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PATTERN of CONGENITAL HEART DISEASES AMONG CHILDREN IN SANA'A-CITY, YEMEN

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AS	Aortic stenosis
ASD	Atrial septal defect
AV	Atrioventricular
AVSD	Atrioventricular septal defect
CHD	Congenital heart disease
COA	coarctation of the aorta
PDA	patent ductus arteriosus
PA	Pulmonary artery
PS	pulmonary stenosis
RV	right ventricle
TAPVR	total anomalous pulmonary venous return
TGA	transposition of the great arteries
TOF	tetralogy of Fallot
VSD	Ventricular septal defect
PFO	Patent foramen ovale

Abstract

Congenital heart disease (CHD) is the most common birth defect among children worldwide. due largely to rapid advances in diagnostic imaging, medications, catheter techniques, and surgical interventions, the mortality rate for CHD has decreased globally. In Yemen, most of the previous studies that describe the pattern of CHD were conducted using retrospective design. This study aimed to assess the pattern of CHD among Yemeni children in Sana'a Yemen as well as describing the factors that associated with CHD. A prospective cross-sectional study was conducted among pediatric age group in Sana'a city. Association between CHD and patients and maternal sociodemographic was assessed using chi-square. Results: A total of 237 CHD cases were collected. The majority of patients were male (52.7%, n = 125) infant (51.7, n =123) who reside in the urban area (49.6 %, n= 118). Down syndrome was diagnosed among 6.3% (n = 15). Regarding the pattern of CHD, PFO was the most fluently encountered (21.4, n = 51) among children in Sana'a, followed by isolated VSD (19.7%, n= 47) then isolated (18.1%, 43), then isolated ASD (17.6%, n=42). Patients' age, maternal age, maternal use of contraception, failure to thrive, and residency of the family were significantly (*P* value < 0.05) associated with PFO and VSD. Cyanosis was significantly associated with tetralogy of fallot (P value < **0.029**), pulmonary stenosis (P value = **0.026**). Heart murmur was significantly associated with tetralogy of fallot (P value < **0.038**), Complex CHD (P value = **0.003**).

Conclusion: PFO, VSD, ASD are the most prevalent CHD among children in Sana'a. Factors related to patients and mother are significantly associated with CHD. A large-scale study is needed to assess other factors that have association with CHD in Yemen

Keywords: Congenital heart disease, children, Sana'a, Yemen

Chapter 1: Introduction

Congenital heart disease (CHD) is a permanent disorder in the structure and function of the heart that is present from birth, affects the heart or nearby major blood arteries or both, and can be present at birth or later in life (Chelo et al., 2016, Tantchou Tchoumi et al., 2011).

The abnormal development of structures in the early stages of embryonic or early fetal development are the most common causes of these abnormalities (Suluba et al., 2020). Depending on their physiology, the deficiencies might be classed as cyanotic or acyanotic (van der Linde et al., 2011a).

CHDs have traditionally been classified as cyanotic or acyanotic depending on whether they cause cyanosis. Tetralogy of Fallot (TOF), transposition of the great arteries (TGA), and Ebstein's anomaly are all cyanotic lesions. Ventricular septal defect (VSD), atrial septal defect (ASD), patent ductus arteriosus (PDA), pulmonary stenosis (PS), aortic stenosis (AS), and coarctation of the aorta (COA) are all examples of acyanotic lesions (Brickner et al., 2000).

Epidemiology of CHDs varies from period to period, area to area and region. The prevalence ranges from 1.07 percent to 4.4 percent worldwide. In some of these countries, the establishment of a congenital anomaly registry or surveillance has allowed for improved monitoring of epidemiological trends and the establishment of preventive procedures (Springett et al., 2014) .Every year an estimated7.9million children are born with serious birth defect of genetic or partially genetic origin (Ndibazza et al.,2011) The proportion of neonatal mortality due to these defects increased from 3% in 2008 to 4.4% in 2013(Liu et;2015,oestergaard et al.,2011). Unfortunately, more than 90% of congenital anomalies occur in low- and middle-income countries (Sitkin et al ;2015). According to the American Heart Association, ASD, VSD, TOF, PDA, PS, AS, COA, and atrioventricular septal defect together account for 85% of all CHD's (Mozaffarian et al., 2015). In Yemen, even if children are not

the immediate casualties of the war. They are also hit the hardest by its indirect result. Women who become pregnant during period of war in Yemen have given birth in deplorable conditions as the pregnancy occurred in difficult conditions presented by no proper medical care ,lack of proper food and water services ,pollution of environment with war remains (chemical materials) in addition to devastated of country economy and increase of poverty among Yemeni population ,all these factors leading to increase numbers of babies born with congenital anomalies in addition to mothers had given birth of premature , malnourished and low birth weight babies .

Etiology, Sudden cardiac death in children can have a variety of causes, and there are even more underlying factors for the development of CHDs. Drugs and their potential for causing teratogenic effects. Also, maternal cigarette smoking during pregnancy is a significant risk factor for CHDs; additionally, maternal diabetes mellitus is another risk factor linked to foetal development of CHD; and genetic factors, specifically some aneuploidies and gene mutations, are another notable cause of CHD development. The most frequent chromosomal anomaly linked to CHD is trisomy 21 (Down's syndrome)(Cooper et al., 2006, Hartman et al., 2011, Negrato et al., 2012, Springett et al., 2014, Sullivan et al., 2015).

1.1 Justification of study

Congenital heart disease is the most common congenital disorder in newborns. Every year, around 1.35 million live babies are diagnosed with CHD around the world (Van Der Linde et al., 2011b). After introduction of echocardiography, which lead to better diagnosis and detect milder form of CHD, the incidence of CHD increases to eight to 12 per 1 000 live births instead of five to eight per 1000 live births (Hoffman, 2013).

In a systematic analysis of the Global Burden of CHD in 195 countries from 1990 to 2017 showed that most deaths occurred in countries in the low and low-middle socio-demographic

Index quintiles and 69% of the mortality occurred among infants younger than 1 year (Zimmerman et al., 2020). A global estimate of nearly 12 million people living with congenital heart disease in 2017. As top-ranking causes of infant mortality, congenital heart disease is likely to continue to increase in the years to come (Zimmerman et al., 2020, Hoffman, 2013). The study showed that middle east region was among the highest infant mortality due to CHD.

Evidence from global burden analysis found that countries with high fertility rates have more children with congenital heart disease and this burden fell most heavily on countries with the lowest incomes and the highest fertility rates. The burden might have greater impact of mortality in the presence of comorbidities, such as malnutrition, malaria, diarrhea, measles, pneumonia and rheumatic fever (Hoffman, 2013, Argent et al., 2017).

Yemen is categorized by world bank as a low-income with a high fertility rate (bank, 2022). Besides, it was classified by World health organization as a high malaria endemic zone (WHO, 2021). Moreover, in the last few years, Yemen suffered from a continuous civil war, leading to increase malnutrition, poverty, and unemployment. These factors are predisposing Yemeni infant for congenital heart lesion.

In Yemen, two retrospective studies were conducted to explore the pattern of congenital heart lesions among children. The findings of these studies showed that the most common three pattern of acyanotic congenital heart disease were Ventricular septal defect, followed by atrial septal defect and patent ductus arteriosus. Whereas tetralogy of fallot (TOF) was the most common cyanotic congenital heart lesions (Al-Wather and Munibari, 2013, Yehya et al., 2022). However, no prospective study was conducted to explore the pattern of congenital heart disease and their predictors

1.2 Objectives:

1.2.1 General:

The aim of this study to assess the pattern of congenital heart disease among children in Sana'a city

1.2.2 Specific Objectives:

1-To estimate the proportion congenital heart disease pattern among children at Sana'a city

2- To describe the characteristic variables of respondents in the study.

3. To determine the risk factors associated with CHD among pediatric age group.

Chapter 2: Literature Review

2.1 An Overview of Congenital Heart Disease

Congenital heart disease is a large and rapidly growing global problem in child health. It is the most common birth defect and is a major cause of infant morbidity and mortality across the globe (Rossano, 2020). In the last few decades, there have been major breakthroughs in cardiovascular care such as improvements in diagnosis and surgical treatment leading to considerable increases in the survival of newborns with CHD in high-income countries. This, however, has not been the case in many LMICs where the burden of CHD is heaviest and rates of death and disability continue to rise(Sheila, 2022).

Unfortunately, most of the data about CHD globally are extrapolated from HICs, and quality regional data from LMICs are lacking. Adequate documentation of the burden of CHD in LMICs is essential to drive a policy shift towards increasing access to high quality care for children with CHD (Zimmerman and Sable, 2020).

