

Some ocular symptoms and sensations experienced by long term users of mobile phones

Effets oculaires en relation avec l'utilisation d'un téléphone mobile cellulaire

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Abstract

In this study, a survey was conducted to investigate the possible effects of long term usage of mobile phone (MP) on eyes. The studied symptoms are blurring of vision, redness on the eyes, vision disturbance, secretion of the eyes, inflammation in the eyes and lacrimation of the eyes. There is no effect on redness on the eyes and vision disturbance, but some statistical evidences are found that MP may cause blurring of vision, secretion of the eyes, inflammation in the eyes and lacrimation of the eyes. These results suggest an awareness of the symptoms and sensations.

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Résumé

Dans ce travail on a réalisé une enquête en vue de rechercher les effets des téléphones portables sur les yeux. La déformation de la vision, le rougissement, le larmolement et l'inflammation des yeux étaient des symptômes qu'on a étudiés. On a constaté que l'usage des portables n'a pas d'effets sur la déformation de la vision et le rougissement des yeux mais on a trouvé quelques données statistiques soulignant que les portables peuvent être la cause de larmolement et d'inflammation des yeux.

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Mots clés : œil ; Symptômes oculaires ; Portables ; Micro-ondes

1. Introduction

The microwaves are increasingly available in our daily environment, for example, mobile phone (MP) transmitters/receivers, radars, satellites, and radio/TV transmitters, video display terminals, microwave ovens and occupational devices [1,2]. A particular concern has been raised about the possibility that exposure to the radiofrequency fields emitted by

MPs could effect people's health and recent alarming reports demand further investigations on this subjects [3].

MPs operate on wireless technology, with communication typically occurring via a 900–1800 MHz signal that is pulsed at 217 Hz. This signal carries essentially no power when the user is not talking or receiving, but when the user communicates the power of this pulsed electromagnetic field reaches a maximum of 250 mW [4]. There are many studies in the literature about the effects of use of MPs, such as; cyto-

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netic [3,5], gene response, DNA damage and central nervous system [6], reproduction and development [7].

Eyes are one of the most thermally vulnerable area of the body because of its low blood supply [8]. Exposure to high density microwaves can cause detrimental effects on the eye and induce significant biological changes through thermal actions [1]. In a study, it was reported that, pulsed microwave at 2.45 GHz and 10 MW/cm² are associated with production of corneal endothelial lesion and with disruption of the blood–aqueous barrier in the non-human primate eye. It was also found that the ocular damage of microwaves at an average specific absorption rate (SAR) of 0.26 W/kg, if administrated after pre-treatment with ophthalmic drugs, can produce significant ocular effects in the anaesthetised monkeys [9].

It was reported in Germany that, the risk of malignant melanoma of the eye was associated with the use of radiofrequency transmitting devices, including MPs. But a study [10] was contrasted the incidence rates of this rare cancer with the number of MP subscribers in Denmark. It was observed that there was no increasing trend in the incidence rate of ocular melanoma associated with the use of the MPs.

A computational investigation was performed to present a theoretical study of the SAR in a human eye, when irradiated by the field of a MP [11]. They have shown the SAR distributions inside the eye, at 900 MHz, for an antenna–eye distance of 2 cm. It was observed that the radiation was essentially absorbed at the eye surface. Higher absorption was found at 1800 MHz and, for the higher output power considered as a worst case, SAR limits can only be exceeded when the antenna–eye distance is lower than 2 cm.

Some survey studies were also showed that visual disturbances were experienced by people living only in the immediate vicinity of base stations [12,13].

No survey study has dealt with the effects of long term (1–4 years and above) use of cellular phones on eye to date as a non-specific health symptoms. This is the main goal of this study in which a survey study, using questionnaire, was conducted in 695 people living in a city in Turkey, where these phones are extensively used, to detect the possible eye symptoms and sensations experienced by the long term users of MPs in order to light the way of further studies.

2. Materials and methods

2.1. Questionnaire

Questionnaire used in this study was composed of two sections. In the first section, general questions were asked to individuals to learn about their general health, use of MP and physical environment to prevent miss leading positives. In the second section questions were asked to directly detect the effects of long term use of MP on each individual's health.

