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High Prevalence Of Congenital Heart Disease Among Referred Pediatric Cardiac Cases In Bisha, Saudi Arabia: Need For Comprehensive Screening Program

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Abstract
Congenital heart disease (CHD) is one of the common health problems in children in the Middle Eastern region including Saudi Arabia. This study was designed to find the types and prevalence of children with congenital heart diseases in Bisha, southwestern Saudi Arabia, where CHD in children is being referred to the pediatric cardiologist. The study also attempted to relate the results to other studies conducted within the country and to other bordering countries. This is a retrospective, between 2017 and 2021, the author conducted a cross-sectional, descriptive study on children referred to a pediatric cardiologist. Referrals were received from 5 rural clinics and 78 primary health facilities. All the referred patients were administered the standard history, clinical assessment, chest x-ray, ECG, and later echocardiographic assessment. Out of 954 patients, about half were confirmed to have CHD. The commonest forms of VSD and other forms like patent ductus arteriosus, atrial septal defect and pulmonary stenosis were found in the rest of the patients. The study shows the concerning availability of heart disease, with half the children from the region being referred with heart disease being diagnosed. The results support the urgent necessity of establishing screening programs in primary health care and telephone follow-ups in the hospitals' peripheral branches for the early diagnosis and management of CHD.

Keywords: Prevalence, Congenital heart diseases, Bisha, Saudi Arabia, screening

Introduction

Congenital heart defect is a grossly structural defect of the heart or of the major intrathoracic vessels that affects the form or function of the heart by embryonic abnormality. It refers to significant structure malformation of the heart or major vessels within the thoracic cavity, resulting from developmental anomalies during embryogenesis. Such malformations can produce a severe effect on the architecture and function of the heart (1). The most common birth defect, with an incidence of 0.8-1% of all live newborns born every year, for instance, CHD is about 1 in every 180 births in the UK (2). World statistics estimate that CHD incidence ranges from 4 to 10 per 1000 births and accounts for child morbidity and mortality globally worldwide (3). The highest incidence of CHD has been reported for Asia with the rate of 9.3 per 1000 live births, followed by Europe (8.2) and North America (6.9) per 1000 live births, while Africa has the lowest rate of incidence (CHD 1.9 per 1000 live births) (4,5). World over, preterm birth and congenital disorders were reported to be the commonest cause of neonatal deaths (4), with CHD accounting for up to 55% of all deaths in infants in the presence of congenital abnormalities, greater than 4% in UK children with the same condition aged under 5 years (2). In fact, CHD is the leading cause of infant mortality in children born with congenital anomalies, even in the developed nations such as the USA and England (6, 7). With early detection, one would leave much to be desired by way of treatment effect, while raising awareness could have meant a rate reduction as documented over three decades in the UK (2).

King Faisal Hospital and Research Centre in Riyadh, Saudi Arabia, is reported to have discovered C angina in patients at a rate of 7.48 per 1000 people throughout 7 surveys between 1989-2002. Perhaps, these surveys greatly detected the dispersed occurrences of angina in various provinces in western regions, i.e. the Asser province (8). However, a sigh shifted review comparing publications from 1993-2013 attributes the range of 2.1 and 10.7 C angina per 1000 people in Saudi Arabia. It is revealed that 30% of children admitted to hospital beds in developed countries regularly suffer from underdeveloped C angina. As for Saudi Arabia, the rate is 16%. (10). The reverse heart phenomena known as angina is a result of numerous surgical interrelations to implant stents in children, or open-heart surgeries that take place in the first year of their life (2,7).

