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Original Article

Effect of Mobile Phone Usage During Pregnancy on Total Oxidant and Antioxidant Levels in Cord Blood

Gebelikte Cep Telefonu Kullanımının Kord Kanında Total Oksidan ve Antioksidan Madde Düzeyleri Üzerine Etkisi

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ABSTRACT

Objective: Although cell phones are considered to have non-ionizing radiation, they have many adverse health effect. Non-ionizing radiation causes oxidant stress when the balance between the production of free oxygen radicals and their elimination by antioxidants is disrupted. The effects of mobile phone usage during pregnancy on the growing fetus is an important problem that needs to be resolved. We aimed to investigate the effects of using mobile phone during pregnancy on cord blood oxidant-antioxidant levels.

Method: Cell phone usage features of 67 healthy pregnant women without additional risk factors were recorded. Total antioxidant status, total oxidant status (TOS), ischemia modified albumin (IMA), total thiol, native thiol, disulfide levels and disulfide/total thiol, disulfide/native thiol, native thiol/total thiol ratios evaluated in umblical cord blood.

Results: A negative correlation was found between daily talking duration by mobile phone and IMA levels; a positive correlation was found between daily talking duration and native thiol, total thiol levels ($p<0.05$). TOS, native thiol and total thiol levels were higher in the mothers who have another mobile phone in their bedroom at night ($p<0.05$).

Conclusion: Our study is the first clinical study that investigates the effects of using mobile phone during pregnancy on cord blood oxidant and antioxidant levels. Mobile phone exposure during pregnancy could have an important potential to cause oxidative stress in cord blood. Therefore, we think that it is important for pregnant women to protect themselves and the fetus by staying away from mobile phones as much as possible during pregnancy.

Keywords: Pregnancy, mobile phone, cord blood, oxidant, antioxidant

ÖZ

Amaç: Cep telefonlarının non-iyonize radyasyona sebep olduğu kabul edilse de, sağlık üzerine birçok olumsuz etkileri vardır. Non-iyonize radyasyon, serbest oksijen radikallerinin üretimi ile bunların antioksidanlar tarafından eliminasyonu arasındaki dengeyi bozarak oksidan strese neden olur. Gebelikte cep telefonu kullanımının oksidan denge ve dolayısıyla fetüs üzerindeki etkileri aydınlatılması gereken önemli bir sorundur. Bu çalışmada gebelikte cep telefonu kullanımının kord kanında oksidan ve antioksidan madde düzeyleri üzerindeki etkisini araştırmayı amaçladık.

Yöntem: Herhangi bir risk faktörü olmayan 67 sağlıklı gebenin gebelik süresince cep telefonu kullanım özellikleri kaydedildi. Umblikal kord kanında total antioksidan düzeyi, total oksidan düzeyi (TOS), iskemi modifiye albümin (IMA), total tiyol, nativ tiyol, disülfit düzeyleri ve disülfit/total tiyol, disülfit/nativ tiyol, nativ tiyol/total tiyol oranları değerlendirildi.

Bulgular: Cep telefonu ile günlük konuşma süresi ile IMA düzeyleri arasında negatif korelasyon; nativ tiyol, total tiyol düzeyleri arasında pozitif korelasyon bulundu ($p<0,05$). Geceleri yatak odalarında kendi telefonlarına ek olarak başka bir cep telefonu daha olan annelerde TOS, nativ tiyol ve total tiyol düzeyleri daha yüksekti ($p<0,05$).

Sonuç: Çalışmamız gebelikte cep telefonu kullanımının kord kanında oksidan ve antioksidan düzeylerine etkisini araştıran ilk klinik çalışmadır. Gebelik sırasında cep telefonu maruziyeti, kord kanında oksidan madde düzeylerinin artması, antioksidan madde düzeylerinin ise azalmasına sebep olarak oksidatif strese neden olabilecek önemli bir potansiyele sahip olabilir. Bu nedenle gebelerin gebelik süresince cep telefonlarından mümkün olduğunca uzak durarak kendilerini ve gelişmekte olan fetüsü korumalarının önemli olduğunu düşünüyoruz.

