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Frequency of Congenital Heart Defects diagnosed by Fetal Echocardiography in Mashhad, Iran

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Abstract

Background: Congenital heart defect (CHD) is the most common type of congenital disorder, especially in the Asian population. However, there are no comprehensive studies assessing the prevalence of this disease in the Iranian population.

Objective: This study aimed to determine the frequency of cardiac abnormalities with a focus on CHD diagnosed by fetal echocardiography in pregnant women.

Methods: This cross-sectional study utilized the medical records of 635 pregnant women who referred to Imam Reza Hospital in Mashhad, Iran, for fetal echocardiography from 2012 to 2017. All medical records of mothers who referred to a pediatric cardiologist at the CHD center have been assessed in this study. The American Heart Association guideline was used to detect the risk of CHD. Data were analyzed in SPSS version 16.

Results: The mean age of the pregnant women was 29.6±5.13 years and their mean gestational age was 23.5±5.9 weeks. The incidence of fetal cardiac abnormalities was highest in those aged between 26 to 31 years. Fetal cardiac abnormalities were reported in 33.22% of the women. Moreover, the frequency of intra-cardiac echogenic focus was estimated at 25.6% and the frequency values of the complex CHD and ventricular septal defect (VSD) were obtained at 21.76% and 8.05%, respectively.

Conclusion: According to the obtained results from this study, fetal cardiac abnormalities were found in more than one-third of pregnant women. In addition, the intracardiac echogenic focus was the most common detected cardiac abnormality. The most prevalent detected CHDs were complex CHD and VSD. This indicates a likelihood that the CHD is more common among Asian populations.

Keywords: Congenital heart defects, Echocardiography, Pregnant women, Ultrasonography

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Abbreviations / Acronyms:
ASD: Atrial Septal Defect; **CHD:** Congenital Heart Defect; **ECD:** Endocardial Cushion Defect; **GA:** Gestational Age; HLHS: Hypoplastic Left Heart Syndrome; **TOF:** Tetralogy of Fallot; **TGA:** Transposition of the Great Arteries; **VSD:** Ventricular Septal Defect; **PDA:** Patent Ductus Arteriosus

1. Introduction

Congenital heart defect (CHD) is the most common type of congenital disorder (1). The prevalence of CHD is almost 8 per 1000 live births. Moreover, the incidence rate of CHD is reported 10-25%, 3-4%, and 2% in aborted fetuses, stillbirths, and premature infants, respectively (2, 3). The high prevalence rate in aborted fetuses can be attributed to the fact that CHD may be a cause of abortion. About 20-30% of CHDs are so serious and life-threatening that they require surgery in the first year of life (4); additionally, 27 per 1000 stillbirths are strongly associated with CHD. Furthermore, more than 50% of the mortalities in children are due to congenital diseases followed by CHD (5). Several studies have shown that congenital heart defects are six and four times more prevalent than chromosomal disorders and neural tube defects, respectively (3, 5). The majority of CHDs are structural and developmental cardiac problems occurring during the prenatal period, whether inherited, or affected by the environment. The most common types of these forms of developmental or structural anomalies in descending order are VSD, atrial septal defect (ASD), and patent ductus arteriosus (PDA) (6).

