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Survey on difference between the electromagnetic fields of simple and smart mobile phones

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Abstract: *Today, using communications devices such as simple and smart mobile phones has led man to face EMFs more. Thus is essential, measuring and comparing the emitted EMFs of simple mobile phones with that of smart phones. The EMFs of 2 simple mobile phones and 2 smart phones were measured by EMFs measurement portable equipment model HI-3603 in a ringing mode. Ultimately, the difference between electric and magnetic fields in simple and smart phones was evaluated by the ANOVA statistical test. The means of the electric fields of simple and smart mobile phones was 2.38±0.18 v/m and 1.9±0.18 v/m respectively. The means of magnetic fields of simple and smart mobile phones was 0.49±0.13 mG and 0.48±0.1 mG, respectively. The ratio of the mean of electric field in simple and smart phones to the standard limit (53.8 v/m) was 4.42% and 3.53% and also the ratio of the mean of electric field in simple and smart phones to the standard limit is 25.12% and 24.61%, respectively. Despite the fact that the mean of electric and magnetic fields of simple mobile phones is more than smart ones, the ANOVA statistical analysis shows that there is no significant difference between these two means (P value > 0.05). Despite the fact that EMFs in simple and smart phones are approximately equal or less than the standard limits, the safety notes shall be considered while using each of these devices.*

Keywords: *Electric Fields, Magnetic Fields, Simple Mobile phones and Smart Mobile phones*

I. Introduction

Today, being exposed to electromagnetic fields (EMFs) emitted from mobile phones, telecommunication antennas, televisions, laptops, tablets, high voltage power cables, power cables and etc. cannot be avoided [1-4]. Using mobile phones started since 1983 and many people all over the world use this device these days [5]. For instance, in 2011, 129.86 million out of the 140 million people of the country Japan, 91% of the population of the United State and 94% of the population of Britain used mobile phones [1, 6, and 7]. Also ownership of mobile phones reached 76% in 2009 which was 12% in 1999. This overuse, especially in the past few decades, has caused many concerns in the field of the effects of the emitted EMFs especially mobile phones on man's health [10-8]. Many reports show that being exposed to EMFs can have effects such as headache, reduction of concentration and memory, fatigue, drowsiness and anger in man

[11,12]. EMFs can also have damaging effects on other creatures for instance EiseniaFetida earthworm if they were to be exposed to EMFs of mobile phones (900 MHz), DNA of their cells will be harmed [13]or they might cause disorders in the reproduction of birds and mice [14]. The world's Health Organization has classified the EMFs emitted from mobile phones in terms of carcinogenesis in the class B2 (probably carcinogenic) [15]. In the recent years, many studies have leaned towards the effect of EMFs on health [16], clinical diseases [17]and behavioral effects [18]. In the recent years, with the improvements of technology and daily increasing entrance of smart phones to the market, using them has become pervasive. Therefore, it has been attempted to compare and evaluate the difference of the EMFs emitted from simple mobile phones and that of smart mobile phones.

II. Materials and Methods

1.1. Measurement of EMFs

Initially, two simple phones and two smart phones made by one of the famous and best-selling brands of the world were selected. Each mobile phones was measured 12 times. The EMF measurement was done by the device EMFs survey meter model HI 3603 (figure 1). Before starting the measurement the background EMF, which can be caused by other devices such as telecommunication antennas, power cables, televisions and other devices, was measured. Then the background EMFs was subtracted from the EMFs of the mobile phones. Since in most cases people hold the phone near their ear while they are on it, thus the EMFs were measured from a 2 cm distance. Measurement was done in a non-vibration mode and without being connected to the internet for all phones. Firstly, the electric field and then the magnetic field were measured. Measurement was done while talking (ringing mode).

Figure 1. The HI-3603 VDT/VLF Radiation Survey Meter

1.2. Statistical Analysis

In order to compare the difference between the mean of EMFs of simple mobile phones and that of smart ones and also comparing them with standard limits, the ANOVA statistical test has been used by the SPSS16 software. The P value<0.05 was selected as the significance level (α=5%).

III. Results

The background electric field was obtained to be 0.3 v/m before starting the measurement and the results were subtracted from this rate. The means of the electric field of the simple and smart phones are respectively 2.38±0.18 v/m and 1.9±0.18 v/m. And also the ranges of electric field of simple and smart phones were 1.8-2.6 v/m and 1.6-2.3 v/m (table 1).

