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Risk Factors of Congenital Heart Disease in Children at the West Bank: Cross-sectional Study

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Abstract

Background: Congenital heart diseases (CHDs) are known as congenital heart defects or anomalies. It refers to structural defects in the heart or major vessels present at birth. CHD is the most prevalent type of birth defect worldwide. The etiology of CHD is complex and multifactorial, involving both genetic and environmental factors. Understating these risk factors is essential for prenatal diagnosis, primary prevention, and decreasing preventable new cases.

Aim of Study: This study aimed to assess the most common CHDs and the maternal associated factors in the West Bank, Palestine.

Method: A cross-sectional descriptive survey was conducted at three major hospitals in the West Bank between August and November 2021 that treat congenital heart diseases (CHDs); Al-Makased Islamic Hospital, Palestine Medical Complex Hospital, and Arab Women Union Society-Nablus. Data were collected through face-to-face interviews using a structured questionnaire.

Result: Data analysis of 108 cases revealed that the most common CHD is atrial septal defect (ASD), accounting for 25.9% of cases. Most mothers were between 20-30 years (52.8%). Among the children, 57 (52.8%) were male. Most children were born between 36-38 weeks of gestation age (34.3%) and had a normal birth weight (54.6%). In addition, 58.3% of families did not have a history of CHD among relatives. There is a significant association was found between CHD diagnosis and Birth weight, a family history of CHD, maternal BMI, periconceptional smoking, and commitment to folic acid intake.

Conclusion: The findings of this study underscore the need for enhanced health policies that prioritize premarital and prenatal counseling, along with proper management of maternal health conditions. Increasing awareness among women of reproductive age about key risk factors; such as family history of CHD, maternal BMI, smoking, and folic acid intake, that they can play a critical role in reducing the incidence of CHD in newborns. Effective preventive strategies and targeted education are vital to mitigating the risk factors associated with congenital heart disease in the West Bank.

Keywords: Congenital Heart Defect, Risk Factor, Epidemiology of Congenital Heart Defects, Maternal Risk factor.

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Introduction

Congenital heart diseases (CHD), also known as congenital heart anomalies and congenital heart defects, are defects in the structure of the heart or major vessels that are present at birth. The global incidence of congenital cardiovascular defects is approximately eight per 1,000 newborn live births (Van Der Linde *et al.*, 2011), with more recent studies suggesting an increases to as high as 9.5 per 1,000 live births (Liu *et al.*, 2019).

CHD remains a major cause of infant mortality; it is about 40% in the U.S. (Lopez *et al.*, 2020), and the incidence of CHD is 25 per 1000 live births at Jordanian Children Born in Jordan (Khasawneh *et al.*, 2020). Moreover, in the Gaza Strip, the incidence of CHD was 8 per 1000 live births (Zaqout *et al.*, 2014). Anyway, CHD is the most common newborn congenital defect, accounting for approximately 28% of all other congenital defects (Abqari *et al.*, 2016).

According to Yasuhara and Garg (2021), in light of an increasing population of survivors, CHD is the most prevalent type of birth defect and a serious pediatric and adult health problem. Hereditary and environmental factors both play crucial roles in the complex etiology of CHD.

Despite the identification of numerous risk factors, the precise causes of these abnormalities remain unidentified. Multifactorial, a genetic and environmental risk factor for CHD, has gained acceptance (Kalisch-Smith, Ved and Sparrow, 2020). Therefore, risk factors for CHD include infection during pregnancy like rubella, using some medication or drug such as tobacco or alcohol, mother and father being closely related, poor nutritional state and obesity of the mother, Down syndrome, Turner syndrome, and Marfan syndrome ((Edwards and Gelb, 2016; Kalisch-Smith, Ved and Sparrow, 2020; Suluba *et al.*, 2020). In addition, diabetic mothers are more predisposed to have children with CHD (Ibrahim *et al.*, 2023).

Heart defects can be partly avoided by getting a Rubella shot, eating foods high in iodine, and adding folic acid to some foods (Mendis *et al.*, 2011; Centers for Disease Control and Prevention (CDC), 2019; Obeid, Holzgreve and Pietrzik, 2019). It can be effectively treated with catheter-based procedures, open heart surgery, and a total heart transplant, and the outcome is good even for people with complex problems (Jerves, Beaton and Kruszka, 2020).

A better understanding of maternal risk factors could help with both diagnosing congenital heart disease before birth by finding pregnancies that are at high risk and preventing the disease in the first place by improving preconception and prenatal care for moms who are at high risk (Helle and Priest, 2020).

