

Mobile Phone and its Effect on Foetal Cardiotocography Pattern

ZAHEERA SAADIA¹, ROBINA FARRUKH²

ABSTRACT

Introduction: Mobile phones have become a part and parcel of our every day's life. As they operate by creating an electromagnetic field therefore, there are concerns for their safety while using in pregnancy.

Aim: The aim of the present study was to study the differences in Foetal Heart Rate (FHR) pattern between women without mobile phone and then after using mobile phone.

Materials and Methods: The present study was conducted as an interventional study at the Department of Obstetrics and Gynecology, Sir Ganga Ram Hospital, Lahore, Pakistan. First the women underwent Cardiotocography (CTG) without mobile

phone (controls) and then exposed to mobile phone in calling mode (served as cases) for 10 minutes. The variables measured for CTG were base line FHR, beat to beat variability, accelerations and decelerations. Multivariate Analysis of Variance (MANOVA) was used to evaluate the research question.

Results: Participants with mobile phones had significantly lower acceleration scores (M=1.330, SD=0.560) as compared to those without a mobile phone (M=1.590, SD=0.551). Additionally, participants with mobile phones had significantly lower variability scores (M=2.522, SD=0.503) as compared to those without a mobile phone (M=2.725, SD=0.450).

Conclusion: Use of mobile phone affects the FHR tracing CTG.

Keywords: Acceleration, Deceleration, Foetal cardiac activity, Pregnancy

INTRODUCTION

Cell Phones have become an important part of every day's life. Research on cell phone and its foetal effects is relatively new. There are concerns about the safety of their use in pregnancy as they operate by creating an electromagnetic field. If an association is noticed future studies may be conducted to confirm the findings and limit the use of cell phones in pregnancy [1,2].

Being wireless devices, they operate by creating electromagnetic fields. Animal studies, report some biological effect on target tissues like oxidative damage by increasing the extent of lipid peroxidation and increasing iron levels. Wi-Fi and mobile phone induced electromagnetic radiations may cause precocious puberty and oxidative kidney and testis injury in growing rats [1]. In another study by Haghani M et al., exposure of rats to 900 MHz for 6 hours/day resulted in decreased neuronal excitability of Purkinje cells [2]. Mobile phone exposure in adolescents exposed to 2G mobile phone raised the alpha activity as detected by Electroencephalography (EEG) [3].

According to Sauter C et al., individuals were exposed to mobile phone in three different modes including sham, Global System for Mobile Communication (GSM) and Wideband Code Division Multiple Access (WCDMA). The results revealed effects on the selective attention as well as working memory [4]. Another data from Cairo, Egypt, observed the effect of mobile phone usage on FHR pattern and the researchers reported that baseline FHR increased by 5 beats/minute above the base line. However, this study had no control group [5]. Celick O and Hascalik S observed the effect of electromagnetic field of mobile phone on FHR pattern of 40 pregnant women and found no significant change in FHR pattern [6].

There is paucity of evidences about the safety of mobile phone use in pregnancy, and in fact little is known on their biological effects. Evidence based data remain lacking. The present study, serve as a pilot study from which further clinical research on identified effects

could be conducted. The primary aim of the present study was to highlight the effect of mobile phone use in pregnancy on foetal cardiac activity. Future interpretations can be made from the results of present study which can serve as the basis for further research.

MATERIALS AND METHODS

The research hypothesis was:

