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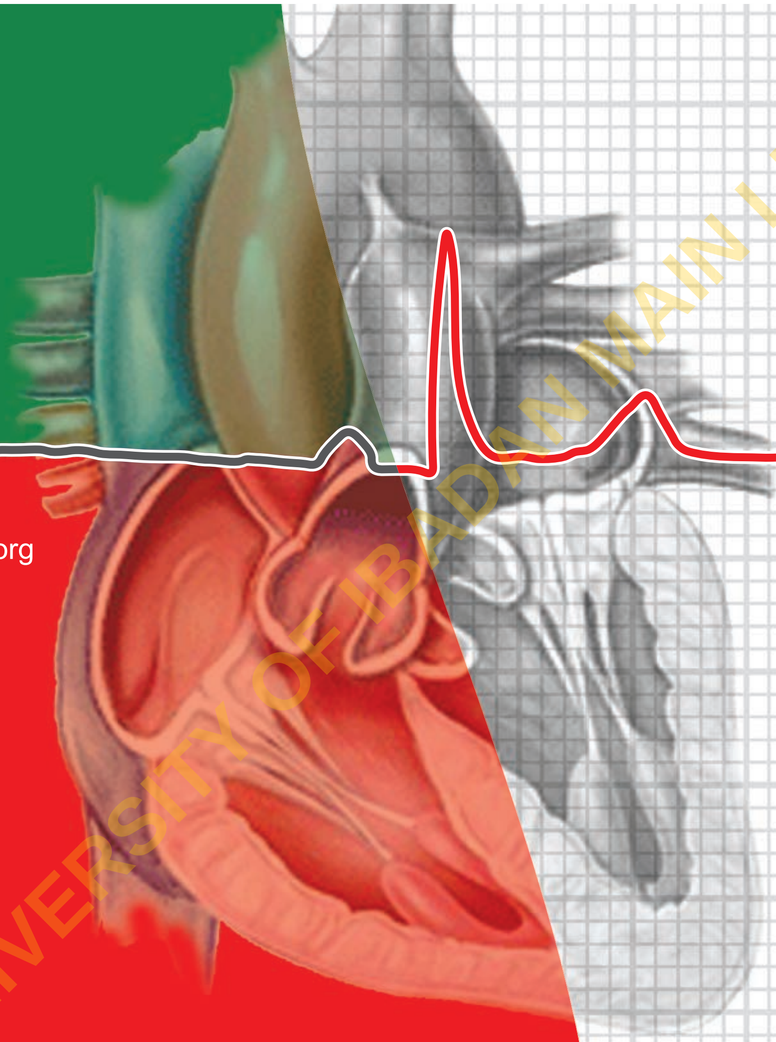

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Original Article

Nutritional profiles and selected parental factors among children with congenital heart diseases in Ibadan, Nigeria

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ABSTRACT

Background: Among the many adverse sequelae of congenital heart disease (CHD), malnutrition stands out as one of the major concerns.

Objective: This study was undertaken to compare the nutritional status, parental age, and mid-parental heights of children with CHD and their apparently healthy control group.

Material and Methods: Electrocardiography and echocardiography were used to confirm the presence or otherwise of CHD in consecutive 100 children with CHDs and 100 age, sex, and social class matched apparently healthy control group. Nutritional parameters, parental ages, and mid-parental heights were also obtained. Associations were tested using student *t* test and Chi square test. Level of significance was $P < 0.05$.

Results: There were 54 males with CHD and the age-range of the children was 1–96 months. The commonest acyanotic CHD was ventricular septal defect (49.0%) while the commonest cyanotic CHD was Fallot's tetralogy (10%). Children with CHD compared with the control group had significantly lower mean z scores for weight for height, height for age, and weight for age. The mid upper arm circumference, triceps, and subscapular skinfold thickness were also lower than that found in the control group. Older parental age and lower mid-parental heights were found among parents of children with CHD compared with those of controls.

Conclusions: Malnutrition can be quite severe in children with CHD if unattended to. Early corrective intervention is necessary to prevent short-term and long-term sequelae of malnutrition in these children. Parental malnutrition and older parental age are likely predisposing factors to CHD.

