Al-Rafidain J Med Sci. 2024;7(2):157-162.
DOI: https://doi.org/10.54133/ajms.v7i2.1476

AJMS
Online ISSN (2789-3219)

Research Article

Assessment of High Risk Pregnant Women by Fetal Echocardiography

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Received: 10 November 2024; Revised: 15 December 2024; Accepted: 19 December 2024

Abstract

Background: Congenital heart defects (CHDs) are the most prevalent type of congenital defect. Early identification of CHDS increases postnatal treatment options and outcomes. ***Objective***: To compare the rate of CHDS in the general pregnant population to those at high risk. It also assesses the efficacy of using periodic fetal echocardiography throughout pregnancy to test for CHDs. ***Methods***: A prospective cross-sectional study was undertaken at the Medical City complex between September 1st, 2023, and May 1st, 2024. The fetal heart was screened antenatally during the mid-trimester. Data were gathered from 250 pregnant women, with half of them classified as high-risk due to fetal or maternal risk factors associated with congenital heart abnormalities. These parameters were compared to those seen in low-risk pregnancies to establish the need for fetal echocardiography. ***Results***: The study comprised 250 pregnant women, with 125 in each of the low-risk and high-risk categories. The prenatal incidence of fetal cardiac disease was discovered to be 18%. Pregnancies with ultrasonography abnormalities had the highest prevalence, accounting for 37% of the overall high-risk category. In addition, 34 instances (14%) featured babies with minor cardiac abnormalities, while 6 cases (2%) involved fetuses with complicated cardiac disorders. ***Conclusions***: The study found that CHDS is more common in high-risk pregnancies than in low-risk ones. All pregnant women, regardless of additional maternal concerns, should undergo prenatal screening, including CHDS detection.

Keywords: Congenital heart diseases, High risk pregnancies, Fetal echo, Prenatal diagnosis.

تقييم النساء الحوامل المعرضات لمخاطر عالية عن طريق تخطيط صدى القلب للجنين

الخلاصة

الخلفية: عيوب القلب الخلقية (CHDs) هي أكثر أنواع العيوب الخلقية انتشارا. يزيد التحديد المبكر لعيوب القلب الخلقية من خيارات ونتائج علاج ما بعد الولادة. **الهدف**: مقارنة معدل عيوب القلب الخلقية لمواليد عامة النساء الحوامل بأولئك المعرضين لخطر كبير وتقييم فعالية استخدام تخطيط صدى القلب الدوري للجنين طوال فترة الحمل لغرض تشخيص مثل هذه العيوب. **الطرائق**:تم إجراء دراسة مقطعية مستقبلية في مجمع المدينة الطبية بين 1 سبتمبر 2023 و 1 مايو 2024. تم فحص قلب الجنين قبل الولادة خلال منتصف الأشهر الثلاثة من الحمل وجمع البيانات من 250 امرأة حامل، تم تصنيف نصفهن على أنهن معرضات لمخاطر عالية بسبب عوامل الخطر الجنينية أو الأمومية المرتبطة بتشوهات القلب الخلقية. تمت مقارنة هذه المعلمات بتلك التي شوهدت في حالات الحمل منخفضة الخطورة لإثبات الحاجة إلى فحص صدى القلب للجنين. **النتائج**: ضمت الدراسة 250 امرأة حامل مع 125 في كل من الفئات منخفضة الخطورة وعالية الخطورة. تم اكتشاف معدل الإصابة بأمراض القلب الجنينية قبل الولادة بنسبة 18٪. كان لحالات الحمل المصاحبة لتشوهات التصوير بالموجات فوق الصوتية أعلى معدل انتشار، حيث تمثل 37٪ من الفئة الإجمالية عالية الخطورة. بالإضافة إلى ذلك، ظهرت في 34 حالة (14٪) أطفالا يعانون من تشوهات قلبية طفيفة، بينما تضمنت 6 حالات (2٪) أجنة مصابة بتشوهات قلبية معقدة. **الاستنتاجات**: أن عيوب القلب التاجية أكثر شيوعا في حالات الحمل عالية الخطورة منها في حالات الحمل منخفضة الخطورة. يجب أن تخضع جميع النساء الحوامل، بغض النظر عن مخاوف الأم الإضافية، لفحص ما قبل الولادة، بما في ذلك الكشف عن أمراض القلب والأوعية الدموية.