2.2 Patterns of CHD in Pediatric Patients during Acute Phase Hospitalization

In Sudan, Abdurrahman and Diab (2022) performed a cross-sectional observation study to determine patterns of CHD in pediatric patients. They reviewed medical records of 596 CHD patients from selected pediatric hospitals in Khartoum State seen over a two-year period using a checklist. Results indicated that ventricular septal defect (VSD) was the most commonly occurring lesion (26.6%), followed by tetralogy of fallot (TOF; 14.1%) and then patent ductus arteriosus (PDA; 10.6%). The most common combined anomalies were transposition of great arteries (TGA) and patent foramen ovale (PFO) at 9.1% (Abdelrahman and Diab, 2022).

Similarly, a retrospective study was conducted at the Ugandan Heart Institute in Mulago Hospital to examine the patterns of CHD among admitted pediatric patients between 2007 and

2014. Results showed that of 4,621 children seen at the hospital during the study period, 76.3% had CHD with 55% of these being females. From the findings, isolated ventricular septal defect was the most common CHD diagnosed -27.2% followed by patent ductus arteriosus - 22% and atrial septal defects (ASD) - 9.4%). Tetralogy of fallot (TOF) and Truncus arteriosus were the most common diagnosed cyanotic heart defects at 7% and 5%, respectively (Namuyonga et al., 2020).

A retrospective study carried out in Ghana also assessed the patterns of diagnosed CHD in a local tertiary health facility. Electronic health records from the hospital's pediatric unit for the period January 2018 to October 2019 were reviewed and analysed. Results showed that from the over 10,000 records reviewed, 79 CHD cases were recorded with a male to female ratio of approximately 1:1. Most (77.2%) of the diagnoses were in children aged below 5 years. Ventricular septal defects (VSD) and patent ductus arteriosus (PDA) were the most common acyanotic CHD diagnosed while Tetralogy of Fallot was the most common cyanotic CHD lesion seen (Thomford et al., 2020).

In a study conducted in Nigeria, Abah et al. (2018) evaluated the spectrum of cardiac diseases among paediatric patients in one of the local tertiary hospitals. They undertook a retrospective review of all pediatric patients seen in the paediatric unit of Benue State University Teaching Hospital from June 2012 to December 2015. Data were analyzed using descriptive statistics using Microsoft Excel. Results showed that of the 8,590 patients seen, 39 had cardiac diseases, with 28(71.8%) of the 39 having CHD. The most prevalent type of CHD was acyanotic CHD (53.8%). Ventricular septal defect (VSD) accounted for most of the cases at 72%.

An empirical study performed in India assessed the pattern of CHD among pediatric patients using echocardiography. Four hundred and thirty CHD cases with a male to female ratio of 1.3:1 were analyzed. Results showed that about 67% of the patients had acyanotic CHD while

33% had cyanotic CHD lesions. The most common acyanotic CHD was ventricular septal defect followed by atrial septal defect and patent ductus arteriosus. The most common cyanotic CHD was TOF followed by transposition of great vessels, total anomalous pulmonary venous connection and single ventricle. The study concluded that VSD and TOF were the most common acyanotic and cyanotic CHD, respectively (Meshram and Gajimwar, 2018).

A prospective descriptive study performed in Iraq sought to establish patterns of CHD in children in the city of Karbala. Children, aged below 5 years, with a confirmed diagnosis of CHD seen in the Pediatric echo-cardiac clinic in Karbala Pediatric Teaching Hospital between October 2011 and October 2012 were enrolled. Data. A total of 110 children were included. The male to female ratio was 1:1.6. Most of the patients had acyanotic CHD - 78.2%while 21.8% had cyanotic CHD. Ventricular septal defect followed by atrial septal defect (ASD), patent ductus arteriosus (PDA) and pulmonary valve stenosis were the most common acyanotic congenital heart lesions while, Tetralogy of Fallot (TOF) followed by transposition of the great arteries (TGA) were the commonest cyanotic congenital heart lesions. Female gender was more dominant in less complex CHD lesions while the male gender had more complex CHD (A Jasim et al., 2017). It is evident from the reviewed studies that acyanotic CHD were more commonly diagnosed among the surveyed children than acyanotic CHD(Khasawneh et al., 2020).

2.3 Risk Factors Associated with Congenital Heart Disease among Pediatric Patients:

In Pakistan, Faheem et al. (2021) did a study on risk factors for CHD among pediatric patients attending a local tertiary care hospital. A total of 500 patients, 250 cases and 250 controls, were enrolled for the study. Results of the study showed that parental consanguinity, family history of CHD, maternal co-morbidities, first born child and low birth weight were independent risk factors for development of congenital heart disease. On the other hand, medications used by

the mother during the index pregnancy, maternal age and gender of the child did not significantly increase the risk of developing CHD (Haq et al., 2011).

A cross-sectional study conducted in Uganda evaluated the factors associated with CHD among 179 cases aged below 5 years at Mulago National Referral Hospital. Multivariate logistic regression was applied in analysis of the data. Results suggested low birth weight, high birth order, and maternal febrile illness during pregnancy, parental alcohol use and paternal socioeconomic status were dominant risk factors for CHD among children. Rigorous implementation of public health policies and interventions targeted at these particular factors could be important in reducing the burden of CHD among children in Uganda(Kapakasi et al., 2021).

Similarly, a cross-sectional case-control study conducted in Iran explored the factors associated with occurrence of CHD in pediatric patients. A total of 1,338 known cases of CHD, diagnosed by echocardiography or angiography and 1,201 healthy controls were included in the study, with the assessment done using a questionnaire. From the findings, the factors found to be statistically associated with CHD among the study population included positive parents' consanguinity, previous maternal history of abortion, maternal age of above 30 years and positive history of CHD among siblings of the cases and underlying maternal chronic diseases including diabetes, hypertension during pregnancy. The study concluded that more frequent prenatal screening and effective management of any diagnosed health conditions was recommended for all pregnant women (Dolk et al., 2011).

A cross-sectional study carried out in Ethiopia investigated the factors associated with occurrence of CHD among children with congenital defects admitted in 4 public hospitals in Addis Ababa. Data were collected using a structured questionnaire and were analyzed using logistic regression analysis. A high burden of congenital heart defects among congenital anomalies was established in the study population. The study also established that maternal

previous history of abortion, maternal diabetes and past history of drug intake during pregnancy were significantly associated with congenital heart defects. The study concluded that maternal behavioural factors were critical predictors of CHD(Musa et al., 2020) [13].

A population-based case-control study was done in China to examine the risk factors for CHDs in Guangdong region. The study included 4,034 pairs of case and control infants enrolled from the Guangdong Registry of CHD, 2004-2013. Data were analyzed using multivariate logistic regression and reported using adjusted odds ratios (ORs). According to the study, multiple maternal environmental exposures, including living in newly renovated rooms, residential proximity to main traffic, paternal smoking, and maternal occupation as manual worker were significantly associated with CHDs. Maternal perinatal diseases including maternal fever, diabetes, influenza, and threatened abortion, maternal medication use during pregnancy, advanced maternal age, low socioeconomic status, and paternal alcohol intake were also significantly associated with CHDs (Ou et al., 2016) .

Similarly, a case control study was undertaken in India to determine risk factors of CHDs in children. A total of 75 cases of CHDs and equal number of matched controls, drawn from a local tertiary hospital in Maharashtra, were enrolled for the study. The study found that maternal factors like consanguinity, family history of congenital heart diseases, maternal co-morbidities like gestational diabetes and hypertension and drug intake during pregnancy as well as fetal factors including prematurity, LBW and chromosomal abnormality were significant underlying risk factors for development of CHDs in children (Rossano, 2020)..

2.4 Treatment Outcomes of Paediatric Patients with CHD

An evaluation of treatment outcomes among children with CHD was undertaken in Sweden. The study investigated the mortality risk in patients with CHD compared with matched controls without CHD using Cox proportional regression models and Kaplan-Meier survival analysis. Results showed that mortality among the cases at 6% was significantly higher than among the

controls at 0.3%. The mortality risk was 17.7 times higher in children with CHD compared with controls. Odds of mortality were also significantly higher among cases with mixed complex cyanotic heart defects compared with those diagnosed with simple isolated acyanotic heart defects. The highest mortality risk was also found during the first 4 years of life in patients with CHD (Mandalenakis et al., 2020).