KEY WORDS: Children, congenital heart diseases, nutritional profile, parental age, parental height

INTRODUCTION

Delayed corrective intervention for congenital heart diseases (CHD) is common in developing countries as a result of non-availability of funds and appropriate diagnostic and therapeutic facilities, predisposing most of the children with CHD to malnutrition and its attendant complications.[1] Malnutrition remains a major concern among children in sub-Saharan Africa and is responsible for almost 60% of deaths among under-five children aided by its interactive effects on preventable diseases.[2] When it begins in infancy, it can impair cognitive and mental development and also cause stunted final adult height.[3] These have been reported to contribute to reduced potential and productivity in adulthood.[4]

Congenital malformations have been reported with a higher frequency among offspring of parents who have malnutrition[5] and some CHD have been associated with underweight mothers.[6] Furthermore, parental ages have been associated with the incidence of CHD but the observations have been inconsistent.[7-9] Older parental ages have been associated with the occurrence of CHD and this was attributed to the significantly increasing age that men and women have their first babies.[10] This is not yet common in developing countries, therefore relationship between age of parents and incidence of CHD in these regions may be different from what have been reported from developed countries.

The present study aims to assess nutritional status of children with CHD and apparently healthy controls, compare nutritional indices of these groups of children as well as parental ages and heights.

MATERIALS AND METHODS

The study was carried out in a tertiary health care center that provides pediatric cardiology services for children mainly from south-western Nigeria. A comparative study design was adopted and ethical approval was obtained from the University of Ibadan/University College Hospital ethical review committee. Sample size was determined using the formula for comparing two independent samples and power was set at 80%.

Study population

Children with CHD were enrolled from the pediatric cardiology clinic while the apparently healthy comparison group were recruited from the children outpatient clinic of the hospital. These were children being followed up for illnesses like malaria, upper respiratory tract infections, etc. The inclusion criteria for the CHD group were that the child should have a confirmed CHD and should be aged between one month and 12 years. Those excluded were the ones in heart failure, born preterm, having obvious chromosomal abnormalities like Down syndrome or syndromes that can affect growth like congenital rubella syndrome or having conditions that can affect nutrition like cleft lip and palate. The control group were selected if they do not have any physical signs of chronic illness like sickle cell disease and they were matched with the children with CHD by age, sex, and socioeconomic class. The matching by age was done such that the maximum disparity in the age in the first year was 3 months and in the subsequent years, 6 months was the maximum disparity.

Informed consent was taken from the parents of the participants and data was obtained using a structured questionnaire which was earlier pretested in the hospital's children outpatient clinic. Data obtained included the socio-demographic parameters of the subjects, diagnosis, or exclusion of CHD based on electrocardiographic and echocardiographic findings, nutritional history (which included breast feeding duration, weaning diets and 24 hours dietary recall), anthropometry, evidence of poor nutrition on physical examination, parental ages, heights, and mid-parental height. The participants were stratified into 5 socioeconomic classes based on a previous Nigerian study[11] in which class I is the highest socioeconomic class and V is the least.

Diagnosis of congenital heart disease

Electrocardiography (ECG) was recorded using a handheld single channel CMS 80A ECG machine (Contec Medical systems Co. Ltd. [China]) with pen calibration set at 10 mm/mv and paper speed was 25 mm/sec. Standard 12 lead ECG recordings were performed with children in supine position. The result was used to screen for possibility of a structural cardiac abnormality. Echocardiography was performed to ascertain the presence or otherwise of CHD using a Toshiba SSA-660A echocardiogram machine and a transducer with a frequency of 5 MHz. When required, chloral hydrate syrup at 30–50 mg/kg was given for sedation.