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Article citation: Yaseen MJ, Neamaa EK, Haji GF. Assessment of High Risk Pregnant Women by Fetal Echocardiography. *Al-Rafidain J Med Sci*. 2024;7(2):157-162. doi: https://doi.org/10.54133/ajms.v7i2.1476

INTRODUCTION

The estimated prevalence of CHDS and structural abnormalities in the main vessels is 3-8 per 1000 live births [1]. The primary use of standard fetal ultrasonography is not to screen for congenital heart defects, which leads to increased rates of prenatal illness and mortality. In contrast, FE is the gold standard for diagnosing these issues in the neonate and has a 100% success rate in identifying them, demonstrating its reliability as a non-invasive procedure. [2,3]. Early prenatal cardiac diagnosis substantially reduces postnatal morbidity and mortality in situations where outcomes are contingent upon ductal flow [4,5]. It also offers comprehensive insights into the evolution of complex lesions, including their potential effects, such as arrhythmias and heart failure, thereby emphasizing the significance of fetal echocardiography [6-9]. Fetal echocardiography is primarily used in high-risk pregnancies due to maternal risk factors, such as the presence of another child with congenital

malformations, maternal diabetes, IVF-conceived newborns, advanced maternal age, a history of obstetric complications, and fetal risk factors, such as fetal hydrops. Fetal echocardiography is predominantly employed in high-risk pregnancies due to a variety of factors, including suspicious cardiac anomalies, aberrant cardiac position, hydrocephalus, microcephalus, and abnormal obstetric sonograms, including nuchal translucency thickness [10-13]. Congenital heart defects are frequently linked to these extracardiac anomalies [14]. The purpose of this study is to assess the effectiveness of periodic fetal echocardiography in the detection of congenital heart defects (CHDs) during pregnancy and to compare the prevalence of CHDs in the general expectant population with high-risk groups.

METHODS

A prospective, cross-sectional analytical and descriptive study was conducted at Baghdad Teaching Hospital and supported by the College of Medicine, University of Baghdad. All singleton pregnant women referred for echocardiography were enrolled without regard for CHDS risk factors. The pregnant women were divided into two categories: high-risk and low-risk. The study was carried out at that time from September 1st, 2023, to May 1st, 2024. Those with poor echo windows, first-trimester pregnancies, and ladies with threatened or incomplete abortions were excluded from the study. A detailed history was obtained from every pregnant woman, encompassing the mother's age, past history of pregnancy, age at gestation (GA), the total number of births (live and stillbirths included), abortion history, use of IVF (in vitro fertilization), and family background of CHDS (mother CHDS, siblings who have CHDS). Additionally, information on chromosomal or other congenital anomalies, maternal medical conditions, infections, and medications was collected as prenatal risk factors. The causes to refer, abnormality scan results, and echocardiography of fetal heart findings were taken into account.

Fetal Echocardigraphy

A single cardiologist performed all of the fetal echocardiograms. and direct interviews were used to collect details about demographics from each one of the mothers, along with, if required, going over the gynecological department's recorded files. The study adhered to the guidelines set by the International Society of Ultrasound in Obstetrics and Gynecology (ISUOG). A 2D and Doppler fetal echocardiography evaluation was performed. 28 Fetal echocardiography was done using a Vivid E9' machine with a 2–5 MHz convex probe through the transabdominal approach. The images were then taken using the standard two-dimensional echocardiography method, which includes a short-axis view, a four-chamber view, a five-chamber view, an aortic arch view, a bicaval view, an RVOT view, a three-vessel view, a three-vessel trachea view, an aortic arch view, and a ductal arch view. The fetal heart rate was recorded, and any arrhythmias were verified using M-mode imaging. Color Doppler and pulse wave Doppler were employed as needed.

