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Demographic Aspects of Congenital Heart Disease in Fallujah Maternity and Children Hospital, Fallujah City, Anbar, West of Iraq

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Congenital heart diseases (CHD) are major global health problem .Several maternal and fetal risk factors have been mentioned to be associated with the development of CHD , though different epidemiological patterns observed in different parts of the world , our study is aiming to demonstrate the descriptive characteristics of a group of children in Fallujah Maternity and Children Hospital (FMCH) diagnosed with (CHD) .
Materials and Methods: This is a prospective study, conducted at the Birth Defect Unit in Fallujah Maternity and Children Hospital. One thousand twenty five pediatric patients for 1018 mothers (14 of them are twins) where investigated, those were admitted to the newborns and children's wards

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and diagnosed as cases of CHD during the period from 1/12/2018 to 30/9/2022 . All the data collected by interviewing the patients' guardians following a registration and questionnaire form including variables and factors related to the child like name, sex, birth weight, type of the CHD ,presence of other associated anomalies, and the mother's variables like name, age and occupation , degree of consanguinity between the parents, history of previous births with congenital CHD or any other congenital anomaly, type of pregnancy (singleton or twins), presence of chronic maternal disease, history of exposure during pregnancy to fever, X-ray irradiation or harmful drug use or toxic encounter ,beside the number of previous abortions (if any), residence of the family (rural or urban).

Results: ASD had the highest encounter, accounting for 72% of the total number, followed by VSD (25%), PDA (21%), PPH (8.8%), TOF (4%), D-TGA (2.7%), and CAVC (2%). Other defects were less frequent. Of all children investigated, 47% were aged 1-28 days, 35% were 29 days -12 months old, 7% were 13 months – 5 years old at the time of diagnosis, and 11% were more than 5 years old. The male/female ratio was 1.2/1, and 0.2% of all participants had an ambiguous gender. Regarding birth weight, 58% weighed ≥ 2.5kg, while 42% weighed < 2.5kg. Only 20% had a previous family history of CHDs, and 8% had a family history of other different congenital anomalies. Of all the patients included in the study, 7% were born with other congenital abnormalities in addition to their CHD. About 15% of the total number were born with ≥ 4 or more defects, 9% were born with 3 defects, 29% with 2 defects, and 47% were diagnosed with a single heart defect. Regarding the ages of mothers at birth of the diseased children, 52% were 14 to 30 years old, while 38% were 31 to 40 years old, and only 10% of the total number of investigated mothers were more than 40 years old. Consanguineous marriage was reported in 76% of all cases. The defects were more frequently reported in the age period of 1-28 days old except for CAVC (AVSD), which had an equal incidence during the first 28 days and the first year of age.

Conclusion: Congenital heart diseases are causing ever-increasing concern in Fallujah city. Therefore, it is necessary to implement preventive strategies for modifiable risk factors, monitor high-risk pregnancies, and raise awareness about the importance of genetic counseling, especially for those with a family history of congenital anomalies in general, and congenital heart diseases, in particular. On the other hand, the cardiology department in the hospital needs more attention from the authorities to enhance its capacity and capabilities to accommodate more patients and improve the diagnostic and therapeutic tools. Conducting more research studies is necessary to investigate the reasons behind the striking increase in the number of newborns diagnosed with congenital heart defects in the last few years.

Keywords: Congenital heart disease; frequency; Fallujah; Anbar; Iraq.

ABBREVIATIONS

ASD = Atrial septal defect
VSD = Ventricular septal defect
PDA = Patent ductus arteriosus
PPH = Primary Pulmonary hypertension
TOF = Tetralogy of Fallot
D.TGA = D-Transposition of great arteries
L-TGA = Levotransposition of great arteries
CAVC = Common atrioventricular canal
AVSD = Atrioventricular septal defect
PS = pulmonary stenosis
BAV = Bicuspid aortic valve
AS = Aortic stenosis
AR = Aortic regurgitation
MR = Mitral regurgitation
MS = Mitral stenosis
LVOTO = Left ventricular outflow tract obstruction
AVSD = Atrio-ventricular septal defect
DORV = Double outlet right ventricle
TV = Tricuspid valve
TAPVR = Total anomalous pulmonary venous return
COA = Coarcitaion of the aorta
HLHS = Hypoplastic left heart syndrome
IUD = Intra Uterine death
DDH = Developmental Dysplasia of the Hip
DS = Down syndrome
M/F = male/female
FGH = Fallujah General Hospital
FMCH = Fallujah Maternity and Children Hospital

