Subjects required medications	38(29.7)	26(38.2)	64(32.7)	0.224
Exposure distance (meter)				
Mean ± SD (Median)	299.1±174.2(300)	278.3±142.4(300)	291.9±163.8(300)	0.326
Minimum-Maximum	200-1500	25-500	25-1500	

* The results are expressed as number (percentage) and mean ±SD (median). P: probability of significance difference between males and females

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Table (2): Scores of subjective signs and symptoms of electromagnetic hypersensitivity syndrome according to the gender

Subjective signs and symptoms	Men (n=130)	Women (n=68)	Total (n=196)	P value
Neurological and locomotor				
Sleep disorder	3.27±1.26(3)	3.06±1.22(3)	3.19±1.25(3)	0.315
Anxiety	3.07±1.02(3)	3.04±1.21(3)	3.06±1.09(3)	0.887
Fluctuated mood	2.96±1.19(3)	2.97±1.43(3)	2.96±1.28(3)	0.950
Tremor	2.42±1.31(3)	2.12±1.41(2)	2.32±1.35(2)	0.176
Short memory amnesia (brain fog)	2.25±1.23(2)	2.46±1.31(2.5)	2.32±1.26(2)	0.199
Decrease auditory acuity	1.46±0.90(1)	1.49±0.94(1)	1.46±0.91(1)	0.700
Transient deafness	1.35±1.09(1)	1.00±0.95(1)	1.23±1.05(1)	0.023
Tension headache	2.52±1.39(3)	2.78±1.30(3)	2.61±1.36(3)	0.191
Migraine headache	1.40±1.03(1)	1.06±0.90(1)	1.28±1.0(1)	0.010
Backache	2.46±1.1(2)	2.71±1.23(3)	2.55±1.15(3)	0.120
Muscle tension	2.52±1.14(3)	2.54±1.15(3)	2.53±1.14(3)	0.730
Sore Joints	2.06±1.16(2)	2.00±1.18(2)	2.04±1.17(2)	0.792
Fatigue	2.33±1.2(2)	2.37±1.17(2)	2.34±1.17(2)	0.714
Stress (unable to cope)	2.33(1.34)(2)	2.18±1.43(2)	2.28±1.38(2)	0.449
Cardiovascular				
Increase blood pressure	1.28±1.13(1)	1.28±1.01(1)	1.28±1.09(1)	0.991
Palpitation	1.41±0.86(1)	1.63±1.20(1)	1.48±0.99(1)	0.171
Dyspnea	1.09±0.59(1)	1.10±0.46(1)	1.09±0.55(1)	0.885
Skin				
Skin dryness	2.05±1.26(2)	2.14±1.40(2)	2.08±1.31(2)	0.622
Cold	2.07±1.32(2)	2.04±1.14(2)	2.06±1.26(2)	0.885
Allergy to the chemicals (cleaning agents, pesticides, perfumes, vehicle exhaust)	1.75±1.54(1)	1.79±1.34(1)	1.77±1.48(1)	0.837
Photosensitivity	1.45±1.17(1)	1.40±1.12(1)	1.43±1.15(1)	0.778

* The results are expressed as mean ±SD (median). P: probability of significance difference between males and females

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Table (3): Distribution of subjects with high score (4 and 5) of electromagnetic hypersensitivity syndrome

Electromagnetic hypersensitivity syndrome	**Men (n=128)**	**Women (n=68)**	**Total (n=196)**
Neurological and locomotor complains			
Sleep disorder	50(39.1)	22(32.4)	72(36.7)
Anxiety	45(35.2)	28(41.2)	73(37.2)
Fluctuated mood	35(27.3)	21(30.1)	56(28.6)
Tremor	22(17.2)	10(14.7)	32(16.3)
Short memory amnesia (brain fog)	14(10.9)	14(20.6)	28(14.3)
Decrease auditory acuity	03(2.3)	02(2.9)	5(2.6)
Transient deafness	07(5.5)	02(2.9)	12(6.1)
Tension headache	32(25.0)	20(29.4)	52(26.5)
Migraine headache	06(4.7)	02(2.9)	8(4.1)
Backache	20(15.6)	18(26.5)	38(19.4)
Muscle tension	20(15.6)	14(20.6)	34(17.3)
Sore Joints	11(8.6)	07(10.3)	18(9.2)
Fatigue	15(11.7)	07(10.3)	22(11.2)
Stress (unable to cope)	23(18.0)	12(17.6)	35(17.9)
Cardiovascular complains			
Increase blood pressure	06(4.7)	02(2.9)	8(4.1)
Palpitation	03(2.3)	05(7.4)	8(4.1)
Dyspnea	01(0.78)	00(0.0)	1(0.51)
Skin and related symptoms			
Skin dryness	18(14.1)	14(20.6)	32(16.3)
Cold	10(7.8)	07(10.3)	17(8.7)
Allergy to the chemicals (cleaning agents, pesticides, perfumes, vehicle exhaust)	21(16.4)	06(8.8)	27(13.8)
Photosensitivity	10(7.8)	04(5.9)	14(7.1)

* The results are expressed as number (percentage)

