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ARAŞTIRMA / RESEARCH

May electromagnetic field exposure during pregnancy have a negative effect on anthropometric measurements of the newborn?

Gebelikte elektromanyetik alan maruziyetinin yenidoğan antropometrik ölçümleri üzerine negatif etkisi olabilir mi?

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Abstract

Purpose: This study was conducted to determine the effect of low frequency electromagnetic field (EMF) exposure due to electronic media device (EMD) during pregnancy on the anthropometric measurements of newborn.

Materials and Methods: A questionnaire was administered among randomly selected women offering Gaziantep University, Faculty of Medicine's Department of Pediatrics Outpatient Clinics for any reason between November 2017-May 2018. Four hundred women who have a child aged between 0-5 years old, completed the questionnaire about their pregnancy history.

Results: A negative correlation was identified between maternal single mobile phone usage during pregnancy and newborn's birth weight. Multiple mobile phone (more than mobile phone) usage during pregnancy was negatively correlated with the birth week, birth weight and birth length of the newborn. The head circumference of the newborn was negatively correlated with watching television (TV) and living close to a base station during pregnancy.

Conclusion: Watching TV, mobile phone usage and living near a base station during pregnancy may cause negative effect on the anthropometric measurements of the newborn.

Keywords: Electromagnetic fields, newborn, pregnancy

Öz

Amaç: Bu çalışma gebelikte elektronik medya cihazlarından kaynaklanan düşük frekanslı elektromanyetik alan maruziyetinin yenidoğanın antropometrik ölçümleri üzerine etkisini araştırmak amacıyla düzenlenmiştir.

Gereç ve Yöntem: Kasım 2017- Mayıs 2018 tarihleri arasında Gaziantep Üniversitesi Tıp Fakültesi Çocuk Hastalıkları Polikliniğine herhangi bir sebeple 0-5 yaş arası çocukları için başvuran kadınlar arasından randomize olarak seçilen 527 kişiye gebelikleri ile ilgili anket soruları yöneltildi.

Bulgular: Annenin gebelik boyunca tek cep telefonu kullanımı ile yenidoğanın doğum kilosu arasında negative korelasyon gözlendi. Birden çok cep telefonu kullanımının yenidoğanın doğum boyu, doğum kilosu ve doğum haftası üzerine negatif etki ettiği görüldü. Televizyon izleyen ve baz istasyonuna yakın bir yerde yaşayan annelerin bebeklerinin daha küçük kafa çapıyla doğdukları belirlendi.

Sonuç: Gebelik boyunca televizyon izlemek, cep telefonu kullanımı ve baz istasyonuna yakın yaşamak bebeğin antropometrik ölçümlerini negative yönde etkileyebilir.

Anahtar kelimeler: Elektromanyetik alanlar, yenidoğan, gebelik

INTRODUCTION

There is considerable concern regarding the probable harmful effects of continued exposure to low frequency electromagnetic fields (EMF) due to electromagnetic devices (EMD). This is linked to increased wireless phone and computer use in recent years, and to the growing number of base stations[1,2].

One of the most important issues regarding exposure to low frequency EMF is the effect of this on fetal

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development. Mobile phone use during pregnancy has been reported to be associated with an increased risk for behavioral problems in children[3]. Previous studies have suggested that low frequency EMF may cause various adverse effects in the fetus, including increased oxidative stress and oxidative uterine injury[4,5], non-reversible changes occurring in the critical stages of egg development and potential fetal death[6-9]. Low frequency EMF also affects the embryo's heart rate, newborn growth, and hippocampal integrity in the fetus[10]. Two previous studies determined no relationship between proximity of the home to sources of low frequency EMF and adverse pregnancy outcomes (preterm birth, low birth weight, and being small for gestational age (SGA)[11,12]. Another study showed that mobile phone and computer use may increase the preterm birth rate[13].

Several previous studies have investigated exposure to low frequency EMF in pregnancy, but the majority of these have focused on the neurobiological development of the baby[14], effects on the baby's hematopoietic tissues and reproductive organs[15,16]. We encountered relatively few studies investigating the effects of maternal low frequency EMF exposure due to electromagnetic devices on fetal development[17,18].

