Anthropometric Assessment of Nutritional Status of Children with Congenital Heart Disease in the Niger Delta Region of Nigeria

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ABSTRACT

Worldwide, congenital heart disease is a significant cause of morbidity and mortality in children being accountable for about one-third of all congenital defects. Malnutrition is known to be prevalent in this group of children owing to a multiplicity of factors. In this environment, because of the underlying burden of malnutrition, children with congenital heart disease may be more predisposed to malnutrition than in other climes. This study aimed to assess the nutritional status of children with congenital heart disease using anthropometric indices and to compare them with healthy age and sex-matched controls to elucidate possible factors influencing their nutritional status. Anthropometric indices of children with congenital heart disease and healthy age and sex-matched controls were taken. WHO and CDC charts were used to assess their nutritional status and subsequently, both groups were compared statistically. Two hundred and thirty children were recruited into the study, 115 each to the study and control groups, respectively. Underweight, stunting and wasting were present in 45.3%, 46.1% and 33% of the children with congenital heart disease compared to 5.2%, 7.8% and 3.5% respectively in the control group and these differences were statistically significant p<0.001. The presence of multiple lesions and ventricular septal defects were significant predictors of malnutrition in children with congenital heart disease. Malnutrition is significantly more common in children with congenital heart disease when compared to normal controls.

Keywords: Congenital, heart, disease, malnutrition, children

INTRODUCTION

Congenital heart diseases occur in about 1% of all live births worldwide[1] and account for about a quarter of all congenital defects.[2] Survival of children with congenital heart disease has been greatly improved with advances in surgical interventions.[3] Poor nutritional status and growth failure, however, can affect the suitability for and outcome of the surgery.[4,5]

The prevalence of malnutrition in children with congenital heart disease has been recorded to be as high as 64% in developed countries.[6] Two studies done in Southern Nigeria gave prevalence rates of 90% and 92% respectively.[7,8] The cause of malnutrition in these children has been attributed to multiple factors such as inadequate intake due to feeding difficulties and poor absorption of nutrients from congestive cardiac failure.[6,9] Other contributory factors to malnutrition in children with congenital heart disease include the increased caloric requirements that are needed to sustain the higher myocardial, respiratory, and neuro-humoral demands that they have as well as the presence of associated chromosomal anomalies/genetic syndromes like trisomy 21.[6,9] Repeated chest infections may also increase metabolic demands.[6,7,9] In developing countries such as Nigeria with a high underlying burden of malnutrition,[10] many of these children with CHD may already be nutritionally compromised in settings of food insecurity and poverty and thus severe malnutrition is fairly common occurring in up to 90% of all children with congenital heart disease.[7,8]

The widespread availability of corrective surgery and appropriate nutritional support for children with congenital heart disease in developed countries has attenuated the effect of malnutrition on disease outcome.[11] It has also been shown that early corrective surgery can significantly improve

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somatic growth deficits in these children.[11,12] The absence of well-established paediatric cardiac surgery programmes in settings such as ours makes it imperative that malnutrition is detected early in children with congenital heart disease so that appropriate interventions can be instituted while corrective surgery is planned.

Therefore, this study aimed to assess the nutritional status of children diagnosed with congenital heart disease using anthropometry and compare them to age and sex-matched controls of otherwise healthy children to elucidate possible factors influencing their nutritional status.

MATERIALS AND METHODS

Study Setting

The study was carried out at the Paediatric Cardiology units of the University of Uyo Teaching Hospital, Uyo, Akwa Ibom State and the Niger Delta University Teaching Hospital, Okolobiri, Bayelsa State. Both hospitals are tertiary health facilities located in the Niger Delta region of Nigeria. The Paediatric Cardiology units of both hospitals receive referrals for children with suspected congenital heart disease from other units within the Paediatrics Department and other health facilities within their respective states.

