

Original Article

# Statistically Significant Difference in the First-trimester Fetal Heart Rate between Genders?

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## Abstract

**Background:** The study aims to establish the pattern of fetal heart rates in the first and second trimesters and determine whether there is a statistically significant difference in the first-trimester fetal heart rate (FHR) of males and females.

**Methods:** This retrospective observational research is a study of FHRs measured at 11<sup>+0</sup>–13<sup>+6</sup> wk and 18<sup>+0</sup>–23<sup>+6</sup> wk, and ultrasound scan-diagnosed fetal sex at 18<sup>+0</sup>–23<sup>+6</sup> wk. Singleton fetuses with nonambiguous external genitalia were recruited. The FHR was measured in B or M mode with Pulsed Wave Doppler, while ultrasound appearance of external genitalia determined the fetal sex at 18<sup>+0</sup>–23<sup>+6</sup> weeks. Student's *t*-test and Chi-square test were used for data analysis, and statistical significance was set at  $p < 0.05$ .

**Results:** A total of 2437 pregnancies meeting the study criteria were analyzed. The fetal sexes were 1398 (57.4%) males and 1039 (42.6%) females. There was no statistically significant difference in the first-trimester FHR between males and females ( $p = 0.74$ ). However, females had higher mean FHR in both the first and second trimesters (First trimester: 165.4 ± 18.2 bpm vs 163.2 ± 17.1 bpm and Second trimester: 150.9 ± 22.6 bpm vs 141.9 ± 23.1 bpm). The FHR reduces with the increase in gestational age.

**Conclusion:** There is no statistically significant difference in the first-trimester FHRs between sexes.

**Keywords:** statistically significant difference, fetal heart rates, fetal sexes, first trimester, ultrasound scan

## 1. Introduction

Prenatal determination of fetal sex traditionally relies on ultrasound scan visualization of well-defined external genitalia anatomical features in second and third trimesters. More recently, however, other ultrasound markers such as the direction of the genital tubercle, anogenital distance, sagittal sign, and fetal heart rate (FHR) differences between sexes in the first trimester have been evaluated as reliable predictors of fetal gender [1, 2]. This rising desire for first-trimester sex determination among women is believed to be due

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to mothers' desire for early planning of social aspects of pre-birthing activities. Prenatal sex determination and reporting is illegal in some countries where it is reportedly associated with increased number of sex-biased selective termination [3, 4]. Prenatal determination of sex also aids the diagnosis of suspected sex-linked genetic disease. The FHRs obtained during second and third trimesters were reported to have statistically significant difference between sexes, with the mean being higher in female fetuses [5, 6]. The outcomes of different studies that evaluated the statistically significant difference in first-trimester FHR as basis for assigning fetal sex has been mixed [7–9]. In the USA, no statistically significant difference ( $p = 0.62$ ) was found between the mean first-trimester FHRs in female ( $167.0 \pm 9.1$  bpm) and male ( $167.3 \pm 10.1$  bpm) fetuses. Similarly, the average female FHR of  $151.7 \pm 22.7$  bpm and male FHR of  $154.9 \pm 22.8$  bpm was not statistically significant ( $p = 0.13$ ) [7, 9]. In addition to the above study findings, the accuracy of the strongly held maternal intuition of significant difference between FHR in male and female fetuses has not been shown to be different from that of random guessing [10]. The available studies from Nigeria were not focused on the implications of FHR difference and fetal gender.

The current study makes an attempt to establish the pattern of FHRs in the first and second trimesters, and to determine whether there is a statistically significant difference in the FHR between males and females.