1. INTRODUCTION

Congenital heart diseases (CHD) are one of the most common congenital diseases in newborns. They have a significant impact on morbidity, mortality, and healthcare costs in children and

adults. In fact, about 30% of infants dying at birth have some type of CHD [1,2]. The pattern of CHDs is different in various geographic locations, and the prevalence of CHD has been reported to be different around the world. The global prevalence of CHD among newborns ranges from approximately 3.7 to 17.5 per 1,000 births, which accounts for 30-45% of all congenital defects. Continental variations in birth prevalence have been reported, from 6.9 per 1,000 births in Europe to 9.3 per 1,000 in Asia [3]. There is little conclusive evidence on the specific cause of many structural CHDs, and collectively they are quite heterogeneous. Current research implicates a combination of genetic, epigenetic, and environmental factors as causative mechanisms underlying CHDs [4]. A link to the immune system has not been well-defined; however, there is a clear association, as evidenced by an increased risk of these children contracting and experiencing severe complications from common infections. Clinical studies have shown a reduced cellular immune response to infection and increased pro-inflammatory cytokine levels among children with structural CHDs which indicates that the immune system may be a dynamic partner in the development of complications from CHDs [5,6,7]. CHD is often divided into two types: Cyanotic (blue skin color caused by a lack of oxygen), including Ebstein anomaly, Hypoplastic left heart syndrome (HLHS), Pulmonary atresia, Tetralogy of Fallot (TOF), Total anomalous pulmonary venous return (TAPVR), Transposition of the great vessels (TGA), Tricuspid atresia, Truncus arteriosus, Double outlet right ventricle (DORV), and Non-cyanotic, including Aortic stenosis (AS), Bicuspid aortic valve (BAV), Atrial septal defect (ASD), Atrioventricular canal (endocardial cushion defect), Coarctation of the aorta (COA), Patent ductus arteriosus (PDA), Pulmonic stenosis, and Ventricular septal defect (VSD). The most common CHD has been ventricular septal defect, followed by atrial septal defect, patent ductus arteriosus, tetralogy of Fallot, single ventricle, atrioventricular septal defect, and double outlet right ventricle [4].

The warning signs of congenital heart disease in infants and children may include a heart murmur or abnormal heart sound, cyanosis (a bluish tint to the skin, fingernails, and/or lips), fast breathing, anorexia, poor weight gain, an inability to exercise, and excessive sweating [4,8]. In this study, we made specific efforts to detect all possible cases of CHDs by examining patients admitted to the neonatal and pediatric wards suspected to have CHDs in the pediatric cardiology clinic in our hospital, which was established in late 2018 and operates one day a week.

CHD is the most common congenital anomaly in Fallujah, with a prevalence of 19.7 per 1000 live births, making it the first most common congenital anomaly [6,7,9].

2. MATERIALS AND METHODS

This prospective descriptive study was conducted at the Birth Defect Unit in Fallujah Maternity and Children Hospital. The unit is comprised of a fetal medicine clinic, clinical genetics clinic, pediatric cardiology clinic, chromosomal laboratory, and a unit for registration, documentation, data analysis, and research studies. Several research studies and case reports have been issued by the unit, all of which confirm a significant increase in the incidence and severity of birth defects in children born after 2005.

The study enrolled patients who were admitted to the newborn and children's wards and were diagnosed with CHD between December 1, 2018, and September 30, 2022.

All children suspected of having CHD underwent a comprehensive evaluation using trans-thoracic echocardiography, which included M-mode, two-dimensional, color, pulse Doppler, and continuous wave echocardiogram with a GE Vivid 5 echo machine. The echocardiogram was performed by a consultant pediatric cardiologist at the pediatric cardiology clinic, which operates one day a week.