Study Design

This was a comparative cross-sectional study carried out for two years (1st January 2017 to 31st December 2019) among one hundred and fifteen children with congenital heart disease and the equal number of age and sex-matched controls. Inclusion criteria into the study group were those with congenital heart diseases confirmed by echocardiography using the *Vivid iq ultrasound machine (GE brand)* recruited from the paediatric cardiology clinic while the controls were healthy children recruited from the children's outpatient clinic. Children with chronic illnesses such as Tuberculosis, Human Immunodeficiency Virus, Sickle cell disease and Cancers were excluded from the study. Children without a definitive echocardiographic diagnosis of congenital heart diseases and those whose cardiac defects had been repaired or surgically palliated were also excluded from the study

Study Procedure

An interviewer-administered semi-structured questionnaire was used to obtain demographic data such as age, sex, and contact details from the study participants. The socioeconomic class was determined using the methods described by Oyedeji *et al.*[13]

Each study participant had a thorough physical examination and anthropometry performed. The weights for children less than 2 years was measured using a bassinet weighing scale (Hana^{R}) which measures to the nearest 0.05kg and a maximum weight of 13kg. A calibrated bathroom weighing scale was used for children older than 2 years, using standard methods. The length was measured for children below two years with a Seca^{R} infantometer with a fixed headboard and a mobile footboard. Heights of children over two years was measured using a stadiometer which measures to the nearest 0.1cm.

The CDC charts for children were used in assessing and evaluating the anthropometric parameters in these children.[14] Nutritional status was determined using the WHO method of classification of malnutrition using the respective Z-score tables assessing weight-for-age, height-for-age and BMI-for-age.[15]

Definition of nutritional parameters

Underweight was classified into (a) Underweight if weight for age (WAZ) - 3 to <- 2SD, (b) Severely underweight if WAZ <- 3SD, (c) Normal weight if WAZ ≥-2 to +2SD (d) Overweight for age if WAZ > +2SD.

Stunting was classified into (a)Stunted if height for age Z-score (HAZ) - 3 to < - 2SD (b) Severe stunting if HAZ <- 3SD (c) Normal height for age if HAZ ≥2 to +2SD. (d) Tall for age if HAZ > +2SD.

Wasting was classified into (a) Wasting if body mass index for age Z score(BAZ) - 3 to < -2SD (b) Severe wasting

if BAZ < -3SD (c) Normal if BAZ ≥ - 2 to 2SD (d) Overweight if BAZ > +2SD

Ethical considerations

Written informed consent was obtained from the parents of the children before including them in the study. Ethical approval was obtained from the Research and Ethics Committees of both institutions before the commencement of the study.

Data Analysis

The data were analyzed using the STATA 14.0 Statistical Package (Texas 77845, USA). Frequency tables were constructed for categorical variables with a Chi-square test of proportions used to assess differences between the case and control groups. Logistic regression was carried out to identify significant predictors of malnutrition among the study population.

RESULTS

Sociodemographic characteristics of children in the case and control group

Two hundred and thirty children (230) were recruited for the study of which one hundred and fifteen (115) children were in both the study and control groups, respectively. As shown in Table 1, most of the children in the study were less than 60 months old (67.0%), and over half of them were males with a male: female ratio of 1.3:1. Chi-square test of proportions shows no significant difference in the age and sex distribution in both the study and control groups ($p > 0.05$). However, more children in the study group were reportedly from lower socioeconomic class parents than children in the control group.

Distribution of Congenital heart defects in the affected children

Table 2 presents the distribution of the structural heart defects among the children with Congenital heart diseases with ASD, VSD, and PDA affecting 38.3%, 36.5% and 20.0% of the children, respectively. Multiple structural heart defects were present in slightly less than a third of the children (29.6%) with acyanotic lesions accounting for 4 in every 5 structural defects (80.9%).

Nutritional status of Children with Congenital Heart Disease

Table 3 shows that there were significantly more cases who were underweight, stunted and wasted compared to the controls which were mostly (87%) children of normal weight ($p<0.001$)

Risk factors associated with malnutrition among children with CHD

Table 4 shows factors associated with an increased likelihood of malnutrition occurring among children with CHD in this study. The odds of malnutrition were noted to decrease with increasing age in the study group however, this observation was only statistically significant between the age group 60-119 months (OR-0.32: p-0.042) (Table 4). Children with multiple heart defects (OR-2.86; p-0.015) and those with VSD (OR-2.49; p-0.023) displayed an increased likelihood of being malnourished when compared to those with single heart defects and those without VSD respectively (Table 4). Table 5 shows that several defects (OR-2.54; p- 0.038) and presence of VSD (OR-2.35; p-0.044) are independent predictors of malnutrition among children with CHD in this study.

