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# Incidence and Types of Congenital Heart Diseases among Children in Sulaimani Governorate

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**Abstract:** ***Congenital heart diseases (CHD) are common causes of cardiovascular morbidity and mortality among young children and adolescents. It is the most common form of structural congenital defects. Little is known about incidence and type of these disorders in Sulaimani. Therefore, this study was undertaken to determine the incidence of congenital heart diseases and their types in Sulaimani Governorate. The study was conducted in Sulaimani Pediatric Teaching Hospital and the Maternity Hospital during January 2015 to December 2016. A sample of 400 consecutive cases of CHD in children aged 0-12 years was recruited attending the echocardiographic department of the hospital for diagnosis or follow-up purposes. Demographic data was collected through a face-to-face interview with the mothers of cases. A total number of new live births for 2015-2016 and those with congenital heart diseases were obtained from the medical records of the department of statistics of Sulaimani Maternity Teaching Hospital. The overall incidence of all types of congenital heart diseases was 1.7/1000, 1.6/1000 live births for the year 2015 and 2016 respectively. There was a statistically significant difference in incidence between males and females over the two years, male to female risk ratio 1.83 (95% CI 1.09-3.14, p 0.007). The commonest types of cyanotic congenital heart diseases were tetralogy of Fallot (38.9% of all cyanotic defects), complete atrioventricular canal (22.1%), and transposition of great arteries (18.2%), while the most common types of non-cyanotic congenital heart disease were atrial septal defect (34.1% of all non-cyanotic defects), ventricular septal defect (31.6%), and the other defects are less common. In conclusion, tetralogy of Fallot, atrial septal defects, and ventricular septal defects are the commonest congenital heart deformities in Sulaimani Governorate; the incidence is lower than other countries but this could be an underestimation.***

**Keywords:** Congenital heart diseases, cyanosis, incidence, consanguinity, prevalence, incidence, Sulaimani.

## INTRODUCTION

Congenital Heart Diseases (CHD) are defined as abnormal cardio-circulatory structures or functions formed during fetal life (3 to 6 weeks of conception) potentially affecting heart and blood vessels making them unable to evolve correctly before birth. The deformities could affect the heart chambers, great arteries, and valves which can be unpretentious or difficult to treat. In infancy and childhood, the diseases are considered the second leading cause of death [1-3]. Congenital heart diseases are the most prevalent types of birth defects [4] with the incidence of 10 per 1000 live births [5]. However, different studies reported variable incidence rates from about 4/1000 to 50/1000 live births [6]. Congenital heart anomalies can be classified into two types, cyanotic and non-cyanotic. The cyanotic congenital heart disease (CCHD) is an important and severe type of complex cardiac anomalies obvious to the clinician with hypoxia resulting in clinical cyanosis [7]. Cyanotic congenital heart diseases include tetralogy of Fallot (TOF), truncus arteriosus (TAr), transposition of the great arteries (TGA), tricuspid atresia (TAr), and double-outlet right ventricle (DORV) the situation in which both great arteries (pulmonary artery and aorta) [4, 7, 8]. The non-cyanotic CHD can further be sub-classified into obstructive and non-obstructive acyanotic congenital heart disease. Obstructive non-cyanotic CHD is characterized by left side obstruction which includes congenital mitral stenosis (MS), congenital pulmonary vein stenosis (PVS), aortic stenosis (AS), and Coarctation of the aorta (CoA). While the right side non-cyanotic obstructions include congenital tricuspid stenosis, pulmonary artery stenosis (PS), valvar pulmonary artery stenosis [7, 8]. The non-obstructive non-cyanotic heart defect includes ventricular septal defect (VSD) which is the second most common types of heart malformations, atrioventricular septal defect (AVSD), patent ductus arteriosus and atrial septal defect [4, 7, 9] [10]. There have been no studies on the incidence of these defects in Sulaimani; therefore the current study was undertaken to estimate incidence and types of CHD in the governorate.

## MATERIAL AND METHODS

A prospective study was conducted in Sulaimani Pediatric Teaching Hospital for the year 2015 and 2016 on 400 consecutive children with congenital heart diseases aged between 0-12 years attending Pediatric Teaching Hospital and who were residents of Sulaimani