Determining the scope of CHD in the population and how severe it helps define the resource requirements as well as the burden of the disease (11). This has led to the construction of specialized care units in different parts of the world which has improved adult survival rates to between 70 and 80% of patients (12). Studies in Europe have shown that the 23.0% and 35.3% reductions in infant and childhood mortality rates from 1994 to 2004 were attributable to improved access to healthcare, increased awareness, and parent education (13). More recently, population-based surveys of the Saudi community showed an astonishing decline in certain types of congenital heart disease such as Down syndrome (14).
The studies of the Kingdom of Saudi Arabia show wide-ranging variances in the reporting prevalence of in-hospital cases of CHD over the years (10). This conflict also arises from the epidemiological surveys tracking the cases of CHD across the Saudi Arabian domain, where the most affected areas were the southwestern districts and the northern parts of the Eastern Province (9). Unlike the previous province-based studies, the more refined CHD epidemiological surveys in Saudi Arabia are focused on urbanized areas (10).
Southwest Kingdom of Saudi Arabia has a population of 193,179, with 102,179 being school-aged children (under 15 years), making up almost 52%. This is a significant difference as in the Kingdom of Saudi Arabia, the school-aged population accounts for only about 30%. King Abdulla Hospital remains the only pediatric cardiology unit in the province of Bisha, which serves as the sole referral Centre for Bisha province.
Accordingly, the proposed study intends to determine the estimated CHD prevalence in Bisha, southwestern Saudi Arabia, as it relates to the pediatric cardiology services, the field's barriers, and the developmental strategies.

Methodology
Throughout the span of 2021-2022, the author has completed a retrospective cross-sectional hospital-based study which analyses the medical records of cardiac screening of children from July 2015 to April 2018 (15). The study utilized the medical records of referred children to the Pediatric Cardiology Unit, King Abdullah Hospital (Bisha, Asir, Saudia Arabia), with suspected CHD in the study duration. The total number of referred children was 954 (534 boys and 420 girls) aged from birth to 12 years. The children were referred from the primary health centers in Bisha governate according to the referral program for further evaluation and assessment.
All children referred to the Pediatric Cardiology Unit, King Abdullah Hospital (Bisha, Asir, Saudia Arabia) in the study duration with complaints of heart murmur; signs of heart failure or cyanosis; abnormal chest radiograph; ECG abnormality; babies with other congenital anomaly; infant of diabetic mother or positive family history of CHD were included in the study. The exclusion criteria are children older than 12 years old or have no complaint related to cardiology after screening.
The diagnosis of CHD is determined using a clinically detailed history and a full examination alongside tests and investigations.
The investigation includes chest X-ray and electrocardiogram, and it is confirmed via echocardiography. Patients' management and handling were done in the Pediatric Cardiology Unit according to unit guidelines and protocol.
The echocardiography involved M-mode along with Doppler color 2D Echocardiography, pulse, and continuous wave Doppler method. A 2D echocardiographic image was captured in the standard views: parasternal long and short axes, apical four chambers, subcostal, and suprasternal. The presence and severity of any cardiac defect were analyzed according to American Society of Echocardiography guidelines (16). All the echocardiographic studies were performed by the same subject specialist.
The study was reviewed and accepted by the Ethical Committee of King Abdullah Hospital Bisha, Saudi Arabia, and followed principles as stated in the Helsinki Declaration. The patients and the patients' guardians were informed about the potential use of their data for research purposes, with the privacy of the patients protected. Informed consent was obtained from all the patients' legal guardians.

Results
During the study, King Abdullah Hospital in Bisha received 816 pediatric referrals for cardiology. Upon evaluation, 337 (41.3%) were diagnosed with congenital heart diseases (CHDs) and were included in the study. Of the included patients, 209 (62. %) were boys and 128 (38%) were girls.
During the study period, the estimated child population in Bisha was 102,179 and the prevalence of CHDs among children was estimated at 4.66 per 1000. Table1: shows the number of referred (n=9411) and diagnosed (n=2287) cases of CHDs in Bisha and the other regions in Saudi Arabia.

Table 1. Numbers of referred and diagnosed cases of children with CHD in Bisha compared to other regions in Saudi Arabia.