In the survey, questions were asked to investigate the following symptoms and sensations; blurring of vision, red-

ness on the eyes, vision disturbance, secretion of the eyes, inflammation in the eyes and lacrimation of the eyes.

If an individual gave positive answer to the questions about any above symptoms and sensations, some extra questions were also asked to detect the beginning of the symptoms and sensations. Otherwise the statistical results yielded would be meaningless, unless person has not the symptoms and sensations after he has started to use MP.

2.2. Study population

The study group was consist of 193 female and 502 male randomly selected from different ages, educations, earnings, locations and occupations in Elazig which is located in the east part of Turkey. Total number of attendant was 695. For simplicity, from now the person who has got a MP and the person who has not got any MP will be named as “MP user” and “non-MP user”, respectively. One hundred and fifty-seven women were MP users whereas 36 were non-MP users and 502 male attendants were consist of 392 MP users and 110 non-MP users. Although individuals were selected randomly around 80% of people were MP users. This shows that MP usage is very much common in the selected region and the results yielded from the survey could be valuable.

Since the aim of this survey is to investigate the possible eye symptoms and sensations experienced by long term usage, attendants were grouped according to time of MP possessions. Time of possessions was divided into four subgroups. These are one, two, three, four and above years, respectively. Almost 60% of female have owned their MP for the last 2 years whereas more then 30% of male have been carrying their MP for at least 4 years.

3. Results

For this survey, an analysis of variance (ANOVA) were used and differences were considered significant at $P < 0.05$.

As mentioned in Section 2.1, some extra questions were also asked to detect the starting time of the symptoms and sensations. The answers were sorted and given in Fig. 1.

When Fig. 1 was analysed closely, majority of the MP users reported that they had the symptoms and sensations after they had started using the cellular phone. With Fig. 1, statistical results found in this contribution should be taken into account, because more then 60% percent of attendant for almost every symptom and sensation had them after the MP usage.

Since ANOVA were used to analyse data, P -values of each symptom and sensation were given in Table 1. The first column of the table shows the considered symptoms and sensations. In the second column, P -values were calculated and written for MP users and non-MP users. For this column P -values of four out of six found to be meaningful. These symptoms and sensations are blurring of vision, secretion of the eyes, inflammation in the eyes and lacrimation of the eyes.

