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**Research Article**

# The Relationship between Congenital Heart Disease and Low Birth Weight in Sudanese Children

Hafiz Osama Hafiz Elshazali[1], Maha Husain Mohamed Hamza[2], Osama Hafiz Elshazali[3*]

[1]Department of Medicine, Cumberland Infirmary, Carlisle, UK
[2]Paediatrician, Ahmed Gasim Hospital, Khartoum North, Sudan
[3]Paediatric Cardiologist, University of Khartoum, Sudan

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**Abstract:** One of the primary causes of mortality and morbidity in children are congenital heart disease (CHD); they have become a major burden on the global health. Babies with congenital heart disease are at a higher risk to be born with low birth weight. The purpose of the study is to investigate the relationship between the presence of CHD and low birth weight in the Sudanese children. This was an observational, cross-sectional study, conducted at Ahmed Gasim hospital, recruiting children with CHD from June to November 2018. The study included 139 study participants; 116(83.5%) mothers were between the ages of 20 to 40, only 85 (61.2%) mothers had regular antenatal care. 96 mothers (69%) were multiparous, 11 mothers (7.9%) reported an illness during pregnancy such as Diabetes and Hypertension. 90 children (64.7%) had been born with low birth weight while 49(35.3%) were born with normal weight. There was statistically a significant difference between the mean birth weight for the study group (2.35 kg) and the mean birth weight in Sudan (3.04 kg). Of the CHD lesions 20.9% were classified as cyanotic heart disease while the remained classified as a cyanotic heart disease. With regard to cyanotic status, a significant difference in the birth weight was not found. In Sudan, the percentage of low birth weight was found to be higher in children with CHD; larger birth weight deficits were found in Sudanese children than in other populations.

**Keywords:** Congenital Heart Disease (CHD), Low Birth Weight, Children, Sudan.



## INTRODUCTION

Congenital heart diseases (CHDs) are the abnormalities and malformations of the heart or in the great vessels that were present from birth; the severity of the abnormalities can range from those incompatible with intrauterine or perinatal life to mild lesions that can only produce slight symptoms at birth or are entirely asymptomatic throughout life. With the incidence rate of CHD being approximately 8-10 per 1000 live birth, CHDs are most prevalent birth defect in the world; CHD are responsible for a third of all of the congenital defects [1]. Despite the amount of progress that has been made in both diagnosis and treatment, they remain responsible for 46% of all fatalities from congenital malformations and 3% of all infant mortalities [2].

According to the WHO, birth weight is defined as the initial weight of a newborn child measured after birth. With live births, the birth weight of the child should ideally be weighed within the first hour of its life before any significant postnatal weight loss occurs.

Low birth weight (LBW) for newborns is defined as having a weight of less than 2.5kg, regardless of gestational age [3]; LBW is a prominent public health issue around the world and is related to a range of conditions, both short and long term. It has been estimated that there are over 20 million births with LBW a year, representing 15% to 20% of all of the births worldwide. WHO has set out to reduce the numbers of infants born with LBW by 30% by the year 2025 [4].

The relationship between CHDs and LBW had already been established [2, 5, 6]; however, there are very few studies that have been conducted in the third world countries including Sudan [7]. Even though the relationship between CHD and LBW has already been investigated in both clinical and pathologic case series as well as in case control studies, there is a limited availability of studies that have been population-based or controlled for the maternal and fetal determinants of growth. Published reports have indicated that newborns with CHD are 1.8 to 3.6 times more likely to have low birth weights for gestational age than those without CHD [7]. This is a concern because Infants with both LBW and CHD suffer from a higher risk of mortality than infants with CHD but are not with LBW [8].

***Corresponding Author:** Osama Hafiz Elshazali

From a haemodynamic perspective, CHD are categorized into four major groups: left-to-right shunts, right-to-left shunts, obstructive lesions and complex with common mixing [9]. The CHD can be classified even further into cyanotic and a cyanotic depending on the cyanosis status.

This paper explores the correlation between CHD and birth weight in the children of Sudan taking into consideration the fact that the lower average birth weight of newborns in Sudan; The mean birth weight in Sudan is approximately 3.040 kg [10].

## OBJECTIVE

To study the relationship between CHD and LBW in children in Sudan and to explore the role of any other maternal or social factors

## METHODS

**Population**

This is a prospective, observational, cross-sectional hospital based study; we have included all the children who attended to the paediatric cardiology clinic at the Ahmed Gasim Cardiac Centre during the study period from June to November 2018.