	Bisha		**Albaha**		**Asir**		**Madina**		**Alhassa**		**Qatif**		**Total study**	
	n	%	n	%	n	%	n	%	n	%	n	%		
Referred	816	0.8	2610		608		4348		740		289		9411	
Diagnosed	337	41.3	445	17.0	286	47.0	522	12.0	624	84.3	73	25.26	2287	24.3
VSD	96	28.5	175	39.3	109	38.1	243	46.6	292	46.8	32	43.84	947	41.4
PDA	78	23.1	56	12.6	53	18.5	42	8.0	64	10.3	0	0.00	293	12.8
ASD	71	21.1	55	12.4	35	12.2	63	12.1	85	13.6	31	42.47	340	14.9

PS	42	12.5	47	10.6	34	11.9	56	10.7	66	10.6	4	5.48	249	10.9
AVCD	12	3.6	36	8.1	12	4.2	27	5.2	26	4.2	2	2.74	115	5.0
TOF	7	2.1	27	6.1	18	6.3	21	4.0	31	5.0	2	2.74	106	4.6
COA	16	4.7	20	4.5	11	3.8	20	3.8	20	3.2	1	1.37	88	3.8
AS	6	1.8	18	4.0	9	3.1	25	4.8	26	4.2	0	0.00	84	3.7
TGA	9	2.7	11	2.5	5	1.7	25	4.8	14	2.2	1	1.37	65	2.8
Duration Months	33		60		25		18		36		12			

Among the included studies, Bisha has 3rd percent referrals (8.7%) and 4th percent diagnoses (14.7%). Table 2 shows the percentages of referred children to the hospital (9411) and suspected cardiac cases (2287). The table also presents a comparison of these rates with other regions in Saudi Arabia.

Table 2. Percentage (rate per 100) of referred and diagnosed CHD cases in Bisha compared to other regions in Saudi Arabia

	Bisha	**Albaha**	**Asir**	**Madina**	**Alhassa**	**Qatif**
Percentage of referred cases among the children population	8.7	27.7	6.5	46.2	7.9	3.0
Percentage of suspected cardiac cases	14.7	19.5	12.5	22.8	27.3	3.2

Figure 1 presents, the distribution of the most common types of CHD pediatric cases in Bisha. As shown VSD (96, 28.49%), followed by PDA (78, 23.15%), and AS is the least common (6, 1.78%). Among all studies, Bisha has the highest percentages of PDA (23.1%), PS (12.5%), and COA (4.7%).

