Sonographic estimation of fetal heart rate in healthy pregnant women in Umuahia South East Nigeria

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Abstract Introduction: There are various methods of estimating fetal heart rate (FHR) in pregnancy such as the use of fetoscope, sonicaid, and others. Of all these methods, Doppler ultrasound evaluation of FHR is preferred because it is real in time, readily available, does not involve the use of ionizing radiation, is cheap, reproducible and is not observer dependent. It does not have any deleterious effect on the fetus, it also shows the fetal cardiac tracing and rhythm such that FHR and heart sound can be heard and calculated. This can help in determining abnormal fetal heart sound.^[1,2] There is not much previous work on the ultrasound estimation of FHR in pregnant women in Umuahia and hence the need for this study.

Aim: The aim of the study is to establish normal ranges of FHR in healthy pregnant women using Doppler-guided ultrasound estimation, to correlate it with the gestational age (GA) and estimated fetal weight (EFW).

Materials and Methods: This is a randomized prospective study of 110 healthy singleton pregnant women on their routine antenatal visit. Data on GA were obtained using the crown-rump length in the first trimester and biparietal diameter (BPD) and femur length (FL) in the second and third trimesters. FHR was obtained using Doppler interrogation of the heart while the weight of the fetus was obtained using three parameters; the FL, abdominal circumference, and the BPD.

Results: The result obtained from the data was analyzed using Statistical Package for Social Sciences (SPSS) version 21. Mean, minimum, and maximum values were obtained. The relationship between the FHR, EFW, and GA was correlated. The minimum GA was n = 10 weeks while the maximum GA was n = 40 weeks with a mean value of 30. The minimum fetal weight was observed to be n = 35 g while the maximum fetal weight was n = 123 bpm and the mean value was 1923.8 the minimum FHR obtained from this research was n = 125 bpm and the maximum = 176 bpm while the mean was observed to be 143.4.

Conclusions: In summary, the FHR is affected by the EFW and the GA in such a manner that as the fetal weight and GA increase, the FHR decreases and vice versa. The FHR ranges from 125 bpm to 176 bpm in a healthy pregnant woman.

Keywords: Fetal heart rate, ultrasonography and estimated fetal weight, Umuahia

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INTRODUCTION

The heart is the first organ in the human body to develop during fetal formation and its contraction signifies the viability of the fetus.^[1] Fetal heart rate (FHR) is used to assess fetal well-being at the earliest stage of fetal life to the late third trimester of pregnancy, hence FHR remains one of the most important parameters obtained during prenatal ultrasound examination. The estimation of FHR in pregnant women goes a long way in determining fetal well-being during routine antenatal visit. FHR is part of biophysical profile and its importance during antenatal care cannot be over-emphasized. There is no consensus as to what constitutes a normal FHR; however, guidelines in the literature reviewed suggest that normal FHR ranges from 110 to 160 bpm. These values can vary depending on factors such as stage of pregnancy, maternal health, and uterine conditions.^[3] There is little or no studies in Umuahia South Eastern part of Nigeria and environs that has evaluated the FHR by ultrasound. Normal ranges may have geographical, ethnic or racial variations.^[4] There are various methods of assessing FHR such as the use of sonicaid, fetoscope, and others. Doppler ultrasound has proven to be more reliable, because it is real time, reproducible, readily available, cheap, uses nonionizing radiation, and gives good result.^[5-7] This study is aimed at using ultrasound to establish normal ranges of FHR values for healthy fetuses in healthy pregnant women in Umuahia.

