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Comparison Nokia, Samsung and Sony mobile phones in the specific absorption rate of head induced to electric field

Yadolah Fakhri[1] and Monireh Majlessi[2]*

[1]*Students Research Office, Department of Environmental Health Engineering, School of Public Health, Shahid Beheshti University of Medical Sciences, Tehran, Iran*
[2]*Associate Professor, Department of Environmental Health Engineering, School of Public Health, Shahid Beheshti University of Medical Sciences, Tehran, Iran*
**Corresponding Email: monireh_majlessi@yahoo.com*

ABSTRACT

The use of mobile phones has expanded in recent decades. Despite the extensive studies in this field, less attention has been paid to the biological effects of electromagnetic fields emitted by the mobile phones. Therefore, in this study there has been an attempt to compare the electric field, the specific absorption rate caused by exposure to mobile phones from samsung, nokia and sony to be followed. The electric field of Samsung mobile phones (8 Brands), Nokia (9 Brands) and Sony (4 Brands) at intervals of 2, 25 and 50 cm in case of ringing, vibration and silent modes by HI-3603 equipment to measure and compare. The electric field amplitude Brand Samsung 0.06 to 1.5 v/m in Nokia brand 0.06 to 10.9 v/m, 0.05 to 2.8 v/m in the Sony brand. Specific absorption rate respectively in different modes Samsung brand; vibration<silent<ringing for nokia and sony; brand vibration<silent<ringing. Specific absorption rate in nokia brand in non-significantly was more than the Sony and Samsung (p value> 0.05). Although the electric field, followed by specific absorption rate was significantly less than standard, many dangers of mobile phone use is unknown, therefore their use should be taken with caution.

Keywords: Electric Field, Mobile Phone, Specific Absorption Rate, Nokia, Samsung and Sony

INTRODUCTION

The electromagnetic fields expand in form of emission fields in a vacuum or matter. The fields include electric and magnetic fields that oscillate in its phase perpendicular to the direction of their energy. Due to the frequency of electromagnetic, radiation fields are classified that its spectrum includes radio fields, radar and, infrared radiation, visible light, ultraviolet radiation, X-rays and gamma [1, 2]. These fields are produced in different equipment's and appliances used in daily life such as refrigerators, freezers, television, radio, micro field, photocopiers, computer screens, halogen lights and printers [3]. The fields of micro field are also part of the electromagnetic fields' spectrum, which its frequency ranges varies from 300 MHz to 300 GHz. Its field length varies from 1 mm to 1 m [5,4]. The fields radiated from mobile phones with mean frequency of 900 MHz up to 1 GHz are placed in this frequency range (Figure 1) [6].