Neonatal echogardiography

Based on the followed protocol, the outcomes were categorized as "normal" or "abnormal." Cases deemed "abnormal" underwent a postnatal echocardiogram at the same hospital. Additionally, neonatal follow-ups were conducted for select cases based on fetal echocardiography results. Postnatal echocardiography utilized a Vivid E9. machine with a 12 MHz convex probe. All images and videos of fetal abnormalities were recorded and stored digitally, with data presented in numerical and percentage formats.

Statistical analysis

The collected data was fed into a Microsoft Excel 2016 spreadsheet and analyzed using SPSS version 26 statistical software. Categorical variables were described using frequencies and percentages. Data analysis involved cross tables and Chi-square tests, with a *p*-value of less than 0.05 deemed significant.

RESULTS

The study involved a total of 250 pregnant women, with 125 belonging to the low-risk group and the remaining 125 to the high-risk group over a 9-month period. Based on the ultrasound scan, the expected gestational age at the time of referrals was around 20 and 40 weeks, where 109 pregnant women got the examination at a gestational age of ≥36 weeks, and 141 pregnant women got fetal echocardiography evaluation at a gestational age between 20 and 36 weeks. Ultrasound abnormalities were the major cause of referral to fetal echo in the high-risk group (Figure 1).

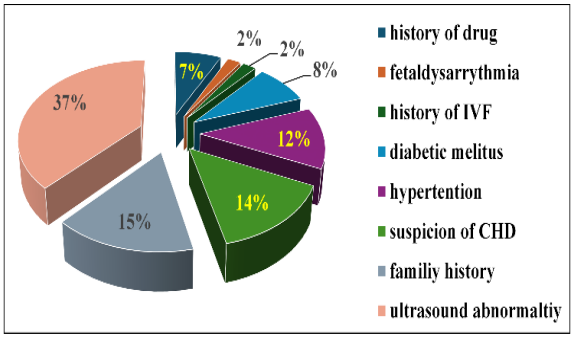

Figure 1: The risk factors for pregnant women at high risk.

The average age of mothers who are pregnant ranges from 17 to 45 years, with a mean age of 29.3±5.9. It's interesting to note that mothers between the ages of 27-31 years (5%). At the time of the fetal echocardiogram, the average gestational age was 33.1 weeks. The means for the number of gestations, parity, and abortions were 4, 2 and 1, respectively. Although some fetuses presented with a single cardiac defect like ASD secundum (Table 2) and others with several anomalies like ASD and pulmonary valve stenosis (Figure 3), from the 250 pregnant women, 70 fetal

cardiac defects were detected in 44 fetal hearts, which is shown in Table 1.

Table 1: Frequency of fetal cardiac abnormalities detected prenatally (n=215)

Heart Defect	n(%)	Low risk	High risk
ASD secundum	27(12.7)	10	17
VSD	12(5.7)	3	8
Pericardial effusion	13(6.1)	4	9
Mild TR	5(2.4)	1	4
HLHS	2(0.9)	1	1
DORV	1(0.4)	0	1
D-malposed great artery	1(0.4)	0	1
Mitral valve atresia	2(0.9)	1	1
Brady arrythmia	2(0.9)	0	2
Pulmonary stenosis	1(0.4)	0	1
Severe right sided dilatation	1(0.4)	0	1
Pleural effusion	1(0.4)	0	1
Cardiac mass	1(0.4)	0	1
Mild LVH	1(0.4)	0	1
Total	70(32.4)	20	50

Among the 70 cardiac abnormalities, 50 were found within the group at high risk, whereas only 20 were observed within the group at low risk (Table 1).