The aim of this study was to determine whether maternal exposure to low frequency EMF due to TV, mobile phones, computers, wi-fi (wireless fidelity) and base stations during pregnancy affects anthropometric findings in the newborn. We also examined other variables that might affect these findings, such as weight gain during pregnancy, smoking, and chronic disease.

MATERIALS AND METHODS

A questionnaire was administered among randomly selected 527 women offering Gaziantep University, Faculty of Medicine's Department of Pediatrics Outpatient Clinics for any reason between November 2017-May 2018. One hundred twentyseven women excluded because they did not meet inclusion criteria. Informed consent forms were signed for the women who will participate in the survey. The study was approved by the Gaziantep University Faculty of Medicine ethical committee (07/2011-11). The inclusion criteria were having a child aged between 0 and 5 years without any metabolic, genetic or chronic disease.

After being informed of the subject matter, the mothers were asked to complete a questionnaire consisting of 31 questions. These were adapted based on a review of previously published questionnaire studies[19,20]. Our clinical assistant helped illiterate mothers to complete the questionnaire. The questionnaire form inquired into two parts. The first part consisted of the questions about the parent's sociodemographic characteristics, previous health problems and behaviors of the mother. The second part consisted of the questions about the pregnancy period and characteristics of EMF exposure (e.g. disease history, drug use, weight gain, tobacco use, EMDs use, presence of base station close to home) and finally gestational age at birth, anthropometric measurements of the infant (birth weight, birth length, head circumference). Women were asked about the duration and number of electronic media devices they use to determine the characteristics of EMF exposure. Also they were asked if they were close to a base station.

Statistical analysis

The sample size was estimated using a power calculation based on previous studies [21,22]. The minimum sample size was determined as 382 at an 80% power level with an alpha error of 5%. The normality of distribution of continuous variables was tested by Shaphiro wilk test. Student's t test was used for comparison of two independent groups of variables with a normal distribution and Mann-Whitney U test was used for comparison of two independent groups of variables with a non-normal distribution. Data were analyzed on SPSS for Windows version 22.00 and a p value < 0.05 was accepted as statistically significant.

RESULTS

Four hundred women were recruited according to inclusion criteria of the study. The mean age of the mothers was 30.9±6.0 years (16-46 years), and the mean age of the children was 2.2±1.6 years (1 month-5 years). Girls constituted 50.3% (201/400) and boys 49.7% (199/400) of the children. Sociodemographic data are summarized in Table 1.

We determined that 9.8% of mothers smoked. The mean number of cigarettes actively smoked per day during pregnancy was 6.4 ± 5.7 (range: 1-20). Additionally, 41.9% of the respondents experienced any temporary disease (163/389) like flu, migraine

attack, gastroenteritis and 42.3% used medications during pregnancy (169/400).

Table 1. Sociodemographic data of the participants*

Variable	*n/Total* (%)*
Mother's education status	
Illiterate	11/394 (2.8%)
Literate	24/394 (6.1%)
Primary school graduate	89/394 (22.6%)
Secondary school graduate	37/394 (9.4%)
High school graduate	84/394 (21.3%)
University graduate	149/394 (37.8%)
Father's education status	
Illiterate	5/385 (1.3%)
Literate	15/385 (3.9%)
Primary school graduate	56 /385 (14.5%)
Secondary school graduate	36 /385 (9.4%)
High school graduate	102 /385(26.5%)
University graduate	171 /385 (44.4%)
Mother's employment status	
Housewife	240 /397 (60.5%)
Working	157 /397 (39.5%)
Father's occupation	
Self-employed	185/396 (46.7 %)
Private employee	96/396 (24.2%)
Public employee	115/396 (29%)
Social security	
No	58/395 (14.7%)
Yes	337/395 (85.3%)
Any disease during pregnancy	
No	312/398 (78.4%)
Yes	86/398 (21.6%)

*Totals vary depending on the number of participants who responded to each question.

The mean weight before the pregnancy was 62.1± 10.2 kg (45-110 kg), and the mean weight gain during pregnancy was 13.5± 5.8 kg (3-35 kg). The mean total number of children was 2.0 ± 1.1 (1-7). The mean gestational age in the birth was 37.8 ± 2.5 weeks (27-41), the mean birth weight of the infant was 3±0.683 kg (0.9-5 kg) and mean birth length of the infant was 49.1±3.2 cm (32-55 cm). Newborns' mean head circumference was 36.0±2.8 cm (28-43 cm). The preterm birth (≤37 week) rate was 22.1% (83/376) and the low birth weight (LBW) rate (<2500 gr) was 14.2% (55/386). Some mothers did not know the gestational age and the birth weight of their babies.

