

Research Paper

Cardiovascular Abnormalities in Infants of Mothers With Diabetes



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ABSTRACT

Background and Aim: Research has shown that maternal diabetes is an important factor in increasing the risk of various congenital heart defects. This research investigated the presence of cardiovascular abnormalities in infants born to diabetic mothers.

Materials and Methods: This cross-sectional study was conducted on pregnant women who were referred to Hazrat Masoumeh (PBUH) Hospital in Qom City, Iran, for echocardiography from 2021 to 2022. Sampling was done among diabetic and healthy pregnant women using a simple random method. First, the necessary information was collected through echocardiography findings in the patients' files, and the data were analyzed using SPSS software, version 26, and related tests.

Results: In this study, 13 infants (14.4%) had a cardiac abnormality, of whom six infants (6.7%) were born to mothers with type 1 diabetes and seven infants (7.8%) were born to mothers with type 2 diabetes. No significant difference was found between the average age of the mothers ($P=0.648$), the gender of the infants ($P=0.733$), the weight of the infants ($P=0.143$), gestational status ($P=0.229$), maternal occupation ($P=0.077$), type of delivery ($P=0.675$), the Apgar score at one minute ($P=0.709$), and Apgar score at five minutes ($P=0.736$) between the two groups of type 1 and type 2 diabetes.

Conclusion: Babies born to mothers with diabetes are more likely to have congenital heart diseases (CHDs). It is recommended to use transthoracic echocardiography as a screening tool to diagnose CHDs in infants born to diabetic mothers.

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Introduction

Congenital heart disease (CHD) is the most common severe congenital abnormality, with an average prevalence of about 8.22 per 1000 live births, increasing by 10% every five years [1]. Studies have shown that maternal diabetes is an important risk factor for all types of CHD [2, 3]. The prevalence of diabetes is rising, with one out of every ten pregnancies diagnosed with diabetes, of which about 90% are classified as gestational diabetes mellitus (GDM) [4]. Diabetes in pregnant women is divided into two main groups: The first group includes those with type 1 or type 2 diabetes before pregnancy, while the second group consists of women diagnosed with gestational diabetes for the first time during pregnancy [5]. During pregnancy, the intrauterine environment significantly affects fetal development; therefore, diabetes in pregnancy increases the risk of maternal, fetal, and neonatal complications, including congenital, metabolic, and hematological abnormalities, as well as cardiac and pulmonary complications and childbirth issues [6]. The main pathophysiology of complications of diabetes in pregnancy includes maternal hyperglycemia and fetal hyperinsulinemia, with the risk of congenital abnormalities in babies born to diabetic mothers being 3 to 5 times that of other babies [7-9].

Maternal diabetes, especially in early pregnancy, disrupts the expression of genes encoding heart growth and has teratogenic effects on the fetal cardiovascular system. Studies have shown that the risk of heart abnormalities increases five times in diabetic pregnant mothers compared to the general population [10]. The structural defects associated with maternal diabetes range from mild defects of the inter-atrial and inter-ventricular septa to severe heart diseases, such as transposition of the great arteries, aortic stenosis, truncus arteriosus, and double exit of the right ventricle. Diabetic individuals are at high risk for asymmetric hypertrophy of the myocardium, especially in the interventricular septum [10-15]. The prevalence of hypertrophy of the interventricular septum is 30% even with strict blood sugar control in the third month, which can lead to symptoms ranging from asymptomatic cases to dystonic dysfunction [15]. Early diagnosis of cardiac disorders is crucial because cardiac malformations are often associated with increased mortality and disability in fetuses and infants [16]. Fetal echocardiography is a non-invasive imaging technique used to investigate the diastolic function of the fetal heart. This can be assessed by measuring the blood flow velocity in the mitral and tricuspid valves

and the velocity of the ventricular inflow volume during diastole, which depends on the gradient between the atrium and the ventricle. It is a method for screening the structure and function of the heart, typically performed between 18 and 22 weeks of pregnancy [17-21].

Since the effects of diabetes on the fetal heart are accompanied by changes in echocardiographic parameters, and studies have shown the utility of fetal echocardiography in pregnant mothers with diabetes to identify CHD, timely intervention in cases of severe abnormalities before the 16th week, along with parental counseling, is both efficient and necessary. Considering the high prevalence of diabetes among pregnant mothers, its teratogenic effects on the fetal heart, and the importance of detecting it as quickly as possible, especially in the intrauterine stage of the fetus, this study aimed to investigate congenital cardiovascular abnormalities using fetal echocardiography in the fetuses of affected mothers.

Materials and Methods

This descriptive cross-sectional study was conducted on pregnant women who were referred to Hazrat Masoumeh (PBUH) Hospital of Qom City, Iran, for echocardiography between 2021 and 2022. A random sampling method was used to select the study participants.

