

Original Article

The relationship between birth weight and congenital heart disease at Ahmed Gasim Cardiac Centre, Bahri, Sudan

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ABSTRACT

Low birth weight is a known comorbidity of congenital heart disease (CHD). This study examines the relationship between CHD and birth weight of singletons, while attempting to remove factors that influence birth weight, and assesses the impact of CHD on growth in later life. The main objective is to study the relationship between birthweight and CHD. This is a cross-sectional study of 141 samples, covering all patients who were referred to the Paediatric Echocardiography Lab at Ahmed Gasim Cardiac Centre between September and October 2016. Infants with genetic syndromes or other major extracardiac abnormalities were excluded. The findings of this study clearly demonstrate that infants with CHD are more likely to be of low birth weight than the general Sudanese population, by a factor of 2.6. Of the sample, 31.9% were born with low or very low birthweight. The mean birth weight of the cases was 2.59 kg, which is 17.3% and 542.4 g less than the national average. CHD that cause a decrement in birth weight in a descending order of severity were atrial septal defect (-721 g/23%), patent ductus arteriosus (-669 g/21%), ventricular

septal defect (-610 g/19%), pulmonary stenosis (-548 g/13%) and tetralogy of Fallot (248 g/8%). Pre/postnatal growth impairment is a common feature among children with CHD. No statistically significant relationship was found between the degree of birth weight/weight to age decrement and the specific type of hemodynamic disturbance. Our results are comparable to other studies that have been undertaken. However, Sudanese patients display larger birthweight deficits than other populations.

Keywords:

Ahmed Gasim Cardiac Centre, Birth weight, Congenital heart disease, Echocardiography, Sudan.

INTRODUCTION

Congenital heart diseases (CHDs) are defined as abnormalities of the heart or great vessels that are present at birth [1]. They include a wide range of malformations, varying from severe abnormalities

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incompatible with intrauterine or perinatal life to mild lesions that produce only slight symptoms at birth or are entirely asymptomatic during life. They are the world's most prevalent birth defect. The incidence varies widely in different studies from 4/1000 per live birth to 50/1000 per live birth [2]. The incidence of all forms is 75/1000 per live birth (including trivial asymptomatic lesions) [2]. Given the known causes of CHD, there is no reason to believe the incidence rate to vary in different countries [2–4]. In premature infants, the prevalence is about 2%. Despite the amount of progress in both diagnosis and treatment, they still cause 46% of all deaths from congenital malformations and 3% of all infant deaths [5].

The aetiology of most CHDs is not fully understood but most likely involves a complex interaction between environmental and genetic factors [6,7]. Similarly, the aetiology for low birth weight (LBW) is also exceedingly broad and wide-ranging.

The relationship between CHDs and LBW is well established, however, no studies have been performed in developing countries or in the region [5,8–10]. Those with acyanotic lesions have been described as having a lower birth weight than those with cyanotic defects [8]. There is a noted increased incidence of low and very low birthweight.

This study explored the relationship between CHD and birth weight in Sudanese children (taking into account the lower average birth weight of newborns in Sudan). The average birth weight in Sudan is 3.1317 kg [11]. Pathologically, the disorders can be divided into 4 major groups, which are left-to-right shunts, right-to-left shunts, obstructive lesions and complex with common mixing [12]. The CHDs were also further classified into cyanotic and acyanotic.

METHODS

Study setting

This is a facility based cross-sectional study that was set in Ahmed Gasim Centre for Cardiac Surgery and Renal Transplant Hospital. Ahmed Gasim tertiary care hospital is located in Khartoum North (Bahri), Sudan. It is the only publically run hospital in the country to offer a full range of paediatric

cardiothoracic services. It receives patients referred from all over the nation and has three paediatric cardiology clinics per week.

Study Population

It included anyone who presented to the pediatric cardiology clinic at Ahmed Gasim Hospital. We tried to remove confounding factors for birth weight. Those with chromosomal abnormalities, born preterm < 35 weeks gestational age, from multiple births, born to hypertensive/diabetic mothers, and those with severe extra-cardiac abnormalities were excluded. Those who their guardians were unable to recall their children's birth weight group were also excluded.