Table 1. Electric Field of Simple and Smart Mobile phones

	Simple Mobile phone 1	Simple Mobile phone 2	MEAN	Smart phone Mobile 1	Smart phone Mobile 2	MEAN
1	2.4	2.1	2.25	1.75	1.9	1.83
2	2.3	2.2	2.25	1.65	1.9	1.78
3	2.4	2.4	2.40	2.1	1.8	1.95
4	2.4	1.8	2.10	2.2	1.9	2.05
5	2.6	2.5	2.55	1.95	1.9	1.93
6	2.2	2.4	2.30	2	1.8	1.90
7	2.2	2.5	2.35	1.8	2.1	1.95
8	2.3	2.5	2.40	1.6	1.8	1.70
9	2.3	2.5	2.40	1.8	1.8	1.80
10	2.6	2.5	2.55	1.9	2.2	2.05
11	2.5	2.5	2.50	1.6	2.2	1.90
12	2.5	2.4	2.45	1.6	2.3	1.95
MEAN	2.39	2.36	2.38	1.83	1.97	1.90
SD	0.14	0.22	0.18	0.20	0.18	0.19

The background magnetic field was obtained to be 0.14 mG and the results were subtracted from this rate. The means of the magnetic field of simple and smart mobile phones was 0.49±0.13 mG and 0.48±0.1 mG, respectively. And also the ranges of the electric field of simple and smart mobile phones was respectively 0.18-0.78 mG and 0.25-0.9 mG (table 2).

Table 2. Magnetic Field of Simple and Smart Mobile phones

Number Detect	Simple Mobile phone 1	Simple Mobile phone 2	MEAN	Smart phone Mobile 1	Smart phone Mobile 2	Mean
1.00	0.18	0.24	0.21	0.30	0.25	0.28
2.00	0.24	0.34	0.29	0.36	0.25	0.31
3.00	0.58	0.53	0.56	0.70	0.30	0.50
4.00	0.78	0.73	0.76	0.90	0.25	0.58
5.00	0.38	0.33	0.36	0.50	0.30	0.40
6.00	0.53	0.43	0.48	0.60	0.40	0.50
7.00	0.43	0.41	0.42	0.50	0.32	0.41

8.00	0.63	0.61	0.62	0.70	0.40	0.55
9.00	0.63	0.56	0.60	0.70	0.50	0.60
10.00	0.63	0.56	0.60	0.70	0.50	0.60
11.00	0.58	0.51	0.55	0.65	0.50	0.58
12.00	0.43	0.43	0.43	0.50	0.40	0.45
MEAN	0.50	0.47	0.49	0.59	0.36	0.48
SD	0.15	0.12	0.13	0.15	0.10	0.10

IV. Discussion

The frequency of the communicative networks in Iran is 900 MHz and 1800 MHz; therefore 1.38, 1.95 mG and 41.25v/m and 53.8v/m have been considered as the standard limits of the exposure of the public [19,20]. The ratio of the mean of electric field in simple and smart phones to the standard limit (53.8 v/m) was 4.42% and 3.53 %, respectively. The mean of electric field in simple and smart mobile phones was way less than the standard limit (figure 2) ($P<0.05$). The ratio of the mean of magnetic field in simple and smart mobile phones to the standard limit is respectively 25.12% and 24.61%. The mean of magnetic field in simple and smart mobile phones is way less than the standard limit (figure 3) ($P<0.05$). Like the study of Ghaffari, et al., the mean of electric field has a significant difference with magnetic field and the electric field is more than magnetic field [21]. In the study of Ghaffari, et al., the electric and magnetic fields of smart phones in a 5 cm distance were 1.78v/m and 0.96 mG, respectively which indicates that, compared to our study, the electric field is less but the magnetic field is more. Since this measurement was done in a 2 cm distance in our study, the electric field was also more (1.9v/m); but it was expected that the magnetic field would also increase as the distance was reduced like the electric field which was not the case. Since the measurement device was the same in both studies, the reduction of the electric field (0.48mG) in comparison with the study of Ghaffari, et al., can be because of the different telephone brands, connection to internet, the age of the phone, the mode of the phone (ringing, vibration or silent) [22,23].