This study is considered unique, as it is the first of its kind to be conducted in West Bank. It aims to provide information about the most common risk factors of CHD at West Bank, reduce the number of preventable cases of CHD, and provide valuable information for future studies on the condition. Therefore, the primary aim for this study was to investigate the risk factors of the CHD; the secondary aim was to investigate what is the most common CHD in West Bank; and the tertiary aim was to investigate the relationship between risk factors and the child's CHD diagnosis.

Methodology

A descriptive cross-sectional quantitative study was used because our aim is to investigate the risk factors of CHD and what is the most common CHD in the West Bank.

Setting and Sampling

The target population consisted of families of pediatric patients from the three major hospitals in the West Bank who were caring for these patients with CHD between August and November 2021. These hospitals are:

1. The Pediatric Cardiac Critical Care Unit is located at the Al-Makassed Islamic Charitable Society Hospital in Jerusalem.
2. The Hospital of the Arab Women Union Society-Nablus offers Pediatric Cardiac Day Care.
3. The Pediatric Cardiac Day Care is located at the Palestine Medical Complex in Ramallah.

According to the 2021 Palestine prime minister of health, there are 2566 children with CHD who are alive and registered. We used the convenience sampling method to collect 108 participants. The inclusion criteria for the participants in the current study were families that have a child with CHD and agree to participate in the study.

Data Collection

Patient family members confirmed that they read the provided information, met the inclusion criteria, and that we would only use the data from their responses for research after accepting the invitation to participate. We conducted a face-to-face interview to collect the data using a structured questionnaire.

Study Instruments

The probing questionnaire was developed based on previous research and expert consultations (Abqari *et al.*, 2016; Ahmadi *et al.*, 2020). To ensure reliability, the questionnaire achieved a Cronbach Alfa of 0.62. For internal validly, it was reviewed by nursing researchers and educators at the An-Najah National University, as well as by cardiac physicians at the Hospital of the Arab Women Union Society and Al-Makassed Islamic Charitable Society Hospital. The questionnaire took approximately 10–15 minutes to complete.

The questionnaire was divided into two sections; the first section describes the demographic data of the child and parents at birth, including maternal age, gestational age, relatives with similar diagnoses, family income, educational level, and the type of CHD the child has.

The second section gathers maternal risk factors for having a child with congenital heart disease (CHD). It describes factors such as obesity prior to pregnancy, a history of abortion, consanguineous marriage, exposure to smoking during pregnancy, exposure to radiation during pregnancy, exposure to teratogens such as alcohol

consumption during pregnancy, the mother's past medical history, regular intake of folic acid (400 mg/daily), regular use of multivitamins, and the course of medication.

Data Analysis

The statistical software IBM Statistical Package for the Social Sciences (SPSS) version 21 was used for data analysis between the variables and descriptive analysis of the variables. Chi-square was used to investigate the relationships between the risk factors and the CHD diagnosis.

Ethical Considerations

This study was conducted in accordance with the Declaration of Helsinki and approved by the Research Ethics Committee of the Nursing Department at An-Najah National University. An information sheet provided potential participants with a detailed explanation of the study, and the Institutional Review Board (IRB) of An-Najah National University approved the consent process. All participants signed the consent form. Upon completion of data entry, the researchers stored the collected data in a locked computer file.

Results

Participants' demographics and characteristics

Overall, approximately half of the children with CHD were male (52.8%), with 52.8% of mothers being between 20 and 30 years old, 42.6% having a gestational age of 38–42 weeks, and 54.6% having a normal birth weight between 2500 and 4000 g. In addition, 41.7% have previous relatives with CHD; 16.7% of relative CHD was the grandfathers, 11.1% of relative CHD diagnosis was atrial septal defect (ASD), and 25.9% of child diagnosis was ASD (Table 1).

Table 1: Demographic and characteristics of participants (*n*=108)

Variable	Values	Frequency	Percentage
Mother Age	Less than 20 years old	8	7.4%
	20-30 years old	57	52.8%
	30-40 years old	34	31.5%
	More than 40 years old	9	8.3%
	Male	57	52.8%
Child Gender	Female	51	47.2%
	Less than 28 weeks	3	2.8%
Gestational Age	28-32 weeks	4	3.7%
	32-36 weeks	13	12.0%
	36-38 weeks	37	34.3%
	38-42 weeks	46	42.6%
	Above 42 weeks	5	4.6%
Birth Weight	Extremely low birth weight: less than 1000g	2	1.9%
	Very low birth weight: 1000-1500g	4	3.7%
	Low birth weight: 1500- 2500g	36	33.3%
	Normal weight: 2500–4000g	59	54.6%
	High birth weight: More than 4000g	7	6.5%
Previous Relative with CHD	Yes	45	41.7%
	No	63	58.3%
Who the relative with CHD	Father	3	2.8%
	Mother	6	5.6%
	brother/sister	10	9.3%
	Grandfather	18	16.7%
	Grandmother	2	1.9%
	Other	6	5.6%
	None	63	58.3%
Relative diagnosis	Atrial Septal Defect	12	11.1%
	Atrioventricular Septal Defect	4	3.7%
	Coarctation of the Aorta	1	0.9%
	Ebstein Anomaly	1	0.9%