Anahtar kelimeler: Gebelik, cep telefonu, kord kanı, oksidan, antioksidan

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INTRODUCTION

Today, mobile phones have become an undetachable part of modern life. Especially in recent years, the use of mobile phones has increased rapidly with the ease of affordability, the increase in its popularity, and the fact that communication technologies are one of the fastest developing technologies in the world. The rate of mobile phone usage, which was 57% with 4.15 billion mobile phone users in the world in 2015, reached 62% with 4.68 billion in 2019[1]. A small increase in the adverse health effects that may occur due to the increase in use may cause serious effects on public health in the long term[1].

Cell phones emit low radiofrequency (RF) energy (450-2700 MHz; peak power=0.1-2 watt), a form of non-ionizing electromagnetic radiation that can be absorbed by tissues that are close to the phone. Mobile phone technology creates an electromagnetic field (EMF) in two ways: 1. Via base stations and 2. Via the phones themselves[2].

The amount of RF energy a mobile phone user is exposed to depends on many factors such as the technology of the phone, the distance between the phone and the user, duration of use, the extent of mobile phone usage, and the users distance from the base stations[2].

The International Agency for Research on Cancer classifies radio-frequency EMFs as possible carcinogens[2]. In studies on the side effects of EMFs on health, it has been shown EMF has been associated with many diseases such as Alzheimer's disease, autism, blood-brain barrier damage, brain tumors, depression, suicide, DNA damage, fatigue, headache and migraine, heart diseases, hormonal imbalance, joint pain, upper respiratory tract infections, immune system disorders, high blood pressure, learning difficulties, leukemia, loss of concentration, decreased sperm count, miscarriages, Parkinson's disease, sleep disorders and insomnia[3-12].

Specific absorption rate (SAR) value is a measure of the maximum energy absorbed by a unit of mass of exposed tissue of a person using a mobile phone, over a given time or more simply the power absorbed per unit mass. The rate of energy transfer measured from an EMF to a specific point is expressed in SAR.

In all organisms, the production of free oxygen radicals and the antioxidant defense system formed against it are in balance. Oxidative stress occurs when the balance between the production of free oxygen radicals and their elimination by antioxidants is disrupted. Oxygen free radicals are toxic biological substances that cause lipid, protein, carbohydrate oxidation, and DNA damage[13].

There are several parameters used to detect oxidative stress and evaluate its severity. One of these is the thiol/disulfide balance. Thiol an important antioxidant that interacts with almost all physiological oxidants, thus preventing tissue and cellular damage, are oxidized by reactive oxygen species (ROS) and transformed into reversible disulfide bonds. The resulting disulfide bond structures can be reduced back to thiol groups and thus the thiol-disulfide balance continues[14,15]. Thiol/disulfide balance is impaired in situations of oxidative stress. This imbalance can impair the function of proteins containing the thiol group, and this leads to increased sensitivity of cysteine-rich proteins to oxidation[14].

Pregnancy is a physiological process, tissue oxygen demand and metabolic demand increase in this process. An increase in oxygen demand causes an increase in the production of free oxygen radicals. Therefore, oxidative stress is seen at an increased rate in a pregnant woman without any problem compared to a non-pregnant woman of the same age[16]. Because of these increased levels of oxidative stress, the effects of mobile phone use during pregnancy on the growing fetus may be an important problem that needs to be resolved.

Since newborns, especially premature babies, are frequently exposed to procedures such as resuscitation and mechanical ventilation, the production of oxygen-free radicals is higher. On the other hand, antioxidant systems are not sufficiently developed in newborn babies therefore newborns are more likely to experience their toxic effects[17,18].

This study aims to evaluate the effects of mobile phone usage during pregnancy on cord blood oxidative and antioxidative systems. Our study is the first clinical study in the English literature investigating the effect of mobile phone use in mothers during pregnancy on oxidant and antioxidant levels in umbilical cord blood.