Procedure for anthropometry

The measurement of weight and length/height were performed using the techniques earlier described by Tanner *et al.*[12] and Owen.[13] Infants were weighed unclothed using a Waymaster infant scale (Waymaster company, Reading, England) while older children were weighed in their underpants on a bathroom scale. Both scales were checked for zero error before each measurement and also periodically with standard weights. The weights were recorded to the nearest 0.1 kg. Recumbent length (for those 1 month to 2 years) was determined using an infantiometer and height (for those 3 years and above) using a stadiometer. Occipito-frontal circumference (OFC), chest circumference (CC), and mid upper arm circumference (MUAC) were obtained using an inelastic tape with measurements recorded to the nearest 0.1 cm. OFC was measured by applying the tape round the head with the supra-orbital ridges or the most prominent frontal bulge and the most prominent part of the occiput as the landmarks. The CC was determined by applying the tape round the chest with the nipples as the landmark while MUAC was obtained by taking the arm circumference at the point midway between the distance of the acromion to the olecranon process. A Lange skinfold calliper (Beta Technology Inc. Cambridge, USA) was used to measure skinfold thickness at the triceps and subscapular regions to the nearest 1mm as described by Tanner *et al.*[12] The mid-parental heights were also obtained using a stadiometer as earlier described. For all the parameters, two measurements were carried out and the average calculated to ensure accuracy and avoid inter-observer errors.

Data analysis

Data was analysed using statistical package for social sciences (SPSS version 20.0, SPSS Inc; Chicago, IL, USA). Z scores for weight for height, height for age and weight for age was determined using the World Health Organisation (WHO) Anthro software and the Centre for Disease Control growth charts. Normal nutrition was defined as anthropometric values greater than, or equal to-1.99 standard deviation (SD) or Z scores and malnutrition (poor nutrition) was defined as less than or equal to-2SD or Z scores relative to the reference or median. The children with CHD were divided into two groups based on the presence or absence of cyanosis with comparison done between these groups and with the children in the control group. Means were generated for continuous variable and associations tested using student's *t* test while categorical variables were compared using Chi square test and where a cell had a variable less than 5, Fisher's exact test was used. Mid-parental heights and parental ages greater than the mean were categorised as higher mid-parental heights and older parental ages. Statistical level of significance was set at $P < 0.05$.

RESULTS

One hundred children with CHD and a 100 age, sex, and socioeconomic class matched control group were recruited from the clinics. There were 54 males and 46 females in each group with the age range for the acyanotic CHD being 2 to 70 months, the cyanotic group 1 to 84 months and the control was 1 to 90 months. The other characteristics of the study participants are as shown in Table 1. The distribution of the CHD is as shown in Table 2. Children with acyanotic and cyanotic CHD were 83 and 17, respectively. The commonest acyanotic CHD was ventricular septal defect (45%) while the commonest cyanotic CHD was Tetralogy of Fallot (9%). Lower nutritional indices were seen among children with CHD compared with the control group especially the acyanotic group [Tables 3 and 4]. There was no significant difference between the nutritional indices of both acyanotic and cyanotic CHD children. Duration of breastfeeding, weaning diet, and 24-hour dietary recall were similar in both study groups. The commonest feature of malnutrition among the CHD group was fluffy hair (20%) and bony prominences (23%). Only one child had pallor and none had leg edema or skin changes. The mean maternal age, paternal age, and mid-parental height were 33 years, 37 years, and 165 cm, respectively. Comparison of the parental ages and heights is shown in Table 5.

Table 1: Characteristics of study participants

Characteristics	Subjects (*n*)	Controls (*n*)
Age		
≤12 months	46	46
13-36 months	33	33
37-60 months	13	13
≥61 months	8	8
Sex		
Male	54	54
Female	46	46
Socioeconomic class		
Class I	18	18
Class II	45	45
Class III	26	26
Class IV	11	11
Class V	0	0
Religion		
Christianity	76	61
Islam	24	39

Table 2: Distribution of congenital heart disease among the study subjects

Cyanotic heart disease	Number	Acyanotic heart disease	Number
Atrioventricularseptal defect	3	Atrial septal defect	20
Tricuspid atresia	3	Atrial and ventricular septal defects	7
Tetralogy of Fallot	9	Atrial septal defects and patent ductusarteriosus	2
Tetralogy of Fallot with patent ductusarteriosus	1	Patent ductusarteiosus	10
Tetralogy of Fallot with ventricular and atrial septal defects	1	Patent ductusarteriosus and ventricular septal defect	7
		Ventricular septal defect	36
		Ventricular septal defect and pulmonary stenosis	1

DISCUSSION

The nutritional condition of children with CHD is very important not only as a result of its negative short- and long-term consequences, but also in its role in determining the outcomes of corrective surgical procedures. The finding of lower nutritional indices in children with CHD in the present study is similar to reports from earlier studies.[12,14] This is important as the malnutrition is likely to persist for a long time in most of them since facilities required for corrective intervention are not readily available in the study environment. Thus, the consequences of malnutrition are a huge burden that cannot be ignored in these children and this draws attention to the urgent need of affordable pediatric cardiology centers in sub-Saharan Africa.