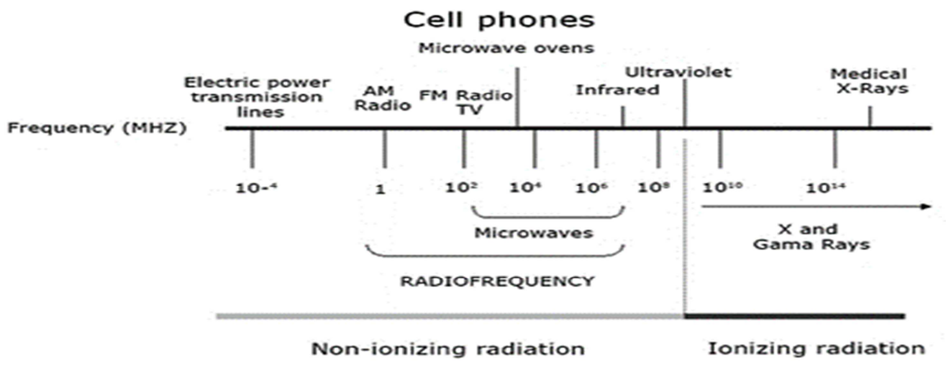

Fig. 1: The frequency range of fields radiated by mobile phones

Because of the radiation of the field on the energy molecules it is absorbed the molecular and causes the molecules vibrations or change of its temperature. Identifying the biological effects of micro field radiation is a complex and controversial issue and there is evidence that doesn't show these fields based on the intensity and frequency of exposure time, different biological effects in molecules under radiation are created [7,8]. The expansion of the widespread use of electrical devices (EMF), especially mobile phones and numerous reports that exist in recent years about the of various abnormalities effects of the fields on different developmental processes causing many concerns regarding the harmful effects of cell phone radiation on human health. Currently, a number of non-thermal symbiosis effects also consisting of alternations in cell function, including changes in reproduction or speed or changes in gene expression that cause cell death, the reduction in melatonin production and human electroencephalogram by the antenna of homes' portable mobile phones have been reported [9]. Today, exposure to the electromagnetic field emitted by mobile phones is inevitable [10,11]. In 2011, 129.86 million of the 140 million populations of Japan, in the United States of America 91 % and 94 % in Great Britain have used mobile phones [12-14]. The mobile phone ownership increases from 12 % in 1999 to 76 % in 2009. In Iran according to the number of SIM cards that have been granted have a rate of 130 % mobile penetration [15]. This overuse, especially in the last two decades caused much concern on the effects of EMFs (Electromagnetic fields) emitted by smart mobile phones on human health [16-18]. Radiations are divided into two categories ionizing and non-ionizing [19]. Many reports indicate that exposure to the light of non-radiation, such as EMFs can cause effects such as headaches, poor concentration and memory, fatigue, drowsiness and anxiety in humans [20,21], intervention in cardiac battery performance (at a distance of less than 15 cm) in people with heart disease [22], adverse effects on the reproductive system, including men's infertility [23]. EMFs also can also have damaging effects in other organisms. For example earthworm FetidaEisenia if exposed to EMFs mobile (900MHz) its cells' DNA will be damaged [24]. The World Health Organization has categorized the EMFs emitted by the cell phones considering the aspects of carcinogenesis in Class 2 B (possibly carcinogenic) [25]. At a frequency of 900 and 1800 MHz, 41.25 m/v and 53.8 m/v is intended as a guide for public exposure [26, 27]. Studies have shown that at frequencies greater than 100MHz, such as mobile frequencies, exposure assessment by calculating the SAR (specific absorption rate) is very important [28, 29]. International Committee of the protection of non-ionizing radiation (International Commission on Non-Ionizing Radiation Protection)for special absorption of electromagnetic field by SAR have suggested the limit of 2 W/Kg in 10 grams of tissue and electrical Institute and electronic (Institute of Electrical and Electronics Engineers)and the World Health Organization 1.6 W/Kg in 10 grams of tissue radiation is required [27,30]. In recent years many studies have tended towards the impact of electromagnetic fields on health [31], clinical disease [32] and behavioral effects [33]. But less attention has been paid to the specific absorption rate of mobile phones is an electro-magnetic field. That's why in this study thee has been an attempt to measure and compare the electric field of Sony, Samsung and Nokia mobile phones. As well as the specific absorption rate of the SAR was compared with the standard limits.

MATERIALS AND METHODS

Measuring the electric field

This descriptive analytical study was conducted in October 2015 in a way that first three models of smart mobile phones of the famous brands and the most used in the world with names of Samsung, Nokia and Sony were selected. From Sony model (4 brands: Xperia L, Xperia G, Xperia E5 and Xperia XA), Nokia (9 brands: 6300, 7330, C5-03, 1202, C6, 5530, X2, X6 and C5) and Mel Samsung (8 brands: Gt-s6312, Gt-18262, Galaxy Star, Galaxy S3, Gt-s5360, Galaxy Ace, Galaxymini2 and Galaxy Tab3). The electric field was measured by EMFs survey meter model HI 3603 equipment. Before you begin measuring the electric field background that can be due to other electrical equipment's such as telecommunication towers, electric substation, television and etc., was measured. Measuring was done at a distance of 2 cm, 25 and 50 cm and the ringing, vibration and silent.

Calculating the Specific Absorption Rate

The specific absorption rate is defined in form of normal energy loss in confrontation of the dense material [34]. To calculate the specific absorption rate of the electric field, the equation 1 was used by ICNIRP [35,36].

$$\mathrm{SAR} = \sigma\frac{E^2}{\rho} \qquad (1)$$

In this equation SAR; electric field specific absorption rate (W/kg), σ is being under guide line of the SAR ($\Omega^{-1}m^{-1}$) that in MHz 900 MHz 1800 equals 0.7665 and 1.1531 $\Omega^{-1}m^{-1}$ equals 1.1531 respectively and ρ is the mass density of the SAR (Kgm^{-3}), which is also in 900 and 1800 MHz equals Kgm^{-3} 1030 [35].

