



ISSN: 2476-8642 (Print)

ISSN: 2536-6149 (Online)

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**PUBLISHED BY THE MEDICAL  
AND DENTAL CONSULTANTS ASSOCIATION  
OF NIGERIA, OOUTH, SAGAMU, NIGERIA.**

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## ORIGINAL RESEARCH

## Fetal Echocardiography Audit in a Tertiary Hospital in Ibadan, Nigeria

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### Abstract

**Background:** Delayed detection of congenital heart diseases in low- and middle-income countries (LMICs) contributes to the poor outcome of infants with cardiac anomalies. Fetal echocardiography (FE) can detect heart defects *in-utero* as early as the 18<sup>th</sup> gestational week (GA), giving parents and medical professionals time to prepare for the baby's delivery and appropriate treatment. University College Hospital, Nigeria, is one of the few centres in Nigeria where FE is performed.

**Objectives:** To examine the indications for referral for FE and the diagnoses made in our first four years of performing FE.

**Methods:** FE was performed in the antenatal clinic of the University College Hospital, Ibadan, Nigeria, using the GE Voluson P6 machine with a 2-6-RS probe. Demographic information was obtained from the antenatal clinic records of the women who had FE using a semi-structured questionnaire. FE diagnoses were retrieved from the FE register.

**Results:** A total of 129 women whose records were available were studied. The mean age of the women was 31.7±5.5 years. Forty-two women (32.6%) were referred because of echogenic foci, making this the most common indication for FE. Twenty-nine (22.5%) fetuses had structural heart defects, the most common being Ventricular Septal Defect.

**Conclusion:** There is a need for Obstetricians and Paediatricians to be aware of the indications for fetal echocardiography and refer women appropriately.

**Keywords:** Cardiac anomaly, Congenital Heart Diseases, Fetal echocardiography, Echogenic foci, Nigeria.

### Introduction

Congenital heart diseases (CHDs) have remained one of the leading causes of death from congenital anomalies worldwide.<sup>[1]</sup> They occur singularly or as part of syndromes associated with birth anomalies, with a stable global incidence as high as 18 per 1000 live births.<sup>[2]</sup> While representing the relatively stable incidence of CHDs over the years, this

global figure reflects the gap in reducing its incidence by interventions ranging from prevention to early diagnosis.<sup>[2]</sup> The disparity in the availability of facilities for early diagnosis and definitive care in the developed and underdeveloped regions of the world further widens this gap. In Nigeria, the first published data on the incidence of CHDs in the newborns by Gupta and Antia recorded a rate of 3.5 per 1000 births in 1967.<sup>[3]</sup> Gupta and Antia utilised clinical findings and postmortem findings. The availability of echocardiography

has made diagnosis easier and more accurate both prenatally and postnatally. In a more recent review, Ige *et al.* using echocardiography in the first week of life found a higher prevalence of 28.8%, a likely more accurate finding as this study did not exclude babies that were asymptomatic at birth compared to the use of clinical findings and autopsies. [4] Prenatal diagnosis of CHDs has been one of the most frequently missed, with resultant socioeconomic, medical, psychological, and even medicolegal consequences.[5]

Studies in Nigeria have shown significant diagnostic gaps in detecting CHDs as well as therapeutic gaps in their management. [6,7,8] Most reported studies on CHDs in Nigeria are based on postnatal findings. [6 - 8]. While postnatal diagnosis is more available, the value of early diagnosis by fetal echocardiography (FE) cannot be overemphasised, especially for cases of critical CHDs. Early diagnostic tools like FE allow for early intervention, potentially reducing CHD death. Major CHDs necessitate intervention or death within one year, and critical defects result in death within four weeks without intervention. 30-50% of infant mortalities due to congenital anomalies are associated with congenital heart diseases.[9] Outside of infancy, there are documented fatal first presentations of CHDs contributing to childhood mortalities. [10] Prenatal diagnosis of critical congenital cardiac anomalies is imperative to prevent mortality in the first year of life. Fetal diagnosis of CHDs has been shown to prevent mortality in the perinatal period in developed countries.[11]

Prenatal diagnosis of critical CHDs enables the parents, obstetricians, paediatricians, and the cardiac team to decide on a place of delivery in terms of care availability, time of delivery and mode of delivery. The early requirements of such a newborn may include prostaglandins to keep the patent ductus arteriosus open and appropriate transportation care for optimal outcomes. Holland *et al.*, after a meta-analysis, found that planning for these surgeries improved the outcome of such infants. [11]