H0=The FHR does not changes with the use of mobile phone

Alternate=The FHR changes by the effect of mobile phone

The present study was conducted as an interventional study at the Department of Obstetrics and Gynaecology, Sir Ganga Ram Hospital, Lahore, Pakistan (October 2016). The present study was approved by Ethical board of Sir Ganga Ram Hospital, Lahore, Pakistan. All women who were willing to participate after informed consent were included in the present study, presenting between 28-37 weeks of gestation. Women whether, primiparous or multiparous, carrying a singleton pregnancy were included in the present study. They were instructed not to use mobile phones, 24 hours before the start of test. There were 138 patients who were willing to participate during this month in antenatal period. Considering this the sample had a confidence level of 95% with confidence interval of five. All high risk women with any medical or obstetrical disorders and women in labour were excluded from the present study. Single mobile phone with Specific Absorption Rate (SAR) rating of 0.99 W/kg was used in the present study. First, the women underwent CTG without mobile phone (controls) and then exposed to mobile phone in calling mode (served as cases) for 10 minutes in a separate room where no other mobile phone was placed. All women had a CTG performed by the same machine (BISTOS BT-300 Korea) for 20 minutes. Data was collected on self-designed proforma. The CTG tracings were analysed blindly without the information of the patient. The variables, measured for CTG were baseline FHR, beat to beat variability, accelerations and decelerations. Baseline FHR of

110-160 beats/minute is considered to be normal. Acceleration was defined as transient rise in FHR above the base line more than 15 beats/minute and lasting at least 15 seconds. Decelerations were transient slowing of FHR below the base line, more than 15 beats/minute lasting more than 15 seconds and the Baseline variability was defined as transient oscillations of FHR between 5-15 beats/minute [7].

STATISTICAL ANALYSIS

The data was statistically analysed with SPSS version 23.0. Microsoft Office for Windows 7 was used. Inferential statistics were used to draw conclusions from the sample tested. The Statistical Package for the Social Sciences (SPSS) was used to code and tabulate scores collected from the survey and provide summarised values where applicable including the mean, central tendency, variance, and standard deviation. Multivariate Analysis of Variance (MANOVA) was used to evaluate the research question.

RESULTS

The hypothesis was evaluated using MANOVA analysis to determine if any significant differences in participants baseline FHR, acceleration, deceleration, and variability existed between those with a mobile phone in calling mode and those with a mobile phone in silent mode. The dependent variables were participants baseline FHR, acceleration, deceleration, and variability scores. Response parameters for participants baseline FHR scores were measured on a six-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 three-point interval scale where 1=absent, 2=1-3, and 3=more than 3. Lastly, response parameters for participants variability scores were measured on a three-point interval scale where 1=absent, 2=reduced (5-9), and 3=good (10-15). The independent variable was whether the participants had a mobile phone or not.

Data Cleaning and Tests of Parametric Assumptions

Before the data was evaluated, the data was screened for missing data, univariate and multivariate outliers. Missing data was investigated using frequency counts, and no cases existed. Thus, 138 responses from participants were received evaluated by the MANOVA model (n=138). Descriptive statistics of participants dependent variable scores by mobile phone groups are shown in [Table/Fig-1].

Variable	n	Minimum	Maximum	Mean	Standard Deviation	Skewness	Kurtosis
With mobile phone							
Baseline FHR	69	1.000	5.000	3.040	1.300	-0.207	-1.049
Acceleration	69	1.000	3.000	1.330	0.560	1.475	1.287
Decelerations	69	1.000	1.000	1.000	N/A	N/A	N/A
Variability	69	2.000	3.000	2.522	0.503	-0.089	-2.052
Without mobile phone							
Baseline FHR	69	1.000	5.000	3.220	1.083	-0.307	-0.490
Acceleration	69	1.000	3.000	1.590	0.551	0.157	-0.948
Decelerations	69	1.000	1.000	1.000	N/A	N/A	N/A
Variability	69	2.000	3.000	2.725	0.450	-1.028	-0.972

[Table/Fig-1]: Descriptive statistics of the dependent variables by mobile phone groups. Note: n=138 FHR= Foetal Heart Rate

The dependent variables (baseline FHR, acceleration, deceleration, and variability) were evaluated for basic parametric assumptions including normality, homogeneity of variance, homogeneity of variance-covariance matrices, and multicollinearity. However, since all participants scored a '1' (absent) on deceleration, the variable was removed from all further analyses. The distributions were examined

for normality using 'Skew' and 'Kurtosis' coefficients and results indicated that two distributions (acceleration and variability) were significantly skewed and one distribution was significantly kurtotic, (variability) was significantly kurtotic. Therefore, the distributions were transformed using square root transformations. Although, the transformed data was found to be normally distributed, results from the MANOVA analysis using the transformed data was similar, compared to those found using the raw (untransformed) scores. Therefore, the raw data was used in the MANOVA model. Skewness and kurtosis statistics of the dependent variables (raw scores) by mobile phone groups are displayed in [Table/Fig-2].