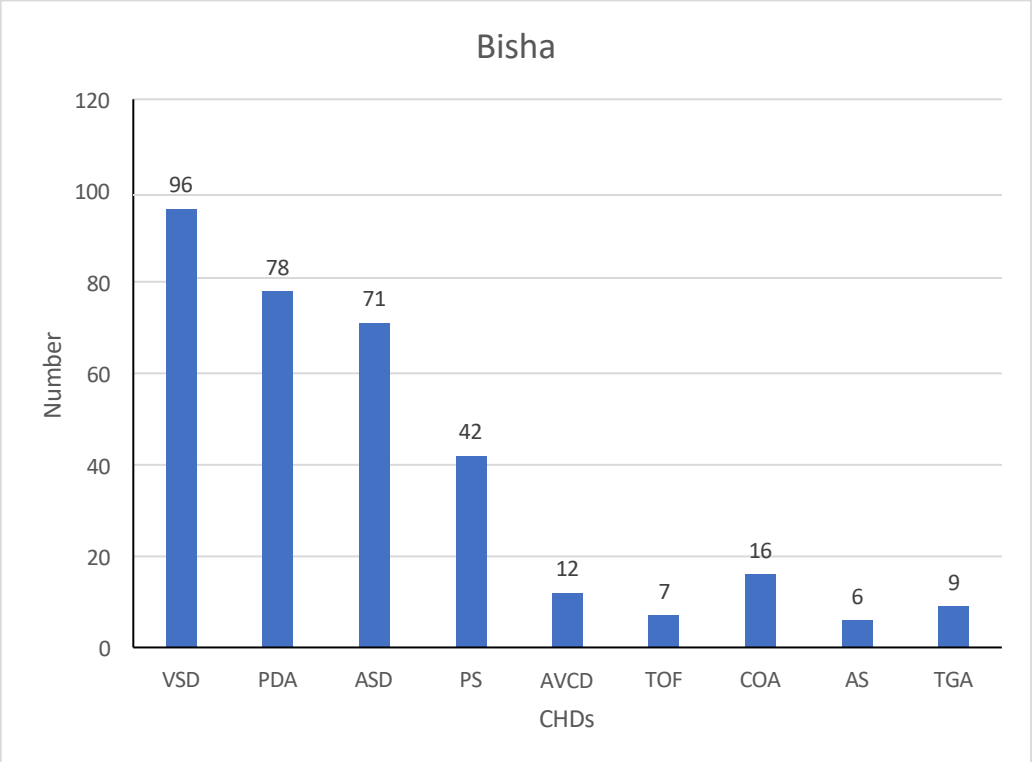

Figure 1. Distribution of the most common types of CHD pediatric cases in Bisha

Table 3. Numbers and percentages of diagnosed CHDs by region.

CHDs	**VSD**	**PDA**	**ASD**	**PS**	**AVCD**	**TOF**	**COA**	**AS**	**TGA**
Number	947	293	340	249	115	106	88	84	65
Percentage	41.41	12.81	14.87	10.89	5.03	4.63	3.85	3.67	2.84

Table 3 shows the numbers and percentages of the types of the cardiac anomalies among the CHD cases in Bisha. VSD was the most common cardiac abnormalities (41.4%) followed ASD and PDA, respectively.

The results in table 4, show data regarding referred and diagnosed congenital heart disease (CHD) cases across six regions: Bisha, Albaha, Asir, Madina, Alhassa, and Qatif.

Of the total 9,411 referred cases, 2,287 (24.3%) were diagnosed with CHD. Across all regions, the diagnosed cases percentage ranged from 2.84% to 41.41%.

The number of patients referred for CHD diagnoses in each region varies. Madina has the highest referral number (4348 cases, 46.2%), followed by Albaha (2610, 27.73%), while Qatif has the lowest (289 cases, 3.2%).

The cases confirmed with a CHD diagnosis vary across regions. Diagnosed cases are proportional to the referrals but vary significantly by region, with Alhassa showing the most cases (624 diagnosed) and the highest percentage of diagnoses (84.3%) in relation to the number of referred cases. Although Madina has the highest number of referrals, it has the lowest percentage of diagnoses (12%) in relation to the referred cases.

Table 4. Numbers of referred and diagnosed CHD pediatric patients by region in Saudi Arabia.

Variables	Bisha	Albaha	Asir	Madina	Alhassa	Qatif
Referred cases	816.0	2610.0	608.0	4348.0	740.0	289.0
Diagnosed cases	337.0	445.0	286.0	522.0	624.0	73.0
percentage	41.3	17.0	47.0	12.0	84.3	25.3

As illustrated in Figure 2, VSD was the most prevalent type of CHD in all regions, particularly in Madina (46.6%) and Alhassa (46.8%). Other significant types included PDA and ASD, with Alhassa having a higher proportion of PDA and Qatif having a higher rate of ASD. Less frequently observed defects included PS (10.9%), TOF (4.6%), AVCD (5.0%), and COA (3.8%)