Statistical Analysis

For statistical analysis the Spss software V16.0 and Office Excel 2013 were used. After determining the parameters of a normal distribution, the test (Fist parameter T-Test) was used for statistical analysis. For the comparison of the mean electric field of mobile phones, Samsung, Nokia and Sony and the comparison of at intervals of (2, 15 and 25 cm) and various modes the test ANOVA (HSD) was used. For the comparison of the electric field and the specific absorption rate with guidelines and standards at frequencies of 900 and 1800 MHZ, the test (One Sample T-Test) was used. P value <0.05 was chosen as the significance level (α = %5).

RESULTS AND DISCUSSION

The electric field amplitude in the Samsung brand equals 1.5 to 0.06, in the Nokia brand equals 10.9 to 0.06and in the Sony brand equals, 2.8 to 0.05 (Table 1).

Table 1. Electric field of Samsung ,Nokia and Sony brand in the ringing, vibration and vibration mode

Brand	Model	EW (v/m)			Brand	Model	EW (v/m)			Brand	Model	EW (v/m)		
		Ringing	**Vibration**	**Silent**			**Ringing**	**Vibration**	**Silent**			**Ringing**	**Vibration**	**Silent**
Samsung	Gt-s6312	0.3*	0.2	0.2	**Nokia**	6300	2.55	9.02	9	**Sony**	Xperia L	1.5	1	1.05
		0.06**	0.06	0.06			0.13	0.15	0.14			0.06	0.06	0.06
		0.06***	0.06	0.06			0.06	0.06	0.06			0.06	0.06	0.06
	Gt-18262	0.1	0.09	0.1		2730	8.735	10.9	9.6		Xperia G	1.73	2.6	1.2
		0.06	0.06	0.06			0.12	0.14	0.14			0.06	0.06	0.06
		0.06	0.06	0.06			0.06	0.06	0.06			0.06	0.06	0.06
	Galaxy Star	1.5	0.92	1.5		C5-03	0.08	0.06	0.06		Xperia E5	1.25	2.1	1.5
		0.06	0.06	0.06			0.06	0.06	0.06			0.05	0.06	0.05
		0.06	0.06	0.06			0.06	0.06	0.06			0.05	0.06	0.05
	Galaxy S3	0.08	0.1	0.08		1202	0.65	0.65	0.44		Xperia XA	2.3	2.8	1.1
		0.06	0.06	0.06			0.06	0.06	0.06			0.06	0.06	0.05
		0.06	0.06	0.06			0.06	0.06	0.06			0.06	0.06	0.05
	Gt-S5360	0.53	0.5	0.57		C6	0.08	0.08	0.06					
		0.06	0.06	0.06			0.06	0.06	0.06					
		0.06	0.06	0.06			0.06	0.06	0.06					
	Galaxy Ace	0.26	0.2	0.16		5530	0.09	0.07	0.06					
		0.06	0.06	0.06			0.06	0.06	0.06					
		0.06	0.06	0.06			0.06	0.06	0.06					
	Mini 2	0.12	0.12	0.11		X2	0.18	0.12	0.1					
		0.06	0.06	0.06			0.06	0.06	0.06					
		0.06	0.06	0.06			0.06	0.06	0.06					
	Tab 3	1.05	0.7	0.7		C5	9.8	8.9	7.92					
		0.06	0.06	0.06			0.1	0.13	0.08					
		0.06	0.06	0.06			0.06	0.06	0.06					
						X6	2.5	2.5	2.5					
							0.06	0.06	0.06					
							0.06	0.06	0.06					

**distance 2 cm, ***distance 25 cm, ****distance 50 cm*

The mean of the electric field at a distance of 2 cm was more than and 25 and 50 cm. At a distance of 2 cm in ringing mode, Vibration and Silent for Samsung brand was 0.49 ± 0.52, 0.35 ± 0.32 v/m and 0.43 ± 0.49 and for Nokia brand was 2.74±3.84, 3.59±4.61 and 3.3±4.24 v/m for the Sony brand was 1.7±0.45, 2.13±0.81 and 1.21 ± 0.2 v/m (Table 2). The background electric field was 0.03 and that's why no intervention took place in the measuring of the electric field.