Sampling

The sample size was calculated as 107 using Cochran's formula. Information from total of 141 cases was collected with complete coverage of patients seen in the echocardiography lab from September to October 2016. A structured interview form was filled in with the patient's diagnosis taken directly from the consultant pediatric cardiologist.

RESULTS

A total of 141 infants were enrolled in this study. The average age of the patients was 2 years and 6 months, ranging from 4 days to 15 years. There was slight male predominance. Some were born preterm \geq 35 weeks gestational age (1.4%). In total, 11.3% were dysmorphic ($n = 16$) (Down syndrome, Noonan's syndrome and other). A total of 9% ($n = 9$) had a positive history of factors previously mentioned in the exclusion criteria that influence birthweight. Few had positive family history of CHDs (0.7%). The average birthweight of the samples was 2.59 kg with 31.9% being of low or very low birthweight.

Acyanotic and cyanotic CHDs were 74.1% and 25.9%, respectively. From the standpoint of pathological category: left-to-right shunt was 56.9%, right-to-left was 19%, obstructive lesions were 15.5% and complex with common mixing that were 8.6%.

All of cases were of low birth weight with 50% being of very low birth weight. 13.5% of all cases were born with chromosomal abnormalities with the most common being Down syndrome followed

by Noonan’s syndrome (Figure 1). The prevalence of Down syndrome in the study was 8.5% compared to 0.14% among the general population and 31.7% of the samples were of low birth weight [13].

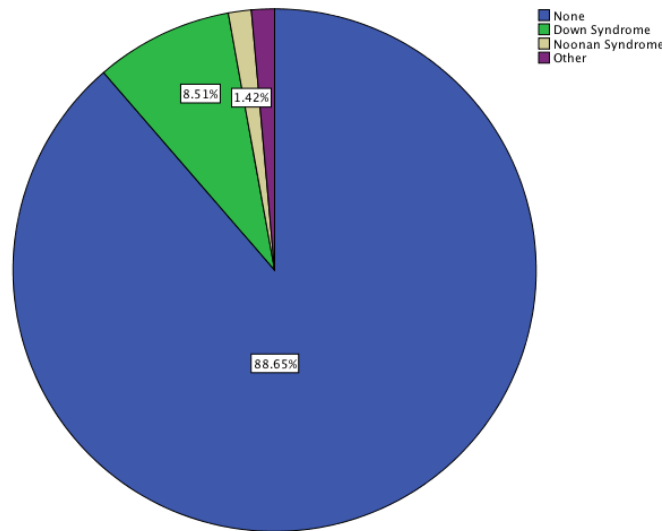


Figure 1- Distribution of chromosomal abnormalities (n = 141).

The five most prevalent CHD lesions were, in (13%), atrial septal defect (ASD) (13%), pulmonary descending order, found to be ventricular septal stenosis (PS) (9%) and tetralogy of Fallot (TOF) (7%) defects (VSD) (24%), patent ductus arteriosus (PDA) (Figure 2).