MATERIALS and METHODS

This prospective, cross-sectional study was carried out between November 2019 and February 2020 in our hospital, departments of the neonatal intensive care unit (NICU) and Gynecology-Obstetrics Clinic. Our center has an average of 1500 births per year and the level III NICU treats approximately 380 newborns annually.

The study was approved by the University of Health Sciences Turkey, Ankara Training and Research Hospital Ethics Committee (decision number: E-19, date: 18.11.2019) and was conducted according to the Declaration of Helsinki.

Sixty-seven mothers and baby pairs who gave birth by normal spontaneous vaginal way in the gynecology and obstetrics clinic were included in this study. Mothers who met the including criteria were hospitalized and prepared for delivery in the last trimester of pregnancy in the obstetric-gynecology service and were informed about the study before delivery. Informed consent was obtained from all individuals who agreed to participate in the study. These participants were included in the study by taking blood samples from the umbilical cord at the time of delivery.

Brands and models were recorded to evaluate the radiation emitted by the mobile phones used by patients and; the head and body SAR value of mobile phones. In addition, how long they have used mobile phones during pregnancy and in their life, the duration of daily phone call time, daily internet usage times, where they leave their mobile phones during the day and night (the place of mobile phones such as in the bed, near the bed, far from the bed in the same room or in a different room) how many mobile phones there are at home asked to evaluate the rate of radiation exposure related to mobile phones.

Prolonged labor, premature rupture of membranes, obstetric intervention, cesarean section delivery, having a concomitant disease (hyper-hypothyroidism, diabetes mellitus, epilepsy, rheumatological diseases, cancer, cirrhosis, hepatitis, kidney diseases, active infection, etc.), small for gestational age, large for gestational age, intrauterine growth restriction, smoking, alcohol and drug use, perinatal asphyxia, neonatal meconium aspiration, multiple pregnancy were excluded from the study, because it may affect oxidant and antioxidant substance levels of cord blood. We evaluated total antioxidant status (TAS), total oxidant status (TOS), ischemia modified albumin (IMA), native thiol, total thiol, disulfide, disulfide/native thiol, disulfide/total thiol levels in cord blood.

After delivery umbilical cord was clamped, 2 mL of blood sample was taken from the umbilical cord vein immediately and put into a serum seperator tube and centrifugated at 1200 rpm for 15 minutes. Serum specimens were stored at -80 ºC until analysis. TAS and TOS levels were measured with a spectrophotometer called Roche Cobas C501 automatic analyzer and a new automated colorimetric method developed by Erel[19]. IMA level measurement was done with the colorimetric method defined by Bar-Or et al.[20]. Thiol-disulfide balance tests were measured using the automatic colorimetric "modified Ellman method" defined by Erel and Neselioglu[21].

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics 22 (Statistical Package for Social Sciences, IBM Inc., Chicago, IL, USA). Histogram, Skewness, and Kurtosis values were used in addition to the Kolmogorov-Smirnov test for normality distribution. Chi-square was used to compare categorical groups. In correlation evaluation, Pearson correlation for normal distribution values and Spearman correlation for those without normal distribution values were performed. Independent samples t-test was used to compare the averages of two independent groups with normal distribution and Mann-Whitney U test was used to compare the median of two independent groups with no normal distribution. The significance level was accepted if the p-value was less than 0.05 ($p<0.05$).

RESULTS

All babies were born at term and by normal spontaneous vaginal delivery. The mean birth weight was 3182±345 (minimum=2515, maximum=4490) grams, all of whom were appropriate for gestational age (Table 1). The sociodemographic characteristics of mothers and babies are presented in Table 1.