The maximum and minimum of the electric field in the distance of 2 cm for Samsung brand in ringing mode was and for Sony brand was in silent mode and in the other mobile distances not the difference was observed between phone brands (Table 2). In the Samsung brand the most amount of the electric field was on the ringing mode (0.49± 0.52 v/m), in the Nokia brand was in vibration mode (3.59±4.61 v/m) and for Sony brand as also in vibration mode (0.81±2.13). Samsung brand also the lowest electric field was related to vibration mode, in Nokia was related to ringing mode and for the Sony was in a silent mode. The sequence of electric field in different modes of Samsung mobile phone was ringing<silent<vibration, for nokia mobile phones was vibration< silent< ringing and for Sony was also Vibration< Silent< Ringing, respectively. Kolmogorov–Smirnov test has shown that the data is normally distributed (p value = 0.19), therefore parametric (t-test) tests were used.

The electric field at a distance of 2 cm for the Nokia brand was more than sony and samsung but in the distance of 35 and 50 cm no difference was observed between the brands (Figure 2).

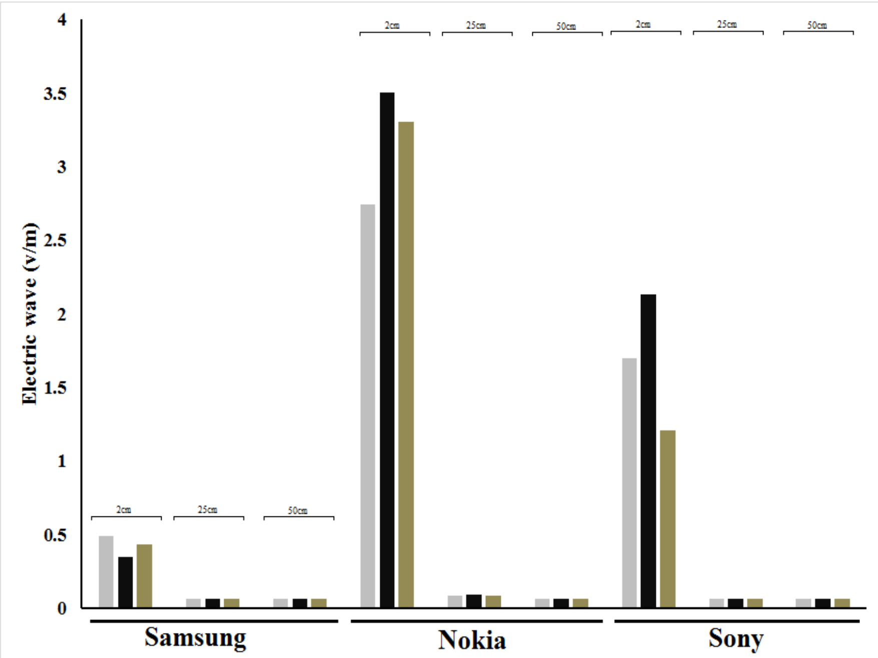

Figure 2. Comparison of the electric field of, Samsung, Nokia and Sony mobile phone brands

Table 2. Mean and standard deviation of the electric field samsung, nokia and sony mobile phone brands

		EW (v/m)		
Brand	Distance	Ringing	Vibration	Silent
Samsung	2 Cm	0.49±0.52	0.35±0.32	0.43±0.49
	25 Cm	0.06±0.01	0.06±0.01	0.06±0.01
	50 Cm	0.06±0.01	0.06±0.01	0.06±0.01
Nokia	2 Cm	2.74±3.84	3.59±4.61	3.3±4.24
	25 Cm	0.08±0.03	0.09±0.04	0.08±0.03
	50 Cm	0.06±0.01	0.06±0.01	0.06±0.01
Sony	2 Cm	1.7±0.45	2.13±0.81	1.21±0.2
	25 Cm	0.06±0.01	0.06±0.01	0.06±0.01
	50 Cm	0.06±0.01	0.06±0.01	0.06±0.01

Since the electric field in Samsung phone was more than Nokia and Sony, so the SAR was also higher on this brand. In the 900 and 1800 MHz frequencies in the distance 2cm the highest and lowest SAR in Samsung brand was in ringing mode and vibration for Nokia brand was in vibration and ringing mode and sony brand was in vibration and ringing mode (Table 3). SAR at a frequency of 1800 in compare to 900 MHz was significantly (p value> 0.05).