MATERIALS AND METHODS

This is a randomized prospective study of 110 healthy singleton pregnant women on their routine antenatal visit from January 2, to October 31, 2022. The population size was arrived at using the formula for estimating a population mean.^[8] Sample size, $N = z^2 \partial^2 / \mathbb{C}^2 N =$ Sample size, Z = the abscissa of the normal curve (1.96). ∂ = Population standard deviation or variance (4.95). $\in =$ Error range (0.97) $N = (1.96)^2$ and $(4.95)^2/$ $(0.97)^2$. N = 100. Then 10 was added to take care of the error making the total sample size 110. The results obtained were analyzed using Statistica Package for Social Sciences (SPSS) [IBM Corp., Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY]. Mean, minimum, and maximum values were obtained. The relationship between the FHR, estimated fetal weight (EFW), and gestational age (GA) was correlated. The t-test was performed to establish the mean difference. A simple scatter plot graph and a box plot graph were created to show a graphical representation of the relationships that exist between the FHR, EFW, and GA. Inclusion criteria were healthy pregnant women, those without a history of diabetes mellitus and hypertension who were screened by fasting blood sugar, routine blood pressure measurement, and anomaly scan at 22 weeks for those who agreed to participate in the study, and also fetuses with normal biometry/biophysical profile, while multiple gestations and established fetal anomaly were excluded in the study. Data on GA were obtained using the crown-rump length in the first trimester and biparietal diameter (BPD) and femur length (FL) in the second and third trimesters. FHR was obtained using Doppler interrogation of the heart while the weight of the fetus was obtained using three parameters the FL, abdominal circumference, and the BPD. The examination was performed using Siemens ultrasound machine model CC-13E71-MTZ made in Japan. Consent was obtained from the patient for their data to be used scientifically.

RESULTS

This study "sonographic estimation of FHR in healthy pregnant women" was carried out in Umuahia, South East Nigeria, from January 2, to October 31, 2022. The result shows that the minimum maternal age was = 20 years while the maximum was n = 42 years, and the mean value was 28.7. The minimum GA was n = 10 weeks while the maximum GA was n = 40 weeks with a mean value of 30. The minimum fetal weight was observed to be n = 35 g while the maximum fetal weight was n = 4402 g and the mean value was 1923.8. The minimum FHR obtained from this research was n = 125 bpm and the maximum = 176 bpm while the mean was observed to be 143.4.

This research also shows that there was a statistical mean difference across the variables when compared with the FHR. The alpha value was set at $P \leq 0.5$. Furthermore, the Chi-square showing the correlation between the FHR, the GA, and the EFW revealed that there is a positive correlation between the FHR, EFW, and GA, for instance, at lower GA and weight, the FHR tends to be on the higher side whereas as the GA and weight increase, the FHR tends to reduce, this is established on the graph in Figure 1 which shows that most of the FHR ranges from 130 bpm to 155 bpm. For the first trimester (0–13 weeks). The peak n = 176 bpm. In the second trimester (14-24 weeks) which accounted for the bulk of the data, the FHR ranged from n = 138 bpm to 158, with the majority at n = 144 bpm, hence it can be said that in the normal second trimester, FHR ranges from 138 to 158 bpm. In the third trimester (25-40 weeks), the FHR reduced drastically to the range between 155 bpm for the early third trimester to 126 bpm for the late third trimester. Although some of the FHR of GAs in the third trimester were outside this range, were very few to be considered as a major deviation. The weight when plotted against the FHR followed the same pattern such that at below 1000 g the FHR is at the peak and reduces as the weight increases to 3000 g and above [Figure 2].



Figure 1: A scatter plot showing the relationship between the fetal heart rate and the gestational age

DISCUSSION

The use of color Doppler ultrasound to determine the FHR is a very reliable method because ultrasound is nonionizing, it is reproducible, readily available, and cheap.

The monitoring of the FHR gives clinicians an idea of fetal well-being and can determine early sign of cardiac anomaly or systemic failure as stated by Grivell *et al.*^[9] in which they documented that fetal heart assessment helps clinicians isolate preventable fetal death. The study established the minimum FHR to be 125 bpm while the maximum was 176 bpm. This was similar to the findings of Serra *et al.*^[10] in their research of computerized cardiotocography parameters throughout gestation. The data were similar to the findings in the study with a lower limit of 115 or 120 bpm for the GAs, minimum GA to be 10 weeks and the maximum to be 40 weeks, furthermore, the result showed that the minimum obtained fetal weight estimation was 35 g while the maximum was 4402 g. These findings are similar to that of Sandman *et al.*^[11]