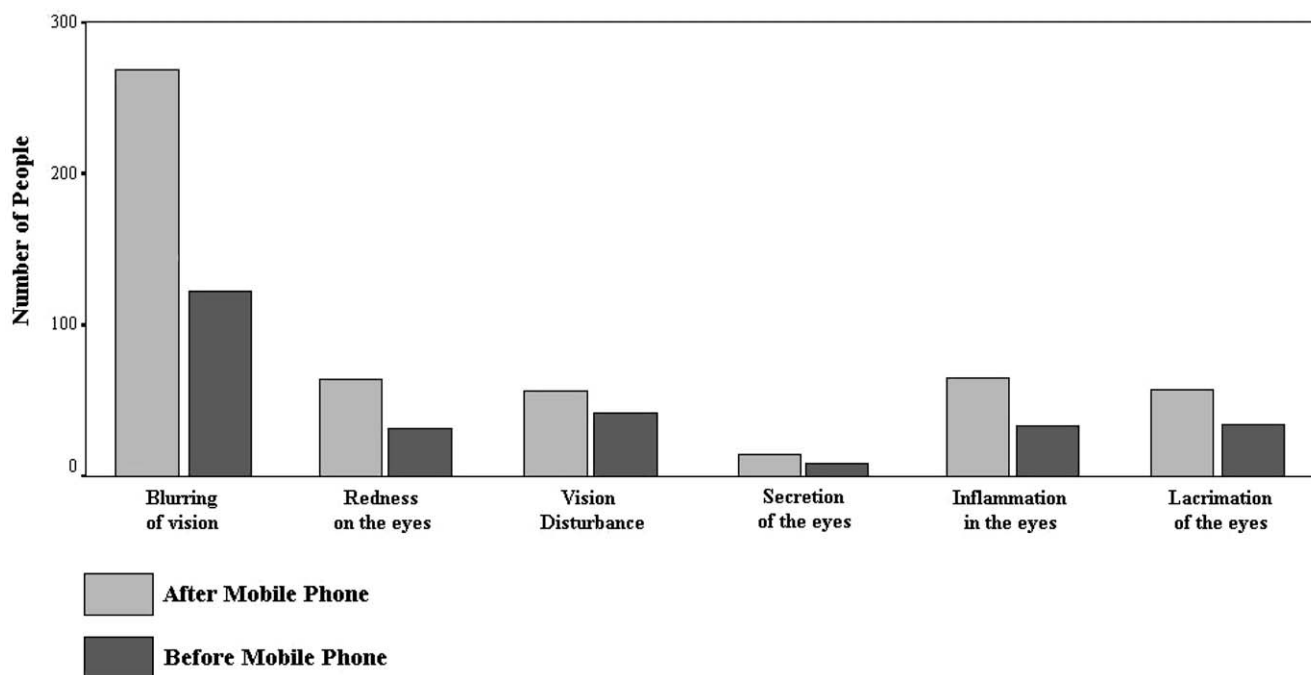


Fig. 1. Starting time of the ocular symptoms and sensations.

In the last column of Table 1, intervals of time that individuals had been using the MP were taken into account. For this case two out of six values of symptoms and sensations which were blurring of vision and lacrimation of the eyes were found to be meaningful.

The main goal of this survey is to investigate the long term ocular effects of MP usage. As seen in Table 1, six ocular symptoms and sensations were investigated. Results were summarised including number of people attended to each case in Table 2 and their percentages were given in Table 3. The statistical results found here as follows.

Table 1
P-values for symptoms and sensations obtained by using ANOVA

Symptoms and sensations	MP user and non-user	How long they have the phone
Blurring of vision	0.000	0.000
Redness on the eyes	0.110	0.576
Vision disturbance	0.149	0.556
Secretion of the eyes	0.031	0.188
Inflammation in the eyes	0.034	0.116
Lacrimation of the eyes	0.031	0.045

Table 2
Distribution of people attended to the survey for symptoms and sensation

Symptoms and sensations	Non-MP users		MP users								Total	
	Total		Intervals		2 years		3 years		4 years and above			
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Blurring of vision	77	69	88	35	110	36	86	44	106	44	304	115
Redness on the eyes	21	125	27	96	29	117	25	105	30	120	86	333
Vision disturbance	23	123	29	94	32	114	25	105	30	120	91	328
Secretion of the eyes	3	143	7	116	8	138	11	119	11	139	26	393
Inflammation in the eyes	19	127	19	104	32	114	29	101	34	116	85	334
Lacrimation of the eyes	17	129	20	103	37	109	22	108	27	123	84	335

3.1. Blurring of vision

According to the results given in Tables 2 and 3, the use of MP may cause blurring of vision, because the percentages of having blurring of vision were increased from 52.7% to 72.6%. But there was no statistical evidence that the percentages were increased for long term usage. This was because total number of people, who had MP, was almost equal to people who had been using MP for 1 year. These percentages were 72.6% and 71.5%, respectively.

3.2. Redness on the eyes and vision disturbance

As a result of Tables 1–3, the use of MP had no visible effects on any of the above symptoms and sensations.

3.3. Secretion of the eyes

Our data showed an indication of causing secretion of the eyes; this is why the percentages of having secretion of the eyes were increased from 2.1% to 6.2% but there was no

Table 3
Distribution of people attended to the survey for symptoms and sensations in percentages

Symptoms and sensations	Non-MP users		MP users								Total	
	Total		Intervals		1 year		2 years		3 years		4 years and above	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Blurring of vision	52.7	47.3	71.5	28.5	75.3	24.7	66.2	33.8	70.7	29.3	72.6	27.4
Redness on the eyes	14.4	85.6	22.0	78.0	19.9	80.1	19.2	80.8	20.0	80.0	20.5	79.5
Vision disturbance	15.8	84.2	23.6	76.4	21.9	78.1	19.2	80.8	20.0	80.0	21.7	78.3
Secretion of the eyes	2.1	97.9	5.7	94.3	5.5	94.5	8.5	91.5	7.3	92.7	6.2	93.8
Inflammation in the eyes	13.0	87.0	15.4	84.6	21.9	78.1	22.3	77.7	22.7	77.3	20.3	79.7
Lacrimation of the eyes	11.6	88.4	16.3	83.7	25.3	74.7	16.9	83.1	18.0	82.0	20.0	80.0

statistical evidence for long term usage that the percentages were increased.

