



Subjective Neurological Symptoms Among Mobile Phone Users

Bidabadi Elham (MD)^{1*}, Mallah-Saeed Mojgan (MD)², Pasandideh Marya (MD)²

ARTICLE INFO

Article type:
Original Article

Article history:
 Received: 14 February 2015
 Accepted: 13 March 2015
 Available online: 20 March 2015
 CJNS 2015; 1 (1): 43-48

1. Pediatric Neurology Department, Faculty of Medicine, Guilan University of Medical Sciences, Rasht, Iran
2. General Practitioner, Guilan University of Medical Sciences, Rasht, Iran

***Corresponding author:**
 Pediatric Neurology Department,
 Faculty of Medicine, Guilan
 University of Medical Sciences,
 Rasht, Iran
 Email: bidabadi@mail.com

ABSTRACT

Background: A lot of investigations exist on the biological effects of radiofrequency and microwave radiation; however only a few studies have considered non-carcinogenic exposure to radiations specifically from mobile phones.

Objectives: To introduce some subjective neurological symptoms in mobile phone users.

Materials and Methods: In this cross-sectional descriptive study conducted from March to August 2012; an eight-item questionnaire was administered to one thousand individuals. The questionnaire included the items concerning current status of mobile phone use, the participants' demographic and occupational data and characteristics of their complaints. Data analysis was done using the Chi-square test and unpaired two-sided t-test in SPSS software version 19.

Results: A total of 731 participants with mean age of 36.52 ± 10.97 years accepted to contribute in the study. The mean duration of mobile phone use was 21.39 ± 16.87 months, and the mean daily duration of use was 42.18 ± 7.15 minutes. Two hundreds and thirteen participants (29.4%) had some complaints. Headache (9.4%), fatigue (6.4%), and scalp warmness (5.3%) were the most frequent complaints. The symptoms were more frequent among men. The number and percent of symptomatic patients increased with increasing daily using time, but not with change of overall duration of mobile usage.

Conclusions: Headache, fatigue, and scalp warmness were reported as the most frequent complaints among mobile phone users. The prevalence of symptoms was related to daily using time, but not to overall duration of mobile usage.

Keywords: Cell Phone; Neurological Manifestations

Copyright © 2015 Caspian Journal of Neurological Sciences. All rights reserved.

➤ **Please cite this paper as:**
 Bidabadi E, Mallah-Saeed M, Pasandideh M. Subjective Neurological Symptoms Among Mobile Phone Users. Caspian J Neurol Sci 2015;1(1):43-48.

Introduction

There is a public concern about the possible increased risk of brain tumors among mobile phone users, despite the absence of a known biological mechanism by which radiofrequency (RF) fields of the cellphones may cause neoplasms. Recently, considerable interest has focused on whether

the use of mobile phones is associated with an increased risk of gliomas and other brain tumors, even though little is known about potential mechanisms (1). Most published epidemiological studies on mobile phone use and gliomas have not generally reported any increased risk either overall or with long term

use; but a few studies have found out this association only in the rural areas (2-6). In addition a positive association was found between cellphone usage and high grade astrocytoma (glioma) in the side of the cellphone usage (7).

A lot of literatures exist on the biological effects of radiofrequency and microwave radiation; however, only a few studies have considered non-carcinogenic exposure to radiations specifically from mobile phones. There have been reported that the people occupationally exposed to microwave radiation have complained headaches, feeling of dullness in their heads, fatigue, drowsiness in the daytime, irritability, poor memory, nausea, vertigo, and sleep disturbances more often than control groups (8-10).

The aim of the present study was to investigate the association between using mobile phones and subjective neurological symptoms.

Materials and Methods

In this cross-sectional descriptive study which was conducted from March to August 2012 we investigated one thousand participants with different occupations in Iran. At the time of the initial questionnaire survey, we asked all participants for written signed consent for participation and excluded those persons who declined to participate.

