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A STUDY OF CORRELATIONS OF FETAL CARDIAC SYMPATHETIC ACTIVITY WITH MATERNAL BODY MASS INDEX

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ABSTRACT

The Doppler ultrasonography technique is used to determine the heart rate variability (HRV) characteristics of the fetus in obese and non-obese mothers. 64 maternal abdominal Doppler ultrasound signals were examined. These allowed us to identify 41 individuals with BMIs between 20 and 37. A significant issue for world health is obesity. Pregnancy complications such as birth defects like heart defects, neural tube defects, and other abnormalities, difficulty seeing all of the baby's organs, difficulty monitoring the baby's heart rate with the fetal heart monitor, gestational diabetes, delivery by emergency caesarian section, heavy bleeding after delivery, and an increase in blood pressure are all more likely to occur in women with high body mass indexes (BMI > 30) before or during pregnancy. The prevalence of obesity and associated disorders is on the increase worldwide. In 2010, 1 in 4 American women of childbearing age (between the ages of 18 and 44) were obese. According to the Perinatal Mortality 2006 study from Confidential Enquiries into Maternal and Child Health (CEMACH), "of the women who had a stillbirth and a recorded BMI, 26% were obese (BMI >30)". Riffat Jaleel demonstrated a substantial correlation between high pre-pregnancy BMI and a history of diabetes and hypertension in 2009. Due of its link to a poor obstetric outcome, it should be considered a high risk state.

KEYWORDS: Fetal Cardiac, Sympathetic Activity, Maternal Body Mass Index, heart rate variability, neural tube defects

INTRODUCTION

Adults who are underweight, overweight, or obese are often classified using the BMI, a straightforward measure of weight-for-height. Its formula is kg/m2, or weight in kilograms divided by height in meters squared. For instance, an adult with a BMI of 28.2 would weigh 67 kg and stand 1.54 m tall. It is not a stand-alone tool in obstetrics since other elements including maternal parity, ethnicity, and smoking patterns must be taken into account to give quality treatment and evaluation. However, it will notify midwives of any potential heightened risk factors linked to either a low or high BMI. People are screened for weight categories that may cause health issues using the BMI. The American Congress of Obstetricians and Gynecologists (ACOG) recommends that all pregnant women have their body mass index (BMI) taken at their first prenatal appointment and that information on the hazards to the mother and fetus of having a very high BMI be given.

Monitoring of Obese Mothers in Pregnancies

Obese moms are thought to need greater monitoring throughout the prenatal stage of their pregnancies. In clinical practice, it might be quite challenging for obese moms to do abdominal palpation for fetal development, presentation, and position evaluation. Fetal heartbeats must be precisely detected in order to quantify FHR variability (FHRV), particularly when short-term variability is involved. Only a few number of technologies are now in use that can attain the necessary beat-to-beat precision; the majority of them are based on fetal magnetic heart impulses. A significant amount of noise interferes with the fetal electrocardiograph (FECG) signal in the present monitoring approach employing direct electrocardiography, rendering it illegible for further examination (diagnosis). The mother's cardiac electrical signal and the fetus' cardiac electrical signal are superimposed to create the maternal abdominal ECG signal. The indirect assessment and variations in heart size result in a reduction of the fetal contribution of at least one order of magnitude. Additionally, there are several other types of noise, including uterine contractions, external electrical interference, maternal muscle activity, and more. From the middle of the pregnancy to the final week, the Doppler ultrasound approach effectively navigates these challenges and delivers findings that are trustworthy and accurate and are equivalent to those obtained using direct electrocardiography.

This system's architecture eliminates incorrect cardiac cycle readings by detecting all fetal heartbeats. The Doppler ultrasonography approach circumvents the direct electrocardiography method's limitations of assessing system parameters for each pregnant participant and obesity. The success of the data acquired demonstrates that BMI had no impact on getting a good recording. Additionally, it has been shown that obese moms had higher fetal heart rate values and lower fetal heart rate deviations. As a result, it is not harder to monitor an obese woman's fetus than a non-obese mother [1, 2].