A positive correlation was identified between the mother's age and the birth length of the newborn (r=0.129, p=0.022). No relationship was identified between weight gained by the mother during pregnancy and the infant's birth weight (p>0.05). A negative correlation was identified between the number of cigarettes actively smoked by the mother and the infant's birth weight (r= -0.368, p=0.038) and head circumference (r= -0.488, p=0.016). Vitamin and food supplement intake during pregnancy increases with the age of the mother (p=0.041).

Eightysix mothers suffered from at least one chronic disease, such as hypertension, anemia or cardiological disease, had more deliveries under 2500 g and had more newborns with a low birth length (respectively; p=0.02, p=0.012).

Sources of exposure to EMF are summarized in Table 2 and durations of exposure in Table 3.

Table 2. Sources of daily exposure to electromagnetic radiation during the latest pregnancy

EMF sources	**n/Total*(%)**
TV	371/400 (92.8%)
Mobile phone	365/400 (91.3%)
Multiple mobile phone	46/400 (11.5%)
Computer	197/400 (49.3 %)
Wi-Fi	208/400 (52%)
Base station near the home+	112/390 (28.7%)

*Totals vary depending on the number of participants who responded to each question.; + Ten mothers do not know whether or not a base station existed near the home;: EMF: Electromagnetic field; TV: Television; Wi-fi: Wireless fidelity

Table 3. Duration of exposure to electromagnetic radiation during the latest pregnancy

Duration of exposure to EMF	**n/Total*(%)**
TV	
Not watching	7/400 (1.7%)
Watching	
1-3 hours	142/393 (36.1%)
4-6 hours	126/393 (32.1%)
7-12 hours	73/393 (18.6%)
More than 12 hours	23/393(5.9%)
Mobile phone	
< 30 minutes	205/392 (52.3%)
30-60 minutes	99/392 (25.3%)
> 60 minutes	53/392 (13.5%)
Computer	
> 1 hour	92/390 (23.6%)
1-3 hours	60/390 (15.4%)
>3 hours	35/390 (9%)
Wi-fi	
< 1 hour	90/392 (23%)
1-3 hours	72/392 (18.4%)
> 3 hours	38/392 (9.7%)

*Totals vary depending on the number of participants responding to each question.; EMF: Electromagnetic field; TV: Television; Wi-fi: Wireless fidelity

Fourty mothers used multiple phones during pregnancy. Mothers using multiple mobile phones had more shorter and lower birth weight infants than

those who used single mobile phone (p=0.02, p=0.003; respectively). Similarly, mothers using multiple mobile phone during pregnancy had more pre-term deliveries (single mobile phone use: 69/336, 20.5%; multiple mobile phone use: 14/40, 35.0%; p=0.037). Low birth weight infants were more common among women who used mobile phones for at least 30 minutes per day during pregnancy, although this finding was not statistically significant (no mobile phone use: 1/34, 2.9%; mobile phone use for at least 30 minutes: 54/352, 15.3%; p=0.067). Duration of maternal computer and Wi-Fi use during pregnancy did not affect birth weight (p>0.05).

The presence of base stations near the home had no effect on birth weight (p>0.05). The preterm birth rate was higher among women with base stations near the home, but the difference was not statistically significant (p>0.05). Among those women who know whether or not a base station existed near the home, a smaller infant head circumference was observed in the presence of a nearby base station (no base station near the home: 36.4±2.6 cm (28-43 cm); base station near the home: 35.5±2.7 cm (30-41 cm); p=0.041).

Infants whose mothers had a chronic disease had a shorter birth length than those whose mothers had no chronic disease (chronic illness in the mother: 48.2±3.0 cm (40.0-55.0 cm); no chronic illness in the mother: 49.3±3.2 cm (32.0-55.0 cm); p=0.012). The birth week and head circumference were lower among women who used medication except vitamins during pregnancy (p=0.008, p=0.032; respectively). The presence of a switched on TV, computer or Wi-Fi in the bedroom had no impact on the baby's development (p>0.05).