An eight-item questionnaire was administered to the participants in their workplaces. The questionnaire included the items concerning characteristics of complaints such as headache, palpitation, fatigue, vertigo, scalps tingling and warmth and etc. The questionnaire also included some items on the current status of mobile phone use (average daily duration and overall duration of mobile phone use, and mobile phone manufacturer and type) and

collected data on the participants' gender, age, and occupation. The Specific Absorption Rate (SAR) data for specific mobile phones was found on manufacturers' websites.

Discrete variables are expressed as counts and percent (%) and are compared using the Chi-square tests. Continuous variables are expressed as mean \pm SD and compared by the unpaired two-sided t-test. Adjusted odds ratios and 95% Wald confidence intervals were calculated based on these models. Statistical significance was set at $p < 0.05$. All of them were done in SPSS software version 19.

Results

A total of 731 subjects accepted to participate; 530 men (72.5%) and 201 women (27.5%) were included in the study. Their mean age was 36.52 ± 10.97 years (14-75 years). The mean duration of mobile phone use was 21.39 ± 16.87 months (1-96 months), and the mean daily duration of its usage was 42.18 ± 7.15 minutes (1-360 minutes). According to our occupational classification, the most prevalent jobs were as employee, marketer, medical doctor and student. Table 1 summarized their complaints associated with mobile phone usage. Two hundred and thirteen participants (29.4% of all cases) had some complaints.

Table 1. The prevalence of complaints associated with mobile phone usage

Complaint	No.	% of total cases
Palpitation	2	0.3
Headache	69	9.4
Fatigue	47	6.4
Vertigo	26	3.1
Scalp tingling	8	2
Scalp warmth	39	5.3
Amnesia	16	2.2
Ear pain	3	0.4
Sense of burning pain on metallic foreign body	1	0.1
Filled teeth pain	1	0.1
Low back pain	1	0.1
Total	213	29.4

Headache in 69 (9.4%), fatigue in 47 (6.4%), and scalp warmness in 39 cases (5.3%) were the most frequent complaints. Symptoms were more frequent among men (20.4% in men versus 17.9% in women); the most frequent complaint in both female and male was headache.

The number and percent of symptomatic patients increased with increasing daily using time and decreased with its decreasing, but not with overall duration of mobile usage as shown in table 2.

Table 2. Changing the number of individuals with and without complaints by altering the duration time of mobile phone use

Subjects	With complaint		Without complaint	
	No.	%	No.	%
Duration of mobile phone use (months)				
0-3	2	3.7	52	96.3
3-6	9	12.2	65	87.8
6-9	10	16.9	49	83.1
9-12	25	20	100	80
>12	95	23.6	307	76.4
Daily duration of mobile phone use (minutes/day)				
0-15	26	14.8	149	85.2
15-30	30	16.7	150	83.3
30-45	30	19.7	122	80.3
45-60	11	24.1	35	75.9
>60	51	28.6	127	71.4

In comparing of some parameters including age, Specific Absorption Rate (SAR), Duration of usage and daily usage time between two groups of with & without complaints, only duration of usage of mobile phone has statistically significant difference in two groups (Table 3).

Table 3: Comparison of mean values of some probably affective parameters on having symptom

	With complaint			Without complaint			p-value
	No.	Mean	Std. Deviation	No.	Mean	Std. Deviation	
Age (years)	82	34.3780	9.86657	330	36.1061	10.65389	NS
SAR	82	0.87341	0.422550	333	0.94944	0.450860	NS
Duration of usage (months)	79	28.8861	20.88920	324	18.7901	15.33019	<0.0001
Daily usage (minutes)	80	51.4875	46.47934	331	44.7341	57.43736	NS

Discussion

The effect of mobile phone radiation on human health is the subject of recent interests and studies, as a result of the enormous increase in mobile phone usage throughout the world. Human populations are increasingly exposed to microwave/RF emissions from wireless communication technology, including mobile phones with use electromagnetic radiation in the microwave range. In spite of years of research, there is still ongoing discussion whether RF could induce any physiologically relevant effects (11).