The data collected were obtained through face-to-face interviews with the parents or one of their first-degree relatives, using a registration form that included variables and factors related to the child, such as name, sex, birth weight, type of CHD, and presence of other associated anomalies. The form also included variables related to the mother, such as name, age, occupation, degree of consanguinity between parents, history of previous births with congenital CHD or other anomalies, type of pregnancy (singleton or twins), presence of chronic maternal disease, history of exposure during pregnancy to fever, X-ray irradiation, or harmful drug use, number of previous abortions, and family residence (rural or urban).

3. RESULTS

This descriptive study aimed to determine the characteristics of a group of children with CHDs and their maternal conditions during pregnancy. A total of 1025 children born to 1018 mothers (14 were twins) were investigated. Categorical variables were reported as frequencies and percentages, and the baseline characteristics of the patients are presented in Table 1. Of the children investigated, 486 (47%) were aged 1-28 days, 357 (35%) were 29 days to 12 months old, 73 (7%) were 13 months to 5 years old at diagnosis, and 109 (11%) were over 5 years old. Males comprised 53.9% of all participants, while females accounted for 45.9% and only 0.2% were of ambiguous gender. With regards to their birth weight, 58% weighed ≥ 2.5kg while 42% weighed < 2.5kg. Singletons and twins accounted for 96% and 4%, respectively.

Among the one thousand twenty five children enrolled in this study, only 20% had a previous family history of CHDs and 8% had other different congenital anomalies. Seven percent of them were born with other associated congenital defects in addition to their CHD. The largest group of children involved in the study (53%) were born with more than one heart defect. About 15% of the total number were born with ≥ 4 or more defects, 9% were born with 3 defects, 29% with 2 defects, and 47% were diagnosed with a single heart defect.

The majority of mothers (52%) were aged between 14 and 30 years at the time of delivery of their child with CHD. About 38% of the 1018 mothers were aged between 31 and 40 years, while only 10% were over 40. Consanguineous marriage was reported in 76% of cases, with 33% being first cousins and 43% being distant marriages. About 96% of the mothers were housewives, 2% were employed, and 2% were students. Of the 1018 families, 58% resided in urban areas, while 42% were from rural areas. During pregnancy, 5% of the mothers had a history of fever, and only 0.1% reported exposure to X-ray irradiation and harmful drugs. Hypertension during pregnancy was reported in 13% of mothers, 2% had diabetes mellitus, and 1% had both hypertension and diabetes. Additionally, 0.4% of all mothers were known cases of epilepsy and were using antiepileptics, 0.2% were cases of hypothyroidism and were on thyroxine therapy, and 0.1% were known to have SLE and sickle cell anemia (refer to Table 2).

ASD was the most frequent isolated and combined defect in 68% of the study population followed by VSD (25%) ,PDA (21%) , PPH (8%), TOF(4%), D-TGA (2.7%), L-TGA(3%) , CAVC (2%) ,PS (1.6%) , P V atresia , BAV (1.8%) ,Dextrocardia (1.4%) and other less frequent defects were all shown in Table 3 in frequency and percentage.

Age distribution of the most frequent heart defects in the study sample is shown in (Table 4).

The frequency of all the defects was found to be higher in the age range of 1-28 days, except for CAVC which was reported in equal percentages during both the 1st 28 days and the 1st year of age. In this study, ten TOF cases who were above 2 years of age were presented for follow-up after total correction. Only one case was corrected at the age of 1 year, and the other was corrected at the age of 10 months, both of which were also presented for follow-up and reported in this study. A previous family history of CHDs was reported in 20% of all the patients involved in this study, and 7.6% of the patients had reported other congenital anomalies and diseases as shown in Table 5.

Apart from congenital heart defects, 72 patients (7% of the total population in the study) were also found to have associated anomalies. Down syndrome was the most common anomaly, reported in 46 patients (4.5%). Other less frequent anomalies are shown in the frequency and percentage table below (Table 6).

Among the patients with Down syndrome in this study, single heart defect was diagnosed in only 35%, while 41% were found to have two defects, and 24% had three heart defects (see Table 7 for details).