Those excluded from the study include: CHD children with other major birth defects, those with chromosomal anomalies such as trisomy 21, trisomy 13 and trisomy 18, the children whose parents cannot recall their birth weight.

The study data was collected by pre-tested questionnaire; the questionnaire included demographic information of the parents such as age, education, occupation and social class as defined by the father's occupation. The questionnaire also included medical information regarding the course of pregnancy and birth weight. The diagnosis of the CHD lesions was confirmed from the medical notes.

**Sample size**

The minimum sample size was calculated to be 109 using Cochran's formula. Information from a total of 139 cases was collected with complete coverage of patients seen in the paediatrics cardiology clinic during the study period.

## DATA ANALYSIS

The data used for this study was analyzed using the Statistic Package for Social Science (SPSS) (IBM, Armonk, NY, USA) software version 25. The chi-square test and cross tabulation were used in the study. A p-value that was calculated to be equal or less than 0.05 was considered as significant.

**Ethical considerations**

Ethical approvals were obtained from the Sudan Medical Specialization Board ethical committee and from Ahmed Gasim hospital.

It was made very clear to the parents that participation is voluntary and that they could withdraw from the study at any time. A written consent was taken from all the parents. The study questionnaire data was coded to protect the patient's confidentiality and privacy.

## RESULTS

139 children were included in the study; concerning the birth weight, 90 (64.7%) of the children had low birth weight while 49 (35.3%) of the children were reported to have normal birth weight (Table 1). The mean birth weight was 2.35 kg ± 0.69.

86 (61.9%) of children were less than one year in age; With almost equal gender distribution with male to female ratio of 1:1 (Table 1).

**Table-1: Children Characteristics (n=139)**

| Child Characteristics | Frequency | Percent |
|---|---|---|
| 0 – 6 months | 34 | 24.5 |
| >6 months – 1 year | 45 | 32.4 |
| >1 – 5 years | 42 | 30.2 |
| > 5 years | 18 | 12.9 |
| Male | 69 | 49.7 |
| Female | 70 | 50.3 |
| Low weight | 90 | 64.7 |
| Normal weight | 49 | 35.3 |

116 (83.5%) mothers age were between 20 to 40 years in age, 14 (10.%) of them were younger than 20 years and nine of them(6.5%) were older than 40 years, significant birth weight difference between the maternal age groups was not found (Table 2).

**Table-2: Maternal Age and Birth weight (n=139)**

| **Maternal age** | | **Birth weight** | | **Total** |
|---|---|---|---|---|
| | | < 2.500 kg | ≥ 2.500 Kg | |
| | < 20 | 10 | 4 | 14 |
| | 20-40 | 75 | 41 | 116 |
| | > 40 | 5 | 4 | 9 |
| | | 90 | 49 | 139 |

The chi-square statistic is 0.6074. The p-value is 0.7380985 mothers (61.2%) had regular antenatal care during the pregnancy .96 (69%) mothers were multipara, eight (5.8%) were Para III, 19 (13.7%) were Para II. There was no significant difference in the birth weight according to parity (Table 3).

**Table-3: Parity and Birth Weight (n=139)**

| **Parity** | | **Birth weight** | | **Total** |
|---|---|---|---|---|
| | | **< 2.500 Kg** | **≥ 2.500 Kg** | |
| | Para I | 11 | 5 | 16 |
| | Para I I | 11 | 8 | 19 |
| | Para III | 7 | 1 | 8 |
| | Multipara | 61 | 35 | 96 |
| Total | | 90 | 49 | 139 |

The chi-square statistic is 2.3788. The p-value is 0.497595, Illnesses during pregnancy such as diabetes, and hypertension were reported in 11 (7.9%) mothers (Table 4).

**Table-4: Illness during Pregnancy** (n = 139)

| **Illness during pregnancy** | | **Frequency** | **Percent** |
|---|---|---|---|
| Yes | | 11 | 7.9 |
| No | | 128 | 92.1 |
| The illness (n = 11) | Diabetes | 4 | |
| | Hypertension | 4 | |
| | Other | 3 | |

Six (4.3%) mothers used medication during pregnancy; three used insulin, one used oral hypoglycemic drugs, one used Amlodipine and one used another other anti-hypertensive drugs (Table 5). There was no significant birth weight difference according to maternal illness during the pregnancy or according to the use of medications during the pregnancy.