3.4. Inflammation in the eyes

As a result of Tables 2 and 3, the use of MP may cause inflammation in the eyes. This is why the percentages of possibility of having increase inflammation in the eyes were increased from 13.0% to 20.3%. But there was no statistical evidence for long term usage that the percentages were increased.

3.5. Lacrimation of the eyes

According to data, the use of MP may cause lacrimation of the eyes because the percentages were increased from 11.6% to 20.0%. Moreover to keep on using MP may slightly increase the possibility of having extreme irritation too. This was because the percentages increased from 16.3% to 25.3% after 2 years.

4. Discussion

As result of the survey, there was no evidence that the use of MP may cause redness on the eyes and vision disturbance. Unfortunately there are nothing available in the literature for redness on the eyes to compare with. But visual disturbances were observed in some studies in general terms [12,13]. In Santini et al. [12,13] people studied were living in the vicinity of cellular phone base stations and were exposed in far-field conditions. But in this contribution, people studied were users of MP and were exposed in near-field conditions.

The use of MP may cause lacrimation of the eyes as a result of our data. In addition talking with MP for longer period may increase it. Again no published data available in the literature about lacrimation of the eyes as well.

Finally there were some evidence that the use of MP may trigger blurring of vision, secretion of the eyes and inflammation in the eyes. Likely no evidence that the more the MP users talk the more they get the above three symptoms. No published papers concerning above three symptoms are available either. Therefore, these symptoms and sensations should be further investigated.

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References

- [1] Nakamura H, Matsuzaki I, Hatta K, Nobukuni Y, Kambayashi Y, Ogino K. Nonthermal effects of mobile-phone frequency microwaves on uteroplacental functions in pregnant rats. *Reproductive Toxicology* 2003;17:321–6.
- [2] Repacholi MH. Health risks from the use of mobile phones. *Toxicology Letters* 2001;120:323–31.
- [3] Maes A, Collier M, Verschaeve L. Cytogenetic effects of 900 MHz (GSM) microwaves on human lymphocytes. *Bioelectromagnetics* 2001;22:91–6.
- [4] Croft RJ, Chandler JS, Burgess AP, Barry RJ, Williams JD, Clark AR. Acute mobile phone operation affects neural function in humans. *Clinical Neurophysiology* 2002;113:1623–32.
- [5] d'Ambrosio G, Massa R, Scarfi MR, Zeni O. Cytogenetic damage in human lymphocytes following GMSK phase modulated microwave exposure. *Bioelectromagnetics* 2002;23:7–13.
- [6] Hossmann KA, Hermann DM. Effects of electromagnetic radiation of mobile phones on the central nervous system. *Bioelectromagnetics* 2003;24:49–62.
- [7] Weisbrot D, Lin H, Ye L, Blank M, Goodman R. Effects of mobile phone radiation on reproduction and development in *Drosophila melanogaster*. *Journal of Cellular Biochemistry* 2003;89:48–55.
- [8] Hyland GJ. Physics and biology of mobile telephony. *The Lancet* 2000;356:1833–6.
- [9] Kues HA, Monahan JC, Danna SA, Mcleod DS, Luty GA, Koslov S. Increased sensitivity of the nonhuman primate eye to microwave radiation following ophthalmic drug pre-treatment. *Bioelectromagnetics* 1992;13(5):379–93.
- [10] Johansen C, Boice JD, McLaughlin JK, Christensen HC, Olsen JH. Mobile phones and malignant melanoma of the eye. *British Journal of Cancer* 2002;86(3):348–9.
- [11] Martinez-Burdalo M, Nonidez L, Martin A, Villar R. FDTD analysis of the maximum SAR when operating a mobile phone near a human eye and a wall. *Microwave and Optical Technology Letters* 2001;28: 83–5.
- [12] Santini R, Santini P, Danze JM, Le Ruz P, Seigne M. Symptoms experienced by people in vicinity of base stations: I/incidences of distance and sex. *Pathologie Biologie* 2002;50(6):369–73.
- [13] Santini R, Santini P, Le Ruz P, Danze JM, Seigne M. Survey study of people living in the vicinity of cellular phone base stations. *Electromagnetic Biology and Medicine* 2003;22(1):41–9.