governorate. In addition, a total live birth record was obtained from the Maternity Teaching Hospital for calculation of incidence. The Pediatric Teaching Hospital is the main public pediatric hospital in Sulaimani city which provides services in a wide range of specialties for children aged 0-12 years referred from the health centers and hospitals, private clinics across the city or from outside of the city. A case of CHD was defined as any child aged 0-12 years and resident of Sulaimani governorate diagnosed by a pediatric cardiologist, clinically and by Echocardiography as a case of congenital heart disease. A convenient sample size of 400 was chosen because this is conservative and adequate when the proportion of exposure is not known. Children were recruited when they reported to the Pediatric Teaching Hospital either for initial diagnosis or follow-up. Data was collected by interview with mothers/caregivers after explaining the aims of the study and obtaining informed consent. Privacy and confidentiality were respected and questionnaires were anonymized. Apart from the interview time, there was no harm or inconvenience to the children and their mothers/caregivers. The study was approved by the ethics committee of Technical College of Health and permission was also taken from the Pediatric Teaching Hospital. Records of total numbers of live births were obtained from the statistic department of Sulaimani Maternity Teaching Hospital for years 2015 and 2016. Data collection extended from January 2015 to December 2016. Data was entered into EpiData version 3.1 and analyzed in Stata version 11. Categorical variables were described using frequencies and percentages. While for numeric variables mean and the standard deviation was used for those normally distributed variables and the incidence rate was estimated per 1000 live births. Association between types of CHD and gender was calculated by using the Chi-square test.

## RESULTS

The sample included 400 children with congenital heart anomalies and 400 participants were interviewed giving a response rate of 100%. There were a similar number of males and females in the sample (201 males and 199 females). Table 1 shows main characteristics of the sample. In relation to ethnicity distribution of the children, the vast majority of the children were Kurds (94%) followed by Arab (5%) and other ethnic groups (1%). Regarding residence, the higher proportion of participants children diagnosed with congenital heart diseases were from inside of Sulaimani (60.8%). In respect to delivery, 47.2% of children were the result of normal delivery and 31.2% had low birth weight. Parental consanguinity was 41.8% and 6% of the children had siblings with congenital heart diseases (Table 1).

The age of children at diagnosis ranged from 0-11 years with a mean age at diagnosis of 2.7 years (SD 3.11). The mother's age ranged from 16-48 years with a mean age at the time of birth of the child under study was 29.3 years (SD 6. 5) (Table2).

We estimated the incidence of congenital heart diseases for the years 2015 and 2016 as shown in table 3. A total of 35 neonates were diagnosed to have CHD among 20802 total live births for the year 2015. The overall incidence of all types of CHD was 1.7/1000 live births. The incidence of males was 2.2/1000 live births, while the incidence in females was1.16/1000 live births with risk ratio 1.88 (95% CI: 0.90-4.16). The difference between the incidence of male and female was not statistically significant (P 0.07).

For the year 2016, a total of 34 neonates (22 males and 12 females) were reported to have CHD among 20677 total live births.

The overall incidence of all types of CHD was1.6/1000 live births. The incidence in males was 2.1/1000 live births and in females, it was 1.18/1000 live births with a risk ratio 1.77 (95% CI: 0.83-3.92). The difference between the incidence of male and female of live birth was not statistically significant (P 0.1). The overall incidence was similar over 2 years (it is 1.7 in 2015 and 1.6 in 2016). When incidence was calculated over the 2 years, there was a significant difference between males and females. The risk ratio for males compared to females was 1.83 (95% CI 1.09-3.14, p=0.007) (Table3).

**Table 1: Characteristics of children with congenital heart diseases**

| Characteristic | Cases (n=400) Number (%) |
|---|---|
| **Gender** | |
| Male | 201 (50.2) |
| Female | 199 (49.8) |
| **Ethnicity** | |
| Kurd | 376 (94) |
| Arab | 20 (5) |
| Other | 4 (1) |
| **Residence** | |
| Inside sulaimani | 243 (60.8) |
| Outside sulaimani | 157 (39.2) |
| **Mode of delivery** | |
| Normal delivery | 189 (47.2) |
| Caesarean section | 211 (52.8) |
| **Birth weight** | |
| Low birth weight g<2500 | 125 (31.2) |
| Normal birth weight g >2500 | 275 (68.8) |
| **Consanguineous marriage** | |
| Yes | 167 (41.8) |
| No | 233 (58.2) |
| **Sibling with CHD** | |
| **Yes** | 24 (6) |
| **No** | 376 (94) |

Table 4 shows the most common types of congenital heart diseases. ASD was the most common type of CHD with 27.5% of all cases followed by VSD with 25.5% of cases. Pulmonary stenosis (8.5%) and AV septal defects

(7.7%) and TOF (7.5%) were also commonly followed by other less common types. The least common types were aortic stenosis, double inlet left ventricular and truncus arteriosis (0.3%).

Table 5 shows types of CHD depending on the presence or absence of cyanosis. The commonest type of cyanotic congenital heart defects was Tetralogy of Fallot (38.9% of all defects), complete atrioventricular canal (22.1%), and transposition of great arteries (18.2%). Other less common types were double outlet left ventricular and truncus arteriosis (1.3%) respectively.