Table 1. Sociodemographic characteristics of study group	
Gestational age (week), median (min-max)	39 (38-41)
Birth weight (gram) mean ± SD	3182±345
Gender n (%)	
Female	35 (52.2)
Male	32 (47.8)
Maternal age (year) median (min-max)	25 (18-41)
Occupation, n (%)	
Housewife	61 (91)
Employed	6 (9)
Mother education n (%)	
Lower primary-primary school	15 (22.4)
Middle school	21 (31.3)
High school-university	31 (46.3)
Gravidity (n) median (min-max)	2 (1-5)
min-max: Minimum-maximum, SD: Standard deviation	

The average mobile phone usage time of mothers was 7 years, daily phone talk time was 30 minutes, and daily internet usage time was 60 minutes. In addition, the average head and body SAR values of their mobile phones and the body SAR values of another mobile phone in the bedrooms at night are shown in Table 2.

TAS, TOS, IMA, native thiol, total thiol, and disulfide levels were evaluated in cord blood at the time of delivery. The results are shown in Table 3.

Table 2. Characteristics of mobile phone usage of study group

Mobile phone usage time (year)*	7 (0.25-20)
Daily talk time (minute)*	30 (1-240)
Daily internet usage time (minute)*	60 (0-420)
Head SAR value of mobile phone (watt/kg) *	0.64 (0.20-1.29)
Body SAR value of mobile phone (watt/kg)*	0.64 (0.22-1.68)
Body SAR value of other mobile phone in the bedroom (watt/kg)*	0.64 (0.30-1.72)

*Median (minimum-maximum), SAR: Specific absorption rate

Table 3. Oxidant and antioxidans substance levels in umblical cord blood

TAS (mmol/L)*	1.45 (1.04-2.97)
TOS (umol/L)*	7.22 (2.11-17.05)
IMA (ABSU)**	0.68±0.11
Native thiol (umol/L)*	391.6 (293.36-586.48)
Total thiol (umol/L)**	440.57±64.65
Albumin (gram/dL)**	3.48±0.81
Disulfide (µmol/L)**	23.13±7.62

*Median (minimum-maximum), **Mean ± standard deviation, TAS: Total antioxidant status, TOS: Total oxidant status, IMA: Ischemia modified albumin, ABSU: Absorbance units

There was no statistically significant relation between the working status-educational status of the mothers, birth weight, gestational age, and oxidant-antioxidant levels (TAS, TOS, albumin, IMA, native thiol, total thiol, disulfide, disulfide/native thiol, disulfide/total thiol, native thiol/total thiol level) (p>0.05).

TOS, native thiol, and total thiol levels were found significantly higher in male babies (p=0.001; 0.002; 0.007, respectively).

A negative correlation was found between maternal age and TAS level of umbilical cord blood (p=0.020, r=-0.283). No significant difference was found between maternal age and other oxidant and antioxidant levels (p>0.05).

When daily mobile phone usage time was evaluated, a positive correlation was found with total thiol, and native thiol (p=0.015, r=0.296; p=0.017, r=0.291). There was no significant relationship between TAS, TOS, disulfide, disulfide/native thiol, disulfide/total thiol, native thiol/total thiol levels, and phone usage time (p>0.05).

The median daily mobile phone use time was 30 minutes. When we compared the oxidant and antioxidant levels between the mothers who use mobile phone more than 30 minutes and less than 30 minutes in a day, a significant relationship was found on TOS, IMA, native thiol, and total thiol levels (p=0.047; 0.006; 0.003; 0.025, respectively); TOS and IMA levels were found higher and total thiol, native thiol levels were found lower with longer daily phone usage time (Table 4).