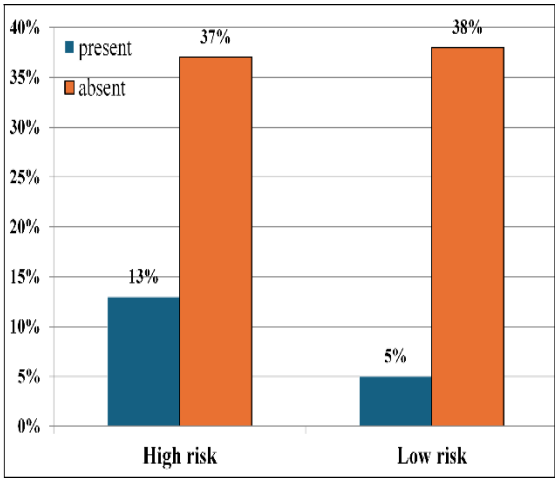

Figure 2: The prevalence of congenital cardiac disease in both high- and low-risk categories.

The highest percentage occurred in pregnancies with ultrasound abnormalities, accounting for 37% of the total high-risk group (Figure 1). From this study, the prenatal rate of fetal cardiac disease is 18%. Thirty-two (13%) of the 44 fetuses with cardiac abnormalities were detected in pregnant women at high risk, while the remaining twelve (5%) instances were found in low-risk women. For example, within this study of high-risk pregnant women, the diagnoses were as follows: The first case involved a history of infertility, and abnormal gynecological ultrasounds revealed hypoplastic left heart syndrome with D-malposed great arteries. In another instance, two cases in the third trimester were examined. One patient had a history of CHD, while the other had low-risk factors. Both fetuses were found to have an atrial septal defect (ASD) accompanied by pericardial effusion. Following birth, both infants were re-examined, confirming the presence of ASD with cardiac tamponade. Necessary procedures were performed, resulting in improved conditions for the infants. In another case, a patient underwent an abnormal ultrasound examination. Fetal heart evaluation revealed a large mass surrounding the heart, diagnosed as rhabdomyoma (Figure 4).

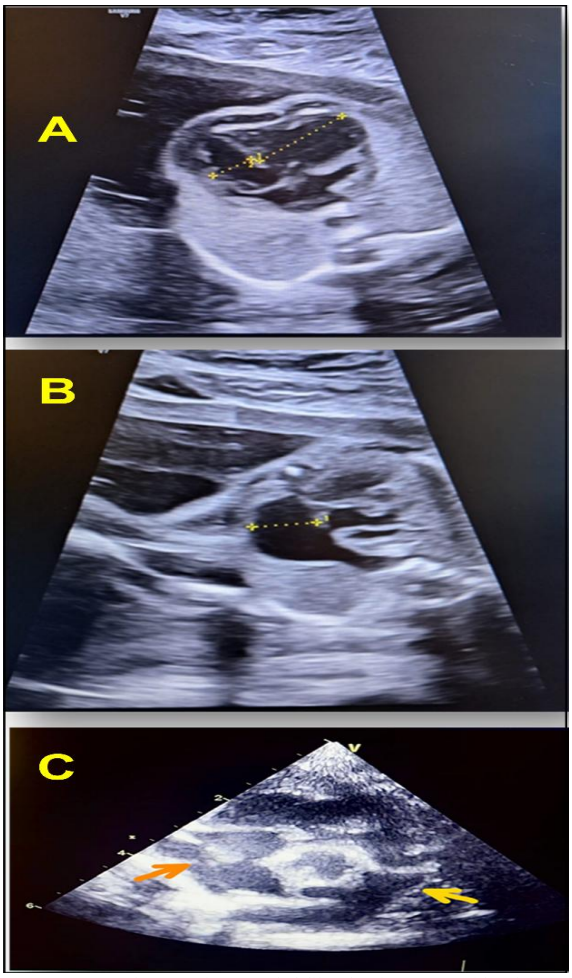

Figure 3: A) Fetal RVOT view revealed dilated main PA case with pulmonary artery stenosis; B) fetal A4C revealed dilated RV; C) postnatal TTE subcostal short axis view revealed thicken cusps and dilated PA (yellow arrow), RV, ASD (orange pointer). RVOT: right ventricular outflow tract; PA: pulmonary artery; ASD: atrial septal defect.