Each recording consists of two concurrently collected signals: a Doppler ultrasound signal from the abdominal transducer and a direct fetal ECG from the electrode implanted on the mother's abdomen. The recording lasted for 5 minutes, however certain pieces were designated as signal loss and discarded either the fetal electrode was unplugged or the ultrasound transducer lost the cardiac signal. Fetal ECG data and a Doppler ultrasonography signal were captured at the same time (Figure 1, top and bottom).

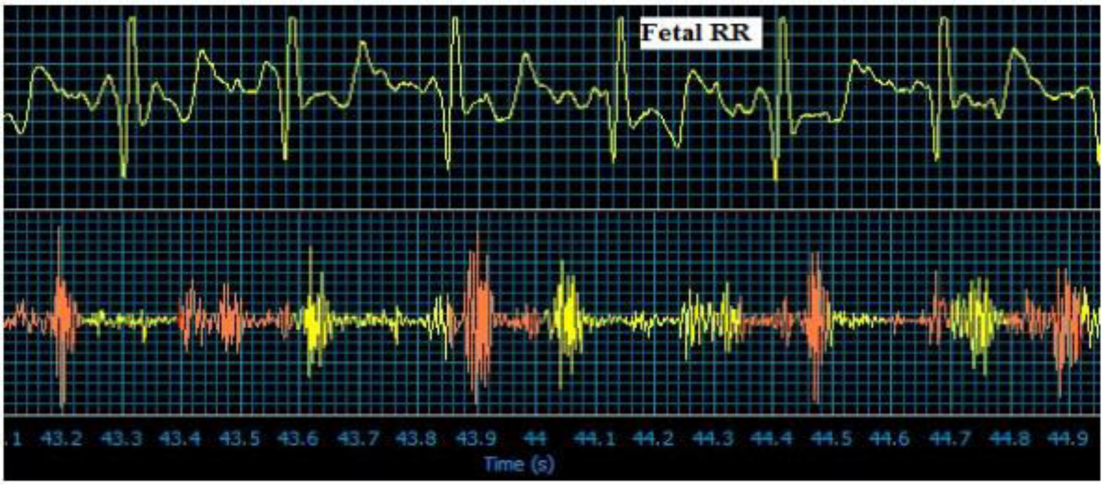


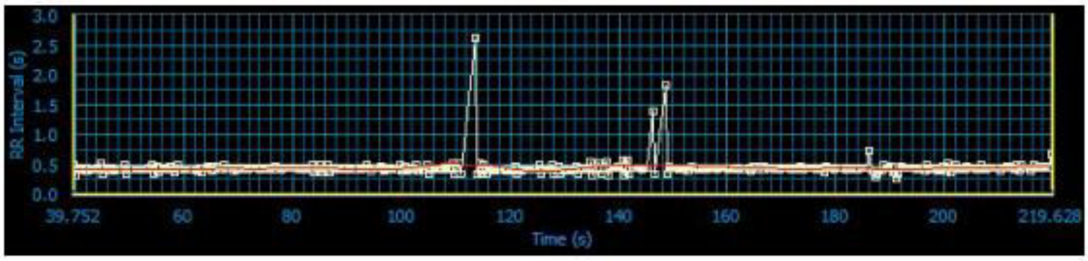
Figure 1 Simultaneously recorded & fetal ECG data (top) Doppler ultrasound signal (bottom).

6.3 Comparison of Different HRV Parameters for Non Obese Mother Fetus and Obese Mother Fetus

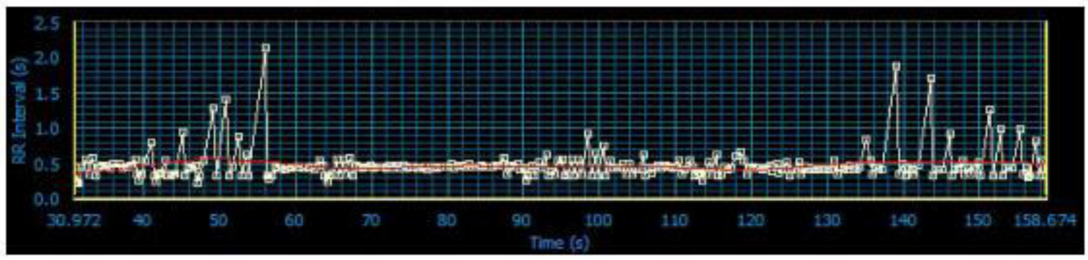
For the non-obese mother fetus and the obese mother fetal groups, various time domain, frequency domain, and nonlinear HRV parameters were acquired in accordance with the criteria of measurements specified by Task Force committee [6].