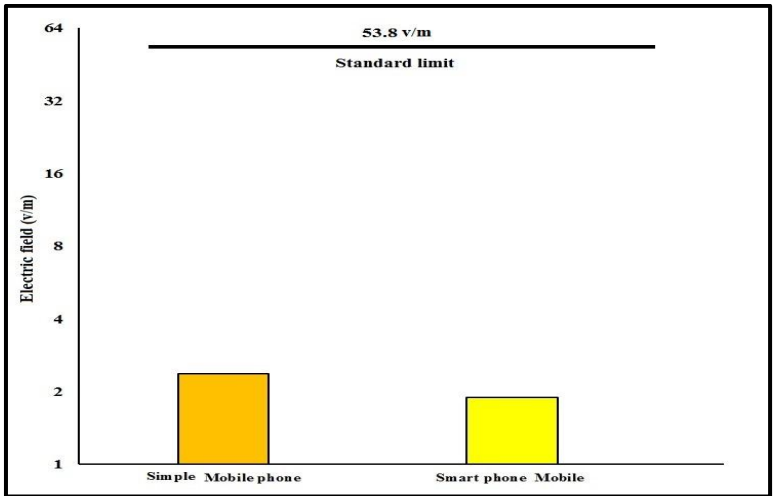

Figure 2. Comparing the Electric Field of Simple and Smart Phones with Standard Limits

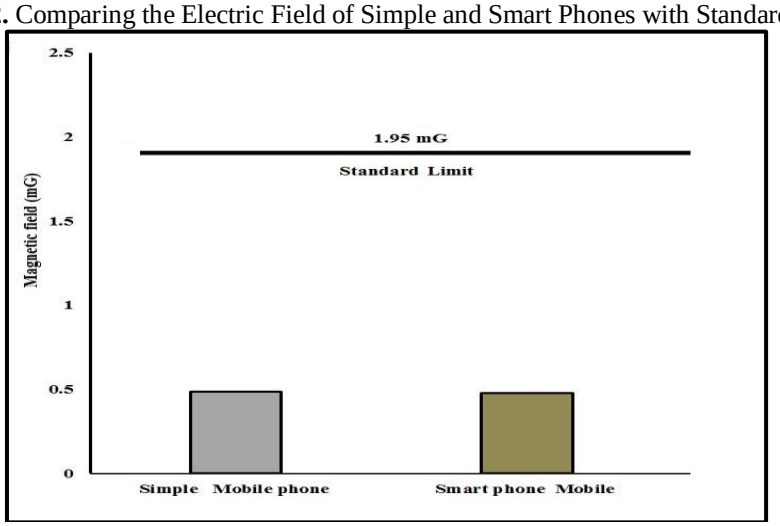

Figure 3. Comparing the Magnetic Field of Simple and Smart Phones with Standard Limits

Despite the fact that the means of electric and magnetic fields of simple phones are more than smart ones, as it is seen in tables 3 and 4, the ANOVA statistical analysis shows that there is not a significant difference between these two means (P value>0.05). In this study, only the electric and magnetic fields of simple phones were compared with those of smart phones and the risk was not evaluated in this study. Therefore, by evaluating the risk of exposure, which includes the time of exposure, the type of exposure (continuous or intermittent), age and distance, we can obtain more useful results [5,24].

Table 3. ANOVA statistical Analysis of Electric Field of Simple and Smart Phones in the Ringing Mode

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
simple * smart	Between Groups	(Combined)	0.239	9	0.027	0.733	0.674
	Within Groups		0.506	14	0.036		
	Total		0.745	23			

Table 4. ANOVA statistical Analysis of Magnetic Field of Simple and Smart Phones in the Ringing Mode

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
simple * smart	Between Groups	(Combined)	0.299	9	0.033	1.873	0.141
	Within Groups		0.248	14	0.018		
	Total		0.546	23			

V. Conclusion

Despite the fact that the electric and magnetic fields of simple and smart phones of the world are lower than the standard limits in this study, but this does not mean that overusing these devices is safe. The electric and magnetic fields of simple mobile phones are slightly more than the smart phones, but no significant difference was observed between the EMFs of these two types of phone. Thus, it can be said that the risks of EMFs are similar in simple and smart phones and the safety notes shall be considered while using each of these devices.

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