The most common types of non-cyanotic congenital heart diseases were atrial septal defect (34.1%), ventricular septal defect (31.6%), while the least common type of non-cyanotic CHD was aortic stenosis (0.3%).

We analyzed the types of CHD by gender as shown in table 6. The frequency of different types of CHD was similar between males and females and there was no statistically significant difference in distribution by gender ($\chi^2$: 6.70, P 0.8).

we also analyzed cyanotic and non-cyanotic types by gender and the results were no statistically significant difference in distribution by gender ($\chi^2$:0.38, P0.5) (Table 6).

**Table 2: Mean age distribution of parents in years**

| Age | Number | Mean (SD) | Minimum | Maximum |
|---|---|---|---|---|
| Child's age at diagnosis (years) | 400 | 2.7(3.11) | 0 | 11.20 |
| Mother's age during birth of the child | 400 | 29.3(6.5) | 16 | 48 |

**Table 3: The incidence of congenital heart diseases in the years 2015 and 2016 in live births**

| Year | Types | Number of neonates with CHD | Total live birth | Incidence /1000 | Risk ratio | 95% CI | *P* value |
|---|---|---|---|---|---|---|---|
| 2015 | Male | 23 | 10488 | 2.2 | 1.88 | 0.9-4.16 | |
| | Female | 12 | 10314 | 1.16 | Reference | | *0.07* |
| | **Total** | **35** | **20802** | 1.7 | | | |
| 2016 | Male | 22 | 10514 | 2.1 | 1.77 | 0.83-3.92 | |
| | Female | 12 | 10163 | 1.18 | Reference | | *0.1* |
| | **Total** | **34** | **20677** | 1.6 | | | |
| 2015-2016 | Male | 45 | 21002 | 2.1 | 1.83 | 1.09 -3.14 | *0.007* |
| | Female | 24 | 20477 | 1.17 | Reference | | |
| | **Total** | **69** | **41479** | 1.7 | | | |

**Table 4. Frequency types of congenital heart diseases**

| Types | Frequency | Percentage% |
|---|---|---|
| Atrial Septal defects | 110 | 27.5% |
| Ventricle Septal Defects | 102 | 25.5% |
| Pulmonary Stenosis | 34 | 8.5% |
| Atrioventricular Septal Defects | 31 | 7.7% |
| Tetralogy of Fallot | 30 | 7.5% |
| Complete Atrioventricular Canal | 17 | 4.2% |
| Transposition of great Artery | 14 | 3.5% |
| Patent Duct Arteriosus | 12 | 3% |
| Atrial septal defects, Patent Duct Arteriosis | 11 | 2.7% |
| Bicuspid Aortic Valve | 9 | 2.3% |
| Coarctation of Aorta | 8 | 2% |
| Double Outlet Right Ventricular | 8 | 2% |
| Ventricle Septal Defects, Patent Duct Arteriosis | 5 | 1.3% |
| Single Ventricular Morphology | 3 | 0.7% |
| Tricuspid Atresia | 3 | 0.7% |
| Aortic Stenosis | 1 | 0.3% |
| Double Inlet Left Ventricular defect | 1 | 0.3% |
| Truncus Arteriosis | 1 | 0.3% |
| **Total** | **400** | **100%** |

**Table 5: Types of cyanotic and non-cyanotic congenital heart diseases**

| | Types | Frequency | Percentage |
|---|---|---|---|
| **Cyanotic** | Tetralogy of Fallot | 30 | 38.9 |
| | Complete Atrioventricular Canal | 17 | 22.1 |
| | Transposition of great Artery | 14 | 18.2 |
| | Double Outlet Right Ventricular | 8 | 10.4 |
| | Single Ventricular Morphology | 3 | 3.9 |
| | Tricuspid Atresia | 3 | 3.9 |
| | Double Inlet Left Ventricular | 1 | 1.3 |
| | Truncus Arteriosis | 1 | 1.3 |
| | **Total** | **77** | **100.0** |
| **Non-cyanotic** | Atrial Septal defects | 110 | 34.1 |
| | Ventricle Septal Defects | 102 | 31.6 |
| | Pulmonary Stenosis | 34 | 10.5 |
| | Atrioventricular Septal Defects | 31 | 9.6 |
| | Patent Duct Arteriosis | 12 | 3.7 |
| | Atrial septal defects, Patent Duct Arteriosis | 11 | 3.4 |
| | Bicuspid Aortic Valve | 9 | 2.8 |
| | Coarctation of Aorta | 8 | 2.5 |
| | Ventricle Septal Defects, Patent Duct Arteriosis | 5 | 1.5 |
| | Aortic Stenosis | 1 | 0.3 |
| | **Total** | **323** | **100.0** |