## 2. Materials and Methods

This study was a retrospective observational study of ultrasound scan procedures done between 2013, January 1 and 2018, December 31. The study data were collated from the ultrasound scan reports of pregnant patients that attended the antenatal clinics of Olabisi Onabanjo University Teaching Hospital and the ultrasound scan clinic in High Rocks Fetal Medicine and Genetic Diagnosis Centre, Lagos. The study inclusion criteria were normal singleton pregnancies with gestational age between  $11^{+0}$  and  $13^{+6}$  wk based on the ultrasound crown rump length (CRL) measurements and nonambiguous genitalia observed during the  $18^{+0}$ – $23^{+6}$  wk anatomy scan. The ultrasound scans were performed by fetal medicine specialist or consultant obstetrician with expertise in obstetric ultrasound scan. Transabdominal ultrasound scan was done in all patients using GE Voluson P8 and Sonoscape S20 on 3.5–7.5 MHz sector transducer probe. The FHRs were measured and documented at both  $11^{+0}$ – $13^{+6}$  and  $18^{+0}$ – $23^{+6}$  wk using real-time B mode imaging of a magnified apical four-chamber view of the fetal heart. The standard protocol in the units was to activate the Pulsed Wavecursor, adjust and

position 2–3 mm sample gate across the tricuspid valve, and maintain an insonation angle of  $<30^\circ$  from the direction of the inter-ventricular septum and a sweep speed of 2–3 cm/sec for good spread of waveforms [11]. The spectral image was frozen when at least six waveforms were visible and measurement was using the electronic calipers (Figure 1). The second FHR-measuring protocol used involved the activation of the M mode cursor across four chamber view of the heart and freezing of appropriate image before positioning the electronic calipers at clearly identified elevations in the M-mode tracing to measure the FHR [12] (Figure 1). The FHR was recorded as beats per minute (bpm). The fetal sex was assigned based on unambiguous identification of clitoris and labia majora in female fetuses and scrotum and penile shaft in male fetuses (Figure 2). The FHRs in both trimesters were reviewed and analyzed after ultrasound confirmation of nonambiguous sex at  $18^{+0}$ – $23^{+6}$  wk.

All patients that met the study criteria during the study period were recruited. Descriptive statistics using percentages, means, and standard deviation were used as appropriate for continuous and categorical variables. Statistical variables such as the mean FHR between male and female fetuses were compared using Student's independent samples *t*-tests, while variables such as proportion of male to female fetuses were compared using the Chi-square test. A  $p < 0.05$  was considered statistically significant.

### 3. Results

Three thousand, three hundred and fifty-three ultrasound scans were done in the first trimester. Of these, 2442 (72.8%) pregnancies participated in the second-trimester scan, 5 of which were assigned unclear fetal sex determination. The data from 2437 pregnancies were collated and analyzed. The fetal sexes were distributed as 1398 (57.4%) males and 1039 (42.6%) females, and majority (58.3%) of the ultrasound scans were done at  $12^{+0}$ – $12^{+6}$  wk gestational age and at  $20^{+0}$ – $20^{+6}$  wk gestational age (24.2%), respectively.

In Table 1, the first trimester mean FHRs in males and females were  $163.2 \pm 18.2$  and  $165.5 \pm 17.1$  bpm, respectively, with no statistically significant difference ( $p = 0.74$ ), while in the second trimester, the mean FHRs were  $150.9 \pm 22.6$  and  $141.9 \pm 23.1$  bpm, respectively, with no statistically significant difference ( $p = 0.83$ ). Generally, FHR reduces with increasing gestational age (Figure 3). The mean FHR was lower in males compared with the mean FHR in females during both  $11^{+0}$ – $13^{+6}$  and  $18^{+0}$ – $23^{+6}$  wk gestational ages (Table 1). The independent *t*-test comparison of the mean FHR between male and female fetuses in both trimesters showed no significant statistical difference ( $p = 0.74$  and  $p =$

0.83, respectively). The difference in the mean FHRs between sexes was higher in the second trimester compared with the first-trimester FHR difference (Figure 3).

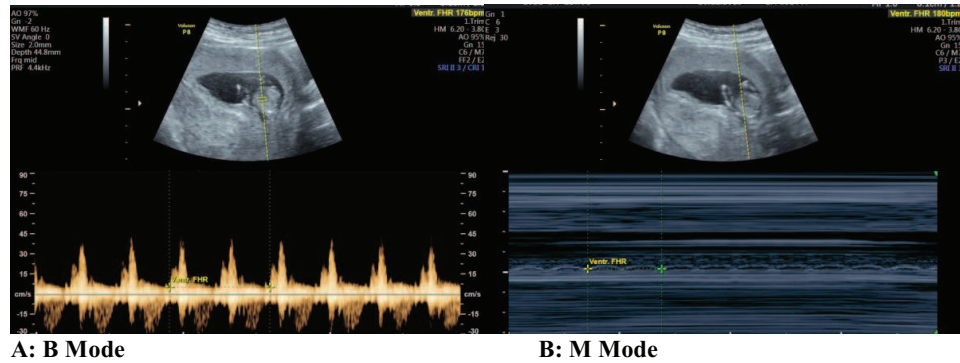


Figure 1: Fetal heart rate measurement methods.

