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Impact of Maternal Obesity and Mobile Phone Use on Fetal Cardiotocography Pattern

Zaheera Saadia

Department of Obstetrics and Gynecology, Qassim University, College of Medicine, Al-Qassim, Saudi Arabia

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***Correspondence:** Zaheera Saadia. Department of Obstetrics and Gynecology, Qassim University, College of Medicine, Al-Qassim, Saudi Arabia. E-mail: zaheerasaadia@hotmail.com

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Abstract

BACKGROUND: The fetal heart rate (FHR) is a good marker of fetal well-being during labour. Cardiotocography is used to record the FHR and uterine contractions and can detect possible fetal hypoxia. Mobile phones use, and obesity is suggested to influence the FHR and cardiovascular development.

AIM: The present study aimed to study the differences in FHR pattern between fetuses of obese vs non-obese groups when using a mobile phone.

METHODS: We conducted a clinical trial to test the impact of mobile phone use on FHR using a single mobile phone with Specific Absorption Rate rating of 0.99 W/kg for 10 minutes. Data from this clinical trial were analysed to compare the FHR pattern between fetuses of obese women (exposed group) vs those of non-obese women (control group). The two study groups (obese vs non-obese) were compared regarding four FHR patterns: baseline FHR, variability, acceleration and deceleration scores. Data were analysed by SPSS software version 23.0 using the independent-samples t-tests.

RESULTS: Sixty-nine women were included in the final analysis (obese group: n = 22 and non-obese group: n = 47). Fetuses of the obese women had significantly higher baseline FHR and less FHR variability scores when compared with fetuses of the non-obese women (mean difference 2.9 and 3.18, respectively).

CONCLUSION: Fetuses of obese women had abnormal FHR pattern compared with fetuses of non-obese women. The use of mobile phone slightly influenced the FHR variability score. These results highlight the importance of proper management of obesity in women within the childbearing period.

Introduction

The prevalence of obesity is increasing worldwide. About one in two US women within the childbearing age are either overweight or obese [1]. Obesity of pregnant women has been linked to increased mortality, morbidity, and neonatal complications as prematurity, stillbirth, macrosomia, and large for gestational age infant. The literature suggests that maternal obesity might influence fetal development and well-being. Another risk factor that might influence fetal development is the mobile phone use.

Mobile phone use has become popular worldwide. Researchers found that the electromagnetic rays of mobile phones might interfere with the signalling process in the brain [2]. There have been concerns about the consequences of exposure to radiofrequency waves including infertility, stillbirths, congenital disabilities, and miscarriages [3] [4]. These poor reproductive outcomes can be explained by calcium efflux from the cell membranes under the effect of reactive oxygen species production causing DNA damage [2]. Elevated body temperature leads to cellular damage especially in organs like the brain, the testis, and the eye lenses which are more susceptible to heat-induced cellular damage [5]. In 2003, Goldstein *et al.,* [6] observed that biological damage to tissue occurs if the temperature rises above 10 C above the baseline temperature for that tissue. In additions, the thermoregulatory mechanisms play an important role in disseminating the elevated temperature to minimise the damaging effect.

The fetal heart rate (FHR) is a prominent marker of fetal well-being in utero and during labour. FHR can be measured by cardiotocography (CTG) which records FHR and uterine contractions and therefore, helps obstetricians to detect the possible fetal hypoxia.

The impact of maternal obesity and mobile phone use on FHR pattern has not been established, yet. Therefore, we conducted this study to investigate the impact of maternal obesity and mobile phone exposure on FHR, an indicator for the general well-being of the fetus.

Methods

This study was approved by the ethics committee of the Sir Ganga Ram Hospital, Lahore Pakistan.

We conducted a clinical trial to assess the impact of mobile phone use of fetal heart rate. This study was conducted at the Department of Obstetrics and Gynaecology of Sir Ganga Ram Hospital, Lahore, Pakistan within the period one month May 2018.

Patients meeting the following inclusion criteria were included in the study:

(1) Pregnant women between 27-38 weeks of gestation; and

(2) Pregnant women are carrying a singleton pregnancy.

We excluded women with high-risk pregnancies and those with any accompanying disorders. Participants were classified into two groups: (1) *obese women group* defined as those with BMI > 30 Kg/m^2 and (2) *non-obese women group* defined as those with BMI < 30 Kg/m^2.