FE is a modality for diagnosing CHDs in utero. It allows for early diagnosis of most major CHDs, thereby circumventing delayed diagnosis and allowing for early intervention in climes where no therapeutic gap exists. [9] FE has progressively developed in the last 2-3 decades in developed countries, with accuracy reaching >90% in skilled hands with appropriate equipment. [12,13]

Indications for FE have evolved with the development of FE over the past three decades. From its onset, indications for FE were in three categories (fetal, maternal, and familial). [14] The fetal indications are extracardiac anomalies, mainly structural anomalies of the fetus, genetic diagnosis of, e.g. DiGeorge syndrome, abnormal four-chamber view and cardiac axis, among others. Maternal indications include maternal CHD and systemic illnesses like diabetes mellitus and phenylketonuria. Familial indications include a previous history of CHD in a sibling alongside autosomal genetic diseases. Other indications in women referred for FE after ultrasound include pericardial effusion, increased nuchal translucency and echogenic foci. Unlike pericardial effusion and echogenic foci (small bright spots seen within the region of the heart during ultrasound examination), which can be seen during anomaly scans in the second trimester, nuchal translucency is measured in the first trimester when the fetal neck base is still transparent. Friedberg and Silverman observed that the initial indications for FE in its first decade in the US were a family history of CHD, maternal diabetes and abnormal cardiac rhythms.[15] By the second decade, with an increasing number of fetal echocardiographers and skills, a trend of changing indications was documented, with obstetric scan suggestive of CHD rising to three times its frequency in the preceding decade and becoming one of the major indications for fetal echocardiography. [15] In Africa, there needs to be more published work on fetal echocardiography. Sium *et al.* in Ethiopia described their experience with FE, with indications for FE being mainly the

presence of other fetal anomalies and maternal diabetes mellitus. [16] The paucity of published work in this region may reflect the limited centres where FE could be performed. Performance of FE commenced in our centre in 2017 after anomaly scans were commenced. Anomaly scans are part of routine antenatal care in our centre, performed between 18 and 24 weeks GA. [17]

There needs to be more data on FE in Nigeria because scanning for fetal anomalies is routine only in a few centres. [18] We conducted this audit to assess the indications and diagnosis of FEs performed in a tertiary hospital in southwest Nigeria.

### Methods

This cross-sectional study reviewed records of women seen in the antenatal clinic of the University College Hospital, Ibadan. The University College Hospital, Ibadan, is a federal tertiary teaching hospital in Southwestern Nigeria. It is a referral hospital for Ibadan and other towns in its environs. Registration for antenatal care is done once a week, and at registration, the women are all offered anomaly scans once the registration is done before 24 weeks of gestation. Before this, the women have a health talk given by a trained nurse educator/ community health nurse on pregnancy and other related health issues. Institutional approval was obtained for this audit.

The antenatal notes of all women attending the antenatal clinic who were referred for fetal echocardiography after routine anomaly scans or obstetrician's review were recruited for this review. The data collected included the women evaluated from January 2017 to December 2020. During this period, 150 women were referred for FE, out of which only the notes of 129 women were found. Information on sociodemographics, parity, chronic illnesses

during pregnancy and past and present obstetric history were obtained. The FE register had the details of FE findings for the women. The demographics and other information from the notes of the women were documented using a structured proforma, and findings from the FE register were also filled in.

ABE had hands-on training in FE through a Commonwealth Medical Fellowship in University Hospitals Bristol. BEA performed the FE using the GE Voluson P6 machine with a 2-6-RS probe.

#### *Protocol for FE*

FE is undertaken between the 20<sup>th</sup> and 24<sup>th</sup> week GA and is performed based on a booked appointment basis. The client is made comfortable in a supine position with an explanation that they are free to change position for comfort as they may require. The reason for the procedure is explained to the client, and verbal consent is taken before the commencement of the procedure.

First, the fetal right and left axes are decided using the Cordes technique. [19] The abdominal situs is then determined with a transverse view of the abdomen. The four-chamber view is then assessed alongside the pulmonary veins and atrioventricular valves. The interventricular and atrial septa are also assessed in this view. The outflow tracts are then assessed alongside the three-vessel view. The ductal and aortic arches are assessed. Where obtainable, the longitudinal axis of the inferior and superior vena cavae flowing into the right atrium was also obtained with the longitudinal axis of the ventricles and outflow tracts to the sidedness of the aortic arch. Every view is interrogated with the colour doppler. The findings are then communicated to the client. Appropriate counselling is done based on the findings of the FE.