The prenatal diagnosis of these cardiac abnormalities is of utmost importance due to the significance of this issue as well as genetic and environmental factors. The early prenatal diagnosis or ideal screening improves survival, complications, as well as mortality rates. In addition, it provides a better condition for delivery and makes necessary termination of pregnancy possible (3, 7). Commonly, the obstetricians perform screening by ultrasonography (7). Routine antenatal diagnostic imaging performed by ultrasound stated that is not completely able to diagnose CHD in more than 15000 low-risk pregnancies. Due to the cardiac complicated anatomy and its nature, several types of CHD, such as VSD are difficult to diagnose during routine prenatal anomaly scanning (8). Nowadays, fetal echocardiography provides excellent images with all specified anatomical details leading to the early diagnosis of CHDs by the pediatric cardiologists; additionally, the presence of more beneficial data focusing on the type of cardiac defect results in the better prognosis and management methods by which the parents can be provided with more clear concepts (9). Prenatal diagnosis of CHD has been employed based on fetal echocardiography in many different countries, and many studies have been performed on the prevalence and types of CHDs; however, most of them have been carried out in western countries (10). Tabib et al. performed a study to determine the prevalence rate of cardiac malformations in fetuses of Iranian diabetic mothers. The results showed cardiac malformations in 8.8% of the diabetic mothers (7). Another cross-sectional study conducted by Molaei et al. in Tabriz revealed the necessity of early detection and timely management, which affected the ultimate prognosis of CHD patients due to the high mortality rate among neonates with critical CHD (11). To the best of our knowledge, there has been no comprehensive study assessing the prevalence rate of patients with CHD in the Iranian population. Due to the importance of assessing the frequency of CHDs diagnosed by fetal echocardiography, high frequency of CHD among the Asian population (12, 13), and lack of studies conducted in Mashhad, Iran, this study aimed to determine the frequency of cardiac abnormalities diagnosed by fetal echocardiography in pregnant women.

2. Material and Methods

In total, 635 medical records of pregnant women who referred to pediatric cardiologists for fetal echocardiography in the CHD center affiliated to Imam-Reza Hospital, Mashhad, Iran were assessed in this retrospective cross-sectional study from 2012 to 2017. The American Heart Association Guideline was used to detect the risk of congenital heart disease. Moreover, prenatal heart evaluation was carried out by expert pediatric cardiologists using GE Vivid 7 color Doppler and Mindray Resona 7 color Doppler with a convex probe 5-7 megahertz. The obtained data were analyzed in SPSS software (version 16); additionally, frequencies and percentages were employed to describe the categorical data. Total and relative frequencies of each CHD type along with maternal age, gestational age (GA) at referral time, and fetal echocardiographic findings were collected in this study. The study protocol was approved by the Ethics Committee of Mashhad University of Medical Sciences, Mashhad, Iran (Ref: IR.MUMS.fm.REC.1394.638).

3. Results

The data were collected from 635 medical records of pregnant women. Based on the obtained results from this study, the mean age of the pregnant women was 29.6±5.13 years (age range: 15-45 years), and the mean GA was obtained at 23.59±5.9 weeks (GA range: 3-39 weeks). Moreover, the highest incidence rate of fetal cardiac

abnormalities was found in mothers aged between 26 and 31 years. In total, 62% and 98% of the women referred after 20 weeks of GA. The frequency of CHD diagnosed by echocardiography in different age groups is shown in Figure 1. Fetal cardiac abnormalities were found in 211 cases with a frequency of 33.2%. Furthermore, the intracardiac echogenic focus was the most common detected cardiac abnormality (25.6%). The most prevalent detected CHDs were complex CHD and VSD with the frequency values of 21.76% and 8.05%, respectively. Table 1 tabulates the distribution of complex CHDs. Some types of complex CHDs were characterized by the Transposition of the Great Arteries (n=8) (TGA), Ebstein's anomaly (n=3), Tetralogy of Fallot (n=2) (TOF), and Hypoplastic Left Heart Syndrome (HLHS) (n=1). The other unclassified complex CHDs (15.16 %) have not been identified in any specific known complex CHD categories. The frequency of CHD diagnosed by echocardiography in different age groups is shown in Figure 1.

Table 1. Distribution of Complex Congenital Heart Defect

Type of Complex Congenital Heart Defect	No. of Patient	Percentage
Other Complex CHDs	32	15.16
TGA	8	3.79
Ebstein	3	1.4
TOF	2	0.94
HLHS	1	0.47

CHD: Congenital Heart Disease; TGA: Transposition of the Great Arteries; TOF: Tetralogy of Fallot; HLHS: Hypoplastic Left Heart Syndrome