Using the sample size formula, and considering a type 1 error of 1%, a power of 0.95, the standard deviation of the tricuspid valve, mitral E/A ratios for mothers with overt diabetes and the control group (0.12 and 0.14, respectively) from the study by Fouda et al., and the difference between the mothers with overt diabetes group and the control group (0.13) [15], the minimum number of samples required to conduct this study was 37 individuals in each group. The inclusion criteria were willingness to participate in the study and being pregnant mothers aged 18 to 45 diagnosed with diabetes before pregnancy or during pregnancy. The exclusion criteria included diabetic vasculopathy, kidney disease, connective tissue disease, multiple pregnancies, maternal high blood pressure, preeclampsia, intrauterine growth restriction, and congenital diseases.

After obtaining the code of ethics, the researcher referred to the fetal echocardiography department and started sampling. The statistical population included mothers with diabetes prior to pregnancy. First, the required information was collected through the findings of echocardiography in the patients' files.

Table 1. Comparison of mothers with types 1 and 2 diabetes

Variables		Meat±SD/No. (%)		P
		Diabetes Type 1	Diabetes Type 2	
Age (y)		34.4±5.42	33.7±4.41	0.648
Gender	Male	4(4.4)	33(36.7)	0.733
	Female	7(7.8)	46(51.1)	
Weight (g)	<2500	0(0)	16 (17.8)	0.143
	2500-4000	6(6.7)	44(48.9)	
	4000>	5(5.6)	19(21.1)	
Term status	Term	7(7.8)	63(70)	0.229
	Pre-term	4(4.4)	16(17.8)	
Occupation	Housewife	3(3.3)	44(48.9)	0.077
	Employed	8(8.9)	35(38.9)	
Delivery type	Cesarean	7(7.8)	45(50)	0.675
	Normal vaginal delivery	4(4.4)	34(37.8)	
Apgar score	The 1 st minute	5.4±1.3	5.3±1.2	0.709
	The 5 th minute	7.1±1.2	7.2±1.4	0.736

Using SPSS software, version 26, and descriptive and inferential statistics, the data were analyzed and the degree of correlation between the variables was tested and investigated. In cases where echocardiography was absent from a patient's file, the patient was removed and replaced by another participant. Descriptive statistics were used to describe the individual characteristics of the research variables, and the Kolmogorov-Smirnov test was used to check the normality of the quantitative variables. If the variables were normally distributed, the independent t-test was used to compare the means of the two groups; if the variables were not normally distributed, the Mann-Whitney non-parametric test was employed. Chi-square and Fisher's exact tests were utilized to examine the correlation of qualitative variables, considering a significance level of <0.05.

Results

The mean age of mothers with type 1 diabetes was 34.4±5.42 years, while the average age for mothers with type 2 diabetes was 33.7±4.41 years. Additionally, 37 male babies (41.1%) and 53 female babies (58.9%) were examined. There was no significant difference between

the mean age of mothers ($P=0.648$), the gender of the infants ($P=0.733$), the weight of the infants ($P=0.143$), term status ($P=0.229$), mothers' occupation ($P=0.077$), type of delivery ($P=0.675$), the Apgar score at one minute ($P=0.709$), and the Apgar score at five minutes ($P=0.736$) (Table 1).

In this study, 13 infants (14.4%) had heart abnormalities, of whom six infants (6.7%) had mothers with type 1 diabetes and seven infants (7.8%) had mothers with type 2 diabetes (Figure 1).

Figure 2 shows the frequency of all types of heart abnormalities in infants across three groups of diabetes patients: Type 1, type 2, and the control group.

Discussion

In general, maternal diabetes poses a threat to the fetal heart in two ways. First, during the early stages of pregnancy, diabetes has a teratogenic effect that disrupts cardiogenesis through the gene coding responsible for heart development [22]. Secondly, diabetes affects the fetus at the end of the second trimester or the beginning

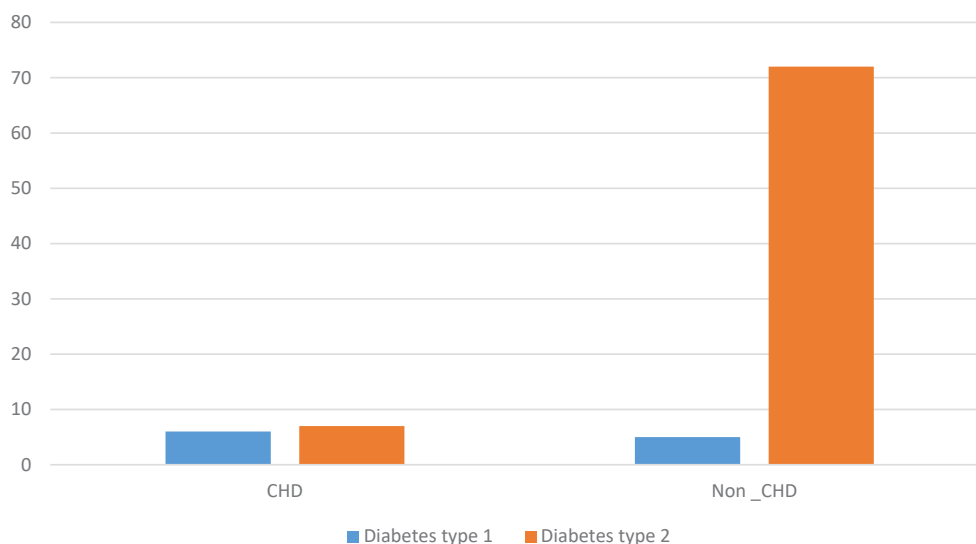


Figure 1. Frequency of newborn heart abnormalities among mothers with types 1 and 2 diabetes



of the third trimester by causing pathological hypertrophy of the ventricles, a condition known as hypertrophic cardiomyopathy [23]. Additionally, an increase in insulin secretion leads to hypertrophy, and an increase in myocardial cells increases fat and protein synthesis in the fetus [24].