All patients gave a written informed consent before participation in the study. All participants were instructed not to use mobile phones one day before the start of the test. We used a single mobile phone with Specific Absorption Rate of 0.99 W/kg for 10 minutes in a room where no other mobile phone was placed. All participants had a CTG (BISTOS BT-300 Korea) for 20 minutes. CTG data were collected on a self-designed proforma, and they were blindly analysed. The variables measured were all the four types of FHR Pattern (baseline FHR, accelerations, decelerations, and beat to beat variability).

Cardiotocography, also known as electronic fetal monitoring, is used to record the changes in the FHR and their temporal relationship to uterine contractions. It aims to identify babies who may suffer from hypoxia and therefore, (1) subsequent well-being assessments can be done before delivery and (2) the baby is delivered by instrumental vaginal birth or cesarean section [7].

A baseline FHR of 110-160 beats/minute was considered normal. Acceleration is defined as a transient rise in FHR above the baseline more than 15 beats/minute and lasting at least 15 seconds. Decelerations are a transient slowing of FHR below the baseline, more than 15 beats/minute lasting more than 15 seconds. The baseline variability was defined as transient oscillations of FHR between 5-15 beats/minute [8].

The sample size was calculated to detect a difference in FHR between the fetuses of obese and to detect this difference with 90% statistical power and 5% margin of error, a minimum sample size of 69 was required for this study.

Categorical data were summarised as frequencies and percentages. Normality of continuous variables was tested by the Kolmogorov-Smirnov test. Continuous variables were summarised as means and standard deviations. Response parameters for participants' baseline FHR scores were measured on a 6-point interval scale (where 1 = 110-120, 2 = 121-130, 3 = 131-140, 4 = 141-150, 5 = 151-160, and 6 = 161 and above). Response parameters for participants' acceleration and deceleration scores were measured on a 3-point interval scale (where 1= absent, 2 = 1-3, and 3 = more than 3). However, all participants scored a value of 1 on deceleration, and the variable was removed from all analyses. Lastly, response parameters for participants' variability scores were measured on a 3-point interval scale where 1 = good (10 to 15), 2 = reduced (5 to 9), and 3 = absent. The comparisons between obese vs non-obese groups and with mobile phone use vs without mobile phone use were done using the independent-samples *t*-test. All analyses were conducted using the Statistical Package for the Social Sciences (SPSS) version 23. An alpha level below 0.05 was considered for statistical significance.

Results

Sixty-nine women were enrolled in the study. Of them, 22 pregnant women were classified in the obese women group (BMI > 30 kg/m^2) and 47 pregnant women were described as the non-obese group (BMI < 30 kg/m^2). Most of the participating women (62.3%) were younger than 30 years. The dominant parity was G2 and above (63.77%) and a minority of primigravida (36.23%). The majority of the patients were housewives (78.8%). A summary of the demographic characteristics of the study population is shown in Table 1.

Table 1: Demographic characteristics of the study population

		Obese Women N = 22		Non-Obese Women N = 47	
Variable	Level	n	%	n	%
Age	Below 25	10	45.40	7	14.89
	25-30	9	40.90	17	36.17
	Above 30	3	13.6	23	48.93
Education	Primary or below	5	22.72	16	34.04
	Secondary	10	45.40	27	57.44
	College and above	7	31.81	04	8.51
Parity	Primigravida	7	31.81	18	38.29
	G2 and above	15	68.18	29	61.70
Occupation	Housewife	18	81.81	35	74.46
	Professional	4	18.18	12	25.53
Gestational age (Weeks)	27-34	5	22.72	7	14.89
	35-38	17	77.27	40	85.10

BMI = Body mass index; Categorical variables are summarized as frequencies and percentages (n, %)

When comparing the FHR scores between the two conditions (with mobile phone use vs without mobile phone use), the differences were not statistically significant, except for the variability score in the subgroup of non-obese women (Figure 1 and Figure 2).