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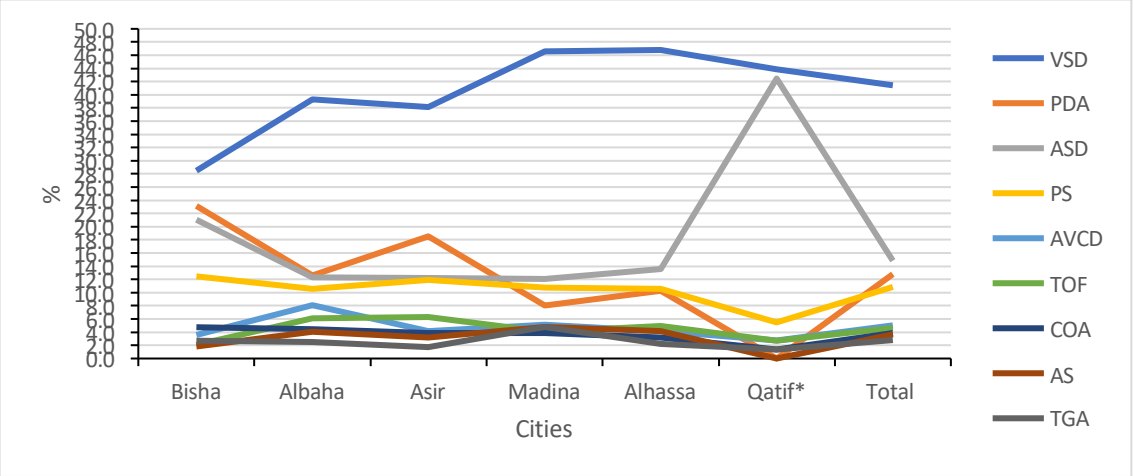

Figure 2. distribution of types of cardiac anomalies among Bisha referred pediatric cases in comparison to other areas in Saudi Arab

Discussion

The purpose of this research was to determine how often congenital heart disease (CHD) occurs, and its severity in the city of Bisha, in Southwestern Saudi Arabia. Contrary to other studies conducted in the entire country of Saudi Arabia, this research suggests Saudi Arabia has seen lower statistics in congenital heart disease. More specifically, this research suggests that the average congenital heart disease in Bisha, Saudi Arabia is 158.3 every year. This is lower in comparison to other studies done in different regions in Saudi Arabia, for example Aseer. On average, Aseer has reported 167.5 cases of congenital heart disease every year. On the other hand, Al-Baha falls below the average stating that only 120 cases of congenital heart disease occur every year. In the whole of Saudi Arabia, the average statistic of congenital heart disease below the age of 15 is 4.66 per 1,000. This research suggests that Saudi Arabia has other regions in the country like Al-Qasim and Aseer that have much higher records; 5.4 and 5.6 per 1,000 respectively. Other studies claim 4.66 per 1,000 is the average for live births with CHD. This research also shows more complex data stating that CHD occurs for different reasons in other cases. VSD is 41.8%, PDA is 23.5%, ASD is 22.9%, and finally, PS which is 13.5%.

The distribution of CHD among males and females in the current study was 56:44 with a ratio of (1.3:1). This consistent with the findings of an epidemiological study on four Saudi regions (17). However, a population-based study covering 13 regions of the Kingdom of Saudi Arabia where the incidence rate of CHD was 21 per 1,000 live birth, the gender distribution was 47:53 males to females (18). This later male-to-female distribution of CHD is in line with the status in Albaha where fewer males than females (47:53) are showing CHD (19). However, the most severe CHD is more frequent in males. This requires a special health care and counseling for the possibility of giving a baby who can suffer similar

abnormalities (20). A similar pattern of high prevalence of CHD has been reported from Saudi Arabia by other researchers (21)

The distribution of CHD incidence between males and females in Iran was found to be 46.6% to 53.4% with a ratio of 1:1.2 (22). In, Iraq (23), Sudan (24), and Jordan (25), the ratio of CHD between males and females was, 1.4:1, 1.3:1, and 1.1:1, respectively. Nevertheless, it was observed that the most severe CHD is more frequent in males, but when appears in females is of much serious concern, especially in adulthood and reproductive periods(24) . In Muscat, Al-Balushi, 2015 found that adolescents and adults are at high mortality risk (26).

The sequence of different types of CHD in the current study was found to be VSD, PDA, ASD, PS, COA, AVCD, and TOF with percentages of 19.8, 16.1, 14.6, 8.7, 3.3, 2.5, and 1.4, respectively. In general, an almost similar sequence, of CHD types was seen in Albaha, and Aseer cities of Saudi Arabia, while regionally such trends were observed in Iran and Sudan (22, 24) respectively.