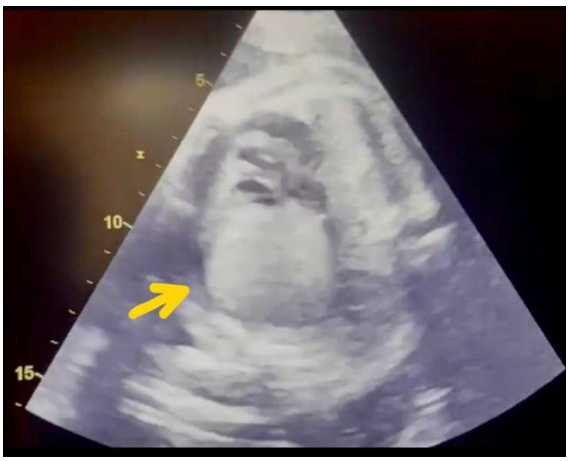

Figure 4: Fetal echocardiography during the second trimester revealed a cardiac mass (yellow arrow) compressing the left side of the heart.

Postnatally, the neonate was diagnosed with tuberous sclerosis, and subsequent follow-ups with a consultant pediatric cardiologist showed regression of the tumor. This highlights the benefits of fetal echocardiography in diagnosing and monitoring such cases.

Additionally, 35 (14%) of the 44 fetuses were classified with simple cardiac abnormalities, while 5 (2%) had complex cardiac disease, as detailed in Table 2.

Table 2: Fetuses with heart illness were classified as having simple or complex cardiac abnormalities

Fetus with simple cardiac abnormalities	n	High/low risk	Fetus with complex cardiac abnormalities	n	High- or low-risk
A Single VSD	1	Low risk	Hypoplastic left heart syndrome, MV atresia normal related great artery and mild TR	1	Low risk
Single ASD	18	High/low risk	Hypoplastic left heart syndrome, MV atresia and D-Malposed great artery	1	High risk
ASD with VSD	9	High/low risk	Pulmonary stenosis and dilated right ventricle	1	High risk
Bradycardia with normal cardiac structure	2	High risk	Double outlet right ventricle	1	High risk
Tricuspid regurgitation	4	High/low risk	Large Cardia mass	1	High risk
Mild left ventricle hypertrophy	1	High risk			
Percentage	14%		Percentage	2%	

Postnatally, just eight newborns with congenital heart abnormalities (CHDs) were monitored., as indicated in Table 3. Most of the fetuses were not followed up, while one case resulted in death, as shown in Table 3. In 84% of the cases, there was complete agreement between the prenatal and postnatal data. There was a statistically significant difference (p=0.01) in the prevalence of congenital heart defects (CHDs) between the two groups. As a result, our findings indicate that the incidence of CHDs differs between high-risk and low-risk births.

Table 3: Fetal outcomes post-delivery

Case No.	A Type of prenatal CHD	Postnatal outcomes
1	Atrial Septal Defect (ASD) with pericardial effusion	Neonatal with ASD secundum
2	ASD, or Atrial Septal Defect and pericardial effusion (increase effusion through fetal life)	Neonatal had dysmorphic feature with cardiac tamponade and small ASD
3	pericardial effusion (progressive increase effusion through fetal life)	Neonatal had dysmorphic feature with cardiac tamponade
4	ASD with VSD and massive bilateral pleural effusion	Neonatal death
5	ASD, or Atrial Septal Defect	Neonatal with ASD secundum
6	Mild regurgitation of the tricuspid valve (TR)	Neonatal with patent formina ovale and mild regurgitation of the tricuspid valve
7	Large cardiac mass	Neonatal had cardiac rhabdomyoma
8	Right ventricle dilated with pulmonary stenosis and dilated pulmonary artery	Neonatal had PS, PDA, mid muscular VSD, dilated right side