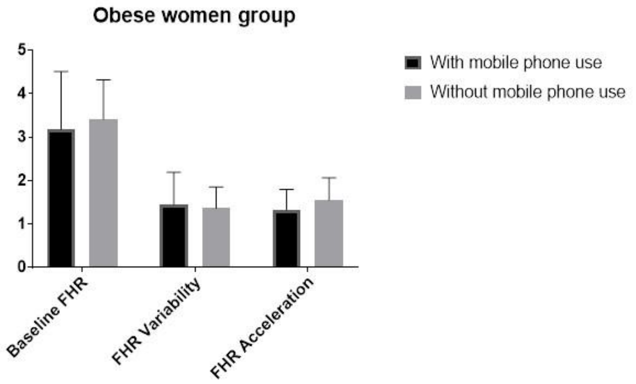

Figure 1: Bar chart of the FHR scores in the obese women group

In the non-obese women group, a significant increase in the variability score from 1.28 to 1.53 was observed (mean difference = 0.25, 95% CI from 0.04 to 0.46, P = 0.017, Figure 1). The comparison of FHR scores in the two conditions (with vs without mobile phone use) stratified by the BMI (obese women vs non-obese women) is shown in Table 2.

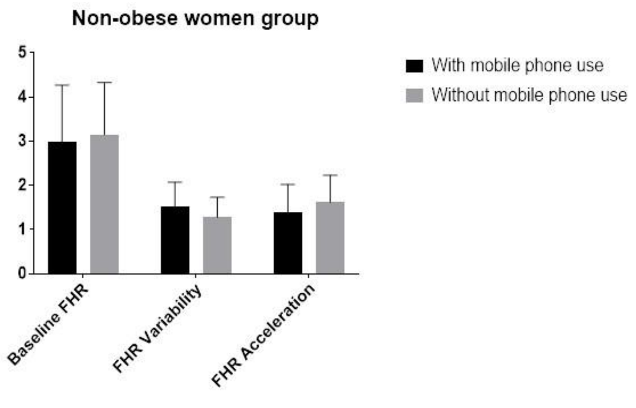

Figure 2: Bar chart of the FHR scores in the non-obese women group

Table 2: Comparison of the FHR scores between the two conditions (with vs without mobile phone use) stratified by BMI into obese and non-obese women

Variable		Without a mobile phone	With mobile phone	Mean Difference	95% CI	P value
Baseline FHR	Non-obese	3.15 (1.18)	2.98 (1.29)	-0.17	-0.68 to 0.34	0.507
	Obese	3.41 (0.91)	3.18 (1.33)	-0.27	-0.96 to 0.42	0.436
Variability FHR	Non-obese	1.28 (0.45)	1.53 (0.55)	0.25	0.04 to 0.46	0.017*
	Obese	1.36 (0.49)	1.45 (0.73)	0.09	-0.29 to 0.47	0.633
Acceleration FHR	Non-obese	1.62 (0.61)	1.38 (0.64)	-0.24	-0.50 to 0.02	0.065
	Obese	1.55 (0.51)	1.32 (0.48)	-0.23	-0.53 to 0.07	0.131

**Statistically significant; BMI = Body Mass Index; CI=Confidence Interval; FHR = Fatal Heart Rate.*

There were statistically significant differences between the obese and non-obese groups in dependent FHR variables: (1) the baseline FHR score with a mobile phone and (2) the FHR variability score with a mobile phone. Lower baseline FHR scores were found in the fetuses of non-obese women compared to the fetuses of obese women (MD -0.690, 95% CI -1.353 to -0.028, P = 0.041, Figure 3).

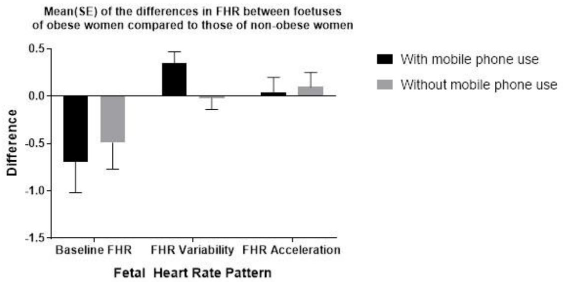

Figure 3: Bar chart of the mean (SE) of differences in the FHR between fetuses of obese women compared to those of non-obese women

Higher FHR variability score was found in the fetuses of non-obese women compared to the fetuses of obese women (MD 0.345, 95% CI 0.105 to 0.586, P = 0.006, Figure 3). The results of the independent-sample t-test are shown in Table 3.