There wasn't any significant relation between the location of mothers' mobile phones and TAS TOS levels (p>0.05). However; disulfide, disulfide/native thiol, and disulfide/total thiol were higher and IMA, native

Table 4. Oxidant and antioxidant statues accoring to daily phone usage time

Daily phone usage time parameters	≤30 min	>30 min	p-value
TAS*	1.37 (1.12-2.89)	1.52 (1.04-2.97)	0.109
TOS*	6.01 (2.11-17.05)	8.26 (3.64-11.86)	0.047
IMA*	0.63±0.10	0.71±0.09	0.006
Native thiol**	407.20 (343.92-512.24)	373.28 (293.36-586.48)	0.003
Total thiol*	462.68±56.95	426.55±65.95	0.025
Disulfide**	21.96±7.21	24.97±8.02	0.115
Disulfide/native thiol**	5.67±1.52	5.97±1.57	0.451
Disulfide/total thiol**	5.06±1.23	5.30±1.25	0.454

*Median (minimum-maximum), **Mean ± standard deviation, TAS: Total antioxidant status, TOS: Total oxidant status, IMA: Ischemia modified albumin

thiol/total thiol levels were statistically lower in the group whose phone was in the same room concerning the whose phone was generally in another room in the daytime (p=0.024; 0.033; 0.033; 0.038; 0.033, respectively) (Table 5).

TAS, TOS, native thiol, and total thiol levels were statistically higher in the group who had more than one mobile phone in the bedroom at night (p=0.003; 0.024; 0.019; 0.044, respectively) (Table 5).

Body SAR values of the phones used by mothers and IMA, native thiol/total thiol were in negative correlation (p=0.043, r=-0.248; p=0.041, r=-0.250, respectively), disulfide/native thiol, disulfide/total thiol levels were in positive correlation (p=0.044, r=0.247; p=0.041, r=0.250, respectively); no significant relationship was found with TAS, TOS, native thiol, total thiol, and disulfide levels (p>0.05).

DISCUSSION

The health effects of non-ionizing radiation from mobile phones are a common topic of many studies, but there are many questions about the underlying mechanism. The basic interaction mechanisms of RF energy and the human body are thermal and non-thermal effects[22]. In the frequency range in which mobile phones are used, most of the energy is absorbed by the skin, brain, and other tissues, and these organs experience an increase in temperature. Studies are showing that this warming of tissues has negative effects on the functions of the body, but these studies do not provide definitive evidence that exposure to EMF below the level that will cause tissue heating has any negative effect on health[1].

Other effects of radio frequency energy on the human body are non-thermal effects seen in energy levels that cannot increase the temperature of the whole body or tissue to a destructive level. It has been reported that free radicals increase in the affected tissue at these energy levels[22]. Reactive free radicals that increase in the body with non-ionized RF energy are mostly oxygen-sourced and are called free oxygen radicals.

The increase in the use of mobile phones in societies and the acceleration of the prevalence of certain diseases suggested that there may be a relationship between these two conditions, and many studies have been conducted on this for many years[3-12,23].

There are many studies on the effects of mobile phone-derived RF energy on pregnant animals; however, human experiments are limited. In two studies by Tomruk et al.[24], it was shown that there was DNA damage in the liver and brain due to the increase of oxidative stress in rabbits and their babies after 1800 MHz RF exposure[25].

There was no significant relationship between birth weight, gestational week of newborns, and the levels of oxidant-antioxidant substances. Premature babies were excluded not only due to having a marked increase in oxidant stress and exposure to exaggerated reactive oxygen/reactive nitrogen products but also a deficiency in antioxidant defense mechanisms responsible for the removal of oxidant stress products in premature. Excluding the newborns with prematurity, postmaturity, and large or small for gestational age, which may affect the levels of these substances, prevented a significant difference between these values.

Table 5. Oxidant and antioxidant substance levels according to mobile phone exposure