DISCUSSION

The study identified an 18% prevalence of congenital heart disease (CHD). It involved 250 pregnant women over a 9-month period, evenly split into low-risk and high-risk groups, with each group comprising 125 participants. The mean age of the pregnant women was 29.3, and their ages ranged from 17 to 45 years. According to Rychik *et al*., between weeks 18 and 22 of pregnancy, is the best time for a comprehensive fetal echocardiography assessment [15]. Out of the 250 pregnant women, 109 underwent fetal echocardiography after 36 weeks of gestation, consistent with the findings of Raheem and Haji [16]. However, this differs from other studies that recommend echocardiography between 25 and 27 weeks due to varying referral patterns [17-20]. About the fetal echocardiography referral criteria, abnormal fetal ultrasound and a family history of CHD were the most frequent factors, which equal 22% and 15%, respectively. Similar findings were reported by others [16-19,21]. Conversely, studies by Rocha *et al*., Ozkutlu *et al*., and Clur *et al*. identified the history of intrauterine fetal demise, abnormal nuchal translucency, maternal metabolic disorders, and extra-cardiac abnormalities as the main causes of referral [22-24]. This study found a higher frequency of simple fetal cardiac abnormalities (14%) compared to complex cases, possibly due to the inclusion of both high-risk and low-risk pregnancies; however, Rocha *et al*. focused solely on high-risk pregnancies [22]. The incidence of CHD in our study was 18%, whereas Yu *et al*. reported a slightly higher incidence (20.3%) [25]. This variability underscores the diverse prenatal incidence of CHD, ranging from 2.4% to 54% [26-28]. Additionally, the study found that prenatal and postnatal diagnoses of CHD agreed 84% of the time, consistent with findings by Raheem and Haji [16]. In contrast, Sharma *et al*. reported a lower agreement (68.17%), likely due to their larger sample size of 1200 pregnant women [1]. The incidence rates of CHDs were significantly greater in the group at high risk (13%) than in the group at low risk (5%). This contrasts with findings from Nayak *et al*. Raheem and Haji, wherein there was no statistically significant difference between pregnancies at high and low risk [28,16].

Study limitations

The small number of abnormal cases, limited detailed statistical analysis, and reliance on referral-based

identification of high-risk pregnancies may have influenced the prevalence of CHDs in fetuses. In addition, it is possible that combining biochemicals with echocardiography would improve prediction power, especially in non-conclusive cases [29,30].

Study strength

The study highlighted the importance of targeted screening in high-risk pregnancies [31]. The current study has adopted fetal echocardiography during mid-trimester with the non-invasive nature of ultrasound to allow timely intervention without risking fetal-maternal well-being [32]. Our results support universal screening for CHD, aiming for better perinatal care and enforcing the clinical guidelines.

Conclusion

The study shows that pregnant women classified as high-risk have a greater rate of congenital heart defects (CHDs) compared to their low-risk counterparts. Moreover, it highlights the efficacy of prenatal echocardiography in accurately identifying CHDs, and high-risk pregnant women benefit greatly from fetal CHD screening compared to those at low risk.

Conflict of interests

No conflict of interest was declared by the authors.

Funding source

The authors did not receive any source of funds.

Data sharing statement

Supplementary data can be shared with the corresponding author upon reasonable request.