Considering the significantly reduced OFC among children with CHD compared with that observed in the control group, there could be impairment in the intellectual development of these children. Unfortunately, many of these children were infants who were at a critical stage of brain development and maximizing head growth in infancy and childhood is critical for the attainment of peak cognitive capacity in adult life.[15] Optimal brain growth in early life also protects against cognitive deterioration in the elderly.[16] Consideration was not given to head growth in earlier studies that looked into the nutritional status of children with CHD[14,17,18] but its importance cannot be overlooked.

The worse nutritional indices found among children with acyanotic CHD suggest that compromise in tissue oxygenation as a result of overperfusion of the lung tissues from shunt lesions with recurrent heart failure and lung infections may be more detrimental to growth than chronic arterial desaturation of cyanotic CHD The impact of cyanosis on nutritional indices in CHD have however been controversial as the findings have not been consistent.[19] It has been suggested that

Table 3: Comparison of nutritional indices among study subjects and control

Nutritional indices	Acyanotic CHD group Number	%	Control Number	%	*P*
Weight for height					
Normal weight	54	65.1	89	80.0	0.00
Wasted	29	34.9	11	11.0	
Height for age					
Normal height	49	59.0	80	80.0	0.00
Stunted	34	41.0	20	20.0	
Weight for age					
Normal weight	44	53.0	92	92.0	0.00
Underweight	39	47.0	8	8.0	
	Cyanotic CHD group		Control		
Weight for height					
Normal weight	12	70.6	89	89.0	0.06
Wasted	5	29.4	11	11.0	
Height for age					
Normal height	14	82.4	80	80.0	0.56
Stunted	3	17.6	20	20.0	
Weight for age					
Normal weight	9	52.9	92	92.0	0.00
Underweight	8	47.1	8	8.0	
	Acyanotic CHD		Cyanotic CHD		
Weight for height					
Normal weight	54	65.1	12	70.6	0.45
Wasted	29	34.9	5	29.4	
Height for age					
Normal height	49	59.0	14	82.4	0.06
Stunted	34	41.0	3	17.6	
Weight for age					
Normal weight	44	53.0	9	52.9	0.60
Underweight	39	47.0	8	47.1	

Chi square test used for comparison. CHD – Congenital heart disease

the level of anaerobic metabolism that accompanies cyanosis in CHD determines the extent of reduction in the total energy production at cellular level, hence, the nutrition.[20]

The conspicuous absence of social economic class V could be as a result of the inability to afford hospital fees since out of pocket payment is the common practice in this environment.[21] Older age of parents of children with CHD may be responsible for the heart abnormalities that these children have as older parental age have been associated with increased mutations and chromosomal aberrations in sperm cells and ova. These genetic changes could lead to birth defects in children with atrial septal defect, ventricular septal defect, pulmonary valve stenosis, and right ventricular outflow tract obstruction specifically associated with higher paternal age.[22] The children with CHD may be from polygamous family settings (which is common in sub-Saharan Africa), in which fathering of babies in older age occurs but family type was not considered in this study. This could be explored in future studies.