Consanguinity is highly prevalent in Arab countries and might account for the top leading genetic factor of congenital abnormalities including CHD, since it was reported to be responsible for 79%, in Kuwait (27) 62% in Saudi Arabia (28), and 36% in Oman (29). It was also postulated that grandchildren of grandparents with cardiovascular disease (CVD) are threefold more susceptible to being born with CHD indicating the genetic inheritance of cardiac abnormalities (30). Thus, genetic mapping for the screening of newborns may be much more effective in detecting the possible underlying causes of CHD (31). On the other hand, comparing a group of families with children having CHD with a group of families with non-malformed children, it was concluded that some non-genetic factors might be responsible for the risk of occurrence of CHD (32). Among the other risk factors of CHD, complications of diabetes mellitus was reported to be responsible for neonatal congenital abnormalities in 7.8% of Saudi diabetic mothers (33). In addition, published literature indicate that diabetic mothers are giving more birth with CHD defects (34). Moreover, future risks associated with CHDs include a high risk of non-cardiac surgery for CHD children (35) which is reported to be responsible for cardiovascular complications in their mums (36). In addition, women with CHD were reported to experience a higher rate of pregnancy complications (37).

Therefore, in a country like Saudi Arabia with culturally high rates of consanguineous marriages along with a high rate of diabetes in the region and worldwide (38), we recommend a multidisciplinary community-oriented national management program is highly needed to combat the burden of possible consequences of this disease, particularly CHD.

Conclusion

CHD remains a major healthcare issue in Saudi Arabia with almost half of the referred suspected cases confirmed to have this condition. A need exists for an active outreach program to peripheral hospitals and health care centers to employ wider screening for CHD.

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Table 1. Frequency of main types of CHD in Bisha compared with some Saudi cities; presented as number and (percentage %).

CHD Type	Bisha n= 974	Albaha n=2610	Asir n=608	Madina n=4348	Alhassa n= 740	Qatif* n= 289
VSD	96 (19.8)	175 (29.6)	109 (32.5)	243 (34.5)	292 (39.5)	32 (43.2)
PDA	78 (16.1)	56 (9.5)	53 (15.8)	42 (6.0)	64 (8.6)	--
ASD	71 (14.6)	55 (9.3)	35 (10.4)	63 (8.6)	85 (11.5)	31 (41.9)
PS	42 (8.7)	47 (7.9)	34 (10.1)	56 (7.9)	66 (8.9)	4 (5.4)
AVCD	12 (2.5)	36 (6.0)	12 (3.6)	27 (3.8)	26 (3.5)	2 (2.7)
TOF	7 (1.4)	27 (4.7)	18 (5.4)	21 (3.0)	31 (4.2)	2 (2.7)
COA	16 (3.3)	20 (3.4)	11 (3.3)	20 (2.8)	20 (2.7)	1 (1.5)
AS	6 (1.2)	18 (3.0)	9 (2.7)	25 (3.5)	26 (3.5)	--
TGA	7 (1.4)	11 (1.9)	5 (1.5)	25 (3.5)	14 (1.9)	1 (1.5)
CHD % to referred	49.8	17.0	55.1	12.0	84.3	25.3
Duration Months	33.0	60.0	25	18.0	36.0	12.0

VSD - Ventricular septal defect, PAD - Patent ductus arteriosus, ASD - Atrial septal defect, PS - Pulmonary stenosis, AVCD - Atrioventricular canal defect, TOF - Tetralogy of Fallot, COA - Coarctation of Aorta, AS - Aortic stenosis, and TGA - Transposition of great arteries