In our study, the most common congenital heart defects observed in children with Down syndrome were ASD, accounting for 72% of cases, followed by PDA (35%), VSD (30%), PPH (24%), CAVC (13%), TOF (9%), MR (4%), and AR (2%). Table 8 provides a detailed breakdown of these findings.

4. DISCUSSION

Our study found that ASD was the most common congenital heart defect, accounting for 72% of all cases. This finding is consistent with a previous study conducted at Fallujah General Hospital by

Mohammed Tafash Dagash et al. [6] (2008-2011), except for one year when VSD was the most frequent. Similar results were reported in two other Iraqi provinces, Sulaimani in 2017 and Mosul in 2015 [7,9]. However, studies conducted in Ramadi, Baghdad, and Basrah found that VSD was the most frequent [10,11]. In Iran in 2008, ASD was also the most frequent defect, but in Jordan, Saudi Arabia, Turkey, Alexandria in Egypt, Oman, and Mysore hospitals in India, VSD was the most common [12,13,14,15,16,17, 18,19].

Our study also found that 54% of ASD cases were diagnosed in children aged 1-28 days, with 34% diagnosed between 29 days to 1 year old. Children above 5 years of age accounted for 9% of the total number, while only 3% of ASD cases were reported in children aged 13 months to 5 years old.

In addition, our study found that VSD was the second most frequent defect, accounting for 25% of all cases, followed by PDA (21%), PPH (8.8%), TOF (4%), D-TGA (2.7%), and CAVC (2%). This sequence was similar to that reported in the Mosul study but differed from the Fallujah General Hospital study and all other previously mentioned Iraqi studies.

Furthermore, about 7% of our patients had other associated congenital anomalies, with Down syndrome being the most frequent, reported in 4.5% of the total number. Of these cases, 65% had 2-3 cardiac defects, while only 35% had a single heart defect. Congenital heart defects are a leading cause of mortality and morbidity during the first two years of life in the Down syndrome population. Studies have shown that 40% to 60% of Down syndrome patients have CHD, with left-to-right shunt lesions predominating [20,21,22,]. In our study, the most common CHD types reported in Down syndrome cases were ASD (72%), PDA (35%), VSD (30%), PPH (24%), AVSD (24%), and TOF (9%). MR (4%) and AR (2%) were reported in only a small percentage of Down syndrome cases. These findings differ from those reported in Nigeria, where complete AVSD was the most frequent type of CHD in Down syndrome children. Higher proportions of complete AVSD among Down syndrome children were also reported in studies conducted in Kano, Nigeria; Morocco; Algeria; and Turkey [23,24, 25,26].

In this study, there was little difference in the gender distribution, with a male/female ratio of 1.2/1, consistent with previous studies in Basra, Fallujah, Sulaymaniyah, Ramadi, and Baghdad. However, the M/F ratio was higher in Mosul at 1.4/1. Out of 14 babies, 7 twins were reported to have congenital heart defects. Around 58% of children had a normal birth weight of 2.5 kg or more, which was lower than in Sulaymani at 68.8%.

Consanguineous unions can increase the risk of inherited susceptibility genes and potentially lead to disease [27], and in this study, 20% of children had a previous family history of CHD. Parental consanguinity was reported in 76% of the study population, with 33% being cousins. This is different from the Sulaimani study, where consanguinity was reported in about 41.8% of the study sample.

In terms of maternal variables, around 52% of mothers were under 30 years old at conception, 38% were between 31-40 years old, and only 10% were over 40, similar to findings in other studies. The majority of mothers in this study were housewives (96%), similar to a previous study on congenital malformations in the hospital. Only 2% were working women.

Regarding maternal risk factors during pregnancy, 5% of all women reported a history of fever, and only 0.1% had a history of harmful drug use and x-ray radiation, which were lower than those reported in the FGH study. Out of 1,018 mothers, 13% had a history of hypertension, 2% had diabetes mellitus, and only 1% reported having both hypertension and diabetes, which were lower than the percentages reported in the Mosul study. Other less common diseases were reported in 0.4% of all cases.