REFERENCES

1. Sharma S, Kaur N, Kaur K, Pawar NC. Role of echocardiography in prenatal screening of congenital heart diseases and its correlation with postnatal outcome. *J Clin Diagn Res*. 2017;11(4):TC12-TC14. doi: 10.7860/JCDR/2017/25929.9750.
2. Moon-Grady AJ, Donofrio MT, Gelehrter S, Hornberger L, Kreeger J, Lee W, et al. Guidelines and recommendations for performance of the fetal echocardiogram: An update from the American Society of Echocardiography. *J Am Soc Echocardiogr*. 2023;36(7):679-723. doi: 10.1016/j.echo.2023.04.014.
3. Mohammed NB, Chinnaiya A. Evolution of foetal echocardiography as a screening tool for prenatal diagnosis of congenital heart disease. *J Pak Med Assoc*. 2011;61(9):904-909. PMID: 22360034.
4. Keighley CL, Skrzypek HJ, Wilson A, Bonning MA, Gilbert GL. Infections in pregnancy. *Med J Aust*. 2019;211(3):134-141. doi: 10.5694/mja2.50261.
5. Van Mieghem T, Hindryckx A, Van Calsteren K. Early fetal anatomy screening: who, what, when and why? *Curr Opin Obstet Gynecol*. 2015;27(2):143-150. doi: 10.1097/GCO.0000000000000161.
6. van Velzen CL, Clur SA, Rijlaarsdam ME, Bax CJ, Pajkrt E, Heymans MW, Bekker MN, Hruda J, de Groot CJ, Blom NA, Haak MC. Prenatal detection of congenital heart disease--results of a national screening programme. *BJOG*. 2016;123(3):400-407. doi: 10.1111/1471-0528.13274.
7. Hernandez-Andrade E, Patwardhan M, Cruz-Lemini M, Luewan S. Early evaluation of the fetal heart. *Fetal Diagn Ther*. 2017;42(3):161-173. doi: 10.1159/000477564.
8. McAuliffe FM, Trines J, Nield LE, Chitayat D, Jaeggi E, Hornberger LK. Early fetal echocardiography--a reliable prenatal diagnosis tool. *Am J Obstet Gynecol*. 2005;193(3 Pt 2):1253-1259. doi: 10.1016/j.ajog.2005.05.086.
9. Sotiriadis A, Papatheodorou S, Eleftheriades M, Makrydimas G. Nuchal translucency and major congenital heart defects in fetuses with normal karyotype: a meta-analysis. *Ultrasound Obstet Gynecol*. 2013;42(4):383-389. doi: 10.1002/uog.12488.
10. Machin GA. Differential diagnosis of hydrops fetalis. *Am J Med Genet*. 1981;9(4):341-350. doi: 10.1002/ajmg.1320090410.
11. Society for Maternal-Fetal Medicine (SMFM); Norton ME, Chauhan SP, Dashe JS. Society for maternal-fetal medicine (SMFM) clinical guideline #7: nonimmune hydrops fetalis. *Am J Obstet Gynecol*. 2015;212(2):127-139. doi: 10.1016/j.ajog.2014.12.018.
12. Nicolaides KH, Azar G, Byrne D, Mansur C, Marks K. Fetal nuchal translucency: ultrasound screening for chromosomal defects in first trimester of pregnancy. *BMJ*. 1992;304(6831):867-869. doi: 10.1136/bmj.304.6831.867.
13. Snijders RJ, Noble P, Sebire N, Souka A, Nicolaides KH. UK multicentre project on assessment of risk of trisomy 21 by maternal age and fetal nuchal translucency thickness at 10-14 weeks of gestation. Fetal Med Found First Trimester Screen Group. *Lancet*. 1998;352(9125):343-346. doi: 10.1016/s0140-6736(97)11280-6.
14. Rosa RCM, Rosa RFM, Zen PRG, Paskulin GA. Congenital heart defects and extracardiac malformations. *Rev Paul Pediatr*. 2013;31(2):243–251. doi: 10.1590/s0103-05822013000200017.
15. Rychik J, Ayres N, Cuneo B, et al. American Society of Echocardiography guidelines and standards for performance of the fetal echocardiogram. J Am Soc Echocardiogr. 2004;17:803-10.
16. Raheem SA, Haji GF. Foetal echocardiography: A novel method for detecting congenital heart disease. *J Clin Diag Res*. 2019;13.2:22-24. doi: 10.7860/JCDR/2019/38300.12607.
17. Midan MF, Alsheemy RI, Eid SM, Abdel Salam ME. Efficacy of fetal echocardiography in prenatal diagnosis of congenital heart diseases. *Int J Reprod Contracept Obstet Gynecol*. 2018;5(5):1553-1557. doi: 10.18203/2320-1770.ijrcog20161323.
18. Chitra N, Vijayalakshmi IB. Fetal echocardiography for early detection of congenital heart diseases. *J Echocardiogr*. 2017;15(1):13-17. doi: 10.1007/s12574-016-0308-2.
19. Li M, Wang W, Yang X, Yan Y, Wu Q. Evaluation of referral indications for fetal echocardiography in Beijing. *J Ultrasound Med*. 2008;27(9):1291-1296. doi: 10.7863/jum.2008.27.9.1291.
20. Vaidyanathan B, Kumar S, Sudhakar A, Kumar RK. Conotruncal anomalies in the fetus: Referral patterns and pregnancy outcomes in a dedicated fetal cardiology unit in South India. *Ann Pediatr Cardiol*. 2013;6(1):15-20. doi: 10.4103/0974-2069.107227.
21. Iftikhar M, Hyder SN, Aziz S. Frequency of congenital heart defects detected on fetal echocardiography in high-risk mothers. *J Pioneer Med Sci*. 2016;7(1):7-10.
22. Rocha LA, Araujo Júnior E, Rolo LC, Barros FS, Silva KP, Leslie AT, et al. Prenatal detection of congenital heart diseases: one-year survey performing a screening protocol in a single reference center in Brazil. *Cardiol Res Pract*. 2014;2014:175635. doi: 10.1155/2014/175635.
23. Ozkutlu S, Akca T, Kafalı G, Beksac S. The results of fetal echocardiography in a tertiary center and comparison of low and high-risk pregnancies for fetal congenital heart defects. *Anadolu Kardiyol Derg*. 2010;10:263-269. doi: 10.5152/akd.2010.068.
24. Clur SAB, Van Brussel PM, Mathijssen IB, Pajkrt E, Ottenkamp J, Bilardo CM. Audit of 10 years of referrals for fetal echocardiography. *Prenat Diagn*. 2011;31:1134-1140. doi: 10.1002/pd.2847.
25. Yu Z, Xi Y, Ding W, Han S, Cao L, Zhu C, et al. Congenital heart disease in a Chinese hospital: pre- and postnatal detection, incidence, clinical characteristics and outcomes.