	Interrupted Aortic Arch	1	0.9%
	Pulmonary Atresia	1	0.9%
	Single Ventricle	2	1.9%
	Tetralogy of Fallot	7	6.5%
	Tricuspid Atresia	2	1.9%
	Truncus Arteriosus	1	0.9%
	Ventricular Septal Defect	10	9.3%
	Aortic valve stenosis	3	2.8%
	None	63	58.3%
Child diagnosis	Atrial Septal Defect	28	25.9%
	Atrioventricular Septal Defect	9	8.3%
	Coarctation of the Aorta	6	5.6%
	Double-outlet Right Ventricle	4	3.7%
	d-Transposition of the Great Arteries	3	2.8%
	Hypoplastic Left Heart Syndrome	2	1.9%
	Interrupted Aortic Arch	1	0.9%
	Pulmonary Atresia	3	2.8%
	Single Ventricle	5	4.6%
	Tetralogy of Fallot	7	6.5%
	Total Anomalous Pulmonary Venous Return	4	3.7%
	Tricuspid Atresia	2	1.9%
	Truncus Arteriosus	1	0.9%
	Ventricular Septal Defect	20	18.5%
	Mitral valve stinosis	1	0.9%
	Aortic stenosis	9	8.3%
	Dexocardia	1	0.9%
	Aortic regurgitation	1	0.9%
	Patent foramen ovale	1	0.9%

Maternal Risk Factors

Table 2 explains the maternal risk factors for mothers of children with CHD. The majority of mothers (57.4%) had body mass index (BMI) between 18.5-25.0 kg/m2, 50.9% of parents were in a consanguineous marriage, 55.6% of mothers had a history of abortion, and 61.1% of mothers had a past medical disease, such as hypothyroidism (18.5%), hypertension (14.8%), diabetic mellitus (6.5%), gestational diabetes (4.6%), and so on (see Table 2).

Overall, the study reveals that 47.2% of mothers reported taking regular folic acid during pregnancy, and 49.1% reported taking regular multivitamins.

On the other hand, most mothers had no peri-conception smoking (76.9%) and were not exposed to radiation during pregnancy (84.3%).

Table 2: Table of percentage and frequency of Maternal Risk Factor (*n*=108)

Variable	Value	Frequency	Percentage
Mother BMI	underweight less than 18	13	12.0%
	normal (18.5-25.0)	62	57.4%
	overweight (25.5-30.0)	28	25.9%
	obese (over 30)	5	4.6%
History of abortion	Yes	60	55.6%
	No	48	44.4%
Consanguineous marriage	Yes	55	50.9%
	No	53	49.1%
Periconceptional smoking	Yes	25	23.1%
	No	83	76.9%
Radiation during pregnancy	Yes	17	15.7%
	No	91	84.3%
periconceptional alcohol drink	Yes	6	5.6%
	No	102	94.4%
Maternal past disease	Yes	66	61.1%
	No	42	38.9%
Diabetes Mellitus (DM)	Yes	7	6.5%
	No	101	93.5%
Gestational Diabetes (GD)	Yes	5	4.6%
	No	103	95.4%
Upper Respiratory Tract Infection (URTI)	Yes	2	1.9%
	No	106	98.1%
Hypertension (HTN)	Yes	19	17.6%
	No	89	82.4%
Urinary Tract Infection (UTI)	Yes	30	27.8%
	No	78	72.2%
Infection of lower genitalia	Yes	16	14.8%
	No	92	85.2%
Hypothyroidism	Yes	20	18.5%
	No	88	81.5%
Other	Yes	14	13.0%
	No	94	87.0%
Are you committed to folic acid?	Yes regular	51	47.2%
	Yes irregular	34	31.5%
	No	23	21.3%
Are you committed multivitamins?	Yes regular	53	49.1%
	Yes irregular	27	25%
	No	28	25.9%

Predictors of congenital heart defects

Tables 3 presents the correlation between demographic variables and the diagnosis of CHD in children. The analysis reveal that the mother's age does not have significant correlation with child CHD diagnosis ($\chi^2 = 56.71$, $P = 0.374$), both birth weight ($\chi^2 = 162.52$, $P < 0.001$) and having a relative with CHD ($\chi^2 = 364.7$, $P < 0.001$) are significantly correlated.