Previous abortions were reported in 25% of cases, which was lower than in the FGH study. In terms of family residence at the time of child birth, 58% were urban and 42% were rural, similar to the Sulaimani study.

Table 1. Child variables associated with congenital heart defects in Fallujah maternity and Children Hospital in number and percentage of the total number of study sample

Child's variable	No.	Percentage% of the total (1025)
Age		
1-29day	486	47
1-12months	357	35
13months-5years	73	7
>5years	109	11
Gender		
Male	552	53.9
Female	471	45.9
Ambiguous	2	0.2
Birth wt		
≥2.5kg	594	58
<2.5kg	431	42
Pregnancy type		
Singleton	989	96
Twin	36	4
Family history of CHD		
Yes	78	8
No	947	92
Presence of other congenital anomalies		
Yes	73	7
No	952	93
No. of children born with		
Single heart defect	486	47
2 heart defects	295	29
3 heart defects	87	9
≥4 heart defects	157	15

Table 2. Maternal variables associated with congenital heart defects in Fallujah maternity and Children Hospital in number and percentage of the total number of study sample

Maternal variable	No.	Percentage% of the total (1018)
Maternal age at pregnancy (yr)		
14-30	532	52
31-40	384	38
>40	103	10
Maternal occupation		
Housewives	976	96
Employed	24	2
Student	18	1.8
Presence of paternal consanguinity		
Cousins	340	33
Distant marriage	439	43
Consanguinity -ve	239	24
Maternal exposure during pregnancy to		
fever	48	4
x.ray irradiation	1	0.1
Harmful drug use	1	0.1
Maternal chronic illness		
Hypertension	135	13
Diabetes mellitus	22	2

Maternal variable	No.	Percentage% of the total (1018)
Hypertension & diabetis	10	1
Epilepsy	4	0/4
Hypothyroidism	2	0.2
SLE	1	0.1
Sickle cell anemia	1	0.1
Presence of abortion or IUD		
1 abortion	109	10
2 abortions	85	8
3 abortions	32	3
≥abortions	22	2
1 IUD	5	0.5
Residence of the family		
Urban	586	58
Rural	432	42

Table 3. Frequency & Percentage (%) of Different types of congenital Heart Disease in the Study population

Variable		No.& percentage% of the total (1025)
ASD	isolated	403(39)
	+ other defects	295(29)
	total	695(68)
VSD	isolated	55(5)
	+ other defects	202(20)
	total	257(25)
PDA	isolated	5(0.5)
	+ other defects	207(20)
	total	212(21)
PH	isolated	1(0.1)
	+ other defects	89(8.7)
	total	90(8.8)
TOF		41(4)
D-TGA	isolated	1(0.1)
	+ other defects	27(2.6)
	total	28(2.7)
L-TGA		3(0.3)
CAVC		20(2)
PS	isolated	10(1)
	+ other defects	6(0.6)
	total	16(1.6)
PV atresia		14(1.4)
Dextrocardia	with situs inversus	4(0.4)
	With multiple heart defects	10(1)
	total	14(1.4)
BAV	isolated	11(1.1)
	+ other defects	7(0.7)
	total	18(1.8)
AS		9(0.9)
MR		21(2.1)
MV atresia		5(0.5)
MS		4(0.4)
LVOTO		9(0.9)
T V atresia		6(0.6)
T V dysplasia		2(0.2)

Variable		No.& percentage% of the total (1025)
Single ventricle	isolated	1(0.1)
	+ other defects	5(0.5)
	total	6(0.6)
TAPVR		4(0.4)
COA	isolated	2(0.2)
	+ other defects	2(0.2)
	total	4(0.4)
HLHS		9(0.9)
Truncus Arteriosus		2(0.2)
Cor-tri-Atriatum		1(0.1)
Common atrium		2(0.2)

Table 4. Age distribution of the most frequent heart defects in the study sample in no. & percentage % of the total no. of each defect