This study was conducted to investigate the prevalence of CHD in diabetic pregnant mothers. In general, the results showed that the incidence of cardiac abnormalities in the infants of diabetic mothers was relatively higher, which is consistent with the results of previous studies. In a similar study, it was concluded that infants of diabetic mothers have a high risk of heart problems, either

in the form of congenital malformations or hypertrophic cardiomyopathy. Furthermore, the incidence of CHD in babies of mothers with pre-pregnancy diabetes is higher than in those with gestational diabetes, highlighting the teratogenic role of diabetes during the first trimester [25].

Babies born to diabetic mothers are at higher risk of heart diseases, including congenital malformations or hypertrophic cardiomyopathy. Also, the incidence of CHD in babies of mothers with pre-pregnancy diabetes is higher than in those with gestational diabetes, indicating the teratogenic role of diabetes in the first trimester of pregnancy. Factors such as the female gender of the baby, abnormal birth weight, the mother's employment

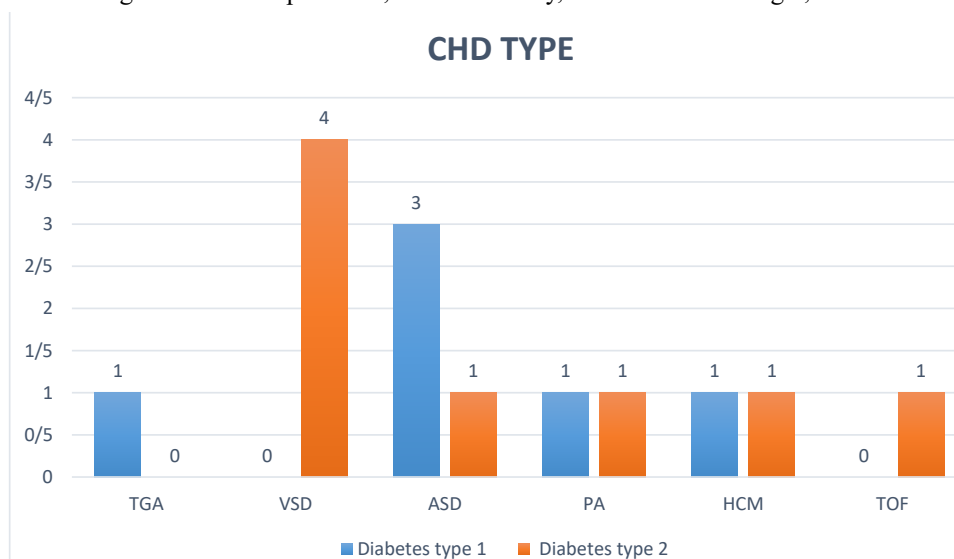


Figure 2. Frequency of types of heart abnormalities in newborns among mothers with types 1 and 2 diabetes



status, control of pre-pregnancy diabetes with oral medications, parental blood relationships, low Apgar scores at birth, and inadequate control of fasting blood sugar during pregnancy all increase the risk of heart diseases in babies [26]. Gestational diabetes is an important risk factor for CHD. This risk is further elevated in the presence of low maternal education, a high body mass index at conception, undiagnosed pre-pregnancy diabetes, inadequate prenatal care, poor diabetes control, and maternal smoking during pregnancy.

Maternal diabetes significantly affects the structure and function of the fetal heart and fetal placental circulation. Cardiovascular diseases and myocardial hypertrophy are three times more common in diabetics. The evaluation of fetal heart structure and function can be performed using fetal electrocardiography and echocardiography. Postnatal heart evaluation can be done with natal electrocardiography and postnatal echocardiography. Ameliorating the effects of gestational diabetes on children depends mainly on the prevention of gestational diabetes during pregnancy. However, other measures to reduce these effects, such as nutritional interventions, medications, or probiotics, require further research [27]. In another study conducted in Pakistan, CHD was diagnosed in 79 patients (52.7%) while it was not diagnosed in 71 patients (47.33%). The result of this study showed a moderate prevalence of CHD in babies born to diabetic mothers [28]. In a similar study conducted in Iran, the authors concluded that nine out of ten infants of diabetic mothers have congenital heart abnormalities, with patent foramen ovale being the most common [29]. Therefore, we suggest that echocardiography should generally be performed to screen for CHD in babies born to diabetic mothers.

Conclusion

Our findings showed that infants of diabetic mothers are at high risk of CHD, and transthoracic echocardiography is recommended for screening CHD in infants of diabetic mothers.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of Qom University of Medical Sciences (Code: IR.MUQ.REC.1402.108).

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Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

The authors declared no conflict of interest.

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