<u>Time Domain Parameters for Non Obese Fetus and Obese Mother Fetus</u>

The period of time between two consecutive R waves is referred to as an RR interval. These RR intervals, which display the variance between successive heartbeats, are the subject of heart rate variability (HRV) studies, which track changes over time. Figure 2 (a) depicts the fetus's HRV for a non-obesity class 2 mother with a BMI of 22.9, whereas Figure 2 (b) depicts the fetus's HRV for an obese class 2 mother with a BMI of 36.6. After analyzing the raw data, it was discovered that panel (b)'s heart rate variability was much lower than that of panel (a).



(a)



(b)

Figure 2 (a) HRV of fetus for non-obese mother having BMI 22.9 and (b) HRV of fetus for obese class 2 mother having BMI 36.6. After processing raw signal it is found that the heart rate variability in panel (b) is much smaller than in panel (a).

Additionally, it has been shown that obese mother fetuses had significantly greater RR interval and heart rate standard deviations (Figure 3). HRV rhythm changes provide a practical and sophisticated indication of health problems. A healthy fetus with effective autonomic mechanisms has a higher HRV, whereas a lower HRV is frequently a sign of abnormal and insufficient ANS adaptation, leading to poor physiological malfunction in the fetus and necessitating further testing to determine a precise diagnosis.

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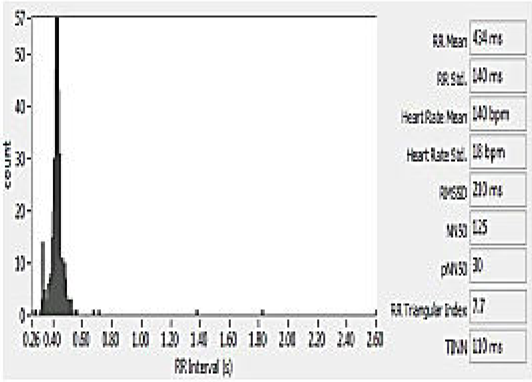
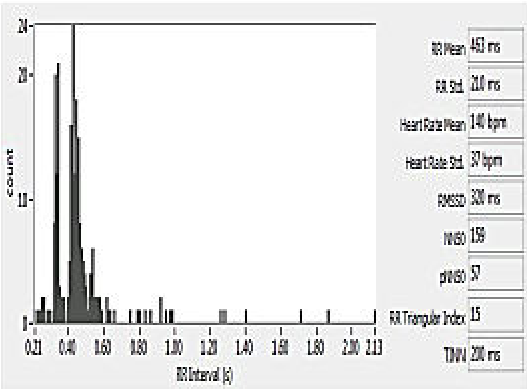


(a)

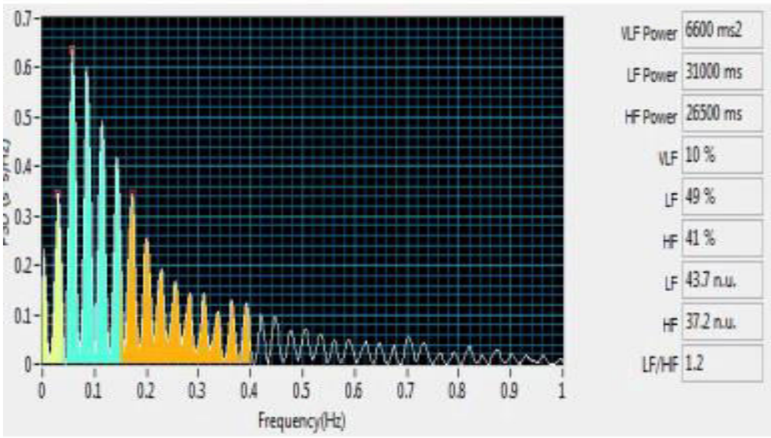


(b)