Table 3. Specific absorption rate due to electric fields of samsung, nokia and sony mobile phones

	SAR-900			SAR-1800		
	Ringing	Vibration	Silent	Ringing	Vibration	Silent
Samsung	3.6E-04	2.6E-04	3.2E-04	5.5E-04	3.9E-04	4.8E-04
	4.0E-05	4.0E-05	4.0E-05	7.0E-05	7.0E-05	7.0E-05
	4.0E-05	4.0E-05	4.0E-05	7.0E-05	7.0E-05	7.0E-05
Nokia	2.0E-03	2.6E-03	2.5E-03	3.1E-03	3.9E-03	3.7E-03
	6.0E-05	7.0E-05	6.0E-05	9.0E-05	1.0E-04	9.0E-05
	4.0E-05	4.0E-05	4.0E-05	7.0E-05	7.0E-05	7.0E-05
Sony	1.3E-03	1.6E-03	9.0E-04	1.9E-03	2.4E-03	1.4E-03
	4.0E-05	4.0E-05	4.0E-05	7.0E-05	7.0E-05	7.0E-05
	4.0E-05	4.0E-05	4.0E-05	7.0E-05	7.0E-05	7.0E-05

The results of this study showed that electric field, the specific absorption rate by the head followed in nokia mobile phone was non-significantly more than samsung and sony mobile phones (P value> 0.05) As can be seen in Figure 3, the specific absorption rate in mobile phones, samsung, nokia and sony in all three modes at a distance of 2 cm was significantly more than the 25 and 50 cm (P value <0.001). The electric field in the distance 25 and 50 cm they were not significantly different (P value> 0.05).

As it can be seen in Table 4, the electric field phone brands samsung, nokia and sony are not different from each other at various distances significantly (P value> 0.05).

Table 4.Comparison of samsung, nokia and sony mobile phones in the electric field (v/m) at a distance of 2 cm

Distance	Brand		p value
2	Samsung	Nokia	0.09
		Sony	0.45
	Nokia	Sony	0.51
25	Samsung	Nokia	0.72
		Sony	0.69
	Nokia	Sony	0.57
50	Samsung	Nokia	0.7
		Sony	0.68
	Nokia	Sony	0.57

The standard limits for the frequency 900 and 1800 MHz is 41.25 and 53.8 v/m. therefore, the mean of electric field in three mobile phone brands, samsung, nokia and sony, was significantly less than these limits (P value<0.001) [26,27]. The mean of SAR at a distance of 2 cm in all three mobile phone brands were significantly less than standard 1.6 and 2 W/Kg [27,30]. According to the inverse-square law [37], with increasing the distance from the source of the electro-magnetic field, the field strength will be reduced that is why the electric field at a distance of 2 cm was much greater than the distance 25 and 50 cm (Figure 3).