Variable	n	Skewness	Skew Std. Error	z-skew	Kurtosis	Kurtosis Std. Error	z-kurtosis
With mobile phone							
Baseline FHR	69	-0.207	0.289	-0.716	-1.049	0.570	-1.840
Acceleration	69	1.475	0.289	5.104*	1.287	0.570	2.258
Variability	69	-0.089	0.289	-0.308	-2.052	0.570	-3.600*
Without mobile phone							
Baseline FHR	69	-0.307	0.289	-1.062	-0.490	0.570	-0.860
Acceleration	69	0.157	0.289	0.543	-0.948	0.570	-1.663
Variability	69	-1.028	0.289	-3.557*	-0.972	0.570	-1.705

[Table/Fig-2]: Skewness and Kurtosis Statistics of the dependent variables by mobile phone groups. Note: *Variable is significantly skewed/kurtotic. n=138 FHR= Foetal Heart Rate

Results of MANOVA Analysis

The null and alternate hypothesis were:

- H0=The FHR does not changes with the use of mobile phone
- Alternate=The FHR changes by the effect of mobile phone

Results indicated that there was a significant multivariate differences between groups (with mobile phone and without mobile) on a model containing three dependent variables (baseline FHR, accelerations, and variability), Wilks' Lambda=0.918, F=(3, 134)=3.997, p.=0.009, η²=0.082. Displayed in [Table/Fig-3].

Effect	Wilks' Lambda	F	Hypothesis df	Error df	Sig. (p)	Partial Eta Squared (η ²)
Intercept	0.025	1758.415	3	134	<0.001	0.975
Mobile Phone Group	0.918	3.977	3	134	0.009	0.082

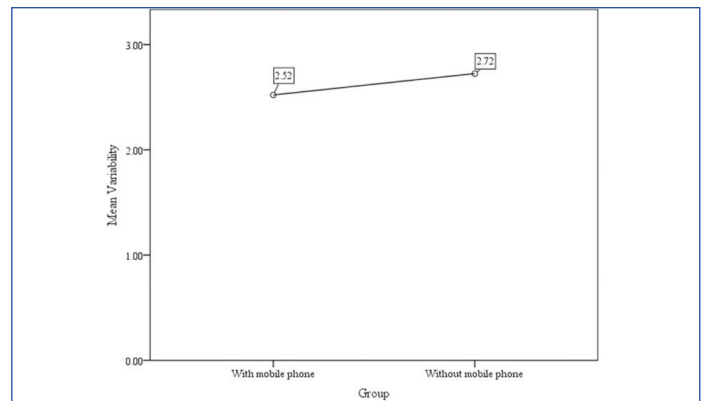
[Table/Fig-3]: Summary of the MANOVA multivariate test conducted for hypothesis. Note. Dependent variables=baseline FHR, acceleration, and variability. n=138

Results from the tests of between-subject effects indicated there were individual significant differences in two of the three dependent variables (acceleration p=0.007 and variability p=0.014) between mobile phone groups. That is, participants with mobile phones had significantly lower acceleration scores (M=1.330, SD=0.560) as compared to those without a mobile phone (M=1.590, SD=0.551). Additionally, participants with mobile phones had significantly lower variability scores (M=2.522, SD=0.503) as compared to those without a mobile phone (M=2.725, SD=0.450). Regarding the variability variable, results from the non-parametric Kruskal-Wallis test affirmed the results from the between-subject effects analysis (p=0.014). Lastly, there was no significant difference in participants baseline FHR scores (p=0.395) among those with a mobile phone (M=3.040, SD=1.300) and those without a mobile phone (M=3.220, SD=1.083). Thus, since there were significant differences in two of the three dependent variables, the null hypothesis was partially rejected in favor of the alternative hypothesis. A model summary of the individual tests of between-subject effects has displayed in [Table/Fig-4].