**Table-5: Medication Use during Pregnancy (n = 139)**

| **Medications during pregnancy** | | **Frequency** | **Percent** |
|---|---|---|---|
| Yes | | 6 | 4.3 |
| No | | 133 | 95.7 |
| Drugs(n= 6) | Oral hypoglycemic drugs | 1 | |
| | Insulin | 3 | |
| | Amlodipine | 1 | |
| | Other antihypertensive | 1 | |

Regarding parents education 119 (85.6%) mothers and 118 (84.9%) fathers were educated up to secondary school or higher (Table 6), there was no significant difference in the birth weight according to parent's education.

**Table-6: Parental education (n = 139)**

| Parental education | | Frequency | Percent |
|---|---|---|---|
| **Mothers** | **Illiterate** | 3 | 2.2 |
| | **Primary** | 17 | 12.2 |
| | **Secondary** | 67 | 48.2 |
| | **University** | 47 | 33.8 |
| | **Postgraduate** | 5 | 3.6 |
| **Fathers** | **Illiterate** | 4 | 2.9 |
| | **Primary** | 17 | 12.2 |
| | **Secondary** | 49 | 35.2 |
| | **University** | 61 | 43.9 |
| | **Postgraduate** | 8 | 5.8 |

There were 51(36.7%) children from medium socioeconomic status and 88 (63.3%) children were from low socioeconomic status and they were no children from high socioeconomic status, no significant difference in the birth weight according to parent's socioeconomic status was found.

11 (7.9%) children were a product of twin pregnancy, their twin siblings had been checked and all were found to have a normal heart. There were six (4.3%) children who were born prematurely, two each born at 32, 34 and 36 weeks gestation. Delivery was normal in in 103 (74.2%) and 36 (25.8%) children were delivered by caesarian sections.

There were 110 (79.1%) children with a cyanotic CHD and 29(20.9%) with cyanotic CHD, no significant difference in the birth weight according to the cyanotic status was observed.

From the perspective of the haemodynamic pathological categories: there were 103(74.5%) children with left to right lesions, 21 (15%) children were with right to left lesions, 9 (6.5%) children were with obstructive lesions and 6(4%) were with complex lesions.

The commonest CHD lesions from the most occurring to the least occurring were found to be ventricular Septal Defect (VSD) in 65 children (46.8%), Patent Ductus Arteriosus (PDA) in 25 children (17.9%), Atrial Septal Defect (ASD) in 21 children (15.1%), Tetralogy of Fallot (TOF) in 19 children (13.7%), Pulmonary Stenosis (PS) in 5 children (3.6%), Transposition of the Great Arteries (TGA) in 4 children (2.9%) (Table 7).

**Table-7: Birth weight and the different congenital heart disease (n = 139)**

| Congenital heart disease | | Birth weight (kg) | | | | | | Pvalue |
|---|---|---|---|---|---|---|---|---|
| | | < 2.5 kg (n = 90) | | ≥ 2.5 kg (n = 49) | | Total (n = 139) | | |
| | | Freq. | % | Freq. | % | Freq. | % | |
| **VSD** | **Yes** | 43 | 47.8 | 22 | 44.9 | 65 | 46.8 | 0.74 |
| | **No** | 47 | 52.2 | 27 | 55.1 | 74 | 53.2 | |
| **PDA** | **Yes** | 19 | 21.1 | 6 | 12.2 | 25 | 17.9 | **0.19** |
| | **No** | 71 | 78.9 | 43 | 87.8 | 114 | 82.1 | |
| **ASD** | **Yes** | 10 | 11.1 | 11 | 28.2 | 21 | 15.1 | **0.07** |
| | **No** | 80 | 88.9 | 38 | 71.8 | 118 | 84.9 | |
| **TOF** | **Yes** | 8 | 8.9 | 11 | 28.2 | 19 | 13.7 | 0.04 |
| | **No** | 82 | 91.1 | 38 | 71.8 | 120 | 86.3 | |
| **PS** | **Yes** | 4 | 4.4 | 1 | 2.0 | 5 | 3.6 | **0.46** |
| | **No** | 86 | 95.6 | 48 | 98.0 | 134 | 96.4 | |
| **AVSD** | **Yes** | 3 | 3.3 | 0 | 0 | 3 | 2.1 | **0.01** |
| | **No** | 87 | 96.7 | 49 | 100 | 136 | 97.9 | |
| **DORV** | **Yes** | 4 | 4.4 | 2 | 4.0 | 6 | 4.3 | **0.90** |
| | **No** | 86 | 95.6 | 47 | 96.0 | 133 | 95.7 | |
| **TGA** | **Yes** | 2 | 3.3 | 2 | 4.0 | 4 | 2.9 | **0.54** |
| | **No** | 88 | 96.7 | 47 | 96.0 | 135 | 97.1 | |
| **CoA** | **Yes** | 3 | 3.3 | 0 | 0.0 | 3 | 2.2 | **0.01** |
| | **No** | 87 | 96.7 | 49 | 100.0 | 136 | 97.8 | |
| **AS** | **Yes** | 0 | 0 | 2 | 4.0 | 2 | 1.4 | **0.01** |
| | **No** | 90 | 100 | 47 | 96.0 | 137 | 98.6 | |