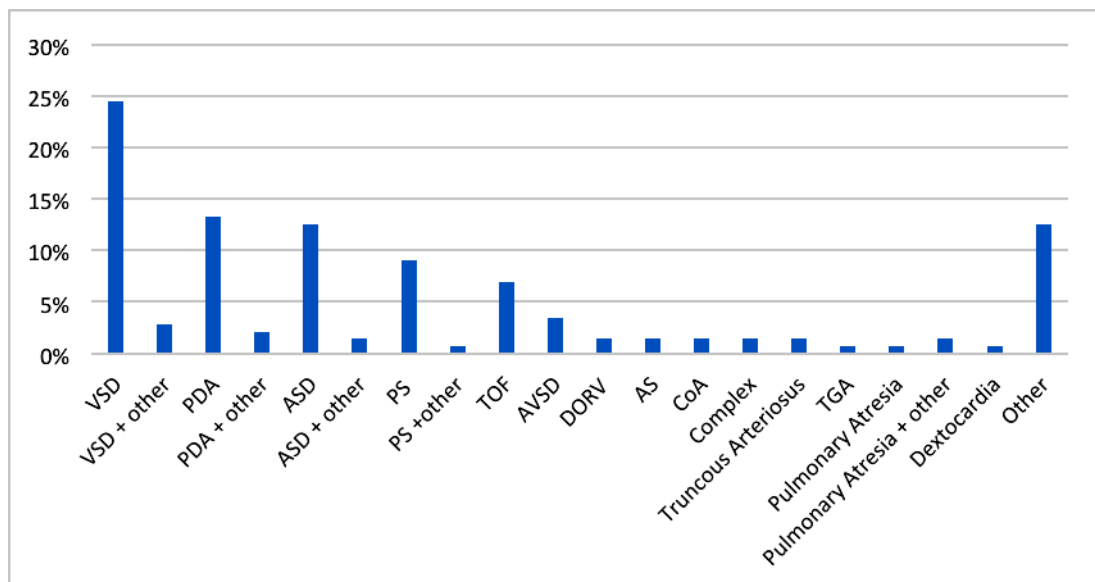


Figure 2- Distribution of individual congenital heart diseases in percentage (n = 141).

ASD - Atrial septal defect, AS- Aortic stenosis, AVSD - Atrioventricular septal defect, CoA- Coarctation of the Aorta, DORV- Double outlet right ventricle, PDA- Patent ductus arteriosus, PS- Pulmonary stenosis, TOF- Tetralogy of Fallot, VSD- Ventricular septal defect.

Infants with CHDs in this study were more likely to be low birth weight (Figure 3). of low birth weight with 32.2% being of a low or very

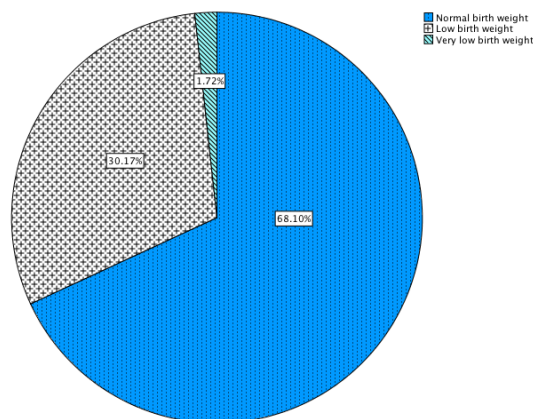


Figure 3– Birth weight group distribution in percentage (n = 116).

However, the left-to-right shunts had the highest prevalence of low birth weight at 37.5% and were the only group of patients to present with very low birth weights (n = 2). Left-to-right was followed shortly by complex lesions at 30%; obstructive and right-to-left were at 21.1% and 17.4% respectively.

The means birth weight of Left-to-right hemodynamic disturbances is 2.52 kg (deficit of 612 g/24%), mean of Right-to-left is 2.70 kg (deficit of 432 g/16%), of Obstructive lesions is 2.73 kg (deficit of 402 g/15%) and of Complex lesions is 2.64 kg (deficit of 492 g) (Table 1).

Table 1- Cross-tabulation between hemodynamic category and birth weight.

Category	Birth weight			Total
	Normal birth weight	Low birth weight	Very low birth weight	
Left-to-Right Shunt	38	26	2	66
Right-to-Left Shunt	19	3	0	22
Obstructive lesion	15	3	0	18
Complex with Common mixing	7	3	0	10
Total	79	35	2	116

DISCUSSION

Taking into account all the cases presented to the clinic at the study time, there was slight male gender predominance. This is in keeping with what other studies have shown [14]. Two percent were born preterm, compared to a Sudanese prevalence of 13.2% perhaps due to fetuses not surviving into infancy [15]. This study confirms what is widely known regarding low birth among those who are preterm. 50.0% were born from consanguineous unions, which is lower

than documented Sudanese norms [16].