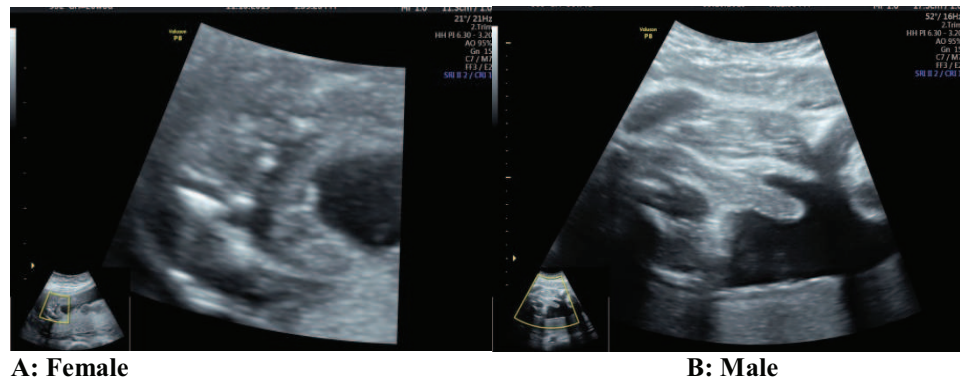


Figure 2: Ultrasound scan appearance of fetal sex in second trimester.

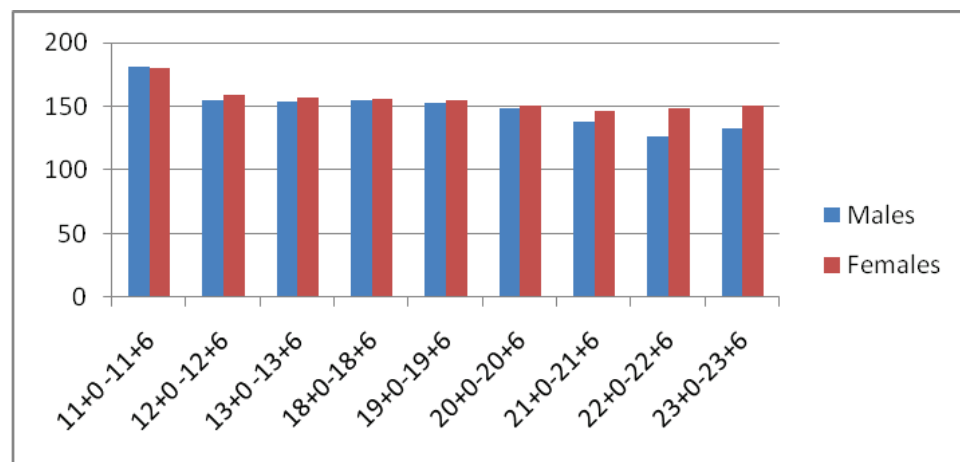


Figure 3: Trend in fetal heart rates in the first and second trimesters. Note: X axis: Fetal heart rates (bpm); Y axis: Gestational age (wk).

TABLE 1: Analysis of pattern of fetal heart rates in first and second trimesters.