Pediatr Int. 2011;53(6):1059-1065. doi: 10.1111/j.1442-200X.2011.03450.x.
26. Galindo A, Herraiz I, Escribano D, Lora D, Melchor JC, de la Cruz J. Prenatal detection of congenital heart defects: a survey on clinical practice in Spain. *Fetal Diagn Ther*. 2011;29(4):287-295. doi: 10.1159/000322519.
27. Dolk H, Loane M, Garne E. Congenital heart defects in Europe: prevalence and perinatal mortality, 2000 to 2005. *Circulation*. 2011;123(8):841-849. doi: 10.1161/CIRCULATIONAHA.110.958405.
28. Nayak K, Chandra GSN, Shetty R, Narayan PK. Evaluation of fetal echocardiography as a routine antenatal screening tool for detection of congenital heart disease. *Cardiovasc Diagn Ther*. 2016;6(1):44-49. doi: 10.3978/j.issn.2223-3652.2015.12.01.
29. Pham A, Melchior M. Screening for fetal congenital heart disease. *CMAJ*. 2017;189(12):E468. doi: 10.1503/cmaj.160700.
30. Akram NN, Yaseen MJ, Nori W. Identifying clinical and biochemical predictors of seizures in children with acute bacterial meningitis: insights from a cross-sectional study. *Al-Rafidain J Med Sci*. 2024;7(1):127-132. doi: 10.54133/ajms.v7i1.1106.
31. Crispín Milart PH, Prieto-Egido I, Díaz Molina CA, Martínez-Fernández A. Detection of high-risk pregnancies in low-resource settings: a case study in Guatemala. *Reprod Health*. 2019;16(1):80. doi: 10.1186/s12978-019-0748-z.
32. Nori W, Akram N, Al-Kinani M. Radiological modalities for the assessment of fetal growth restriction: a comprehensive review. *Al-Kindy Coll Med J*. 2024;20(1):4-13. doi: 10.47723/nz221421.