Similarly, a study conducted in US also examined the treatment outcomes in infants diagnosed with CHD over the past few years. It was a retrospective analysis of infant treatment outcomes following CHD diagnosis and treatment over the period 1999-2015. Results showed that, over the study period, 5.7% of the total infant deaths were due to CHD. The incidence of infant CHD mortality decreased from 0.45 in 1999 to 0.33 in 2015 per 1000 births and from 64 to 56 per 1000 infant deaths. However, mortality rates were higher in infants born to African American mothers compared to those born to white mothers. Thus, despite the decline in CHD mortality, significant racial disparities still exist (Monroe et al., 2022).

in Spain a retrospective study was undertaken to evaluate treatment outcomes for infants with CHD from 2003 to 2012. Poisson regression was used to estimate the mortality rate and relative risk of mortality. The study found that there were 2,970 (4.58%) infant deaths in a population of 64,831 patients with CHD. Most (73.8%) of the deaths occurred during the first week of life. Infant mortality rate in patients with CHD was 6.23 per 10,000 live births and did not change over the period. The congenital heart diseases with highest mortality rates, among the infants, were hypoplastic left heart syndrome -41.4%, interruption of aortic arch -20% and total anomalous pulmonary drainage -16.8%. Pulmonary stenosis (1.1%) and atrial septal defect (1%) showed the lowest mortality rate (Picarzo et al., 2018).

Chapter 3: Material and Methods

3.1 Study area:

This study was conducted in cardiac centers in public and private hospitals in Sana'a city, the capital of Yemen. These institutions will be chosen to be representative of all hospitals in Yemen since these institutions serve as the referral hospitals for most of the patients in Yemen. This study was conducted in three governmental hospital: Al-Gumhori Teaching Hospital , Al-Thawra Modern General Hospital, and Al-Sabeen Hospital for Maternity and Childhood in Sana'a City over five months, from October/2022 to February/2023. These hospitals were selected since they are referral hospitals.

3.2 Study design:

This is a Cross-sectional descriptive study among pediatric age group with confirmed diagnosis of congenital heart disease.

3.3 Study population:

All pediatric age group (less than 15 years) who attend cardiac centers in Sana'a, Yemen during the study period was recruited.

3.4 Sample size:

The study was conducted over a period of 5 months from October/2022 to February/2023. All children with confirmed structural CHD who were diagnosed from the first day of life up till the age of 15 years were recruited. A total of 200 participants from the above-mentioned hospitals were selected using continence sampling technique.

3.5 Sampling method:

Non-probability convenient sampling was used in the current study.

3.6 Data collection:

All patients who attend cardiac center and diagnosed as congenital heart disease were evaluated for inclusion in the study. After obtaining the form consent from patients' parent, data was collected through interviewing the patients or their parents using a **valid structure questionnaire** data collection form.

3.7 Sample tools:

Data collection form includes 49 questions divided into three parts. The first part consists of 23 questions including cases, maternal and paternal sociodemographic data, such as age, gender, family history, occupation, comorbidity, consanguinity, syndromes, etc. (refer to data collection form). The second part consists of 20 questions related to the pattern or types of congenital heart diseases, including atrial septal defect, ventricular septal defects, patent ductus arteriosus, total anomalous pulmonary venous return, transposition of great arteries, Mitral valve prolapse, Coarctation of aorta, Tricuspid atresia, Hypoplastic left heart, Truncus Arteriosus, Pulmonary atresia, Ebstein anomaly, Dextrocardia, or mixed of the above anomalies. The third part consists of 6 questions related to the clinical features of the study participants, such as murmur, recurrent chest infections, Cyanosis, Failure to thrive, Neonatal sepsis-like illness, and Shortness of breath.

3.8 Inclusion criteria:

All pediatric age group who had a confirmed diagnosis of CHD and attend cardiac centers during the study period were included.

3.9 Exclusion criteria:

- Any patient with acquired heart disease including acute viral myocarditis/post viral cardiomyopathy and rheumatic heart diseases will be excluded from the study. Additionally,
- Patients with age greater than 15 years and those who refuse to participate in this study were excluded.

3.10 Data analysis:

Statistical analyses were performed using IBM SPSS version 21 (SPSS Institute, Chicago, IL, USA). Continuous variables were expressed as mean ± Standard deviation, categorical variables will be presented as frequency and percentage. Chi-square test ($\chi 2$) was used to detect associations in categorical data. A p value of less than 0.05 was regarded as a statistic significance.

3.11 Ethical consideration:

Data collection form, proposal, ethical consideration forms was provided to the ethical committee. Before collecting data, the objectives of the study were explained to every participant and the consent form was signed. Every participant has the right to withdraw from the current study without negative consequence. Participants' names will be remained anonymous. All participants were informed about the objectives of the study and consented to participate. The study was conducted in accordance with the Declaration of Helsinki.

Chapter 4: Results:

4.1 Patients and parent's sociodemographic data

A total of 237 CHD cases were collected. The majority of patients were male (52.7%, n = 125) infant (51.7, n =123) who reside in the urban area (49.6 %, n= 118) and were ranked the second children (23.9 %, n= 57). Down syndrome was diagnosed among 6.3% (n = 15) as shown in Figure 1 and Table 1.

The majority of the mothers for children with CHD were aged 20-29 years (47.7 %, n = 113), had no education (36.3 %, n = 86), and were occupied as housewife (95%, n = 226). Regarding of the fathers, most of them were aged greater than 33 years (52.3%, n = 124) and were manual workers (61%, n = 144) as shown in Table 1.

Table 1: Sociodemographic data of the participants

		Count	(%)
Age	Neonate (<29 days)	29	(12.2)
	Infant (1-12 months)	123	(51.7)
	Toddler (1-3 years)	32	(13.4)
	Preschool (3-5 years)	13	(5.5)
	School (6-12 years)	35	(14.7)
	Adolescent (>12 years)	6	(2.5)
Gender	Male	125	(52.7)
	Female	112	(47.3)
Rank	First child	54	(22.7)
	Second child	57	(23.9)
	Third child	44	(18.5)
	Fourth child	30	(12.6)
	Fifth child	25	(10.5)
	Sixth child	14	(5.9)
	Seven child and more	14	(5.9)
Residence	Rural	111	(46.6)

	Urban	118	(49.6)
	Suburban	9	(3.8)
Maternal age	≤ 19 Years	14	(5.9)
	20-29 years	113	(47.7)
	30-34 years	44	(18.6)
	≥ 35 Years	66	(27.8)
Maternal education	College and above	15	(6.3)
	Senior high school	26	(11.0)
	Junior high school	27	(11.4)
	Primary school	83	(35.0)
	No education	86	(36.3)
Maternal occupation	Housewife	226	(95.0)
	Manual worker	6	(2.5)
	Professional work	6	(2.5)
Father age	≤33 years	113	(47.7)
	>33 years	124	(52.3)
Paternal occupation	Farmer	39	(16.5)
	Manual worker	144	(61.0)
	Professional work	30	(12.7)
	Unemployed	23	(9.7)