Mobile phones emit radiofrequency electromagnetic fields that are non-ionizing radiation, i.e. have too low energy to break chemical bonds. Hence, such fields cannot cause DNA damage (mutations), which is required for cancer initiation; however, radiofrequency fields might be involved in cancer development during later stages, including tumor progression or promotion. In addition to the fact that no carcinogenic mechanism for radiofrequency radiation has been established, it must be regarded that earlier studies did not have sufficient numbers of long-term mobile phone users for meaningful risk assessment; considering the need for a latency of at least 5–10 years (12–17). A meta-analysis also failed to reveal any significant association between long-term mobile phone use and intracranial tumors (18).

In 2011, International Agency for Research on Cancer (IARC) classified mobile phone radiation as Group 2B - possibly carcinogenic (in this classification; Group 2A means as probably carcinogenic and Group 1 as dangerous). That means that there could be some risk of carcinogenicity, so additional research into the long-term, heavy use of mobile phones needs to be conducted (19).

WHO added: "To date, no adverse health effects have been established as being caused by mobile phone use" (20). Many scientific studies have investigated possible health symptoms of mobile phone radiation. These studies are occasionally reviewed by some scientific committees to assess the overall risks. An assessment in 2007, published by the European Commission Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) concludes that the three lines of evidences; i.e. animal, in vitro, and epidemiological studies indicate that "exposure to RF fields is unlikely to lead to an increase in cancers prevalence among humans" (21).

One well-understood effect of microwave radiation is dielectric heating, in which any dielectric material (such as living tissue) is heated by rotations of polar molecules induced by the electromagnetic field. In the case of a person using a cell phone, most of the heating effect will occur at the surface of the head, causing its temperature to increase by a fraction of a degree. In this case, the amount of temperature increment is an order of magnitude less than that obtained during the exposure of the head to direct sunlight. Van Leeuwen et al. calculated a maximum rise in brain temperature of 0.11°C for an antenna with an average emitted power of 0.25 watt, the maximum value in common mobile phones, and indefinite exposure. Maximum temperature rise occurred on the skin (22). Scalp warmth was the third most common symptom among our participants, reported by 39 cases (5.3% of all participants). Some preliminary reports of mobile usage complaints, explained that next to the sensations of warmth on the ear and behind and around the ear, burning sensations in the facial skin and headaches were most commonly reported (23).

Some users of mobile handsets have reported several unspecific symptoms during and after its use; ranging from burning and tingling sensations in the skin of the head and extremities, fatigue, sleep disturbances, dizziness, loss of mental attention and memory retentiveness, increased reaction times, headaches, malaise, tachycardia, and disturbance of the digestive system (24-26). Gómez-Perretta et al. reported the symptoms most related to exposure as lack of appetite (OR=1.58, 95% CI 1.23 to 2.03); lack of concentration (OR=1.54, 95% CI 1.25 to 1.89); irritability (OR=1.51, 95% CI 1.23 to 1.85); and trouble sleeping (OR=1.49, 95% CI 1.20 to 1.84) (27). Similar to our results, Szyjkowska et al. showed that headaches were reported significantly more often by the people who talked more frequently and longer time by mobile phone compared with other users (63.2% of the subjects, $p = 0.0029$), just like the symptoms of fatigue (45%, $p = 0.013$). Also, the feeling of warmth around the ear and directly to the auricle was reported significantly more frequently by the intensive mobile phone users, compared with other mobile phone users (47.3%, $p = 0.00004$ vs. 44.6%, $p = 0.00063$, respectively) (28).