Heart Defect	Total No.	1-28 days old		29days-12months		13months-5years		> 5years	
		No.	%	No.	%	No.	%	No.	%
ASD	**698**	376	54	236	34	22	3	64	9
VSD	**257**	116	45	102	40	21	8	18	7
PDA	**212**	142	67	36	17	3	1	31	15
PPH	**90**	48	53	32	36	2	2	8	9
TOF	**41**	10	24	11	27	14	34	6	15
D.TGA	**27**	12	44	7	26	5	19	3	11
CAVC	**20**	9	45	9	45	1	5	1	5

Table 5. Types of previous congenital anomalies (diseases) in the families of children involved in this study in number & percentage of the total

Congenital anomaly	No.	Percentage % of the total (1025)
Congenital heart disease	205	20
Congenital brain atrophy	25	2.4
Down syndrome	16	1.6
Skeletal anomalies	8	0.8
Cleft lip	4	0.4
Eye abnormalities	4	0.4
Cleft palate	3	0.3
Spina bifida	3	0.3
Multiple congenital anomalies	3	0.3
Hydrocephaly	2	0.2
Congenital hypotonia	2	0.2
Thalassemia major	2	0.2
Congenital goiter	1	0.1
Omphalocele	1	0.1
Cleft lip & palate	1	0.1
Microcephaly	1	0.1
Esophageal atresia	1	0.1
Inborn errors of metabolism	1	0.1
Total	283	27.6

Table 6. Frequency & percentage of the other associated congenital anomalies in the study sample

Congenital anomaly	No. of children	Percentage % of the total (1025)
Down syndrome	46	4.5
Dysmorphic features	4	0.4
Cleft palate	3	0.3
Diaphragmatic hernia	2	0.2
Metatropic dysplasia	2	0.2
Holt Oram syndrome	1	0.1
Cleft lip & palate	1	0.1
Syndactyly	1	0.1
Marfan syndrome	1	0.1
Achondroplasia	1	0.1
Omphalocele	1	0.1
William syndrome	1	0.1
Spina bifida	1	0.1
Edward syndrome	1	0.1
Turner syndrome	1	0.1
Congenital brain atrophy	1	0.1
Microphthalmia	1	0.1
DDH	1	0.1
Multiple congenital anomalies	1	0.1
Total	72	7

**DDH = Developmental Dysplasia of the Hip*

Table 7. Distribution of heart defects no. in children with Down syndrome

No. of heart defects	No. of children	Percentage% of total no.(46)
Single defect	16	35
Two defects	19	41
Three defects	11	24

Table 8. The most frequent types of congenital heart defects in No. & percentage of the total in children with Down syndrome in the study sample

Heart defect	No. of patients	percentage % of the total(46)
ASD	33	72
PDA	16	35
VSD	14	30
PPH	11	24
CAVC	6	13
TOF	4	9
MR	2	4
AR	1	2

5. CONCLUSION AND RECOMMENDATIONS

Congenital heart defects remain a significant problem in Fallujah, as evidenced by this study and previous reports. However, conducting research studies on congenital malformations remains challenging due to the poor and unreliable registration system. Thus, it is crucial to establish strict rules and procedures to improve the health registration and statistical system. Furthermore, efforts should be made to provide preventive strategies for modifiable risk factors, monitor high-risk pregnancies, and raise awareness about the importance of genetic counseling, particularly for those with a family history of congenital anomalies in general and congenital heart diseases in particular. Additionally, the cardiology clinic in the hospital must be supported with more pediatric cardiologists and sufficient facilities to handle cases that require more invasive diagnostic

and therapeutic measures. Finally, it is recommended that more research studies be conducted to investigate the underlying causes behind the marked increase in the number of newborns with congenital heart defects in recent years.

6. LIMITATIONS OF THE STUDY

1. A major limitation of this study is the lack of a healthy control group, which could have led to bias in the data.
2. Another limitation is the relatively small sample size (1025). A larger sample size could have resulted in more accurate reporting of frequencies.
3. The study only included hospitalized children during the study period, as the cardiology clinic operates only one day per week. This may have resulted in important cases being missed.
4. The study was also limited by a poor registration and documentation system.

CONSENT

As per international standard or university standard, patient(s) written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

This study was granted ethical approval by the scientific committee at Fallujah Maternity and Children Hospital.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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