Table 1: Sociodemographic characteristics of children in the study and control groups

Characteristics	Total N = 230 (%)	Study Groups Case N = 115 (%)	Control N=115 (%)	Chi-square	P-value
Sex					
Male	129(56.1)	68(59.1)	61(53.0)	0.86	0.352
Female	101(43.9)	47(40.9)	54(47.0)		
Age group					
< 60 months	154(67.0)	80(69.6)	74(64.3)	0.73	0.693
60-119 months	42(18.3)	19(16.5)	23(20.0)		
>120 months	34(14.8)	16(13.9)	18(15.7)		
Social Class					
Lower Class	21(9.1)	20(17.4)	1(0.9)	22.18	<0.001*
Middle Class	89(38.7)	34(29.6)	55(47.8)		
Upper Class	120(52.2)	61(53.0)	59(51.3)		

Table 2: Distribution of Structural heart defects among children with Congenital Heart Disease

Characteristics	Frequency (N = 115)	Percent (%)
Congenital heart disease*		
Atrial Septal defect	44	38.3
Ven tricular septal defect	42	36.5
Patent ductus arteriosus	23	20.0
Pulmonary Stenosis	7	6.1
Transposition of Great Arteries	7	6.1
Tetralogy of Fallot	7	6.1
Atrioventricular Canal Defect	6	5.2
Atrioventricular septal defect	6	5.2
Dextrocardia	5	4.3
Cor Triatriatum Dexter	3	2.5
Pulmonary Atresia	2	1.6
Others[+]	16	14.0
Number of Structural Defects		
Single Structural Defect	81	70.4
Multiple Structural Defects	34	29.6
Type of Structural Defect		
Acyanotic	93	80.9
Cyanotic	22	19.1

*More than one structural defect co-exists

[+]Aortic Valve stenosis, Aortic Incompetence, Ebstein Anomaly, Mitral Atresia, Taussig Bing Syndrome, Single ventricle, Pulmonary Valve Stenosis, Mitral Incompetence, Truncus Arteriosus, Tricuspid Incompetence, Hypoplastic left ventricle

Table 3: Nutritional Status among Cases and Control groups

Characteristics	Study Groups Case N= 115 (%)	Control N=115 (%)	Chi-square	P-value
Weight-for-age (WAZ) [+]				
Severely underweight (WAZ < -3)	31(27.0)	1(0.9)	51.89	<0.001*
Underweight (WAZ - 3 to <- 2)	21(18.3)	5(4.3)		
Normal (WAZ >-2 to +2)	61(53.0)	100(87.0)		
Overweight for age (WAZ > +2)	2(1.7)	9(7.8)		
Height-for-age (HAZ) [++]				
Severe stunting (HAZ < -3)	31(27.0)	5(4.3)	42.77	<0.001*
Stunted (HAZ - 3 to < - 2)	22(19.1)	4(3.5)		
Normal (HAZ > - 2 to +2)	56(48.7)	96(83.5)		
Tall for age (HAZ >+2)	6(2.6)	10(8.7)		
Weight-for-height				
Severe Wasting (BAZ [+++] < - 3)	23(20.0)	3(2.6)	34.86	<0.001*
Wasting (BAZ - 3 to < - 2)	15(13.0)	1(0.9)		
Normal (BAZ > - 2 to +2)	68(59.1)	103(89.6)		
Obese (BAZ > +2)	9(7.8)	8(7.0)		

[+]WAZ-weight for age Z-score, [++]HAZ-height for age z-score, [+++]BAZ-Body mass index for age Z-score

Table 4: Risk factors associated with malnutrition among children with Congenital Heart Disease

Characteristics (Reference group)	B coefficient	UOR	95%CI Min	95%CI Max	P-value
Sex (Male)					
Female	0.33	1.39	0.66	2.94	0.384
Age Group (< 60 months)					
60-119 months	-1.16	0.32	0.10	0.96	0.042*
120-179 months	-1.04	0.35	0.10	1.22	0.099
>180 months	-0.82	0.44	0.04	5.05	0.510
Social Class (Lower Class)					
Middle class	-0.68	0.51	0.17	1.57	0.240
Upper class	-0.14	0.87	0.31	2.45	0.792
Type of defects (Acyanotic heart defect)					
Cyanotic heart defect	0.24	1.27	0.50	3.33	0.617
Number of defects (Single Defect)					
Multiple defects	1.14	3.12	1.35	7.18	0.008*
Patent Ductus Arteriosus (No)					
Yes	-0.09	0.92	0.36	2.30	0.851
Ventricular Septal defect (No)					
Yes	0.92	2.51	1.15	5.46	0.021*
Atrial Septal defect (No)					
Yes	0.16	1.18	0.55	2.51	0.670
Transposition of Great Arteries (No)					
Yes	0.51	1.67	0.36	7.81	0.517
Tetralogy of Fallot (No)					
Yes	0.19	1.21	0.23	6.26	0.822

*Statistically Significant; UOR Unadjusted Odds ratio.