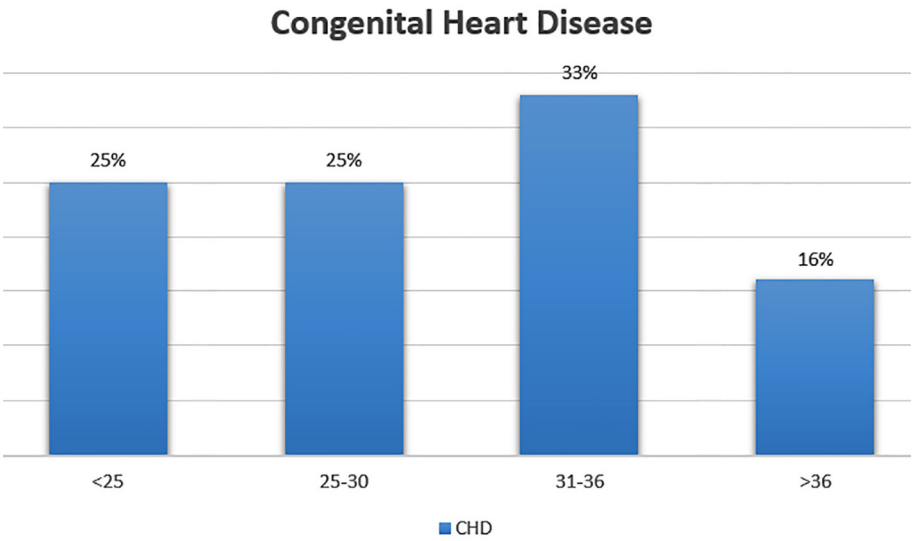

Figure 1. Frequency of Congenital Heart Defect in different age groups

4. Discussion

CHDs are the most common type of congenital malformation. This study aimed at assessing the frequency and types of CHDs using the medical records of pregnant women who referred to pediatric cardiologists for fetal echocardiography. Based on the obtained results in this study, the frequency of CHDs was observed in one-third of the pregnant women. In the studies conducted by Sharma et al. and Nayak et al., the prevalence rates of CHD were reported as 15 (14) and 20.3 (10) per 1000 pregnancies, respectively. However, the incidence of CHD was estimated at 6-12 per 1000 pregnancies by the American Heart Association Guideline (15). It seems that the frequency of CHD is different among the various populations. This inconsistency may be attributed to differences in sample size, genetic characteristics, and other confounding variables.

In the present study, the most common type of CHD was complex CHD, which was observed in 21% of the pregnant women, whereas the majority of the surveys reported VSD as the most common type of CHD. The VSD was considered as the second most common CHD in this study. Sharma et al. and Nayak et al. mentioned VSD and endocardial cushion defects as the most common type of these disorders, respectively (10, 14). The prevalence of CHD in the study carried out by Wu et al. was similar to that reported by Nakazawa et al., which was estimated at

10.6 per 1000 live births (16). Based on a study performed by Hoffman and Kaplan, there was a positive correlation between the prevalence of CHD and the relative frequency of VSD (17).

The frequency of TOF was reported in 0.9% of the women, whereas PDA and ASD were not observed in this study. A higher prevalence of pulmonary stenosis and TOF was reported in a study carried out by Wu et al. in Taiwan. The ASD and PDA may be recognized early and over-represented due to the wide application of echocardiography in Taiwan. According to the literature, right-sided obstructive lesions are more common among the Asian population, compared to Caucasian patients; however, left-sided obstructive lesions are less common in this population (12, 13). Sharma mentioned specific features of the complex CHDs (TGA), the only anomaly in common with our study (1, 5.5%), whereas the frequency of TGA was found in 8 patients in this study (3.7%). Another study was conducted by Donyaee et al. in Iran to determine fetal cardiac arrhythmia based on echocardiography findings. Based on the obtained results, TGA was observed in 3% of the patients (18). In the same line, Nayak et al. revealed 1, 2, and 4 cases with Ebstein's anomaly, HLHS, and TGA, respectively, which were slightly higher than the prevalence rate observed among the individuals with complex CHD in the current study (10).