**Table 6: Cardiovascular malformation distributed by gender**

| Type of Congenital Heart Diseases | Male (n=201) Number (%) | Female (n=199) Number (%) | Chi-square | P value |
|---|---|---|---|---|
| ASD | 55 | 55 | 6.70 | 0.8 |
| ASD,PDA | 7 | 4 | | |
| CAV | 9 | 8 | | |
| DORV | 5 | 3 | | |
| PDA | 6 | 6 | | |
| PS | 20 | 14 | | |
| TGA | 6 | 8 | | |
| TOF | 17 | 13 | | |
| VSD | 52 | 50 | | |
| AVSD | 11 | 20 | | |
| Other | 13 | 18 | | |
| **Cyanotic** | 37 | 32 | 0.38 | 0.5 |
| **Non-cyanotic** | 164 | 167 | | |

## DISCUSSION

We estimated the incidence of congenital heart diseases among children in sulaimani governorate for the years 2015 and 2016. The overall incidence of all types of congenital heart diseases for the year 2015 was 1.7/1000 live births with a male to female risk ratio was 1.88 (95% CI: 0.90-4.16) and 1.6/1000 live births for the year 2016 with a male to female risk ratio was 1.77 (95% CI 0.83-3.92). Although, the risk is apparently higher in males but this was not statistically significant in individual years which could be due to the fact that the number of new cases is small in each year. To support this, the total incidence of males and females over the two years revealed that males are approximately twice as likely to be at risk of having diseases compare to female

RR 1.83 which is statistically significant P 0.007. This is in accordance with studies carried out in Netherlands and Boston [11, 12]. In fact, our study reported a lower overall incidence rate of CHD for the two years in comparison to several previous studies [13, 14]. The incidence reported by a study from California, Sweden and France show similar incidence [15]. Several studies

estimate the incidence of CHD is 4 up to 10 cases per 1000 live births [6, 16]. A study from Iran have reported higher CHD incidence 8.6 per 1000 live births[17], another from China reports an overall CHD of 8.2 per 1000 total live births[14] and a study from India reports a lower incidence of 3.9 per 1000 live births but still higher than our study[18]. The lower incidence of CHD in our study may be due to lack proper checking and follow-up for all live births resulting in missed cases at birth and early neonatal period. In addition lack of detection and diagnosis, especially the simpler types of CHD could be another cause for the possible underestimation of incidence in our study.

Our study demonstrated no association between gender and types of congenital heart diseases in children ($\chi^2$: 6.70, P 0.8). In addition, there was no association between cyanotic and non-cyanotic types of congenital heart disease with the gender ($\chi^2$:0.38, P0.5). The results are in accordance with the study done in India [19]. However, the study was done in Netherland is in contrary with our study that female gender at greater risk of having several types of CHD than male [12].

The congenital heart diseases were classified into cyanotic and non-cyanotic types [7]. Our study showed the number of children with non-cyanotic congenital heart anomalies is higher than a number of children with cyanotic CHD and the most frequent types of non-cyanotic congenital heart disease were found to be atrial septal defects, ventricular septal defects counting for 34.1%, 31.6%, followed by the least common aortic stenosis 0.3%. While the most common types detected of cyanotic congenital heart defects were tetralogy of Fallot 38.9%, complete AV canal 22.1%, 18.2% compared to many unfrequented types as double inlet left ventricle and truncus arteriosis (1.3%). These results are in accordance with studies in Gorgan, northern Iran [17], South distract in Iran [20] Rwanda [4], and Xinjiang in China [21]. The study was done in India presented ASD was the commonest lesion followed by VSD similar to our study [18]. While another study presented VSD was the commonest (39.5%) then followed by ASD, PS, and PDA [22] also the study was carried out in Southwestern of Iran reported the commonest types were VSD (28.47%), ASD (10.39%) and TOF (9.3%) [13]. The interpretation of this state indicates the pattern of CHD differs from one country to another country based on the exposure to the risk factors and geographical region.

The study is not without limitations. Estimation of incidence depended on existing data which has the inherent limitations of inconsistency and inmpletenes. Other data were collected from caregivers using an interview which is prone to recall bias. Information on the types of CHD depended on clinical records and investigations making the analysis of types more reliable.

## CONCLUSION

In conclusion, the overall incidence of CHD in Sulaimani is lower than other studies but this could be an underestimation because of suboptimal checking and follow-up. The non-cyanotic CHD is more common than cyanotic CHD. The commonest types of non-cyanotic congenital heart diseases in our study are ASD, VSD, pulmonary stenosis, atrioventricular septal defects, while TOF, and CAV canal and TGA in our series are the commonest types of cyanotic CHD. Strengthening of the early detection of the CHD immediately after delivery or in the early neonatal period is required. Further research especially prospective studies could be able to provide a more accurate incidence. Research is also needed on potential risk factors contributing to the condition.

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