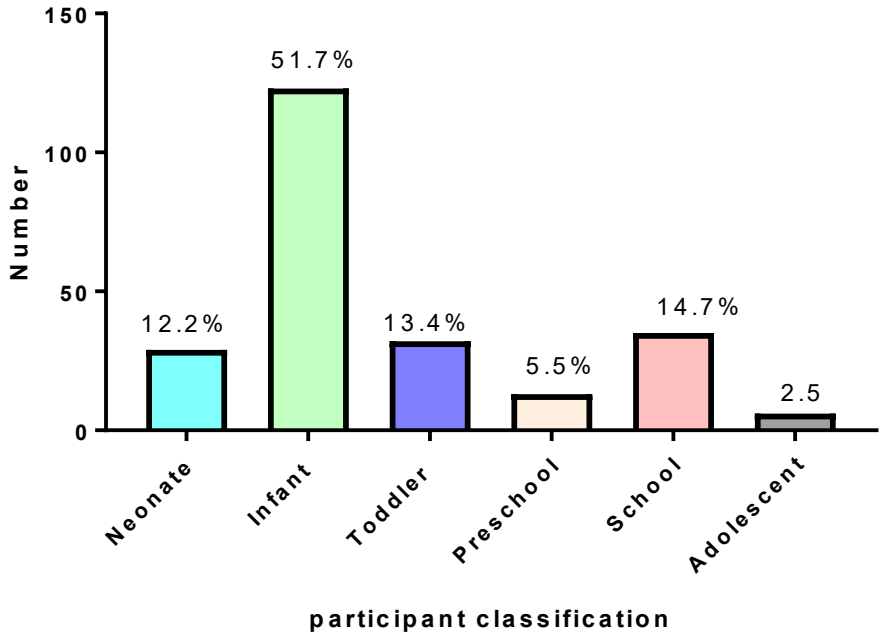

Figure 1: classification of the participants' age group

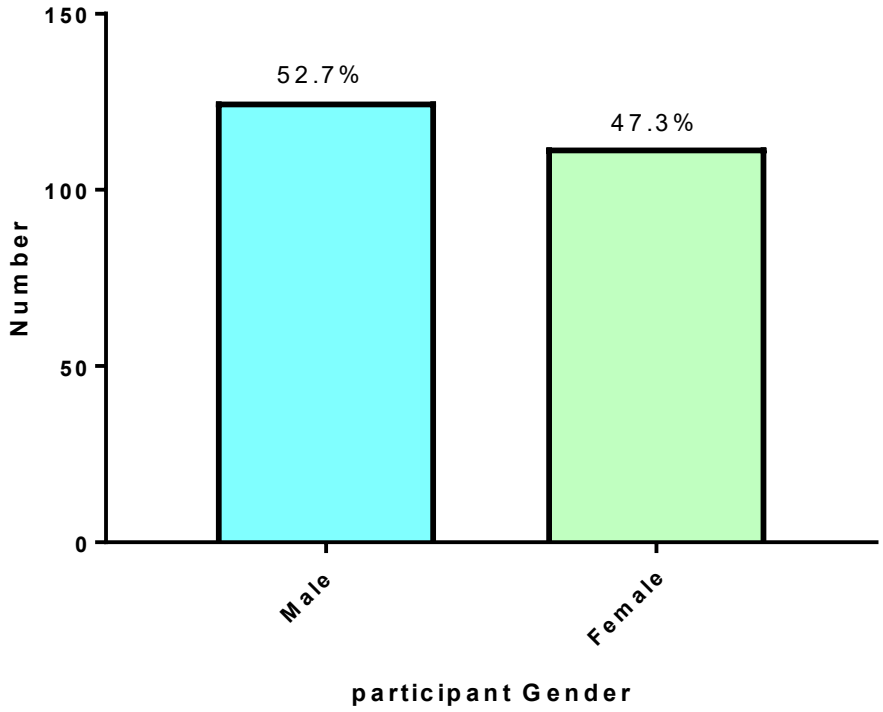

Figure 2: participants' gender

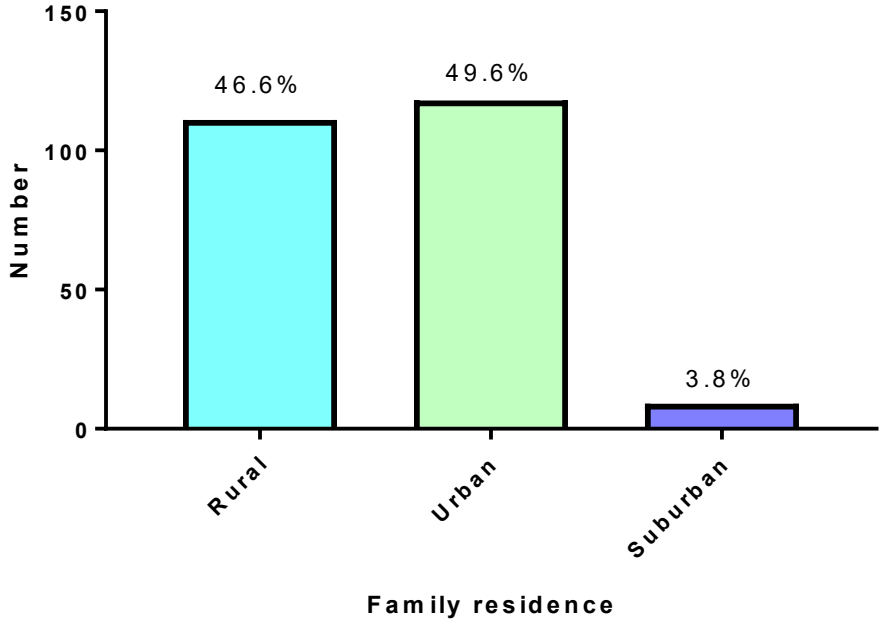

Figure 3: residency of the family

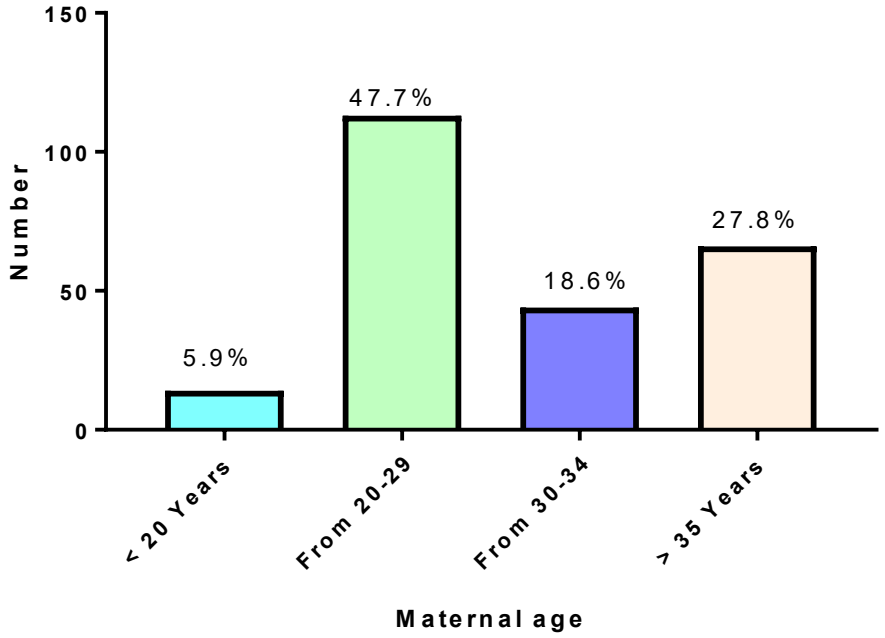

Figure 4: Maternal age

4.2 Social and medical history of the Participants

The majority of the mothers were not smokers (89.1%, n = 212) and not Kat chewers (66.8%, n = 159). Regarding the parity, the majority of the mothers were multiparous (79.7, n= 189), had no consanguinity (59.1, n= 140), and not exposed to radiation (95.4%, n = 226), had full term delivery (81.9%, n = 195), had no family history of CHD (84.5%, n = 201), and (70.2, n 167) no abortion, and no maternal medical illness (76.9, n = 183), had no febrile illness at the first trimester (47.1%, n= 112) and not taking medication (71.3, n = 169) but taking multivitamin (66 %, n= 157). Regarding contraceptive, 45% of the mothers have experience with the contraceptive as shown in Table 2.

Table 2:Social and medical history of the Participants

		Count	(%)
Maternal smoking habit	Yes	26	(10.9)
	No	212	(89.1)
Maternal Kat chewing Habit	Yes	79	(33.2)
	No	159	(66.8)

Maternal Shamma habit	Yes	0	(.0)
	No	238	(100.0)
Parity	Nulliparous	48	(20.3)
	Multiparous	189	(79.7)
Consanguinity	Yes	97	(40.9)
	No	140	(59.1)
Radiation exposure	Yes	11	(4.6)
	No	226	(95.4)
Prematurity	Yes	43	(18.1)
	No	195	(81.9)
Assisted reproduction	Yes	33	(13.9)
	No	205	(86.1)
Family history of CHD	Yes	37	(15.5)
	No	201	(84.5)
Abortions	Yes	71	(29.8)
	No	167	(70.2)
Maternal medical illnesses	Diabetes	10	(4.2)
	Bronchial asthma	7	(2.9)
	Hypertension	17	(7.1)
	Epilepsy	1	(.4)
	Others	18	(7.6)
	Non	183	(76.9)
	More than one	2	(.8)
History of febrile Illness in the first trimester	Yes	68	(28.6)
	No	112	(47.1)
	I don’t know	58	(24.4)
History of drug taking at first trimester	Yes	67	(28.3)
	No	169	(71.3)
	I don’t know	1	(.4)
History of multivitamin and folic acid intake during pregnancy	Yes	157	(66.0)
	No	79	(33.2)
	I don’t know	2	(.8)
Contraceptive	Yes	107	(45.0)
	No	122	(51.3)
	I don’t remember	9	(3.8)
Syndromes	Down Syndrome	15	(6.3)
	Disgorge Syndrome	0	(.0)
	Other	8	(3.4)
	Non	215	(90.3)
Comorbidity	Hypertension	0	(0.0)
	Renal dysplasia	1	(0.4)
	Diabetes	1	(0.4)
	Other	15	(6.3)
	No comorbidity	221	(92.9)
Extra-cardiac anomalies	Inguinal hernia	0	(0.0)

	Diaphragmatic hernia	2	(0.8)
	Other	11	(4.6)
	None	225	(94.5)

4.3 Pattern of CHD of the participants

Regarding the pattern of CHD, PFO was the most fluently encountered (21.4, n = 51), Followed by isolated VSD (19.7%, n= 47) then isolated (18.1%, 43), then isolated ASD (17.6%, n=42) as shown in **Table 3** and **Figure** 5.