	Locations of mobile phone in daytime		p-value	Existence of another mobile phone in bedroom at nights		p-value
	Same room (n=23)	Different room (n=44)		Existence (n=42)	None (n=25)	
TAS*	1.51 (1.13-2.89)	1.41 (1.04-2.97)	0.362	1.52 (1.04-2.97)	1.34 (1.13-1.70)	**0.003**
TOS*	6.97 (3.64-11.86)	7.54 (2.11-17.05)	0.526	8.14 (2.11-17.05)	5.86 (3.21-11.31)	**0.024**
IMA *	0.64±0.11	0.70±0.10	**0.038**	0.68±0.11	0.68±0.10	0.951
Native thiol **	400.16 (293.68- 512.26)	382.88 (293.36-586.48)	0.103	399.28 (293.68-586.48)	368.24 (293.36-488.08)	**0.019**
Total thiol *	457.18±64.53	431.89±63.72	0.129	452.79±67.53	420.04±54.80	**0.044**
Disulfide **	26.02±7.82	21.61±7.14	**0.024**	23.98±7.86	21.69±7.11	0.237
Disulfide/native thiol**	6.34±1.46	5.50±1.5	**0.033**	5.84±1.52	5.69±1.58	0.704
Disulfide/total thiol**	5.60±1.14	4.92±1.23	**0.033**	5.20±1.22	5.08±1.28	0.699
Native thiol/total thiol **	88.80±2.29	90.14±2.46	**0.033**	89.59±2.45	89.83±2.56	0.699

*Median (minimum-maximum), **Mean ± standard deviation, TAS: Total antioxidant status, TOS: Total oxidant status, IMA: Ischemia modified albümin

TOS level was higher in male babies compared to females. In a study evaluating the levels of oxidative stress markers by gender, it was shown that their levels were higher in young men than in women of the same age[26]. Similarly, in another study, SOR production in vascular cells was reported to be at higher levels in men than in women[27]. Under healthy conditions, cellular respiration in the mitochondria is the main source of SORs. It is thought that oxidant stress in men may be higher than in women due to the faster basal metabolism in men compared to women and the antioxidant effect of the higher level of estrogen in women[28,29]. Consistent with this, in our study, in addition to the increase of TOS levels in male babies' native thiol, total thiol levels were also found to be higher compared to female babies.

It was observed that as the mothers' age increased, the level of TAS in cord blood decreased. The oxidative stress theory of aging is based on the hypothesis that age-related functional losses occur due to the damage of macromolecules (DNA, lipids, proteins) by reactive oxygen and nitrogen derivatives. As oxidative stress increases, antioxidant levels decrease, and age-related morbidity and mortality increase[30]. Antioxidant capacity, which decreases with advancing age, explains the low level of TAS in older mothers.

IMA levels were found statistically higher in mothers with longer daily mobile phone talking time. Oxidative stress causes a decrease in the binding affinity of albumin due to free radical damage at the n-terminal end of the albumin molecule. This chemically altered albumin molecule is called IMA. It is a sensitive biochemical marker of ischemia and oxidative stress as a result of tissue hypoxia[31]. In a study investigating the relationship between IMA levels and morbidity-mortality in preeclamptic mothers and their babies, IMA levels in venous blood in preeclamptic pregnant women and their babies were found to be significantly higher than in the control group[32]. In our study, in addition to the increased IMA levels, the higher levels of TOS and lower levels of Native thiol and Total thiol in these mothers support that the increased exposure to radiation due to longer time of phone calls increases the oxidant capacity of the organism.

Disulfide levels and disulfide/native thiol and disulfide/total thiol ratios were found higher in those whose mobile phones were in the same room during the day compared to those in different rooms. It is difficult to measure the levels of SORs, which are formed as a result of RF energy and play an important role in cell regulation, in cells, tissues, and body fluids due to their short half-life and low concentrations. Therefore, other lipid peroxidation, DNA, and protein damage biomarkers are used to measure the potential and the level of oxidative stress. Cysteine and methionine amino acids contained in thiol groups are the primary targets of ROSs. The reversible transformation of thiol groups to disulfide form causes a decrease in thiol levels. This thiol/disulfide balance plays a critical role in detoxification, signal transfer, apoptosis, and enzyme activity regulation[33,34]. In a study on rats exposed to whole-body radiation, conducted by Deniz et al.,[35] antioxidant-effective native thiol and native thiol/total thiol ratios were found lower, while disulfide/native thiol and disulfide/total thiol ratios were found to be higher compared to the control group. We think that RF exposure, which increases with the shortening of the distance between mothers and the mobile phone, increases the free oxidant radicals. As a result of the increased SORs, conversion of thiol groups to disulfide is increased and the disulfide levels were found in higher titers.