Means plots of the dependent variables by mobile phone groups are displayed in [Table/Figs-5-7].

Source	Type III Sum of Squares	df	Mean Square	F	Sig. (p)	Partial Eta Squared (η^2)
Corrected Model	1.043	1	1.043	0.729	0.395	0.005
Baseline FHR	2.348	1	2.348	7.608	0.007	0.053
Acceleration Variability	1.420	1	1.420	6.234	0.014	0.044
Intercept						
Baseline FHR	1352.348	1	1352.348	945.072	<0.001	0.874
Acceleration	295.681	1	295.681	958.105	<0.001	0.876
Variability	949.594	1	949.594	4167.910	<0.001	0.968
Certification Type						
Baseline FHR	1.043	1	1.043	0.729	0.395	0.005
Acceleration	2.348	1	2.348	7.608	0.007	0.053
Variability	1.420	1	1.420	6.234	0.014	0.044
Error						
Baseline FHR	194.609	136	1.431			
Acceleration	41.971	136	0.309			
Variability	30.986	136	0.228			
Total						
Baseline FHR	1548.000	138				
Acceleration	340.000	138				
Variability	982.000	138				
Corrected Total						
Baseline FHR	195.652	137				
Acceleration	44.319	137				
Variability	32.406	137				

[Table/Fig-4]: Model summary of the MANOVA tests of between-subjects effects for hypothesis 1.
 Note: n=138
 FHR= Foetal Heart Rate



[Table/Fig-7]: Mean plots of participants fetal heart rate variability scores between mobile phone and non mobile phone groups.

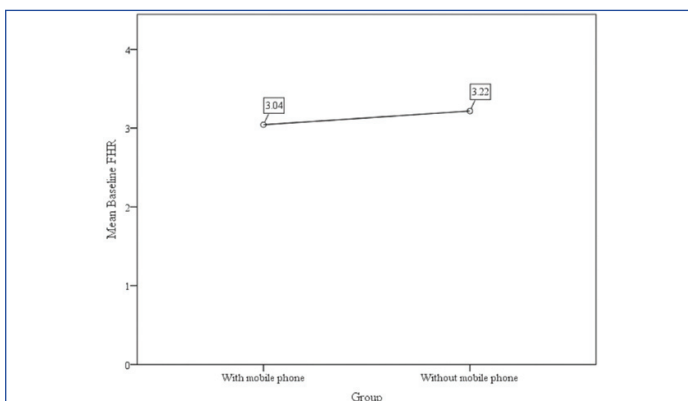
DISCUSSION

The FHR tracing depicts foetal response. Four main features are noted from the trace including the base line FHR, variability, presence or absence of decelerations and accelerations. When reviewing the CTG trace, four features are noted baseline heart rate, variability and presence of accelerations and decelerations. Normal trace constitutes a baseline heart rate of 100-160 beats/minute, beat to beat variability of 5-15 beats/minute and no decelerations. Absence of accelerations has no significance in another wise normal trace [7]. The presence of FHR accelerations is generally a sign that the baby is healthy.