The frequency of TOF was 0.9% in this study, whereas its prevalence was reported at 0.62 per 1000 pregnancies by Wu et al. in Taiwan (16). Moreover, it was estimated at 0.26-0.47 per 1000 pregnancies in western reports (13, 19). The prevalence of TOF in another study performed in Korea (0.73 per1000 pregnancies) was similar to that obtained from a study carried out by Wu et al. (20). Based on the California Birth Defects Monitoring Program, an ethnic-related difference for TOF was reported between African-American and Caucasian populations. However, a higher prevalence rate of TOF in the CHD population was reported in some previous Asian institutional studies (12, 20). Probably, the TOF as a conotruncal defect with potential genetic susceptibility is higher among Asians. In our study, the frequency of HLHS was obtained at 0.4%. Based on a review study, a decrease (i.e., ≥10%) in the prevalence of HLHS, common ventricle, Endocardial Cushion Defect (ECD), Ebstein's anomaly, Tricuspid atresia, and TOF can lead to early cardiac fetal diagnosis (21).

In the present study, the highest incidence rate of fetal cardiac abnormalities was found in mothers aged 26 to 31 years, and the distribution of GA of pregnant women was 23.5 weeks. This result is almost consistent with the findings in the study conducted by Sharma et al. (14). The cardiac abnormalities were most commonly diagnosed between 16 and 19 weeks either using ultrasonography or echocardiography, which was not in line with the procedure used by Sharma (14). Donyaee et al. showed no differences between patients with normal - and those with abnormal echocardiography findings regarding mothers' age, GA, and family history of cardiovascular disease (18). According to the literature, the second trimester of pregnancy is considered as the most appropriate referral time to diagnose prenatal cardiac abnormalities. However, delays were observed in the referral time in the current study; 62% and 98% referred after 20 weeks of GA. This may be an approved time for the diagnosis of arrhythmias, not for structural cardiac malformations. According to the moral aspects as well as religious and legal limitations regarding the required termination of pregnancy, a timely referral is highly substantial and it should preferably be before 20 weeks of GA.

5. Study strength and Limitations

The descriptive cross-sectional nature of this study is one of the main limitations of this research. Therefore, it was impossible to control the confounding variables during the study. The medical records of the cases in this study were from one city in Iran (i.e., Mashhad); therefore, they are not generalizable to the Iranian population as a whole. The obtained results from this study may be affected by differences in the diagnostic criteria and the timing for follow-up outpatient clinic visits. Moreover, it is possible that CHD resulted in death before mothers' referral to the hospital. Additionally, not all pregnant women were referred to the clinic at an appropriate time for fetal echocardiography to diagnose prenatal CHD. Considering the aforementioned limitations, future studies are recommended to be conducted with larger sample size and multi-center trials.

6. Conclusions

Fetal echocardiography is a safe and non-invasive method for prenatal diagnosis and management of CHD even in low-risk pregnancies. Based on the obtained results in this study, the highest incidence rate of fetal cardiac abnormalities was found in mothers aged 26 to 31 years. Moreover, fetal cardiac abnormalities were found in more than one-third of the cases. Furthermore, the intracardiac echogenic focus was the most common detected cardiac abnormality in this study. The most prevalent detected CHDs were complex CHD and VSD.

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Conflict of Interest:
There is no conflict of interest to be declared.

Authors' contributions:
All authors contributed to this project and article equally. All authors read and approved the final manuscript.

References:

1) Dolk H, et al. Congenital heart defects in Europe: prevalence and perinatal mortality, 2000 to 2005 Circulation 2011;123(8):841-9. doi: 10.1161/CIRCULATIONAHA.110.958405 PMid: 21321151
2) Mottaghi H, Heidari E, Ghiasi SS. A Review Study on the Prenatal Diagnosis of Congenital Heart Disease Using Fetal Echocardiography. Reviews in Clinical Medicine. 2018;5(1):12-5.
3) Abbott MB, and Christopher H. Vlasses. Nelson textbook of pediatrics: JAMA. 2387-8. p.
4) van Velzen CL, Clur SA, Rijlaarsdam ME, Bax CJ, Pajkrt E, Heymans MW, et al. Prenatal detection of congenital heart disease--results of a national screening programme. Bjog. 2016;123(3):400-7. doi: 10.1111/1471-0528.13274 PMid: 25625301
5) Ayres NA. Advances in fetal echocardiography. Tex Heart Inst J. 1997;24(4):250-9.
6) Levi S, Zhang WH, Alexander S, Viart P, Grandjean H. Short-term outcome of isolated and associated congenital heart defects in relation to antenatal ultrasound screening. Ultrasound Obstet Gynecol. 2003;21(6):532-8. doi: 10.1002/uog.146 PMid: 12808668
7) Tabib A, Shirzad N, Sheikhbahaei S, Mohammadi S, Qorbani M, Haghpanah V, et al. Cardiac malformations in fetuses of gestational and pre gestational diabetic mothers. Iran J Pediatr. 2013;23(6):664-8.
8) Simpson LLSfchdQJ, Spong CY, Lockwood CJ. Queenan's management of high-risk pregnancy: an evidence-based approach: Malden (MA): John Wiley & Sons 2012. 47-54 p.
9) Ghiasi S, Mottaghi H, Heidari E. Fetal Echocardiography Indications: A Single-Center Experience. International Journal of Pediatrics. 2019.
10) Nayak K, Chandra G S N, 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):44-9.
11) Molaei A, Gholamreza Asadi, and Maryam Khoshbakht. Prognosis of the newborns with congenital heart diseases. Advances in Bioscience and Clinical Medicine 2015;3:49-55. doi: 10.7575/aiac.abcmed.15.03.03.08
12) Jacobs EG, Leung MP, Karlberg J. Distribution of symptomatic congenital heart disease in Hong Kong. Pediatr Cardiol. 2000;21(2):148-57. doi: 10.1007/s002469910025 PMid: 10754087
13) Pradat P, Francannet C, Harris JA, Robert E. The epidemiology of cardiovascular defects, part I: a study based on data from three large registries of congenital malformations. Pediatr Cardiol. 2003;24(3):195-221. doi: 10.1007/s00246-002-9401-6 PMid: 12632215
14) Sharma S, Kaur N, Kaur K, Pawar NC. Role of echocardiography in prenatal screening of congenital heart diseases and its correlation with postnatal outcome. Journal of clinical and diagnostic research: JCDR. 2017;11(4):TC12. doi: 10.7860/JCDR/2017/25929.9750 PMid: 28571229 PMCid: PMC5449875
15) Donofrio MT, Moon-Grady AJ, Hornberger LK, Copel JA, Sklansky MS, Abuhamad A, et al. Diagnosis and treatment of fetal cardiac disease: a scientific statement from the American Heart Association. Circulation. 2014;129(21):2183-242. doi: 10.1161/01.cir.0000437597.44550.5d PMid: 24763516
16) Wu MH, Chen HC, Lu CW, Wang JK, Huang SC, Huang SK. Prevalence of congenital heart disease at live birth in Taiwan. J Pediatr. 2010;156(5):782-5. doi: 10.1016/j.jpeds.2009.11.062 PMid: 20138303
17) Hoffman JI, Kaplan S. The incidence of congenital heart disease. J Am Coll Cardiol. 2002;39(12):1890-900. doi: 10.1016/S0735-1097(02)01886-7
18) Donyaee J. Survey the Echocardiographic Findings in Fetus with Cardiac Arrhythmiش. Journal of Scientific Achievements 2016;1:11-3.
19) Reller MD, Strickland MJ, Riehle-Colarusso T, Mahle WT, Correa A. Prevalence of congenital heart defects in metropolitan Atlanta, 1998-2005. J Pediatr. 2008;153(6):807-13. doi: 10.1016/j.jpeds.2008.05.059 PMid: 18657826 PMCid: PMC2613036

20) Jung SC, Kim SS, Yoon KS, Lee JS. Prevalence of congenital malformations and genetic diseases in Korea. J Hum Genet. 1999;44(1):30-4. doi: 10.1007/s100380050102 PMid: 9929974
21) Germanakis I, Sifakis S. The impact of fetal echocardiography on the prevalence of liveborn congenital heart disease. Pediatr Cardiol. 2006;27(4):465-72. doi: 10.1007/s00246-006-1291-6 PMid: 16830077