Table 3 : Pattern of CHD of the participants

CHD pattern	Count	Percent
Isolated VSD	47	(19.7)
Isolated ASD	42	(17.6)
Atrio-ventricular canal	3	(1.3)
Tetralogy of Fallot	17	(7.1)
Isolated PDA	43	(18.1)
Pulmonary stenosis	11	(4.6)
ASD-VSD	10	(4.2)
ASD-PDA	10	(4.2)
Complex CHD	11	(4.6)
VSD_PDA	12	(5.0)
TGA	3	(1.30
Mitral Valve Prolapse	5	(2.1)
Tricuspid atresia	2	(0.8)
Truncus Arteriosus	2	(0.8)
PFO	51	(21.4)
Pulmonary Atresia	2	(0.8)
Dextrocardia	2	(0.8)
Others	17	(7.1)

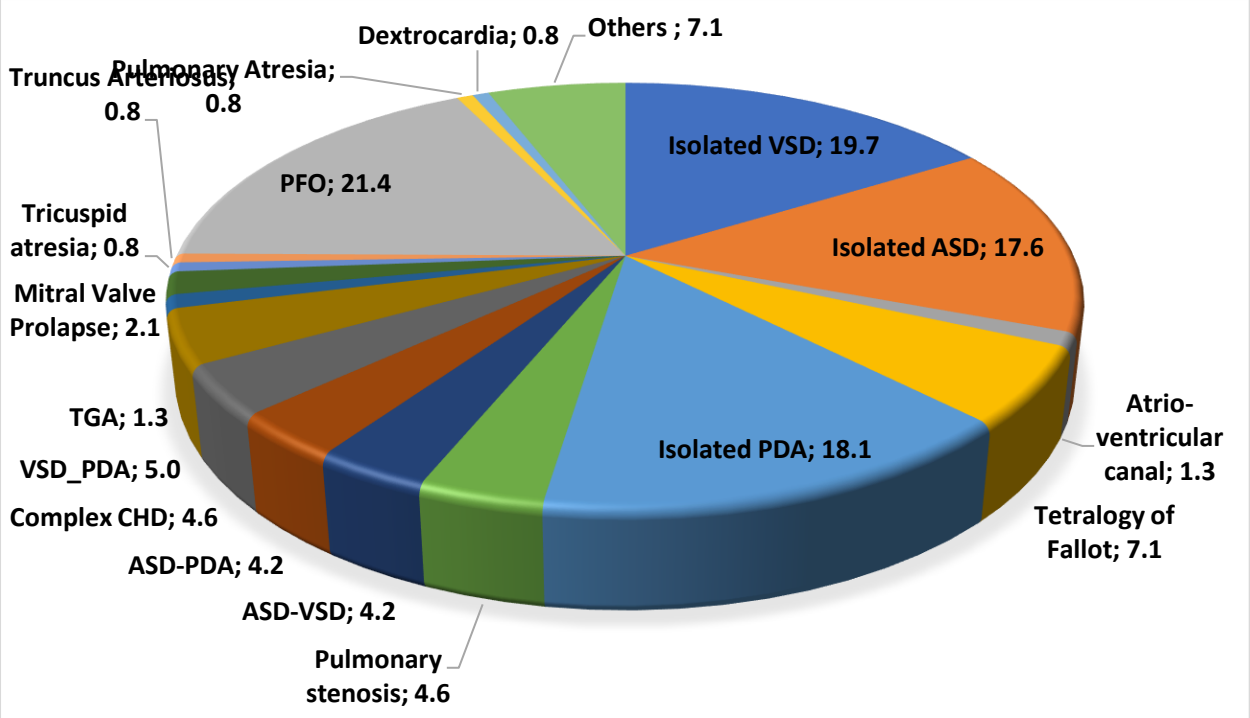

Figure 5: Pattern of CHD among participants

4.4 Clinical presentation of the studied population

Regarding the clinical presentations of the studied CHD, the most frequently encountered clinical presentation is SOB (79.3 %, n = 188), followed by recurrent chest infection (64.3, n = 153), then cyanosis (57.4%, n = 136), and failure to thrive (30.7%, n= 73) as shown in Table 4.

Table 4: Clinical presentation of the studied population

		Count	(%)
Accidental discovery of murmur	Present	37	(15.6)
	Absent	132	(55.7)
	Not known	68	(28.7)
Recurrent chest infections	Present	153	(64.3)
	Absent	65	(27.3)
	Not known	20	(8.4)
Cyanosis	Present	136	(57.4)
	Absent	94	(39.7)
	Not known	7	(3.0)
Failure to thrive	Present	73	(30.7)

	Absent	142	(59.7)
	Not known	23	(9.7)
Neonatal sepsis-like illness	Present	35	(14.8)
	Absent	152	(64.1)
	Not known	50	(21.1)
SOB	Present	188	(79.3)
	Absent	44	(18.6)
	Not known	5	(2.1)

4.5 Association between PFO and sociodemographic data

Association between PFO and sociodemographic data of the patients and parents was studies using chi-square and fisher's exact test where appropriate. PFO found to have significant association with patients' age (P value < 0.001), resident area of the family (P value =0.044), maternal age (p value < 0.014), paternal occupation (p value =0.009), exposure to radiation (p value = 0.014), history of multivitamin and Folic Acid (p value =0.045), and down syndrome (p value = 0.009) as shown in Table 5.

Table 5: Association between PFO and sociodemographic data

		PFO				Chi-square	P value
		Present		Absent			
		Count	%	Count	%		
Age (Months)	< 7 months	44	(86.3)	74	(39.6)	34.962	**<0.001***
	≥ 7 months	7	(13.7)	113	(60.4)		
Gender	Male	32	(64.0)	93	(49.7)	3.222	0.073
	Female	18	(36.0)	94	(50.3)		
Rank of child	First child	13	(25.5)	41	(21.9)	3.539	0.739
	Second child	8	(15.7)	49	(26.2)		
	Third child	11	(21.6)	33	(17.6)		
	Fourth child	7	(13.7)	23	(12.3)		
	Fifth child	7	(13.7)	18	(9.6)		
	Sixth child	2	(3.9)	12	(6.4)		
	Seven child and more	3	(5.9)	11	(5.9)		
Residence area	Rural	16	(31.4)	95	(50.8)	6.242	**0.044***
	Urban	33	(64.7)	85	(45.5)		
	Suburban	2	(3.9)	7	(3.7)		
Maternal Age	≤ 29 Years	35	(68.6)	92	(49.2)	6.078	**0.014***
	>29 Years	16	(31.4)	95	(50.8)		
Maternal Occupation	Housewife	50	(98.0)	176	(94.1)	1.782	0.410[b]

	Manual worker	0	(.0)	6	(3.2)		
	Professional work	1	(2.0)	5	(2.7)		
Maternal Smoking Habits	Yes	6	(11.8)	20	(10.7)	0.047	0.828
	No	45	(88.2)	167	(89.3)		
Maternal Kat Habits	Yes	15	(29.4)	64	(34.2)	0.419	0.518
	No	36	(70.6)	123	(65.8)		
Paternal Occupation	Farmer	6	(11.8)	33	(17.8)	11.588	**0.009***
	Manual worker	34	(66.7)	110	(59.5)		
	Professional work	11	(21.6)	19	(10.3)		
	Unemployed	0	(.0)	23	(12.4)		
Parity	Nulliparous	13	(25.5)	35	(18.8)	1.103	0.294
	Multiparous	38	(74.5)	151	(81.2)		
Maternal Age at Conception	≤ 19 Years	10	(19.6)	31	(16.7)	.643	0.887
	20-29 years	31	(60.8)	110	(59.1)		
	30-34 years	6	(11.8)	29	(15.6)		
	≥ 35 Years	4	(7.8)	16	(8.6)		
Consanguinity	Yes	20	(39.2)	77	(41.4)	0.079	0.779
	No	31	(60.8)	109	(58.6)		
Radiation Exposure	Yes	6	(11.8)	5	(2.7)	7.450	**0.014*,b**
	No	45	(88.2)	181	(97.3)		
Prematurity	Yes	12	(23.5)	31	(16.6)	1.308	0.253
	No	39	(76.5)	156	(83.4)		
Assisted Reproduction	Yes	9	(17.6)	24	(12.8)	0.777	0.378
	No	42	(82.4)	163	(87.2)		
Family history of CHD	Yes	7	(13.7)	30	(16.0)	0.164	0.686
	No	44	(86.3)	157	(84.0)		
Abortions	Yes	13	(25.5)	58	(31.0)	0.585	0.445
	No	38	(74.5)	129	(69.0)		
Maternal medical illness	Yes	12	(23.5)	43	(23.0)	0.006	0.936
	No	39	(76.5)	144	(77.0)		
History of Febrile Illness at first trimester	Yes	12	(32.4)	56	(39.2)	0.566	0.452
	No	25	(67.6)	87	(60.8)		
History of Drug taking at first trimester	Yes	11	(21.6)	56	(30.1)	1.439	0.230
	No	40	(78.4)	130	(69.9)		
History of multivitamin and Folic Acid	Yes	40	(78.4)	117	(62.6)	4.492	**0.045***
	No	11	(21.6)	70	(37.4)		
contraceptive	Yes	18	(38.3)	89	(48.9)	1.687	0.194
	No	29	(61.7)	93	(51.1)		
Syndromes	Down Syndrome	1	(2.0)	14	(7.5)	9.988	**0.009*,b**
	Other	5	(9.8)	3	(1.6)		
	Non	45	(88.2)	170	(90.9)		
Comorbidity	Yes	5	(9.8)	12	(6.4)	0.693	0.405[b]
	No	46	(90.2)	175	(93.6)		

b: indicated that fisher's exact test was conducted.