## DISCUSSION

The study included 139 children. There were 90 ( 64.7%) children with LB, the average birth weight for the study group was 2350 g ± 690g; studies from Sudan[10] showed that 12.5% were born with LBW and the average birth weight was 3040 g ± 573 g, this mean birth weight is significantly different from the mean birth weight found in this study ( p value 0.001). A previous study from the same center by Hafiz *et al*. found that 31.9% were born with LBW [7].

With respect to the mother's age, parity, parental education or socioeconomic status; there was no significant difference in the birth weight to be found. Also, there were no significant statistical differences that could be determined between the birth weights of the 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 [2, 5].

In the Petrossian study from USA, CAVSD, left heart obstructive lesions, ASD and membranous VSD showed significant birth weight deficit compared to the control group [2].

A study from Hong Kong [5] found 15% of all CHD newborns had a birth weight below the reference mean of −2 Z-score. After correction for length of gestation, no significant difference could be detected in birth weight between the cyanotic and cyanotic groups, nor between the different haemodynamic disturbances. Infants with atrial or ventricular septal defects, tetralogy of Fallot, and pulmonary atresia with ventricular septal defect, heart with univentricular a trio-ventricular connection or double outlet right ventricle showed significant birth weight deficits. Transposition of the great arteries was not related to being small for gestational age [5].

In this study, we did not find significant difference in the birth weight between cyanotic and a cyanotic lesions (p value =0.159).

The birth weight in Tetralogy of Fallot (TOF) was significantly different with more children on the normal birth weight than with those with low birth weight ( p value = 0.04) (Table 7), this is in contrast with a systemic review of CHD and low birth weight, which showed that TOF was associated with low birth weight [11].

The birth weight for Complete Atrioventricular Septal defect(AVSD) and Coarctation of Aorta was significantly different ( p value =0.01) (Table 7) with children tending to have lower birth weights, this result was consistent with other previous studies [2, 5].

This study found that more than one third of the mothers (38.8%) had no regular antenatal care, this lack of antenatal care was identified as being significantly associated with LBW [12]. Kotelchuck reported that the relative risk of LBW is 1.47 in pregnant women with inadequate antenatal compared to a risk of 0.56 in pregnant women with adequate antenatal visits (13). The provision of antenatal care is one of the necessary measures to lower the potential risk of LBW, it promotes health awareness regarding LBW and allows for timely identification of complications [12].

The frequency of different types of CHD is in line with international figures and is consistent with the Sudanese norms (Table 7) [7, 14, 15]. The figure of 64.7% of Children with CHD who were born with low birth weight is significantly higher than other studies; the National Birth Defects Prevention study from the USA found a figure of 15.2% [16] and a study from Hong Kong found a figure of 15% [5].

The average birth weight in the study is 2.35 kg, It is lower than the Sudanese average of 3.04 kg by 22.7% or a 690 g difference. The results from this study have verified that the new borns with CHD are more like to exhibit a lower birth weight than the general Sudanese population (p value = 0.01), with 64.7% of the infants with CHD being of a low or very low birth weight in comparison to the percentage of 12.5% for the general Sudanese population; a factor of 5.1 times [10]. This mean of 2.35 kg is significantly lower than 2.91 kg reported from China [5], 3.039 kg reported from USA [16] and 3.071 kg reported from USA [6] among CHD patients.