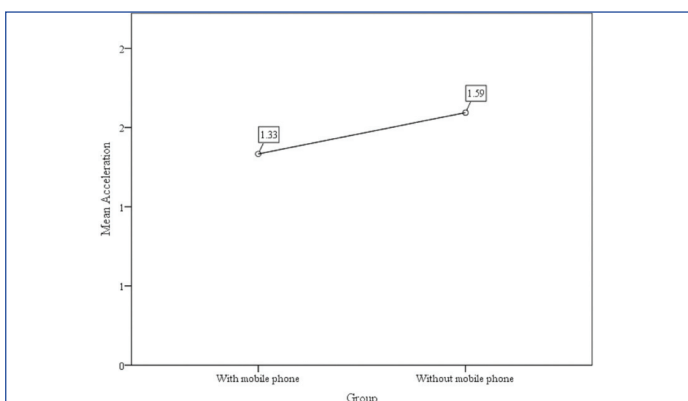
In the present study, among participants there were significant differences in two of the three dependent variables. Women with mobile phones had significantly lower acceleration scores as compared to those without mobile phones. Additionally, participants with mobile phones had significantly lower variability scores as compared to those without a mobile phone. Lastly, there was no significant difference in participants baseline FHR scores. We noticed no change in baseline FHR. However, in another study by Rezk AY, et al., reported an increased FHR in fetuses who were exposed to cell phone in calling mode [8].

Physiologically accelerations reflect foetal alertness and Central Nervous System (CNS) activity and depicts healthy fetus with intact Autonomic Nervous System (ANS). They are commonly seen in association with foetal movements and external stimuli. Their absence is the indication of CNS depression, seen with certain drugs and foetal sleep [9]. A typical acceleration has two components, first a gradual rise to the peak which is under sympathetic control and the second a rapid return to base line which is mediated through parasympathetic system. Van Geijn HP, states that absence of accelerations above 45 minutes is suspicious of fetal distress [9]. Lower acceleration score in the present study raises concerns; therefore about the health of foetal CNS. Results in the present study were in contrast to Celick O and Hasclik S, who noticed no change in acceleration pattern among 40 pregnant women who had cell phone in dialing mode for five minutes [6]. There is a difference in the timing of exposure between present study and Celick O and Hasclik S study. In the present study, timing of exposure was 10 minutes in contrast to Celick O and Hasclik S study [6].

Additionally, participants with mobile phones had significantly lower variability scores as compared to those who were without a mobile phone. Base line variability also has two components short and long term, short term variability is indicative of vagal and the long term is under the sympathetic control. Therefore, heart rate variability is an assessment tool for monitoring cardiac conditions in adults with ANS abnormalities [10]. There is evidence to suggest that FHR variability is depressed by factors that depress foetal brain functioning or myocardial activity [10]. Therefore, in the present study, lower variability score in women using mobile phone may be an indirect indicator of CNS and ANS, depression under the effect of mobile phone radiations. Heart rate variability is a sensitive indicator of ANS



[Table/Fig-5]: Mean plots of participants base line fetal heart rate score between mobile phone and non mobile phone groups.



[Table/Fig-6]: Mean plots of participants fetal heart rate accelerations score between mobile phone and non mobile phone groups.

modulation. A change in its patterns indicates foetal health [11]. It is affected by many physiological conditions like posture, age, sex, breathing and other daily activities [12]. Therefore, it can be assumed that mobile phone use can affect it as seen in the present study.

There are concerns about the long term health consequences of mobile phone used by pregnant women and appearance of behavioral disturbances in children [13-15]. Foetal safety is the primary objective of obstetric care. Hence, the results of foetal heart pattern are linked to CTG changes. Further research is required to interpret the results and if proven recommendations can be made for safe use of mobile phones in pregnancy periods.

LIMITATION

The present study had strength of having a good sample size with confidence level of 95% with confidence interval of 5. However, the study had the limitation of using one type of mobile phone only and the world is full of cellular phones with different SAR.

CONCLUSION

Mobile phone affects the FHR pattern. We observed a significant multivariate differences between groups (with mobile phone and without mobile phone). Participants with mobile phones had significantly lower acceleration scores as well as lower variability scores.

ACKNOWLEDGMENTS

The authors are extremely grateful to women who participated in the present study.