*4.6 A*ssociation between isolated VSD and sociodemographic data

Association between VSD and sociodemographic data of the patients and parents was studies using chi-square and fisher's exact test where appropriate.VSD found to have significant association with patients' age (P value < 0.001), resident area of the family (P value =0.044), maternal contraceptive use (p value < 0.013), comorbidity of the patients (p value =0.034) as shown in Table 6.

Table 6: association between isolated VSD and sociodemographic data

		Isolated VSD				Chi-square	P value
		Present		Absent			
		Count	%	Count	%		
Age (Months)	< 7 months	12	(25.5)	106	(55.5)	13.548	**<0.001***
	≥ 7 months	35	(74.5)	85	(44.5)		
Gender	Male	24	(51.1)	101	(53.2)	0.066	0.797
	Female	23	(48.9)	89	(46.8)		
Rank of child	First child	10	(21.3)	44	(23.0)	2.585	0.859[b]
	Second child	11	(23.4)	46	(24.1)		
	Third child	8	(17.0)	36	(18.8)		
	Fourth child	5	(10.6)	25	(13.1)		
	Fifth child	5	(10.6)	20	(10.5)		
	Sixth child	3	(6.4)	11	(5.8)		
	Seven child and more	5	(10.6)	9	(4.7)		
Residence area	Rural	31	(66.0)	80	(41.9)	9.753	**0.008***
	Urban	16	(34.0)	102	(53.4)		
	Suburban	0	(.0)	9	(4.7)		
Maternal Age	≤ 29 Years	20	(42.6)	107	(56.0)	2.749	0.097
	>29 Years	27	(57.4)	84	(44.0)		
Maternal Occupation	Housewife	47	(100.0)	179	(93.7)	3.110	0.211[b]
	Manual worker	0	(.0)	6	(3.1)		
	Professional work	0	(.0)	6	(3.1)		
Maternal Smoking Habits	Yes	2	(4.3)	24	(12.6)	2.677	0.102
	No	45	(95.7)	167	(87.4)		
Maternal Kat Habits	Yes	16	(34.0)	63	(33.0)	.019	0.890
	No	31	(66.0)	128	(67.0)		
Paternal Occupation	Farmer	8	(17.0)	31	(16.4)	1.150	0.765
	Manual worker	31	(66.0)	113	(59.8)		
	Professional work	4	(8.5)	26	(13.8)		
	Unemployed	4	(8.5)	19	(10.1)		
Parity	Nulliparous	8	(17.0)	40	(21.1)	0.379	0.538
	Multiparous	39	(83.0)	150	(78.9)		

Maternal Age at Conception	≤ 19 Years	7	(14.9)	34	(17.9)	3.622	0.305
	20-29 years	26	(55.3)	115	(60.5)		
	30-34 years	11	(23.4)	24	(12.6)		
	≥ 35 Years	3	(6.4)	17	(8.9)		
Consanguinity	Yes	14	(29.8)	83	(43.7)	3.010	0.083
	No	33	(70.2)	107	(56.3)		
Radiation Exposure	Yes	1	(2.1)	10	(5.3)	0.837	0.360[b]
	No	46	(97.9)	180	(94.7)		
Prematurity	Yes	4	(8.5)	39	(20.4)	3.613	0.057
	No	43	(91.5)	152	(79.6)		
Assisted Reproduction	Yes	3	(6.4)	30	(15.7)	2.746	0.098
	No	44	(93.6)	161	(84.3)		
Family history of CHD	Yes	8	(17.0)	29	(15.2)	0.097	0.755
	No	39	(83.0)	162	(84.8)		
Abortions	Yes	18	(38.3)	53	(27.7)	2.005	0.157
	No	29	(61.7)	138	(72.3)		
Maternal medical illness	Yes	12	(25.5)	43	(22.5)	0.193	0.660
	No	35	(74.5)	148	(77.5)		
History of Febrile Illness at first trimester	Yes	11	(33.3)	57	(38.8)	0.340	0.560
	No	22	(66.7)	90	(61.2)		
History of Drug taking at first trimester	Yes	10	(21.3)	57	(30.0)	1.414	0.234
	No	37	(78.7)	133	(70.0)		
History of multivitamin and Folic Acid	Yes	32	(68.1)	125	(65.4)	0.117	0.732
	No	15	(31.9)	66	(34.6)		
contraceptive	Yes	29	(63.0)	78	(42.6)	6.158	**0.013**[*]
	No	17	(37.0)	105	(57.4)		
Syndromes	Down Syndrome	3	(6.4)	12	(6.3)	2.039	0.361[b]
	Other	0	(.0)	8	(4.2)		
	Non	44	(93.6)	171	(89.5)		
Comorbidity	Yes	0	(.0)	17	(8.9)	4.505	**0.034**[*,b]
	No	47	(100.0)	174	(91.1)		

4.7 *A*ssociation between CHD pattern and cyanosis

Association between CHD and patients' cyanosis was studies using chi-square and fisher's exact test where appropriate. cyanosis was significantly associated with tetralogy of fallot (P value < **0.029**), pulmonary stenosis (P value = **0.026**), as shown in Table 7.

Table 7: *A*ssociation between CHD pattern and cyanosis

	Cyanosis				Chi-square	P value
	Present		Absent			
	Count	(%)	Count	(%)		

Isolated VSD	Present	27	(57.4)	20	(42.6)	0.002	0.963
	Absent	109	(57.1)	82	(42.9)		
Isolated ASD	Present	19	(45.2)	23	(54.8)	2.862	0.091
	Absent	116	(59.5)	79	(40.5)		
Tetralogy of Fallot	Present	14	(82.4)	3	(17.6)	4.751	**0.029***
	Absent	122	(55.2)	99	(44.8)		
Isolated PDA	Present	24	(55.8)	19	(44.2)	0.038	0.846
	Absent	112	(57.4)	83	(42.6)		
PFO	Present	26	(51.0)	25	(49.0)	1.007	0.316
	Absent	110	(58.8)	77	(41.2)		
Pulmonary stenosis	Present	10	(90.9)	1	(9.1)	5.369	**0.026*b**
	Absent	126	(55.5)	101	(44.5)		
ASD_VSD	Present	8	(80.0)	2	(20.0)	2.217	0.196b
	Absent	127	(55.9)	100	(44.1)		
ASD_PDA	Present	8	(80.0)	2	(20.0)	2.217	0.196b
	Absent	127	(55.9)	100	(44.1)		
Complex CHD	Present	9	(81.8)	2	(18.2)	2.884	0.186b
	Absent	124	(55.6)	99	(44.4)		
VSD-PDA	Present	9	(75.0)	3	(25.0)	1.636	0.201
	Absent	126	(56.0)	99	(44.0)		
Other	Present	11	(64.7)	6	(35.3)	0.428	0.513
	Absent	125	(56.6)	96	(43.4)		

*: indicates significant association; b: indicates fisher's exact test is conducted

4.8 *A*ssociation between CHD pattern and murmur

Association between CHD and patients' heart murmur was studies using chi-square and fisher's exact test where appropriate. Heart murmur was significantly associated with tetralogy of fallot (P value < **0.038**), Complex CHD (P value = **0.003**) as shown in Table 8.