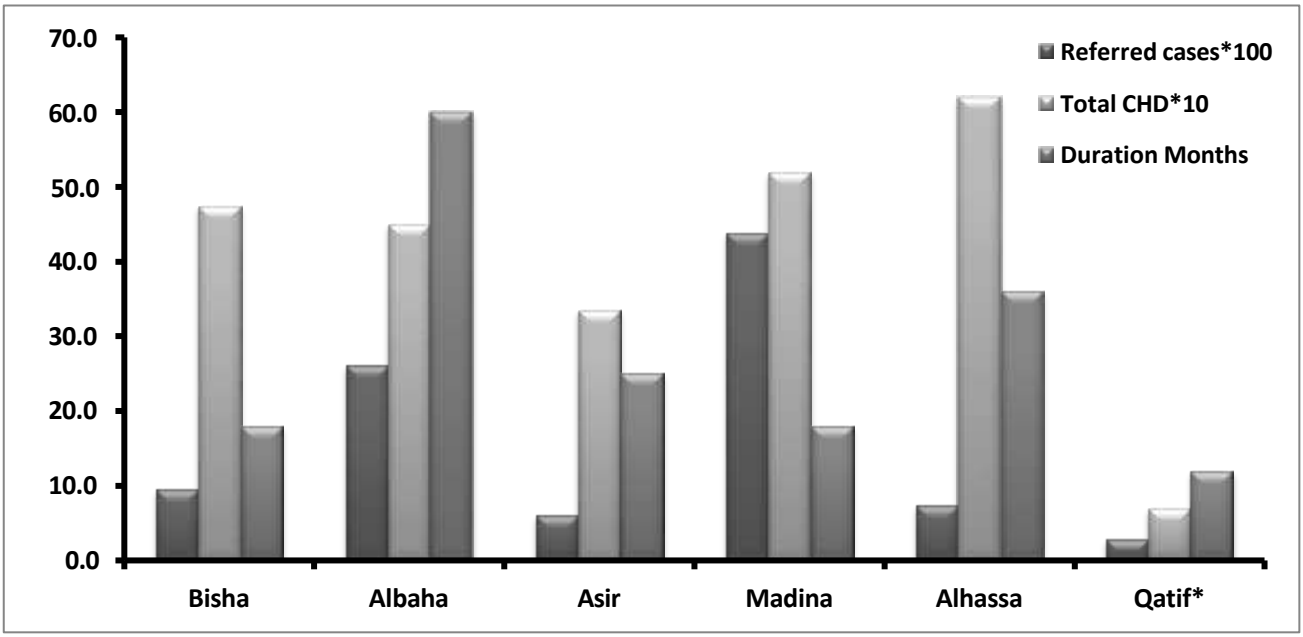

Figure 1. Comparison between CHD cases and duration of some Saudi Cities

Table 2. Frequency of main types of CHD in Bisha compared with some Countries in and around the Middle East

CHD Type	Saudi Arabia Bisha n= 954	Iran n= 3714	Jordan n=298	Iraq n=86	Oman n=600	Sudan n=522*
VSD	96 (19.8)	1002 (27.0)	75 (25.2)	41 (47.7)	126 (21.0)	68 (16.1)
PDA	78 (16.1)	625 (16.8)	132(44.3)	3 (3.9)	8 (1.3)	20 (4.6)
ASD	71 (14.6)	585 (15.8)	76 (25.5)	18 (20.9)	251 (41.8)	27 (6.2)
PS	42 (8.7)	409 (11.0)	1 (0.3)	4 (4.7)	17 (2.8)	26 (6.0)
AVCD	12 (2.5)	34 (0.9)	6 (2.0)	……..	7 (1.2)	37 (8.6)
TOF	7 (1.4)	329 (8.9)	8 (2.7)	10 (11.6)	61 (10.2)	77 (17.7)
COA	16 (3.3)	173 (4.7)	7 (2.3)	---------	13 (2.2)	3 (0.7)
AS	6 (1.2)	102 (2.7)	0	---------	21 (3.5)	6 (1.3)
TGA	7 (1.4)	61 (1.6)	5 (1.7)	2 (2.3)	42 (7.0)	29 (6.6)
Duration /months	33	24	36	12	84	12

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