Most of the mothers (83.5%) were between 20 to 40 years in age and 6.5% were over the age of 40 years; there was no statistically significant difference in the birth weight for the infants with respect to the maternal age (Table 1).

A study by Schulkey *et al.* [17] had argued that even in the absence of any chromosomal abnormalities in the newborns, increased maternal age was a risk factor for CHD; On the other hand, another study by Goisis *et al*. [18] from Finland had not found any significant association between LBW and advanced maternal age. This study found that 69% of mothers were multipara (Table 3); There was no significant difference in the birth weight with regard to parity, this is consistent with a meta-analysis that was conducted by Shah *et al*. [19]. A meta-analysis study by Feng *et al* that was investigating the relationship between parity and the increased risk of CHD in the offspring had found a positive association between increased parity and risk of CHD [20]., this could be a possible explanation for the high percentage of multipara in this study group.

This study found that a small proportion of the mothers (7.9%) reported illnesses during pregnancy such as Diabetes, and Hypertension (Table 4). Chou *et al*. [21] reported that the children of women who were affected with chronic disease were at increased risk for CHD. The list includes Type 1 and 2 Diabetes, Anemia, CHD and Epilepsy. It is crucial in order to secure the best outcome for the mothers and babies that women receive preconception counselling and the optimum treatment for the medical condition during the pregnancy. Graham *et al*. [22] reported that maternal chronic Hypertension and Diabetes were significantly associated with preterm delivery and LBW.

The study found that only six (4.3%) of the mothers used medications during pregnancy such as insulin, oral hypoglycemic drugs, Amlodipine and other anti-hypertensive drugs (Table 5). Ray *et al*. [23] stated that there remains uncertainty with regards to the potential side-effects of antihypertensive therapy on the developing fetus. Moreover, the results from a study by Fisher *et al*. [24] argued that antihypertensive medication use is potentially associated with the heightened risk of specific CH, including pulmonary stenosis, permembranous VSD, Secondum ASD and Coarctation of the aorta.

This study found that 119 (85.6%) mothers and 118 (84.9%) fathers were educated up to the secondary level or above, 88 (63.3%) families were of low socioeconomic status. There was no significant association between parents' education or socioeconomic status and LBW.

A meta-analysis by Feng *et al*. [20] had found that at lower levels of socioeconomic status, the child is at a higher risk of CHD. In addition, a study from Malawi by Muula *et al*. [25] reported that mothers without an education and of low socioeconomic status had a greater probability to deliver a baby with LBW.

Congenital Heart Disease is a known cause of failure to thrive, infants in particular are at a high risk and should be identified as early as possible so that the specific nutritional management can be introduced before the failure to thrive occurs [26].

**Study Limitations**

There are a number of limitations that are present with this study that should be noted. The birth weights collected for the children were obtained from the recollection of the mothers' memory, leading to a degree of recall error as they could not be reliably verified. The ideal scenario would have been to obtain the data retrospectively from records; this was however not possible due to the inadequate records keepingin Sudan. In addition to the need for records, the sample pool available was relatively low in comparison to the other studies; the majority of the studies referenced in the literature review had access to more abundant data from either the Baltimore-Washington study or the National Birth Defects Prevention Study (which contains 3395 cases, in comparison with the 139 cases in this study).

## CONCLUSION

Newborns with CHD were found to be more likely to be born with LBW than the general population; the degree to which CHD can affect the populations' birth weight was shown to be more prominent in our population compared to western children; it should be noted that the average birth weight in Sudan is lower than the international average. The infants with CHD are at a much higher risk suffering from post-natal growth retardation than those without CHD.

The study found no significant association between the cyanotic status and LBW or between haemodynamic group and LBW. AVSD and Coarctation of the aorta were significantly associated with low birth weight, while TOF was associated with a normal birth weight.

## RECOMMENDATIONS

To follow the WHO antenatal care model [27] in which fetal growth monitoring and neonatal size evaluation is integrated at all levels of care.

Focusing on health education about the need for regular antenatal care during pregnancy. Health education program should be tailored according to educational and social level and high risk group such as mothers with no education and poor Low birth weight babies should undergo cardiac assessment including echocardiography as part of their screening.

Regular follow-ups of CHD children with LBW to monitor growth properly and to assess the nutritional needs. Nutritional intervention program to be implemented as soon as possible if deemed necessarily.

## DECLARATIONS

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