Table 8: *A*ssociation between CHD pattern and murmur

CHD type		Accidental discovery of murmur				chi-square	P value
		Present		Absent			
		Count	%	Count	%		
Isolated VSD	Present	9	(23.1)	30	(76.9)	0.051	0.821
	Absent	28	(21.4)	103	(78.6)		
Isolated ASD	Present	6	(18.8)	26	(81.3)	0.153	0.695
	Absent	30	(21.9)	107	(78.1)		
Tetralogy of Fallot	Present	5	(50.0)	5	(50.0)	4.975	**0.038*,b**
	Absent	32	(20.0)	128	(80.0)		
Isolated PDA	Present	9	(29.0)	22	(71.0)	1.176	0.278
	Absent	28	(20.1)	111	(79.9)		

PFO	Present	6	(20.0)	24	(80.0)	0.067	0.796
	Absent	31	(22.1)	109	(77.9)		
Pulmonary stenosis	Present	1	(20.0)	4	(80.0)	0.009	0.169[b]
	Absent	36	(21.8)	129	(78.2)		
ASD_VSD	Present	2	(28.6)	5	(71.4)	0.230	0.354[b]
	Absent	34	(21.0)	128	(79.0)		
ASD_PDA	Present	1	(11.1)	8	(88.9)	0.589	0.152[b]
	Absent	35	(21.9)	125	(78.1)		
Complex CHD	Present	3	(50.0)	3	(50.0)	12.372	**0.003**[*b]
	Absent	31	(19.3)	130	(80.7)		
VSD-PDA	Present	3	(33.3)	6	(66.7)	0.821	0.252[b]
	Absent	33	(20.6)	127	(79.4)		
Other	Present	5	(50.0)	5	(50.0)	4.975	**0.038**[*,b]
	Absent	32	(20.0)	128	(80.0)		

*: indicates significant association; b: indicates fisher's exact test is conducted

4.9 *A*ssociation between CHD pattern and Failure to thrive

Association between CHD and patients' failure to thrive studies using chi-square and fisher's exact test where appropriate. patients' failure to thrive was significantly associated with PFO (P value < **0.044**), unclassified types of CHD (P value = **0.014**), as shown in Table 9.

Table 9: *A*ssociation between CHD pattern and Failure to thrive

		Failure to thrive					
		Present		Absent			
		Count	%	Count	%	chi-square	P value
Isolated VSD	Present	18	(40.9)	26	(59.1)	1.194	0.275
	Absent	55	(32.2)	116	(67.8)		
Isolated ASD	Present	15	(36.6)	26	(63.4)	0.196	0.658
	Absent	57	(32.9)	116	(67.1)		
Tetralogy of Fallot	Present	5	(33.3)	10	(66.7)	0.003	0.958
	Absent	68	(34.0)	132	(66.0)		
Isolated PDA	Present	13	(33.3)	26	(66.7)	0.008	0.928
	Absent	60	(34.1)	116	(65.9)		
PFO	Present	9	(20.9)	34	(79.1)	4.065	**0.044**[*]
	Absent	64	(37.2)	108	(62.8)		
Pulmonary stenosis	Present	4	(40.0)	6	(60.0)	0.171	0.897[b]
	Absent	69	(33.7)	136	(66.3)		
ASD_VSD	Present	4	(44.4)	5	(55.6)	0.491	0.502[b]
	Absent	68	(33.2)	137	(66.8)		
ASD_PDA	Present	4	(40.0)	6	(60.0)	0.190	0.451[b]
	Absent	68	(33.3)	136	(66.7)		

Complex CHD	Present	6	(60.0)	4	(40.0)	3.311	0.128[b]
	Absent	65	(32.2)	137	(67.8)		
VSD-PDA	Present	6	(54.5)	5	(45.5)	2.269	0.259[b]
	Absent	66	(32.5)	137	(67.5)		
Other	Present	6	(50.0)	6	(50.0)	1.459	**0.014**[*,b]
	Absent	67	(33.0)	136	(67.0)		

*: indicates significant association; b: indicates fisher's exact test is conducted

4.10 *A*ssociation between CHD pattern *and Recurrent chest infections*

Association between CHD and recurrent chest infections was studies using chi-square and fisher's exact test where appropriate. Patients' recurrent chest infections were significantly association with the unclassified types of CHD (P value = 0.001), as shown in **Table 10.**

Table 10: *A*ssociation between CHD pattern *and Recurrent chest infections*

		Recurrent chest infections					
		Present		Absent			
		Count	%	Count	%	chi-square	P value
Isolated VSD	Present	31	(70.5)	13	(29.5)	0.002	0.965
	Absent	122	(70.1)	52	(29.9)		
Isolated ASD	Present	29	(70.7)	12	(29.3)	0.001	0.972
	Absent	124	(70.5)	52	(29.5)		
Tetralogy of Fallot	Present	11	(68.8)	5	(31.3)	0.017	0.896[a]
	Absent	142	(70.3)	60	(29.7)		
Isolated PDA	Present	26	(63.4)	15	(36.6)	1.106	0.293
	Absent	127	(71.8)	50	(28.2)		
PFO	Present	24	(61.5)	15	(38.5)	1.696	0.193
	Absent	129	(72.1)	50	(27.9)		
Pulmonary stenosis	Present	8	(72.7)	3	(27.3)	0.036	0.892[a]
	Absent	145	(70.0)	62	(30.0)		
ASD_VSD	Present	9	(90.0)	1	(10.0)	1.916	0.256[a]
	Absent	144	(69.6)	63	(30.4)		
ASD_PDA	Present	7	(70.0)	3	(30.0)	0.001	0.534[a]
	Absent	146	(70.5)	61	(29.5)		
Complex CHD	Present	7	(70.0)	3	(30.0)	0.001	0.106[a]
	Absent	145	(70.4)	61	(29.6)		
VSD-PDA	Present	6	(60.0)	4	(40.0)	0.557	0.239[a]
	Absent	147	(71.0)	60	(29.0)		
Other	Present	8	(80.0)	2	(20.0)	0.483	**0.001**[*,a]
	Absent	145	(69.7)	63	(30.3)		

*: indicates significant association; a: indicates fisher's exact test is conducted

4.11 *A*ssociation between CHD pattern and neonatal sepsis-like illness

Association between CHD and neonatal sepsis-like illness was studies using chi-square and fisher's exact test where appropriate. neonatal sepsis-like illness was the only factor that had a significant association with Complex CHD (P value = 0.001), as shown in Table 11.

Table 11: *A*ssociation between CHD pattern and neonatal sepsis-like illness

		Neonatal sepsis-like illness					
		Present		Absent			
		Count	%	Count	%	chi-square	P value
Isolated VSD	Present	7	(17.5)	33	(82.5)	0.042	0.838
	Absent	28	(18.9)	120	(81.1)		
Isolated ASD	Present	6	(15.8)	32	(84.2)	0.251	0.616
	Absent	29	(19.3)	121	(80.7)		
Tetralogy of Fallot	Present	2	(18.2)	9	(81.8)	0.001	0.340[a]
	Absent	33	(18.6)	144	(81.4)		
Isolated PDA	Present	6	(16.7)	30	(83.3)	0.112	0.738
	Absent	29	(19.1)	123	(80.9)		
PFO	Present	7	(20.6)	27	(79.4)	0.106	0.744
	Absent	28	(18.2)	126	(81.8)		
Pulmonary stenosis	Present	0	(.0)	7	(100.0)	1.663	0.197[a]
	Absent	35	(19.3)	146	(80.7)		
ASD_VSD	Present	2	(33.3)	4	(66.7)	0.886	0.094[a]
	Absent	33	(18.1)	149	(81.9)		
ASD_PDA	Present	2	(20.0)	8	(80.0)	0.013	0.134[a]
	Absent	33	(18.5)	145	(81.5)		
Complex CHD	Present	2	(28.6)	5	(71.4)	12.476	**0.004**[*,a]
	Absent	33	(18.2)	148	(81.8)		
VSD-PDA	Present	1	(14.3)	6	(85.7)	0.090	0.132[a]
	Absent	34	(18.8)	147	(81.2)		
Other	Present	2	(22.2)	7	(77.8)	0.081	0.776[a]
	Absent	33	(18.4)	146	(81.6)		

Chapter 5: Discussion:

The present study indicates that CHD is an important pediatric cardiac problem in our study group. To the best of our knowledge there are no other local studies and reports about cases of CHD at Sanaa governate. There were (237) cases, 125 were male (٥٢،٧%) CHD and 112 (47.3%) females. This is slightly higher than that shown by other studies of equal frequency(Stephensen et al., 2002).

in our study, most children with congenital heart disease were infants (51.7%) followed by School 6-12 years (14.7%), and then Toddlers 1-3 years (13.4%) .this finding differs from another study that showed that most children with congenital heart disease were infants (88%) followed by neonates (12%) (Abah et al., 2018).

Our results showed, the commonest presentation for CHD was the SOB (35%) followed by recurrent chest infections (64.3%), cyanosis (57.4%), failure to thrive (13%), neonatal sepsis-like illness (3.3%). this result is higher than that of another study conducted in Egypt showed, the commonest presentation for CHD was the accidental discovery (79.3%) followed by recurrent chest infections (30.2%), cyanosis (16.7%), failure to thrive (30.7%), neonatal sepsis-like illness (14.8%), and finally shortness of breath (1.7%)(Al-Fahham and Ali, 2021).

in contrast, a study done by Otaigbe and Tabansi indications for screening echocardiography were auscultation of a murmur (36%), rapid breathing (19.8%), failure to gain weight (11%), and cyanosis (9.9%) (Otaigbe and Tabansi, 2014). whereas in a study done by George and

Frank- Briggs , fast breathing and inability to gain weight were the commonest presenting symptoms among CHD children (George and Frank-Briggs, 2009).

prevalence of murmurs is variable in different studies as it depends on the clinical skills, frequency, and timing of examination as nearly half of newborns with CHD will have no murmurs and possibly no other signs when examined at birth. In this study, we detected Accidental discovery of murmur in 15.6 % of patients. Our finding consider lower than other study detected audible murmurs in 74.4% of patients (Ainsworth et al., 1999).