Sociodemographic data, parity, indication for FE, referring physician and FE findings were collated using IBM SPSS Version 23. The data

were cleaned, and missing data were sought for and included. The categorical variables obtained are presented as frequencies, proportions, and percentages. These are represented using charts and tables. Continuous variables were analysed to derive the mean  $\pm$  standard deviation for normally distributed data.

## Results

A total of 150 women were referred for fetal echocardiography during this period. The records of only 129 (86.0%) women were

retrieved, and the review and analysis were based just on these records.

Table I shows the sociodemographic parameters of the women who had fetal echocardiograms performed. The mean age of the women was  $31.7 \pm 5.5$  years.

The estimated gestational age at the time of having FE performed ranged from 20-24 weeks, as the women who registered for antenatal care were not offered anomaly scans after this gestational age. Most (118) of the referrals were from radiologists, with only 11 being from obstetricians and paediatricians. The paediatrician indicated a history of a previous baby with congenital heart disease.

**Table I: Characteristics of women who had fetal echocardiography**

<i>Characteristics</i>	<i>Categories</i>	<i>Frequency</i>	<i>Percentage</i>
Marital status	Married	125	96.9
	Single	4	3.1
Age	<35 years	95	73.6
	$\geq 35$ years	34	26.4
Parity	Primipara	20	15.5
	Multipara	109	84.5

Forty-two women (32.6%) were referred because of echogenic foci, making this the most common indication for fetal echocardiography in this centre. Other indications include poor visibility (this refers to suboptimal visualisation of the cardiac structure of the fetus, which does not allow for accurate delineation of the cardiac anatomy), maternal systemic illnesses like systemic lupus erythematosus, diabetes mellitus and a previous history of having a baby with congenital heart disease.

Intracardiac echogenic focus (IEF) formed the largest percentage of indications for FE, with only three of the fetuses having structural heart defects. Two of these three fetuses had other isolated soft markers like choroid plexus cysts and echogenic bowel. The indication for fetal echocardiography was not stated in about a quarter of the cases referred, and another

quarter was also referred because of poor visibility (Figure 1). Of the 29 patients referred for poor visibility of the fetal heart, only 6 had poorly visible fetal hearts during FE. The indications with the highest yield for cardiac anomalies were the abnormal four-chamber view, with eight fetuses (61.5%) out of thirteen having congenital cardiac anomalies. Fetal echocardiography findings are seen in Table II and Figure 2. Twenty-nine (22.5%) fetuses had structural heart defects, with two of the fetuses belonging to mothers  $\geq 35$  years old. Of those with structural heart defects, 13 (44.8%) had Ventricular septal defects. Five (17.3%) had Primum or Atrioventricular septal defect (AVSD). Other structural defects were Hypoplastic right heart, pericardial effusion, pulmonary stenosis, transposition of the great arteries, hypoplastic left heart syndrome and double outlet right ventricle.

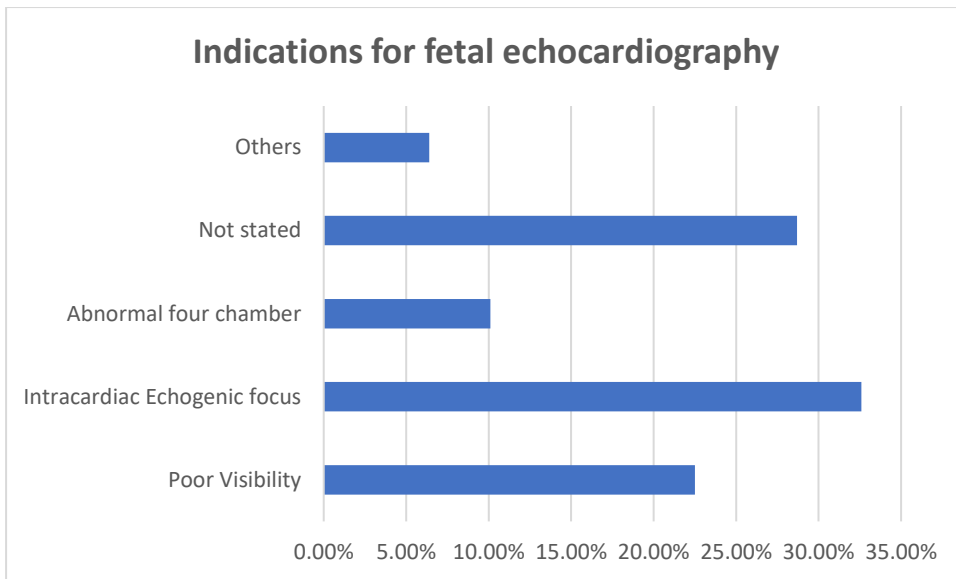


Figure 1: Indications for fetal echocardiography

Table II: Fetal echocardiographic findings

Variable	Frequency	Percentage
Normal	94	72.9
Poor visibility	6	4.6
Structural heart disease	29	22.5
<b>Total</b>	<b>129</b>	<b>100.0</b>