The lower mid-parental heights of children with CHD may point to the possibility that the parents were malnourished in childhood and it has been suggested that parental malnutrition could be a risk factor for having children with birth defects.[5,14] Despite the matching of the socioeconomic class in the study groups, it is likely that parents of the children with CHD were exposed to poor nutrition in childhood irrespective of their present socioeconomic class which could have compromised their final adult heights, predisposing them to having children with CHD. This is possible since both childhood and adult malnutrition are common in this region of the world.[23]

The strength of this study include the homogeneity of children with CHD as those in heart failure (which has

Table 4: Comparison of some nutritional indices among children with congenital heart disease and control

Nutritional indices	Acyanotic CHD group Mean (cm)	SD	Control group Mean (cm)	SD	*P*	95% CI
OFC	44.57	4.27	46.68	4.67	0.00	−3.42 - −0.79
CC	43.64	11.13	47.08	8.50	0.02	−6.31 - −0.58
MUAC	13.20	5.48	15.40	3.89	0.00	−3.56 - −0.83
Triceps sft	5.91	2.36	8.23	2.90	0.00	−1.85 - −0.79
Sub-scapular sft	4.58	1.70	5.90	1.91	0.00	−3.10 - −1.53
	Cyanotic CHD group		Control group			
†OFC	47.72	3.44	46.68	4.67	0.00	−3.42 - −0.79
‡CC	48.86	11.51	47.08	8.50	0.02	−6.31 - −0.58
§MUAC	13.20	2.25	15.40	3.89	0.00	−3.56 - −0.83
Triceps ||sft	5.31	1.53	8.23	2.90	0.00	−1.85 - −0.79
Sub-scapular ||sft	4.53	1.43	5.90	1.90	0.00	−3.10 - −1.53

Student's *t* test used for comparison. *SD – Standard deviation, †OFC – Occipito-frontal circumference, ‡CC – Chest circumference, §MUAC – Mid upper arm circumference, ||sft – Skin fold thickness

Table 5: Age and mid-parental heights of parents of participants in congenital heart disease and comparison groups

Variable	Acyanotic CHD group		Control		*P*
	Number	%	Number	%	
Mothers' age					
≤33 years	42	50.6	65	65.0	0.05
>33 years	23	27.7	89	61.2	
Fathers' age					
≤37 years	36	43.4	73	73.0	0.00
>37 years	40	48.2	20	20.0	
Mid-parental heights					
≤165 cm	60	72.3	11	11	0.00
>165 cm	23	27.7	89	89.0	
	Cyanotic CHD group		Control		
Mothers' age					
≤33 years	9	52.9	65	65.0	0.34
>33 years	8	47.1	35	35.0	
Fathers' age					
≤37 years	6	35.3	73	73.0	0.00
>37 years	11	64.7	27	27.0	
Mid-parental heights					
≤165 cm	10	58.8	11	11.0	0.00
>165 cm	7	41.2	89	89.0	

Chi square test used for comparison. CHD – Congenital heart disease

been shown to worsen malnutrition in them)[17] and other factors that could affect nutrition, like chromosomal abnormalities and congenital rubella syndrome, were excluded. Matching of the study participants was done carefully in order to ensure comparable similarities in the study groups. The adiposity, muscle bulk, and OFC were also compared which gives a more holistic assessment of nutrition and this is important in child growth. To the best of our knowledge, this is the first study in sub-Saharan Africa to consider the association of parental ages and heights with CHD among children. This was taken into account because of the peculiarity of younger parenting age, high fertility rate,[24] and the interplay of malnutrition prevalence and the incidence of congenital malformation in this region.[14]

The costly consequences of malnutrition in CHD can be prevented with the availability of affordable pediatric cardiac services which will promote prompt diagnosis and early corrective intervention. Education about the dangers of old parental age is also necessary and prevention of malnutrition at all stages of life may reduce the incidence of CHD. A larger and probably longitudinal study is required to establish firmly the possible causality between CHD and low mid-parental heights. This is a hospital-based study and may explain the absence of children from the lowest socioeconomic class. Similar study in a community setting will likely capture children across all social classes with a more representative finding. Biochemical parameters of nutritional status like serum albumin were not considered in this study. The presence of CHD may have effect on these parameters as well.

CONCLUSIONS

There is severe malnutrition among children with CHD in this study. These children also have older fathers and lower mid-parental heights compared with the apparently healthy controls. Availability of affordable pediatric cardiology services is crucial to ensure early correction of CHD, thereby preventing malnutrition and its dire consequences. Efforts to improve the present socioeconomic situation in order to prevent malnutrition at all stages of life should be intensified. Public enlightenment is also required to raise awareness about the association of old parental age with CHD.

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