There are almost no cases with positive family history. The Najmeddin study, which was performed in Sudan found family history to be positive in 7.8% patients; perhaps due to them using a different definition of family history of CHD (only first-degree relative were considered for this research) [13].

The frequency of different types of CHD corresponded with international averages and is mostly similar to

Sudanese norms [4,12,17]. VSD had a prevalence of 24.5%, PDA with 13.3%, ASD with 12.6%, PS with 9.1%, TOF with 7.0%, AVSD with 3.5% DORV with 2.1% and AS and CoA both at 1.6%. The El Haj study in Sudan found VSD had a prevalence of 45%, TOF at 13%, PS at 8%, PDA & AVSD at 5% and ASD at only 4% [4]. This study used a very small sample ($n = 27$) and the cases were only diagnosed by examination. The prevalence in the El Nour study was also vaguely similar [18]. Disregarding the TGA found in 21.5% of patients (compared to in 0.7% in this study). Both of these studies found VSD prevalence to be higher than noted in our study. This could be due to only including pure VSD, and not in combination with anything else.

Regarding the complications that the cases presented with; 2.1% mothers presented with overt/gestational diabetes. The prevalence of preeclampsia/hypertension was found to be 2.8% in the study. While the prevalence of hypertension among women in Sudan was found to be 25.9% after the screening, the vast majority of whom are undiagnosed [19]. This goes some way to explaining the low-recorded prevalence. The prevalence of infants born from twin/triplet pregnancies was 1.4%. This figure is precisely the same as found in the literature [20]. So it might be safe to assume that multiple birth pregnancies are not a risk factor for being born with CHD.

The presence of extracardiac congenital abnormalities was 3.5%. This is slightly less than the literature figure of 4.53% [21]. This decrease was probably due to lack of other screening tests done. A study found that 44% of neonates with CHD who were screened with abdominal ultrasound had an abnormality with 27% having an abnormality that was classified as significant or marginally significant [12]. A screening process for extra-cardiac abnormalities for those born with CHDs should be considered.

The findings of this study clearly demonstrate that infants with CHDs are more likely to be of low birth weight than the general Sudanese population (p value = 0.000), with 32.2% being of a low or very low birthweight compared to to the Sudanese percentage of 12.6%; a factor of times 2.6 [22].

The recorded mean birthweight among the cases is 2.56 kg; this is 22% and 571.7 g less than the national average (3.1317 kg). This figure is significantly less than the 3.039 kg, 3.071 kg and 2.91 kg means found in other studies among CHD patients [7-9].

No significant statistical differences could be discerned between the birth weights of different pathological groups. The literature is divided between studies that found the distinct group of hemodynamic to have a distinct effect on birth weight and studies that found no significant relationship between the two [5,8]. The mean BW of pure VSD and ASD case subjects was 2.52 kg and 2.41 kg, which is correspondingly 23% (deficit of 612 g) and 28.6% (deficit of 722 g) less the control. The EGJ Jacobs study found the mean birth weights of VSD to be 2.93 kg (deficit of 14.8% compared with its control) and of ASD to be 2.70 kg [8]. Forty one percent of VSD patients are of low or very low birthweight while 45.5% of ASD cases are of low birth weight. It is well established that ventricular and atrial septal are associated with significant decrease in birth weight [8]. The mean BW of PDA patients is 2.46 kg (27%/617.7 g decrease) with 53% being of low birth weight. The mean birthweight of pulmonary stenosis is 2.77 kg (13%/316.7 g decrease) with 18.2% being of low birth weight. Transposition of the great arteries is a known exception to rule of CHD patients presenting with low birth weight, with one study finding a higher than average mean [5,23]. The one recorded case of pure TGA was of normal. TOF was found to be close to the normal with a mean of 2.88 kg and all cases being of normal birthweight. All of these values are comparable to literature.