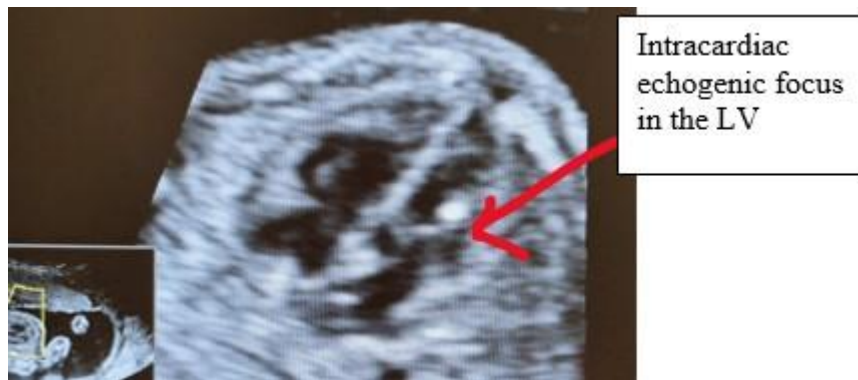


Figure 2: Image of fetal echocardiography showing an echogenic focus in the left ventricle

## Discussion

FE aids early diagnosis of congenital heart diseases, especially the critical types.<sup>[1]</sup> We set out to review indications for FE in our centre in its first four years and diagnoses made during this audit. This audit of FE in our setting reveals

that most referrals come from radiologists who perform routine anomaly scans in our centre. The referrals from anomaly scans may explain why the most common indications are fetal indications such as intracardiac echogenic foci, poor visualisation of the fetal heart, and abnormal cardiac four-chamber views. On FE, structural heart abnormalities diagnosed

ranged from septal defects to critical lesions such as hypoplastic left heart syndrome.

This review of FE on one hundred and twenty-nine women over four years is a small number of referrals compared with the figures of Agarwal *et al.*, who had more than three thousand referrals for FE within four years.<sup>[20]</sup> The number of FEs in this audit reflects the nascent stage of FE in our setting. The perceived indications for FE and healthcare providers' awareness of the availability of FE in our centre are also likely reasons for the low numbers of FE. Adebayo and Agaja had earlier documented a low awareness of fetal echocardiography among paediatricians, who are the primary specialists who manage children with congenital heart diseases at one time or another. They also observed that only a few centres in Nigeria are performing anomaly scans.<sup>[18]</sup> Therefore, the number of FEs performed in a centre can reflect a need for more awareness of its availability, low knowledge of the indications and a lack of trained specialists to carry out FE. It was, however, interesting to note that in a three-year survey, Pike *et al.* in Washington, DC, had a number similar to ours, with 142 fetuses over three years.<sup>[13]</sup> The similarity in the number, despite the difference in the year of study, is, however, unlike the reason in our study, likely due to the availability of several facilities equipped to carry out this investigation in the study area because of the availability of trained specialists and equipment.

The majority (74%) of the women who had FE were under the age of 35, with a mean age of 31 years, which was similar to the findings of Agarwal *et al.*<sup>[20]</sup> In both studies, the women being screened for fetal cardiac anomalies were mostly below the age of 35 years. The indications for FE in its first decade in developed countries were in three main categories, with fetal indications like extracardiac anomalies, abnormal four-chamber view and arrhythmias being prominent.<sup>[14]</sup> In this audit, our finding of