Discussion

The results of this study show that individuals exposed to the electromagnetic field are prone to several health problems. Gender-based differences in health problems are significantly observed in this study. The highest score of the neurological and locomotor complaints was sleep disorder and the lowest scores were transient deafness and migraine headache indicating that electromagnetic radiation-induced non-specific symptoms-related to the central nervous system [15,16]. Some authors believed that the imbalance between the endogenous antioxidants and the generation of reactive oxygen species is responsible for the sleep disturbances, fatigue, and headache in subjects exposed to electromagnetic radiation [17]. Experimental studies showed that sleep deprivation can induce oxidative stress syndrome as a result of the accumulation of the free radicles [18]. Our findings are in agreement with Peñuela-Epalza's study,19 which reported that 74.5 % of the subjects aged 18-60 years, who lived in the areas with higher exposure to EMF, were complaining from insomnia. Leitgeb and Schröttner 20 found that women are hypersensitive to EMF than men and this is true for several items of the EHS

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questionnaire, but not to all as mentioned in Table (2). Moreover, women are subjected to genetic damage more than men when they exposed to the mobile phone base station.21 Cai et al [22] reported that γ-radiation-induced significant changes in the peripheral lymphocytes in females compared with males represented by micronuclei demonstrated by cytome assay. The scores of the health problem that related to the cardiovascular system were less than the scores of neurological problems. The results of this study are in agreement with others that demonstrated the radiation of the mobile phone base station did not induce significant changes in the heart rate or the blood pressure [23]. The scores of the skin dryness and cold extremities as health problems due to the exposure to the EMF were less than that reported with some neurological problems and higher than the cardiovascular problems. Previous studies demonstrated skin changes in term of burning or tingling sensation, and dermographism as common health problem due to EMF exposure, which our study does not disclose these problems [24]. The total scores of health problems did not correlate with the duration of the symptoms indicating that there is no further deterioration of the health status as the exposure to the EMF is prolonged. Szyjkowska et al [25] demonstrated the people talking with mobile more than 60 minutes/day) had a significantly high percentage of subjective health problems compared with those fewer talked. A significant positive correlation between the age and the total scores can be simply explained that older patients are more prone to neurodegeneration compared with young people. Taking into consideration the mean of the total scores of health problems, there is no significant difference between men and women, and this observation is in agreement with others [26].

One of the important limitations of the study is the determination of the sex hormones in order to explain the significant difference in the health problems between men and women.

Conclusions

We conclude that subjective health problems are common in people living in the vicinity of the phone mobile station, particularly those related to the neuropsychiatric symptoms which showed significantly related to the gender. Taking in consideration the total scores of the health problems will mask the gender based effect.

Recommendations

The recommendation from this research is that people should set distances from Internet stations inside and outside homes to a safe distance from electromagnetic fields and reduce their use.

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Ethical clearance: Ethical approval was obtained from the College of Medicine / University of Diyala ethical committee for this study.

Conflict of interest: Nil

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تقييم متلازمة فرط الحساسية الكهرومغناطيسية في الأشخاص الذين يعيشون بالقرب من محطة قاعدة الهاتف المحمول: دراسة قائمة على النوع الاجتماعي

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الملخص

خلفية الدراسة: متلازمة فرط الحساسية الكهرومغناطيسية (EHS) هي علامات وأعراض سريرية ذاتية ناجمة عن التعرض للمجال الكهرومغناطيسي.

اهداف الدراسة: إظهار التوزيع بين الجنسين لكل فئة من فئات البيئة والصحة والسلامة لدى الأشخاص الذين يعيشون بالقرب من محطة الهاتف المحمول.

المرضى والطرائق: أجريت هذه الدراسة المقطعية في كلية الطب، جامعة ديالى. كان إجمالي عدد الأفراد(١٩٦) (١٢٨ رجلاً و٦٨ امرأة) يعيشون على مسافة ١٥٠٠ متر من محطة الهاتف المحمول في محافظة ديالى شمال شرق بغداد-العراق المشمولة في الدراسة. أجرى الباحثون مقابلات مع المشاركين وأكملوا استبيانات البيئة والصحة والسلامة.

النتائج: أبلغ المشاركون عن درجات عالية من اضطرابات النوم والقلق وتقلب المزاج مقارنة مع الشكاوى الأخرى. كان لدى الرجال درجات أعلى بكثير من الصمم العابر والصداع الشبيه بالصداع النصفي مقارنة بالنساء. لم تكن هناك فروق ذات دلالة إحصائية بين الرجال والنساء الذين لديهم علامات وأعراض ذاتية تتعلق بنظام القلب والأوعية الدموية أو الجلد. كشفت بيانات الانحدار الخطي متعدد المتغيرات عن وجود علاقة ذات دلالة إحصائية (R=0.253) بين إجمالي درجات الصحة والسلامة البيئية مع العمر، والمسافة من المحطة الأساسية، وبداية المرض.

الاستنتاجات: نستنتج أن الرجال الذين يعيشون بالقرب من محطة الهاتف المحمول معرضون بشكل كبير لاضطراب النوم والقلق وتقلب المزاج الناجم عن الإشعاع الكهرومغناطيسي.

الكلمات المفتاحية: متلازمة فرط الحساسية الكهرومغناطيسية؛ محطة الهاتف المحمول؛ الجنس؛ الجهاز العصبي المركزي.

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[٤] مستشفى بعقوبة التعليمي- ديالى - العراق