The mean difference as demonstrated by the result in Table 2 shows that there was a significant mean difference between the FHR, GA and EFW. This study also revealed that the estimation of FHR can be done as early as 10 weeks of intrauterine life, this is in tandem with the works of Doubilet *et al.*^[12] who stated that FHR can even be detected as early as 5 weeks *in utero*. The weight can also be assessed at an early stage. This gives the clinicians leverage to be able to monitor fetal development and offer the best possible care for antenatal women. We observed that there was a significant correlation between FHR, the GA, and the EFW, this is also synonymous with the works of Sandman



Figure 2: The relationship between the fetal heart rate and the estimated fetal weight

Table 1: Variables table

	n	Minimum	Maximum	Mean
Maternal age (years)	110	20	42	28.7
GA (weeks)	110	10	40	30.0
Estimated fetal weight (g)	110	35	4402	1923.8
FHR (bpm)	110	125	176	143.41

A total number of 110 healthy pregnant women were evaluated for the research study. The minimum column represents the minimum value while the maximum column represents the maximum value. The mean column represents the mean values. GA – Gestational age, FHR – Fetal heart rate

 Table 2: Mean difference between fetal heart rate, gestational age, estimated fetal weight, and maternal age

	n	Mean	t	Р
GA	110	-1780.38	-15.85	0.000*
Estimated fetal weight	110	113.40	82.54	0.000*
Maternal age	110	114.73	117.31	0.000*

*It signifies the correlation between the fetal heart rate gestational age, estimated fetal weight and maternal age. P=0.05. A *t*-test showing the comparison of the mean of the fetal heart rate, GA, estimated fetal weight and maternal age. The table shows that there is a significant mean difference between the FHR, GA and estimated fetal weight and maternal age. GA – Gestational age, FHR – Fetal heart rate

 Table 3: Correlation between the fetal heart rate gestational age, estimated fetal weight and maternal age

	χ^2	Р
GA	43.90	0.001
Estimated fetal weight	4.54	0.011*
Maternal age	48.22	0.001*

*It signifies the correlation between the fetal heart rate gestational age, estimated fetal weight and maternal age.P=0.05. The correlation between the FHR. GA, estimated fetal weight and maternal age. It shows that there is correlation between them and the FHR. GA – Gestational age, FHR – Fetal heart rate

et al.^[11] This shows that the GA and EFW have an effect on the outcome of the FHR. The maternal age however does not contribute much to the base of this research. The result followed a regular pattern as has been demonstrated by the graphs. At early stage of gestation, the FHR is at the peak n = 175 bpm but drops down as the pregnancy advances as shown in Figure 1. This finding is similar to that of Serra et al.[10] At 35 weeks, some of the FHR remain at the top while majority have decreased to n = 130-147bpm. At late pregnancy 40 weeks (term), the heart rate reduces drastically to n = 125 bpm while some maintain a range between 125 and 144 bpm. This graph suggests that the GA has a strong effect on the FHR. Furthermore, the relationship between the EFWs on the FHR shows a similar pattern with the GA. At 4000 g (4.0 kg) the FHR drops to n = 125 bpm and at below 1000 g the FHR increases this is similar to the findings of Nijhuis et al.[13] This follows the physiological development of the fetus as the heartbeat increases during the early trimester and drops as pregnancy progresses this study have revealed a finding similar to Afors and Chandraharan^[14]

CONCLUSIONS

In summary, the FHR is affected by the EFW and the GA in such a manner that as the fetal weight and GA increase, the FHR decreases and vice versa. The fetal heart ranges from 125 bpm to 176 bpm in a healthy pregnant woman. Furthermore, the FHR is at its peak during the first trimester but reduces as the GA increases. This is also the case with the fetal weight. Nevertheless, the maternal age has no direct bearing on the FHR.

Result in Table 1: A total number of 110 healthy pregnant women were evaluated for the research study. The minimum column represents the minimum value while the maximum column represents the maximum value. The mean column represents the mean values.

Result in Table 2: Is a *t*-test showing the comparison of the mean of the fetal heart rate, Gestational age, estimated fetal weight and maternal age. The table shows that there is a significant mean difference between the fetal heart rate, gestational age and estimated fetal weight and maternal age.

Result in Table 3: The correlation between the fetal heart rate. Gestational age, Estimated fetal weight and maternal age. It shows that there is correlation between them and the fetal heart rate.

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Conflicts of interest

There are no conflicts of interest.

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