intracardiac echogenic focus (IEF) contributing majorly to the indications is in tandem with fetal findings contributing majorly to indications for FE. The indication with the highest frequency in this audit is the presence of echogenic foci. IEF are microcalcifications of the papillary muscle or chordae tendinae. They are described as a variation of normal. Being first associated with Trisomy 21, they became soft markers for aneuploidy. Studies have shown that when occurring singly and in isolation, they are variants of normal and should not necessitate further investigations.<sup>[21]</sup> In this audit, our findings agree with the earlier reports advising non-pursuance of isolated IEF, as only one fetus with isolated IEF had a small VSD. Soft markers like choroid plexus cysts, echogenic bowels, fetal ventriculomegaly, and increased nuchal translucency (NT) were not isolated as reasons for referral for FE in this audit. This may have been due to other findings on anomaly scans not being suggestive of cardiac malformations in the view of the radiologists. Notably absent among indications for FE referrals were other extracardiac anomalies. This reflects the knowledge of the indications for FE among practitioners, sonographers, and obstetricians in our setting. NT was not evaluated in the women we reviewed. This is probably because NT is usually assessed in the first trimester, and the women were evaluated at the 20-24 weeks GA for anomaly scan. Minnela *et al.* reported that up to 32% of the fetuses with CHD had increased NT.<sup>[22]</sup> Singh *et al.* and Sotiriadis *et al.* found NT had a specificity of 99.2% at the 99<sup>th</sup> centile cut-off in high-risk mothers.<sup>[23,24]</sup> These findings demonstrate the high specificity of NT compared to findings by Chiu *et al.*, reporting a lower specificity with IEF.<sup>[25]</sup> While we found maternal illnesses like diabetes and SLE to constitute a smaller percentage of the referrals, Boehme *et al.* found that maternal DM contributed a large percentage of the indications for FE, with 3,525 (18%) being referred for FE due to maternal DM.<sup>[26]</sup> DM in pregnancy in Nigeria is estimated to have a prevalence of 0.3 – 38%, but only one woman in

this audit was referred because of diabetes mellitus.<sup>[27]</sup> These indications for FE in our audit reflect the awareness of the availability of FE, its indications, and the frequency of referrals for FE.

In this review, the prevalence of congenital heart disease was about 23%, less than a prevalence of 28.8% obtained by Ige *et al.* in their echocardiography screening of Nigerian newborns for CHDs in Nigerian newborns in the first week of life. This finding may be due to mild lesions like small VSDs, which may be missed by FE, Patent Ductus Arteriosus, which can only be diagnosed postnatally, and a larger sample size.<sup>[4]</sup> However, the prevalence in this study is comparable to the 22.9% found by Sun *et al.* in China in a study of infants who were three months old. <sup>[28]</sup> The sample size in the Chinese study was significantly more extensive than that of Ige *et al.* This prevalence may be related to our denominator being a small study population. The small study population in this review also reflects the referrals for FE and is proportional to a knowledge of the indications for FE in our environment. Boehme *et al.*, in a review of over 19,000 FE, had an estimated prevalence of about 13%. <sup>[29]</sup> These findings appear to have been in centres where referrals for FE included significant contributions from maternal indications like diabetes and family history of congenital heart diseases, which were found to have a low yield of congenital heart diseases. Most of the indications in this review were also ultrasound-detected and not based on history or maternal risks for having fetuses with congenital heart disease.

Ventricular septal defects (VSDs) were the most common defects seen in this audit. This is similar to findings by Varunashree *et al.* <sup>[30]</sup> and Agarwal *et al.*<sup>[20]</sup> Reports of postnatal presentations of congenital heart diseases confirm that VSDs are the most common structural heart defects seen worldwide.<sup>[24]</sup> The other cardiac defects seen also reflect the frequency of the spectrum of congenital cardiac lesions, with HLHS, for example, being less

frequent. However, it is one of the easily diagnosed anomalies during FE. Comparing the cardiac lesions with maternal age, only two women with ages greater than 35 years had fetuses diagnosed with structural lesions.

### Limitations

This audit was based on a retrospective collection of data, and some data were not retrieved due to losses, further reducing the relatively small sample size. There was no genetic screening for pregnancies suspected to have genetic anomalies, and some babies did not have postnatal transthoracic echocardiography as they were lost to follow-up.

## Conclusion

FE is a helpful tool for the early detection of congenital heart diseases as a prenatal diagnosis in our environment. The prevalence of CHDs detected prenatally in this environment is high. This study underscores the need for more awareness of the availability of FE and its indications for obstetricians and other healthcare providers.

**Acknowledgement:** ABE acknowledges the Commonwealth Scholarship Commission for the fellowship awarded to acquire skills in fetal echocardiography at the Bristol Children's Hospital under Drs Bev Tsai-Goodman and Patricia Caldas. The authors also acknowledge the supports of the Health Information Department of the University College Hospital, Ibadan.

**Authors' Contributions:** ABE and AJA conceptualised and designed the study. ABE and AOT did the literature review. All the authors participated in data acquisition while ABE and AOT performed data analysis and drafted the manuscript. ABE and AJA revised the manuscript for sound intellectual content. All the authors approved the final version of the manuscript.

**Conflicts of Interest:** None.

**Funding:** Self-funded.

**Publication History:** Submitted 05 February 2023; Accepted 06 August 2023.



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