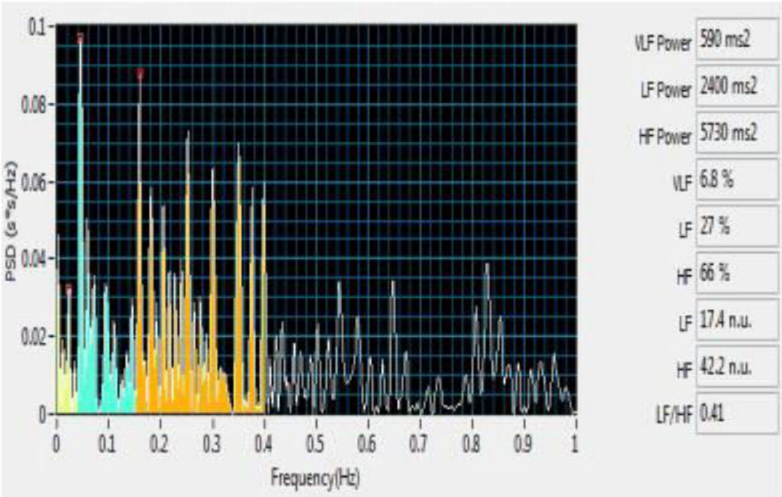
Figure 3 (a) Statistics of fetus for non obese mother having BMI 22.9 and (b) Statistics of fetus for obese class 2 mother having BMI 36.6. It is observed that standard deviation of RR intervals & heart rate standard deviation are much higher in obese mother fet

<u>Frequency Domain Parameters for Non Obese Fetus and Obese Mother Fetus</u>

The LF/HF ratio is derived from the FHRV calculation utilizing power spectrum analysis as a measure of sympathetic activity of the vegetative nervous system control. Spectral analysis of frequencies [Nonparametric Fast Fourier Transform (FFT) technique] of the fetus for a non-obesity class 2 mother with a BMI of 22.9 is shown in Figure 4(a), whereas (b) displays the same analysis for a class 2 obese mother with a BMI of 36.6. The equilibrium between sympathetic and parasympathetic tone is shown by the LF/HF ratio. This score might drop if parasympathetic tone increases or sympathetic tone decreases. In order to identify the element that leads to autonomic misbalance, it must be taken into account together with the absolute levels of both LF and HF. A low frequency/high frequency (LF/HF) ratio was characterized as having lower sympathetic activity in obese mother fetuse. By describing the sympathetic vagal balance on the heart, the LF/HF ratio represents the absolute and relative shifts between the sympathetic and parasympathetic components of the ANS.

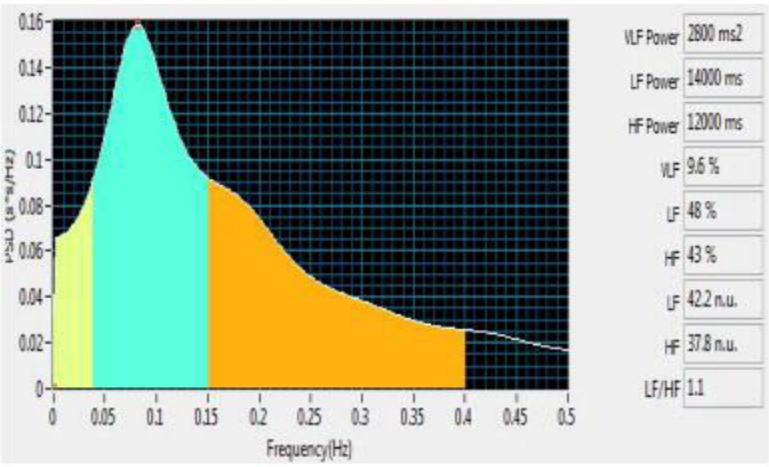


(a)



(b)

Figure 4 (a) Shows Spectral analysis of frequencies [Nonparametric Fast Fourier Transform (FFT) method] of fetus for non obese mother having BMI 22.9 and (b) Spectral analysis of frequencies [Nonparametric Fast Fourier Transform (FFT) method] of fetus for obese



(a)