Our results showed the most maternal age included in this study was 47.7% young mothers between 20-29 years followed by 27.8% of older mothers more than 35 years These results are consistent with other studies conducted in more than one country demonstrated the pattern of maternal age as a hazardous factor for congenital defects differs among different countries which imply possible underlying genetic and environmental background rather than only the biological age (Loane et al., 2009).

Some studies suggested that the gynecological immaturity , lack of proper antenatal care, low socioeconomic class, poor diet, and other environmental nonbiological factors account for birth defects among young mothers (Wahn and Nissen, 2008)

Other studies had observed the prevalence of CHDs among older mothers (Reefhuis and Honein, 2004, Miller et al., 2011), whereas Best and Rankin failed to find a strong evidence to support that advanced maternal age is a risk factor for CHD. Older maternal age has been linked to chromosomal-related congenital abnormalities while the risk of maternal age on the non-chromosomal abnormalities is considered negligible (Best and Rankin, 2016).

Various studies had shown the effect of maternal diabetes as a risk factor for fetal cardiac malformations (Nielsen et al., 2005), as well as maternal hypertension, cigarette smoking, and other maternal chronic illnesses . In this study, maternal diabetes, asthma, hypertension, and

epilepsy were found in 4.2%, 2.9 %, 7.1%, and 0.4% of the studied population, respectively. these results lower than other study showed that, the maternal diabetes, asthma, hypertension, and epilepsy were found in 27.9%, 14.5%, 7.4%, and 4.2% of the studied population, respectively (Liu et al., 2013).

in our study, abortions occurred in 29.8) % of the studied population. In contrast to Li et al (Liu et al., 2013). WHO failed to find an association between bad obstetric history, recurrent abortions, and the risk of CHD, Abqari et al. detected such an association (Abqari et al., 2016). Also, Feng et al.(Feng et al., 2015) found that mothers will have a 24% higher risk of cardiac anomalies in their children if they experienced repeated abortions before. Etiological arguments include possible uterine factors that influence the implanted embryo and associated chronic maternal illnesses (Feng et al., 2015, Wang et al., 2010).

Our results, we also detected prematurity in 18.1% of our studied patients. Tanner et al. (Tanner et al., 2005) found that preterm infants are 2-times prone to CHD when compared to term infants; they detected prematurity in 16% of their CHD patients.

Findings of the study indicated that most of the cases of CHD diagnosed among the study participants were cyanotic 57.4% while the remaining were a cyanotic CHD cases. This differ with the findings of Ekure et al. (2018)(Ekure et al., 2018) and Abdelrahman and Diab (2022)(Abdelrahman and Diab, 2022)

According to the findings, the most prevalent CHD diagnosed were PFO (21.4%), Isolated VSD(19.7%) , Isolated PDA(18.1%) , and Isolated ASD(17.6%). This finding in contrast with another study conducted by Namuyonga et al., (2020) establish a ventricular septal defect, patent ductus arteriosus and atrial septal defects as the most commonly diagnosed CHD among children drawn from a tertiary care hospital in Uganda (Namuyonga et al., 2020).

Similar observations were also made by Thomford et al. (2020) who in studies conducted in Sudan and Ghana respectively also identified ventricular septal defect (VSD), patent ductus arteriosus, atrial septal defect and pulmonary valve stenosis as the most commonly diagnosed acyanotic CHDs in children while tetralogy of fallot and transposition of the great vessels were the most prevalent forms of cyanotic CHDs diagnosed in children (Thomford et al., 2020).

Other studies by Abah et al. (2018) in Nigeria[2], Meshram and Gajimwar (2018) in India (Meshram and Gajimwar, 2018), Jasim et al. (2017) in Iraq(A Jasim et al., 2017) also cited ventricular septal defect VSD; atrial septal defect ASD, patent ductus arteriosus, pulmonary valve stenosis, tetralogy of fallot and transposition of the great arteries as common CHD lesions seen in children. According to CDC, the prevalence of certain CHD like PDA and septal heart lesions is increasing, while the prevalence of some other CHD is decreasing (Abah et al., 2018).

Regarding to Association between PFO and sociodemographic data we finding the most risk factors was Age (Months) p-value <0.001, Residence area showed the Urban persons more susceptible to PFO than Rural persons 64.7% with p-value 0.044. also, we find the female ≤ 29 Years was more susceptible to PFO than male but without statical significant.

Other risk factors associate with PFO was Paternal Occupation, where we noted that Manual worker more susceptible to PFO p-value 0.009. as well as Radiation Exposure, History of multivitamin and Folic Acid and Syndromes was also correlated with PFO. These results are not consistent with the results of other studies conducted in Jordan and Iran (Khasawneh et al., 2020).

Down Syndrome was found to have a statistically significant association with PFO CHD among the children, The findings were in agreement with those of Faraoni et al. (2016) and

Asbagh et al. (2020) who also established infants' down syndrome and prematurity as risk factors of CHD in children (Sheila, 2022, Faraoni et al., 2016).

On the other hand, our study demonstrated that age, Residence area, contraceptive and Comorbidity are the most risk factors attribute to isolated VSD congenital heart diseases, this is inconsistent with the results of previous studies(Khasawneh et al., 2020, Sheila, 2022, Namuyonga et al., 2020).

Our results showed the Tetralogy of Fallot (ToF) and Pulmonary stenosis was the major cyanotic CHD with statically significant p-value less than 0.05. This is consistent with previous studies demonstrated that the Tetralogy of Fallot remains the most common cyanotic heart defect as has been reported elsewhere(Namuyonga et al., 2020).

Chapter 6: References

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Annex

Part one: Demographic Data:	
Child Age…(years)…….. Rank of child ( )	
Gender:	☐Male ☐ Female
Height, cm : ……..	Body weight, kg : ----------
Residence area:	☐Rural ☐Urban ☐ Suburban
Maternal age (in years)	
Maternal education	
Maternal occupation	☐Housewife ☐Manual worker ☐ Professional work
Maternal bad habits	Smoking (☐ Yes ☐ No), Kat chewing (☐ Yes ☐ No), Shama ((☐ Yes ☐ No)
Father age (in years)	
Paternal occupation	☐Farmer ☐Manual worker ☐Professional work ☐ Unemployed
Parity	☐Nulliparous ☐Multiparous
Maternal age at conception (years)	☐ ≤ 19 ☐ 20-29 ☐30-34 ☐≥ 35
Consanguinity	☐ Yes ☐ No
Prematurity	☐ Yes (…..weeks) ☐ No
Assisted reproduction	☐ Yes ☐ No
Exposure to Radiation	Yes No
Family history of CHD	☐ Yes ☐ No
Abortions	☐ Yes ☐ No
Maternal medical illnesses	☐Diabetes ☐Bronchial asthma ☐Hypertension ☐Epilepsy Other
History of febrile illness in 1st trimester	☐ Yes ☐ No ☐ I don't know
History of multivitamin and folic acid intake	☐ Yes ☐ No
Mother was used contraceptive methods before current pregnancy	☐ Yes ☐ No ☐ I don't remember
Syndromes	☐Down S ☐Disgorge S ☐Other
Comorbidity	☐ Diabetes ☐Hypertension ☐ Renal dysplasia,

	☐Other
Extra-cardiac anomalies	☐Inguinal hernia ☐ Diaphragmatic hernia Other

Part two: Pattern of CHD			
Types of CHD	Present	Absent	Don't know
Isolated VSD			
PFO			
Isolated ASD			
Atrio-ventricular canal			
Tetralogy of Fallot			
AVSD			
Pulmonary stenosis			
ASD/VSD			
ASD/PDA			
Complex CHD			
VSD/PDA			
TGA			
Mitral valve prolapse			
Coarctation of aorta			
Tricuspid atresia			
Hypoplastic left heart			
Truncus Arteriosus			
TAPVR			
Pulmonary atresia			
Ebstein anomaly			
Dextrocardia			

CHD congenital heart disease VSD ventricle septal defect PFO Patent foramen ovale ASD atrial septal defect; AVSD atrioventricular septal defects; PDA patent ductus arteriosus; TAPVR total anomalous pulmonary venous return; TGA transposition of great arteries; VSD ventricular septal defect;

Part three: Mode of presentation among studied population			
Clinical picture	Present	Absent	Don't know
Accidental discovery of a murmur			
Recurrent chest infections			
Cyanosis			
Failure to thrive			
Neonatal sepsis-like illness			
Shortness of breath			