Head circumference was lower among infants whose mothers watching TV more than 6 hours (watching TV: 35.8±2.8 cm (28-43 cm); not watching TV; 37.0±2.3 cm (33-41 cm); p=0.040. Infant birth weight was lower among mobile phone users during pregnancy (Mobile phone users: 3.0±0.7 kg (900 gr-5 kg); non-users: 3.2±0.6 kg (2.3-4.75 kg); p=0.0419).

DISCUSSION

Numerous devices, such as mobile phones, Wi-Fi, and TV result in exposure to low frequency EMF in daily life[23]. Our findings show that exposure to various sources of low frequency EMF during pregnancy can affect the neonate's anthropometric measurements and birth time, depending on the duration and intensity of the exposure. Factors such as weight gain during pregnancy, smoking and chronic disease can also affect these measurements.

Interestingly, we observed a positive correlation between mother's age and the birth length of the newborn. The women receiving multiple micronutrient supplements were reported to be greater than those of mothers not receiving the supplement in a previous study[24]. Our study suggest that vitamin and food supplement intake increases with the age of the patient, and this may be related to the care taken over pregnancy at more advanced ages. Additionally, a previous study has shown that early age pregnancy is the most important risk factor for preterm and LBW births [25]. Various studies have shown that smoking during pregnancy can cause LBW and preterm birth [26,27]. Also we observed a negative correlation between smoking during pregnancy and the infant's head circumference.

Mothers with at least one chronic disease had shorter and weaker babies compared to those with no disease. Chronic diseases such as hypertension or diabetes trigger a systemic inflammatory response, leading to endothelial damage and placental dysfunction[28]. Also the premature birth rate was higher and head circumference was lower among infants whose mothers used medication without vitamins during pregnancy.

One previous study reported that watching TV and using mobile phones, especially during the first trimester of pregnancy, can adversely affect embryo growth[29]. In the current study, the use of multiple mobile phones also increased the risk of low birth weight and low birth length. The preterm delivery rate was higher among women using multiple cell phones compared to single cell phone users. In addition, mothers using single mobile phone during pregnancy had more LBW babies compared to non-users. The mean radiofrequency energy deposition in children is twice as high in the brain and 10 times higher in the skull compared to that in adults[30]. Since children are much more affected by exposure to EMF than adults, it is natural that fetal development should also be similarly affected. LBW births seemed to be more common among women who used mobile phones for at least 30 minutes per day during pregnancy, but this result was not statistically significant. Further studies involving larger case series are now needed to confirm this finding. Head circumference was lower among infants whose mothers watched TV during pregnancy. However,

duration of computer and Wi-Fi use did not affect birth weight. Living close to a base station had no effect on birth weight. Only head circumference was smaller among infants whose mothers living close to base stations during pregnancy. In agreement with previous studies, we also observed that Wi-Fi use had no effect on fetal development . The results of our study suggest that using cell phone effects fetal development negatively. However, this was a preliminary study, and more comprehensive and measurement-based studies are needed in order to reach a definite conclusion regarding this.

There are some limitations of this study. The nature and length of exposure were evaluated on the basis of responses received from patients. The level of exposure to EMF was not measured quantitatively since this was a questionnaire study. Despite these limitations, factors such as the number of participants and the inclusion of other factors that may affect fetal development represent particular strengths of the study. Our research is also valuable in the light of the scarce nature of previous investigation of this subject.

Our findings indicate that exposure to low frequency EMF during pregnancy may have adverse effects on fetal development. The most significant factors determining the effects of exposure to EMF on the fetus are the distance of the source of EMF, the duration of exposure and the presence of multiple sources. Despite the importance of this subject, the number of studies investigating fetal development and electromagnetic radiation in daily life is insufficient. We anticipate that wider-ranging studies will be performed in the next few years, and that the effects of exposure to EMF, to which we are all subjected on a continuous basis, will then be understood more clearly.

Yazar Katkıları: Çalışma konsepti/Tasarımı: NÇ; Veri toplama: ÖKK; Veri analizi ve yorumlama: NÇ; Yazı taslağı: NÇ, ÖKK; İçeriğin eleştirel incelenmesi: CD; Son onay ve sorumluluk: ÖKK, NÇ, CD; Teknik ve malzeme desteği: NÇ, ÖKK; Süpervizyon: CD; Fon sağlama (mevcut ise): yok.
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