A part of the radio waves emitted by a mobile telephone handset is absorbed by the body. The radio waves emitted by a GSM (Global System for Mobile) handset are typically below one watt. The maximum power output from a mobile phone is regulated by the mobile phone standard and by the regulatory agencies in each country. In most systems, the mobile phone and the base station check reception quality and signal strength. So the power level is increased or decreased automatically within a certain span to accommodate different situations such as

inside or outside of buildings and vehicles. The rate at which energy is absorbed by the human body is measured by SAR, and its maximum levels for modern handsets have been set by governmental regulating agencies in many countries. The SAR is widely accepted as a dosimetric quantity in International Commission on Non-Ionizing Radiation Protection guidelines for limiting exposure to electric, magnetic, and electromagnetic fields (up to 300 GHz) (29). In the USA, the Federal Communications Commission (FCC) has set a SAR limit of 1.6 W/kg, averaged over a volume of 1 gram of tissue, for the head. In Europe, the limit is 2 W/kg, averaged over a volume of 10 grams of tissue. SAR values are heavily dependent on the size of the averaging volume. Without information about the averaging volume used, comparisons between different measurements cannot be made. Thus, the European 10-gram ratings should be compared among themselves, and the American 1-gram ratings should only be compared among themselves. SAR data for specific mobile phones, along with other useful information, can be found directly on manufacturers' websites, as well as on third party web sites (30).

Conclusion

Headache, fatigue, and scalp warmth are the most frequent complaints. The number and percent of symptomatic patients increase with increasing daily using time. It would be rational to diminish our daily usage of mobile phone as much as possible, and use phones with low SAR.

Conflict of Interest

No conflict of interest.

References

1. Sienkiewicz ZJ, Kowalczyk CI. A Summary of Recent Reports on Mobile Phones and Health (2000-2004). National Radiological Protection Board (NRPB), 2005. P: 1-3.
2. Inskip PD, Tarone RE, Hatch EE, Wilcosky TC, Shapiro WR, Selker RG, et al. Cellular Telephone Use and Brain Tumors. *N Engl J Med* 2001; 344(2):79-86.
3. Muscat JE, Malkin MG, Thompson S, Shore RE, Stellman SD, McRee D, et al. Handheld Cellular Telephone Use and Risk of Brain Cancer. *JAMA* 2000; 284(23):3001-7.
4. Lonn S, Ahlbom A, Hall P, Feychting M; Swedish Interphone Study Group. Long Term Mobile Phone Use and Brain Tumor Risk. *Am J Epidemiol* 2005; 161 (6): 526-35.
5. Christensen HC, Schuz J, Kosteljanetz M, Poulsen HS, Boice JD Jr, McLaughlin JK, et al. Cellular Telephones and Risk for Brain Tumours. *Neurology* 2005; 64(7):1189-95.
6. Hardell L, HanssonMild K, Carlberg M. Further Aspects on Cellular and Cordless Telephones and Brain Tumours. *Int J Oncol* 2003; 22(2):399-407.
7. Hardell L, Carlberg M, HanssonMild K. Use of Cellular Telephones and Brain Tumour Risk in Urban and Rural Areas. *Occup Env Med* 2005; 62(6):390-4.
8. Seitz H, Stinner D, Eikmann T, Herr C, Rösli M. Electromagnetic Hypersensitivity (EHS) and Subjective Health Complaints Associated with Electromagnetic Fields of Mobile Phone Communication – a Literature Review Published Between 2000 and 2004. *Sci Total Environ* 2005; 349(1-3):45-55.
9. Hocking B, Westerman R. Neurological Changes Induced by a Mobile Phone. *Occup Med (Lond)* 2002; 52(7):413-5.
10. Roosli M, Moser M, Baldinini Y, Meier M, Braun-Fahrlander C. Symptoms of Ill Health Ascribed to Electromagnetic Field Exposure-a Questionnaire Survey. *Int J Hyg Environ Health* 2004; 207(2):141-50.
11. Krewski D, Glickman BW, Habash RW, Habbick B, Lotz WG, Mandeville R, et al. Recent Advances in Research on Radiofrequency Fields and Health: 2001-2003. *J Toxicol Environ Health B Crit Rev* 2007; 10 (4):287-318.