Table 3: Mean difference between obese vs non-obese women groups regarding FHR scores

Variable		Mean Difference	SE	95% C.I. Lower	95% C.I. Upper	P value
Baseline FHR	With mobile phone use	-0.69	0.33	-1.35	-0.03	0.041*
	Without mobile phone use	-0.49	0.28	-1.05	0.08	0.090
FHR Variability	With mobile phone use	0.35	0.12	0.11	0.59	0.006*
	Without mobile phone use	-0.02	0.12	-0.25	0.22	0.901
FHR Acceleration	With mobile phone use	0.04	0.16	-0.27	0.35	0.791
	Without mobile phone use	0.10	0.15	-0.20	0.40	0.507

**Statistically significant; N = 69; Independent variable = Body mass index; FHR = Fetal Heart Rate.*

Discussion

Our study showed that maternal obesity influences the FHR pattern. Fetuses of obese women had significantly higher baseline FHR scores and lowered FHR variability scores when compared to fetuses of non-obese women. Additionally, mobile phone use significantly changed the FHR variability scores in the control group but not in the obese women group.

FHR pattern is controlled by the sympathetic activity of the fetus. It was found that maternal BMI positively correlates with fetal sympathetic activity and therefore, might explain the alteration in FHR pattern [9]. Also, it was found that the nutritional status of pregnant women and their pre-pregnancy BMI contributes to fetal blood pressure programming [10].

The literature suggests that high maternal BMI influences the fetal cardiac development. However, the impact of mobile phone use on fetal cardiac development has not been established yet. FHR has been used as an indicator of the fetal well-being in pregnancy and during labour. Therefore, for studies assessing the impact of mobile phone use on fetal well-being, FHR is considered a reliable outcome measure. Our study showed that mobile phone use significantly changes the FHR variability scores in the control group (BMI < 30). In 2004, Celik *et al.,* [11] investigated the effects of electromagnetic fields of cellular phones on baseline FHR, and they found that these electromagnetic fields do not influence the FHR scores highlighting that mobile phone use in pregnancy is safe. Another study was conducted by Rezk *et al.,* [12] who studied the FHR and cardiac output following acute maternal exposure to electromagnetic fields of mobile phones. The study group included 90 women with uncomplicated pregnancies enrolled from Benha University Hospital and El-Shorouq hospital in Egypt. In this study, the exposure to electromagnetic fields resulted in a significant increase in FHR and significant decreases in stroke volume and cardiac output [12].

Regarding maternal BMI, a longitudinal study of 610 pregnant women showed that maternal obesity affects FHR and alters the normal trajectory of cardiac and motor development [13]. Avci *et al.,* [14] studied a group of 931 pregnant females between March 2012 and March 2013. They found significantly more abnormal FHR pattern in the obese group than the control group. A Norwegian case-control study was conducted on 52 obese pregnant women and 25 normal weight pregnant women. Fetuses of obese women had more fetal myocardial dysfunctions with reduced left ventricular and right ventricular global strain rate compared with fetuses of women with normal weight [15]. The impact of maternal obesity on cardiac functions and development extends to the development of congenital heart defects [16]. It was found that infants with congenital heart disease are more likely to have obese mothers (OR 1.22, 95% CI 1.15-1.30) [16]. Also, the strength of association increased with increasing the maternal BMI [16]. The relationship between maternal BMI and fetal cardiac functions extends beyond the pregnancy period. An observational study of Gademan *et al.,* [17] showed that high maternal BMI was associated with high diastolic (β = 0.11 mm Hg; 95% confidence interval, 0.05-0.17) and systolic blood pressure (β = 0.14 mm Hg; 95% confidence interval, 0.07-0.21) in their children aged 4-5 years. These results highlight the importance of proper management of obesity in women within the childbearing period.

Our study has several strong points: (1) the exposure to mobile phone use was standardised in all participants, and (2) our study had a control group unlike some of the previous reports. However, our study is limited by the use of only one type of mobile phones with specific magnetic field properties.

Fetuses of obese women had abnormal FHR pattern compared to fetuses of non-obese women. The use of mobile phone slightly influenced the FHR variability score. These results highlight the importance of proper management of obesity in women within the childbearing period.

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