In addition to a high level of TOS; TAS, native thiol, and total thiol levels were also found to be high in the umbilical cord blood of mothers who had one other mobile phone in their bedrooms at night. However, the result was not considered meaningful because the SAR values of all those other phones, and the exposure times and patterns of the mothers to those phones were not known well.

Native thiol/total thiol ratio was lower and disulfide/native thiol, and disulfide/ total thiol ratios were significantly higher in cord blood in participants with higher body SAR value of their mobile phones. Limit SAR values permitted for the sale of mobile phones have been determined in the USA and EU. The SAR value allowed by the American Federal Communications Commission in the USA is 1.6 W/kg[36]. In the USA, measurements are made based on values per 1 gram of tissue, while in Europe, measurements are made on 10 grams of tissue. With the increase in the measured tissue, the limit SAR value also increases. In Europe, smartphones with a SAR value of up to 2 W/kg are allowed to be sold by following IEC standards[36]. Therefore, phone use with a high SAR value increases radiation exposure, and these rates, which indicate increased oxidant levels, are in line with the increased exposure to higher energy levels of radiation.

Study Limitations

This study has some limitations. Although the conditions such as the presence of comorbid disorders, being under medical treatment, smoking, alcohol and drug use, premature rupture of membranes, prolonged labor, intervened birth, perinatal asphyxia, delivery with meconium, prematurity or postmaturity, large or small for gestational age, cesarean delivery, multiple pregnancy and ethnicity that may affect oxidant and antioxidant substance levels were carefully excluded, it was not possible to exclude all possible factors that could cause oxidant stress. In addition, searching the effects of oxidant stress on the fetus in mothers exposed to oxidant stress has several difficulties in this and similar studies. These difficulties are the need for long-term follow-up to investigate the effects of long time and low doses of exposure to environmental factors, the long latent period of the diseases that may be seen due to RF, the need to be repeated to evaluate the results in terms of accuracy but this is difficult because it requires manpower, equipment and sufficient time. It is difficult the ethical issues of the study and to identify the early stages of the health impact being investigated. Today, the number of young women who do not use mobile phones is very low due to developing communication technologies and easier access to this technology. For this reason, a control group that does not use mobile phones could not be formed in our study and the comparison was made according to the exposure time and characteristics. In addition, the number of cases is limited because it is the first human study conducted on this subject.

CONCLUSION

Best of our knowledge, it was the first study in English literature that investigates the effect of mobile phone use during pregnancy on oxidant and antioxidant levels in cord blood, the exclusion of many personal and environmental factors that could negatively affect these substance levels, and guide further studies on this subject.

The lack of certainty about the health problems caused by the use of mobile phones and related radiation does not necessarily indicate the absence of risks. The principle of "avoidance" should be adopted for known risky situations and "precautionary" for suspicious and unknown situations. The need for large-scale and long-term epidemiological studies within the community is clear for more precise results.

Ethics

Ethics Committee Approval: The study was approved by the University of Health Sciences Turkey, Ankara Training and Research Hospital Ethics Committee (decision number: E-19, date: 18.11.2019) and was conducted according to the Declaration of Helsinki.

Informed Consent: Informed consent was obtained from all individuals who agreed to participate in the study.

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Author Contributions

Surgical and Medical Practices: G.Ö., D.K., Y.Ü., M.A.T., Concept: G.Ö., İ.B., Ö.E., M.A.T., Design: G.Ö., S.N., Y.Ü., M.A.T., Data Collection or Processing: G.Ö., D.K., Y.Ü., M.A.T., Analysis or Interpretation: G.Ö., M.A.T., Literature Search: G.Ö., D.K., İ.B., Ö.E., S.N., Y.Ü., M.A.T., Writing: G.Ö., D.K., Ö.E., S.N., M.A.T.

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