12. Valberg PA. Radiofrequency Radiation (RFR): the Nature of Exposure and Carcinogenic Potential. *Cancer Causes Control* 1997; 8 (3): 323–32.
13. Muscat JE, Malkin MG, Thompson S, Shore RE, Stellman SD, McRee D, et al. Handheld Cellular Telephone Use and Risk of Brain Cancer. *JAMA* 2000; 284(23): 3001–7
14. Inskip PD, Tarone RE, Hatch EE, Wilcosky TC, Shapiro WR, Selker RG, et al. Cellular-Telephone Use and Brain Tumors. *N Engl J Med* 2001; 344 (2): 79–86.
15. Johansen C, Boice J Jr, McLaughlin J, Olsen J. Cellular Telephones and Cancer—a Nationwide Cohort Studies in Denmark. *J Natl Cancer Inst* 2001; 93(3): 203–7.
16. Auvinen A, Hietanen M, Luukkonen R, Koskela RS. Brain Tumors and Salivary Gland Cancers among Cellular Telephone Users. *Epidemiology* 2002; 13 (3): 356–9.
17. Muscat JE, Malkin MG, Shore RE, Thompson S, Neugut AI, Stellman SD, et al. Handheld Cellular Telephones and Risk of Acoustic Neuroma. *Neurology* 2002; 58 (8): 1304–6.
18. Lahkola A, Tokola K, Auvinen A. Meta-Analysis of Mobile Phone Use and Intracranial Tumors. *Scand J Work Environ Health* 2006; 32 (3): 171–7.
19. "IARC Classifies Radiofrequency Electromagnetic Fields as Possibly Carcinogenic to Humans". World Health Organization Press Release N° 208 (Press release). International Agency for Research on Cancer. 31 May 2011.
20. WHO. Electromagnetic Fields and Public Health: Mobile Phones. Fact sheet N°193, 2014. On the World Wide Web: <http://www.who.int/mediacentre/factsheets/fs193/en/>
21. Šinik V, Despotovic Ž, Jankovic S, Bjelica M, Kerleta V. Radiofrequency Radiation of GSM Networks. III International Conference "Ecology of Urban Areas 2013", 2013, Zrenjanin, Serbia.
22. Van Leeuwen GM, Lagendijk JJ, Van Leersum BJ, Zwamborn AP, Hornsleth SN, Kotte AN. Calculation of Change in Brain Temperatures Due to Exposure to a Mobile Phone. *Phys Med Biol* 1999; 44(10): 2367–79.
23. Oftedal G, Wilén J, Sandström M, Mild KH. Symptoms Experienced in Connection with Mobile Phone Use. *Occup Med (Lond)* 2000; 50(4): 237–45.
24. Rössli M. Radiofrequency Electromagnetic Field Exposure and Non-Specific Symptoms of Ill Health: A Systematic Review. *Environ Res* 2008; 107(2):277–87.
25. Hocking B. Preliminary report: Symptoms associated with mobile phone use. *Occup Med (Lond)* 1998; 48(6):357–60.
26. Repacholi MH. Health Risks from the Use of Mobile Phones. *Toxicol Lett* 2001; 120(1-3):323–31.
27. Gómez-Perretta C, Navarro EA, Segura J, Portolés M. Subjective Symptoms Related to GSM Radiation from Mobile Phone Base Stations: A Cross-Sectional Study. *BMJ Open* 2013; 3(12):e003836.
28. Szyjkowska A, Gadzicka E, Szymczak W, Bortkiewicz A. The Risk of Subjective Symptoms in Mobile Phone Users in Poland – An Epidemiological Study. *Int J Occup Med Environ Health* 2014; 27(2):293–303.
29. Manapatia MB, Kshetrimayumb RS. SAR Reduction in Human Head from Mobile Phone Radiation using Single Negative Metamaterials. *J Electromagnet Waves* 2009; 23(10): 1385-95.
30. Ahlbom A, Bergqvist U, Bernhardt JH, Cesarini Jp, Court LA, Grandolfo M, et al. Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz). International Commission on Non-Ionizing Radiation Protection. *Health Phys* 1998; 74(4): 494-522.