In descending order of severity, there is ASD, PDA, VSD, PS and TOF. This closely mirrors previous research done on the topic. The Petrossian study found Conotruncal disorders (e.g. TOF, Truncous Arteriosm) to have the greatest proportion of low birth weight infants at 24.7% followed by ASD at 22.8% with a high proportion of very low birth weights (at 7.1% and 3.9%, respectively) and extremely low (at 3.9% and 1.4%, respectively) and the greatest average weight deficits from their control (of 3.519 kg) at 265 g [5]. That is compared to a deficit of 153.9 g to my control (of 3.132 kg). This differs from our conclusion, Conotruncal disorders were found to have the lowest percentage of low birthweight in my study. This is due to the defects, which comprise conotruncal disorders being all TOF in my study (barring two cases of Truncous Arteriosm, which were of normal birthweight), as noted above TOF presents with almost average birth weights.

The difference that was found between the birth weights of infants born with the presence or absence of

cyanosis was not statistically significant. Nonetheless, the mean birth weights of those with acyanotic lesions are 200 g less than those with cyanotic defects. And low birth weights are present in 16.7% of those who presented cyanotic versus 37.8% who were acyanotic; this is in keeping with what other studies have reported [8].

From the standpoint of growth in later life using weight-to-age, the results were 21.5% and 32.7% as moderately and severely underweight respectively. The Najmeddin study done in Sudan, which created its own controls found 15.4% of the cases to be moderately underweight and 3.8% to be severely underweight [23]. The H. Musa study found the prevalence of being underweight among school children in Khartoum state to be 15.4% in total with 8.8% being moderately underweight and 6.6% were severely underweight among School children in Sudan [24]. The former study found 29.4% of the cases to be moderately underweight and 62.7% were severely underweight. No statistically significant relationship was found between those cyanotic/acyanotic and weight-for-age; and hemodynamic category and weight for age. It is clear that being born with CHD leads to and increased likelihood of being moderately and severely underweight. My study, for the most part, concurs with previous literature.

This study has several limitations that should be noted. Unfortunately, we couldn't fully monitor all factors that affect birthweight. The birth weights used were recalled from the mother's memory as such there is a degree of recall error, so they could not be independently verified. It would have been preferable to obtain the data retrospectively from records (not possible due to inadequate records). In addition is the relatively small sample size. All the studies in the literature review used data from either the Baltimore-Washington study or the National Birth Defects Prevention Study (which contains 3395 cases, compared to my 117 cases); a number of samples that simply isn't feasible with the current resources at my disposal.

Numerous other variables were not taken due to time constraints and to prevent inconveniencing the staff at the clinic e.g. socioeconomics, maternal nutrition, maternal smoking, mother's education, previous pregnancies, other infant anthropometric measurements (e.g. height, head circumference)

etc. There is a measure of selection bias in this study as all the data was taken from one paediatric echocardiography clinic at Ahmed Gasim Cardiac Centre however they receive cases referred from all over the country. This selection bias is further countered by the high degree of parents' participation; no one refused to be included after having the study explained to them. A merit of this study is the accurateness of the diagnoses. The data was taken by the consultant paediatric cardiologist using echocardiography.

CONCLUSION

Newborns with congenital heart defects are more likely to be born with low birth weights than the national population. The degree to which congenital heart disease affects the populations birth weight seems to be more pronounced than in Western children, even after taking into account our lower than international means average birthweight. Those with congenital heart defect have a much greater chance of suffering from post-natal retarded growth than normal. Further studies are required to determine whether any relationship exists between birthweight and the different hemodynamic disturbances or cyanotic status and to examine the consequences of persistent growth deficits on patient outcome and mental development.

RECOMMENDATIONS

- Regular follow ups to properly assess growth. With the nutritional needs assessed.
- A nutritional program should be implemented if necessary, by a professional nutritionist in conjunction with a paediatrician.
- Those with low birthweight should undergo an echocardiography assessment.
- An effort should be made to preform interventional treatment (if required) as soon as possible.
- Those who are persistently severely underweight should undergo echocardiography assessment.
- Screening program for those with CHDs to rule out the possibility of extra-cardiac congenital anomalies.

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