REFERENCES

- [1] Özorak A, Naziroglu M, Çelik Ö, Yüksel M, Özçelik D, Özkaya MO et al. Wi-Fi (2.45 GHz)- and mobile phone (900 and 1800 MHz)-induced risks on oxidative stress and elements in kidney and testis of rats during pregnancy and the development of offspring. *Biol Trace Elem Res.* 2013;156:221-29.
- [2] Haghani M, Shabani M, Moazzami K. Maternal mobile phone exposure adversely affects the electrophysiological properties of Purkinje neurons in rat offspring. *Neuroscience.* 2013;250:588-98.
- [3] Croft RJ, Leung S, McKenzie RJ, Loughran SP, Iskra S, Hamblin DL, et al. Effects of 2G and 3G mobile phones on human alpha rhythms: Resting EEG in adolescents, young adults, and the elderly. *Bioelectromagnetics.* 2010;31(6):434-44.
- [4] Sauter C, Dorn H, Bahr A, Hansen ML, Peter A, Bajbouj M, et al. Effects of exposure to electromagnetic fields emitted by GSM 900 and WCDMA mobile phones on cognitive function in young male subjects. *Bioelectromagnetics.* 2011;32(3):179-90.
- [5] Asma F, Osama A, Tamer T, Mamdouh B, Amr A. Consequences of exposure to electromagnetic waves of mobile phones on fetal blood flow and heart rate. *Int J Med.* 2009;2(3):279-81.
- [6] Celik O, Hascalik S. Effect of electromagnetic field emitted by cellular phones on fetal heart rate patterns. *Eur J Obstet Gynecol Reprod Biol.* 2004;112(1):55-56.
- [7] NICE (2017). Interpretation of fetal cardiotocography. Retrieved on 3/11/2017 from <https://www.nice.org.uk/guidance/cg190/resources/interpretation-of-cardiotocograph-traces-pdf-248732173>.
- [8] Rezk AY, Abdulqawi K, Mustafa RM, Abo El-Azm TM, Al-Inany H. Fetal and neonatal responses following maternal exposure to mobile phones. *Saudi Med J.* 2008;29(2):218-23.
- [9] van Geijn HP. Antepartum assessment of fetal condition by means of cardiotocography. *Curr Obstet Gynecol.* 1997;7(2):87-92.
- [10] van Ravenswaaij-Arts C, Kollée LA, Hopman JC, Stoelinga GB, van Geijn HP. Heart rate variability. *Ann Intern Med.* 1993;118:436-47.
- [11] Vanderlei LC, Pastre CM, Hoshi RA, Carvalho TD, Godoy MF. Basic notions of heart rate variability and its clinical applicability. *Rev Bras Cir Cardiovasc.* 2009;24(2):205-17.
- [12] Longo A, Ferreira D, Correia MJ. Variability of heart rate. *Rev Port Cardiol.* 1995;14(3):241-62.
- [13] Aldad TS, Gan G, Gao XB, Taylor HS. Fetal radiofrequency radiation exposure from 800-1900 mhz-rated cellular telephones affects neurodevelopment and behavior in mice. *Sci Rep.* 2012;2:312.
- [14] Divan HA, Kheifets L, Obel C, Olsen J. Prenatal and postnatal exposure to cell phone use and behavioral problems in children. *Epidemiology.* 2008;19(4):523-29.
- [15] Guxens M, van Eijsden M, Vermeulen R, Loomans E, Vrijkotte TG, Komhout H et al. Maternal cell phone and cordless phone use during pregnancy and behaviour problems in 5-year-old children. *J Epidemiol Community Health.* 2013;67:432-38.

PARTICULARS OF CONTRIBUTORS:

1. Associate Professor, Department of Obstetrics and Gynaecology, Qassim University, College of Medicine, Al-Qassim, Saudi Arabia.
2. Associate Professor, Department of Obstetrics and Gynaecology, Sir Ganga Ram Hospital, Lahore, Pakistan.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Zaheera Saadia,
Alrajhi Building 4, Apartment 108, King Khalid Road, Buraidah, AlQassim-52366, Saudi Arabia.
E-mail: zaheerasaadia@hotmail.com

FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Jun 29, 2017**

Date of Peer Review: **Sep 28, 2017**

Date of Acceptance: **Nov 15, 2017**

Date of Publishing: **Mar 01, 2018**