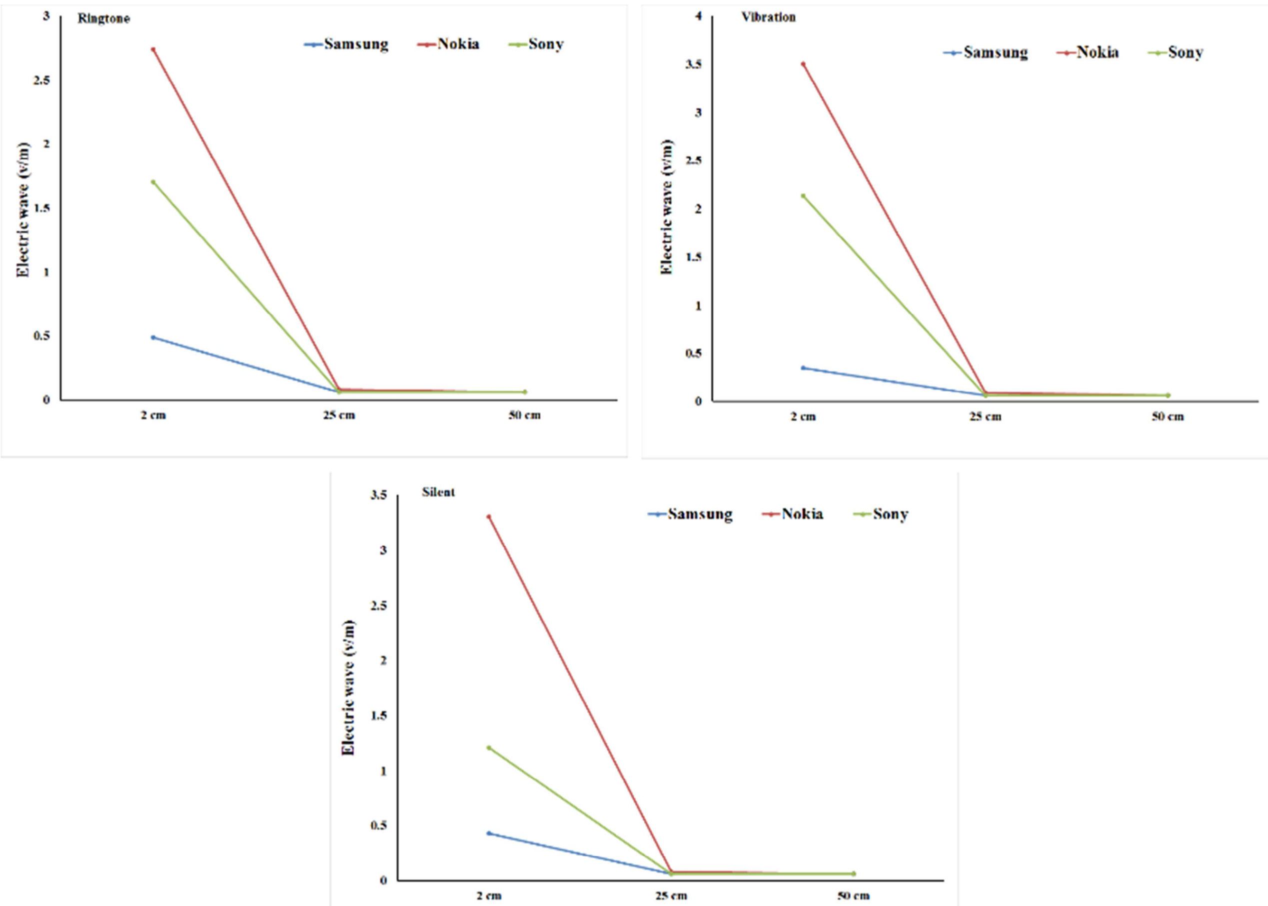

Figure 3. The Electric field at a distance of 2, 25 and 50 cm in the ringing tone, vibrate and silent modes

In the study of Fakhri et al that was performed on 6 different models of samsung and nokia, the mean of the electric field at a distance of 5 mm was respectively 1.8±0.19 v/m and 2.23±0.39 v/m that in comparison to this study was significantly higher (p value <0.05) [8]. Since the distance in the study of Fakhri et al was and closer than this study (2 cm), therefore, The electric field was also grater on the other hand, difference between the brands under the study could be another reason for the increase is the electric field.

In another study done between smart and simple phones conducted by Fakhri et al on the electric field in the distances respectively was 1.9±0.18 v/m and 2.38±0.18 v/m that in comparison to this study was also significantly higher than [29]. Thus, the main cause for the differences of electric field in the previous studies in compare to the current study was the larger number of mobile phones and the difference in phones brand. The mean of the electric field in the study of Lehmann et al was (5.5 v/m) that was higher than our study [38].

The SAR in the study Naif et al in the distance of 0.01mm equaled 1.57 W/kg, which was much higher than our study in comparison [39]. But in the study of Burdalo et al the specific absorption rate in adults at a frequency of 900 and 1800 MHz respectively was 2.35 and 2.74 W/Kg that in compare to our study the results were higher than [40]. According to the manufacturers, the mean SAR in 116 nokia models of mobile phone equals 0.75±0.27W/Kg and in 96 models of Samsung mobile phones was 0.65±0.23 W/Kg and in 15 models of Sony mobile phone was 0.67±0.17 W/kg that in compare to our study was significantly higher [41]. In addition, in the study of Hadjem et al SAR for adults at frequencies 900 and 1800 MHz, was respectively, 0.13 and 0.27 W/kg, that in comparison to our study it was higher than our study (P value <0.05) [42].

CONCLUSION

The electric field of the nokia mobile phones are non- significantly more than sony and samsung brands. The sequence of the mobile phone brands based on SAR was respectively as such, samsung<sony<nokia was (P value> 0.05). The electric field, followed by the SAR was significantly less than the standards. Although the SAR in this study was less than standard, the possible risks of the excessive use of mobile phones cannot be overlooked. Therefore it is recommended that the use of mobile phones, especially nokia should be done with more caution.

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