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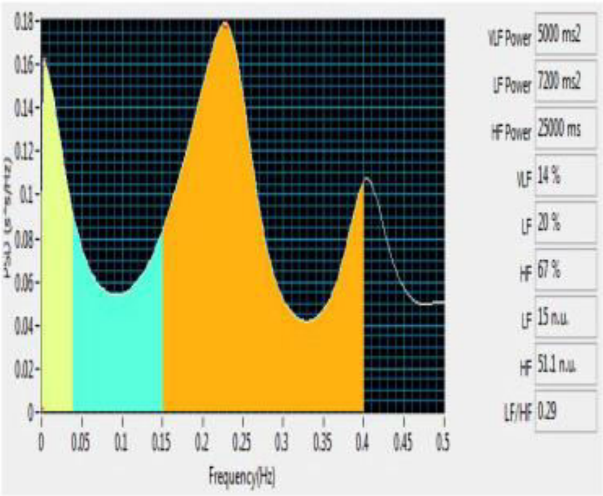
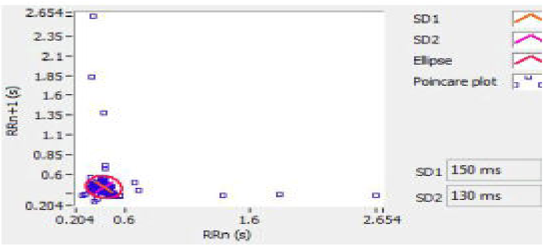


(b)

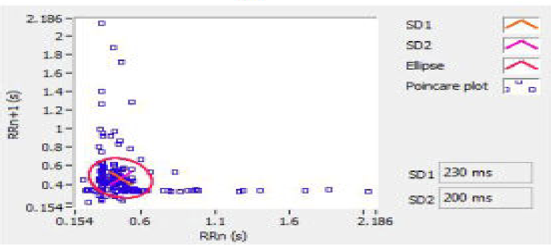
Figure 5 (a) shows the spectrum of frequencies of the fetus for a non-obesity class 2 mother with a BMI of 22.9 and (b) shows the spectrum of frequencies of the fetus for a class 2 obese mother with a BMI of 36.6.

Nonlinear Parameters for Non Obese Fetus and Obese Mother Fetus

The fetus's level of cardiac function is shown by the nonlinear index. Nonlinear Plots give information on heartbeat-to-beat variability and RR interval variations. In comparing normal and abnormal fetal groups, as well as obese and non-obese mother fetal groups, the value of the nonlinear index demonstrates statistical significance. Figure 6 (a) depicts the Poincare chart of the fetus for a non-obesity class 2 mother with a BMI of 22.9, and (b) the Poincare chart of the fetus for a class 2 obese mother with a BMI of 36.6. In mother fetuses of normal weight, both the short-term (SD1) and long-term (SD2) dispersion are less.



(a)



(b)

Figure 6 (a) shows Poincare chart of fetus for non-obese mother having BMI 22.9 and (b) Poincare chart of fetus for obese class 2 mother having BMI 36.6. The dispersion of both short (SD1) & Long term (SD2) is smaller in normal weight mother fetus.

CONCLUSION

To extract the fetal electrocardiogram (FECG) from a maternal abdominal ECG signal, an algorithm for real-time FECG QRS complex feature extraction system based on multi-scale discrete wavelet transform (DWT) approach has been developed. In order to conduct clinical monitoring research, a real-time fetal maternal ECG monitor has been created and tested in the nearby hospital. Real signals that were captured at various gestational weeks and spanned the majority of the pregnancy were used to test the suggested approach. Since all fetal beats are found after five minutes of recording for each patient, the technique works well.

The cardiac electrical signals of the mother and the fetus are superimposed to create the maternal abdomen ECG signal. The indirect assessment and variations in heart size result in a reduction of the fetal contribution of at least one order of magnitude. In addition, there are several other causes of noise, including fetal movement, uterine contractions, external electrical interference, and mother muscle activity. For both obese and non-obese mothers, we have created and developed a novel technique to measure fetal heart rate variability throughout the gestation period utilizing automated analysis of FHR variability. By effectively overcoming these challenges, the Doppler ultrasound technique produces consistent, accurate findings that are on par with those of direct electrocardiography. We were thus able to investigate the maturation and development of fetal autonomic function. By avoiding the inaccurate cardiac cycle readings, this approach is seen and followed to be more accurate than the direct electrocardiography method. These results lead to the conclusion that the established Doppler ultrasonography technique offers a useful resource for gathering power spectrum data on the fetal heart rate in stages prior to labor.

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