Gestational age (wk)	Number of fetuses	Fetal heart rates (Male)			Number of fetuses	Fetal heart rates (Female)			P-value
		Range	Mean	SD		Range	Mean	SD	
<b>First trimester</b>	(2437)				(1398)				0.74
11 <sup>+0</sup> –11 <sup>+6</sup>	183	170–192	181.0	17.9	105	164–202	180.1	17.1	
12 <sup>+0</sup> –12 <sup>+6</sup>	1422	105–178	154.3	22.8	738	148–172	159.4	21.7	
13 <sup>+0</sup> –13 <sup>+6</sup>	832	113–170	154.2	22.1	555	146–168	156.8	21.9	
		Mean FHR: 163.2 + 18.2 bpm				Mean FHR: 165.4 + 17.1 bpm			
		Range: 105.0–195.0 bpm				Range: 146.0–202.0 bpm			
<b>Second trimester</b>	(2437)				(2437)				0.83
18 <sup>+0</sup> –18 <sup>+6</sup>	441	130–162	154.4	21.0	247	134–158	156.4		
19 <sup>+0</sup> –19 <sup>+6</sup>	617	141–170	152.4	23.1	396	136–152	154.4		
20 <sup>+0</sup> –20 <sup>+6</sup>	590	140–162	148.0	23.4	314	138–154	150.8		
21 <sup>+0</sup> –21 <sup>+6</sup>	509	105–138	138.2	18.0	241	110–148	146.0		
22 <sup>+0</sup> –22 <sup>+6</sup>	155	110–144	126.0	20.8	97	106–150	148.2		
23 <sup>+0</sup> –23 <sup>+6</sup>	125	114–156	132.8	21.2	103	108–152	150.0		
		Mean FHR: 141.9 + 23.1 bpm				Mean FHR: 150.9 + 22.6 bpm			
		Range: 105.0–170.0 bpm				Range: 106–158 bpm			
<b>150 + 23.1 bpm and 152 + 22.6 bpm</b>									

## 4. Discussion

The difference in the mean FHRs in the first trimester between male and female fetuses was not statistically significant in the study population. Consequently, the first-trimester FHR difference from the study is not a reliable method of assigning fetal sex. The pattern of FHR demonstrates decline in FHR with the increase in gestational age, with higher measurements in females in both trimesters. Our results are consistent with research outcomes that reported the absence of statistically significant difference in the FHR between males and females in first trimester [7–9]. However, statistical difference was reported to be predictive of fetal sex by other workers [5, 6]. The trend of FHR with gestational age in the study agrees with the physiological pattern of a reduction in FHR as gestational age increases.

The 11–13<sup>+6</sup> wk of the first trimester was chosen as the period to establish the FHR difference for two reasons: (i) the functional maturation of the parasympathetic system and the morphological maturation of the heart are not well-established before 11 wk and (ii) the variations and fluctuations in the FHR is least at this gestational age period [13]. It has been reported that the morphologic maturation and parasympathetic system

effect on the cardiac development and function in the fetuses mature with increasing gestational age and also earlier in males than females [13]. This may also explain the significant difference in FHR reported in the second and third trimesters by other researchers [5, 6]. That morphologic and autonomic effects on cardiac function are delayed and supported by the slowed reduction in FHR in females compared with males in the second trimester measurements. Ultrasound scan at 11<sup>+0</sup>–13<sup>+6</sup> wk gestation age provides opportunity to achieve other aims of early trimester ultrasound scan such as accurate estimation of gestational age and reliable risk prediction for aneuploidy [11, 14]. The FHR was measured in B mode or the M mode, both of which have been validated to be reliable and accurate for FHR measurement in clinical practice. The B mode is, however, the more commonly used in clinical practice.

The most important strength of this study is the sample size, which is higher than the sample size in most other studies. Hence, the inferences from the study are expected to have higher statistical power and be better predictive of the influence of the role of first-trimester FHR differences for assigning fetal sex.

## 5. Conclusion

The study reveals no statistically significant difference in first-trimester FHR between male and female fetuses. The FHR could therefore not be recommended for routine clinical use to avoid the consequences of misdiagnosis such as medico-legal and psycho-social issues.

## Acknowledgements

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## Ethical Considerations

Ethical approval was obtained from the Health Research Ethics Committee (HREC) of Olabisi Onabanjo University Teaching Hospital, Sagamu Ogun State.

## Competing Interests

The author received honorarium as sessional consultant in one of the study centers.

## Availability of Data and Materials

All data and materials used in the study are available from the corresponding author upon reasonable request from interested researcher.

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None.

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