Table 3: Correlation between demographic variables and child CHD diagnosis

Variable	Chi-square (χ2)	*P*-value
Mother Age	**56.71**	**0.374**
Birth Weight	**162.52**	**>0.001**
Relative Diagnosis	**364.7***	**>0.001**

*** Correlation is significant at the 0.05 level**

In addition, Table 4 explains the correlation between various maternal risk factors and child CHD diagnosis. The findings show that maternal BMI ($\chi^2 = 84.02$, P = 0.006), periconceptional smoking ($\chi^2 = 29.10$, P = 0.040), and commitment to folic acid intake ($\chi^2 = 51.18$, P = 0.048) have significant correlations with child CHD diagnosis. Other factors, including a history of abortion, consanguineous marriage, exposure to radiation during pregnancy, maternal past diseases, and commitment to multivitamin use, did not display a statistically significant correlation at the 0.05 level.

Table 4: Correlation between the maternal risk factors and child CHD diagnosis

Variable	Chi-square (χ2)	*P*-value
Mother BMI	**84.02***	**0.006**
History of abortion	**13.21**	**0.779**
Consanguineous marriage	**16.62**	**0.549**
Periconceptional smoking	**29.10***	**0.040**
Radiation during pregnancy	**13.90**	**0.735**
Maternal past disease	**20.06**	**0.585**
Are you committed to folic acid?	**51.18***	**0.048**
Are you committed multivitamins?	**45.24**	**0.139**

*** Correlation is significant at the 0.05 level**

Discussion

The current study found that atrial septal defect (ASD) was the most commonly diagnosed congenital heart defect (CHD) in children. However, globally, ventricular septal defect (VSD) is considered the most prevalent CHD, as reported by Zhao *et al.* (2019) in China and AL-Ammouri, Ayoub and Tutunji (2018) in Jordan.

In our study, no significant correlation was found between maternal age and the prevalence of CHD, which aligns with Ahmadi *et al.* (2020) who conducted a similar study on Iranian women and also found no relationship between maternal age and CHD. However, this contrasts with the findings of Abqari *et al.* (2016), who identified a positive association between maternal age and heart defects.

We observed that the risk of CHD increased in newborns with low birth weight (LBW), supporting Yan *et al.* (2022) in China, who reported a higher frequency of CHDs in very low birth weight (VLBW) and LBW infants compared to the general population. Similarly, Elshazali, Elshazali and Elshazali (2017) noted that infants with CHD tend to have low or very low birth weights more frequently.

A significant association was also found between a family history of CHD and the likelihood of CHD in the child, consistent with the findings of Peyvandi *et al.* (2014) in the U.S., who noted that having a sibling or parent with a conotruncal cardiac defect increases the risk of CHD compared to the general population. Moreover, our study identified a significant association between maternal BMI and CHD diagnosis, which is in line with Ahmadi *et al.* (2020), who also reported a strong link between maternal BMI and CHD risk.

Although we did not find a significant correlation between a history of abortion and child CHD diagnosis, Ahmadi *et al.* (2020) reported a substantial association. Additionally, our study found no significant relationship between consanguineous marriage and child CHD diagnosis, which is consistent with Abqari *et al.* (2016), though contrary to Ahmadi *et al.* (2020), who found a significant association between them.

As expected, prenatal radiation exposure did not increase the risk of CHD in our study, aligning with the findings of Ahmadi *et al.* (2020). We also did not observe a significant correlation between maternal past diseases and child CHD diagnosis, which contrasts with Ahmadi *et al.* (2020).

Finally, irregular folic acid supplementation was significantly associated with CHD diagnosis in our study, as also noted by Abqari *et al.* (2016). However, we could not establish a strong link between irregular multivitamin use and CHD diagnosis, which contrasts with the findings from Abqari *et al.* (2016) in India, where a lack of multivitamin use was associated with CHD.

Limitations

Data are not fully represent the true prevalence of CHD in Palestine, as it was collected exclusively from the West Bank and there a difficulties in finding participants due to repetition of cases in the same hospital and the early closure of pediatric cardiac clinic. Most of the mothers did not receive continuous antenatal care. The assessment of risk factors relied on a questionnaire rather than recognized evidence, which may increase the risk for bias.

Conclusion

This paper is the first of its nature in the West Bank, and reveals various risk factors associated with children with CHD with ASD being the dominant case. Hence, there is need to enhance the premarital and prenatal data processing and counselling; effective handling of maternal health disorders; and awareness on CHD risk factors. It was therefore deemed necessary that health education, research and training be directed towards the goal of CHD risk reduction in Palestine.

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List of abbreviations

Abbreviation	Definition
CHD	Congenital Heart Diseases
ASD	Atrial septal defect
VSD	Ventricular Septal Defect
SPSS	Statistical Package for the Social Sciences
G	Gram
LBW	low birth weight
Mg	Milligram
VLBW	Very low birth weight
BMI	Body mass index
CDC	Centers for Disease Control and Prevention

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