Table 5: Independent Predictors of malnutrition among children with Congenital Heart Disease

Characteristics (Reference group)	B coefficient	aOR	95%CI		P-value
			Min	Max	
Age Group (< 60 months)					
60-119 months	-1.17	0.31	0.09	1.01	0.052
120-179 months	-0.86	0.43	0.12	1.57	0.200
>180 months	-1.17	0.31	0.02	4.18	0.377
Number of defects (Single Defect)					
Multiple defects	0.93	2.54	1.05	6.13	0.038*
Ventricular Septal defect (No)					
Yes	0.85	2.35	1.02	5.38	0.044*

*Statistically Significant; aOR-adjusted Odds ratio

DISCUSSION

Congenital heart disease (CHD) continues to be a significant source of morbidity and mortality in children in developing countries such as ours with extremely limited resources available for early diagnosis, care, and surgical management of these patients.[16] Furthermore, malnutrition is a scourge that is still present in our environment with the prevalence of malnutrition in children aged between 6-59 months being 14%.[17] Thus, besides the malnutrition that is prevalent in children in the general populace, CHD predisposes affected children even further to malnutrition as a result of factors such as decreased intake arising from feeding difficulties, repeated chest infections, anaemia, heart failure, cyanosis, pulmonary hypertension and delay in surgical correction of the lesions which is a major constraint in resource-poor environments such as ours.[18]

In this study, males showed a slight preponderance of affectation of CHD when compared to female subjects. There is a sustained variation in the ratio of males to females affected by CHD in studies done by different researchers.[7,18,19] Acyanotic congenital lesions were the most common lesions seen compared to cyanotic cardiac lesions. This pattern is corroborated by several authors who have documented the same and appears to be the pattern globally.[5,8,20,21,22]

Assessment of the nutritional status of subjects with CHD in this study revealed that 33.0%, 46.1% and 45.3% of them were wasted, underweight or stunted respectively with the difference in the rates of malnutrition between the study and the control groups being statistically significant. Batte *et al.* observed similar findings with the prevalence of wasting, underweight and stunting being 31.5%, 42.5% and 45.4% respectively.[18] Differing findings were observed in children in Lagos and Zaria where Okoromah *et al.* had a lower prevalence of stunting (28.8%) and underweight (20.5%) while Isezuo *et al.* had a much higher prevalence of wasting (60.7%), underweight (72.9%) and stunting (57.8%) in the northern part of Nigeria.[5,7] Regional differences in the rates of underlying malnutrition in children not affected by CHD have also been observed with higher rates noted in the northern parts of the country.[17] This variation may explain the further exacerbation that is seen in cardiac patients in these regions.

Younger age group, presence of multiple defects and ventricular septal defects were factors found to be associated with significant risk for the development of malnutrition in our study subjects. Furthermore, only the presence of multiple defects and ventricular septal defects were significant predictors of malnutrition in children with CHD in this study. The finding of age as a significant risk factor for the development of malnutrition in children with CHD has been corroborated by other researchers.[7,8] In particular, younger children

are more predisposed compared to older children with CHD. This may be a reflection of their dependence on caregivers for their nutrition and the increased growth requirements in that age group although dietary adequacy was not assessed in this study which was a study limitation.

The presence of multiple cardiac lesions and ventricular septal defects as significant predictors of malnutrition may be due to the increased metabolic demands placed by these lesions on the growth of the affected children. Indeed, it has been found that children with complex cardiac lesions require greater than 120% of their energy intake to have reasonable growth rates.[23] Also, children with VSD who also make up a significant proportion of children with congenital heart disease, are predisposed to developing heart failure and repeated chest infections depending on the size of the lesion. The resulting heart failure in itself is a significant predictor of malnutrition in children with CHD.[7,18,23,24] Also, the delay in the surgical repair which is a major constraint in our environment predisposes these children to later development of pulmonary hypertension which has also been found to be significantly associated with malnutrition in these patients.[6,8,24]

In conclusion, this study demonstrates that children with CHD are at increased risk of developing malnutrition than their normal counterparts. Also, those with multiple cardiac lesions and VSD are more susceptible to malnutrition. Therefore, it becomes imperative that a nutritional program is put in place to cater for these children. Also, the need for timely surgical repair of these lesions to prevent the development of complications that further predispose these children to malnutrition cannot be overemphasized.

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