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Research Article

Impact of Unoperated Congenital Heart Diseases on the Nutritional Status of Children in a Depressed Economy

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Abstract

Background: Malnutrition in children with congenital heart diseases has been associated with increased morbidity and mortality. The prevalence of severe malnutrition in this category of children ranged between 31.5% and 42.5% in developing countries and this figure may be rising with the declining global economic and security profile.

Objectives: To determine the prevalence of under-nutrition among children with un-operated congenital heart defects and the relationship between types of heart defects and nutritional status of the patients.

Methods: A cross sectional study of the nutritional status of children with unoperated congenital heart diseases attending the Pediatric Cardiology Clinic of the University of Abuja Teaching Hospital, Gwagwalada, Abuja was done.

Results: Of the 63 patients enrolled, 50 patients were analyzed: 29 (58%) were males. Median age was 24 months, median weight was 7.4 kg and the median length/height was 70.5cm; 75% of the weight-for-age Z-scores and 60% of the height-for-age Z-scores were below the 5th percentile. 52% had moderate-to-severe malnutrition, 54% were stunted. 38 (76%) patients had acyanotic heart defects. Total protein was lower in stunted children than in the normal height group: 65.0±7.6 g/l vs.70.2±8.9 g/l, p=0.03. Hypoproteinemia and hypoalbuminemia occurred in 10 (27.8%) and 8 (22.2%) undernourished children, respectively. Overall, serum albumin level correlated positively with patient's weight-for-age percentile (p=0.008) and weight-for-height Z-score, p=0.026.

Conclusion: Malnutrition is prevalent in children with congenital heart diseases in this community. Therefore, aggressive nutritional rehabilitation should form an integral part of the wholistic management of children awaiting surgical correction of their congenital heart diseases.

Keywords: Malnutrition; Congenital heart disease; Depressed economy; Nigeria

Introduction

Malnutrition in children with congenital heart disease has been associated with increased morbidity and mortality [1-3]. Studies from other clime have indicated a prevalence rate of severe malnutrition to be as high as 31.5% (Mulago, Uganda) [4], 36.4% (Ibadan, Nigeria) [5] and 42.5% (Surabaya, Indonesia) [6]. Aggressive nutritional support has been canvassed for children with congenital heart diseases awaiting surgery. Global changes in economic and social security poses a great threat to the nutritional programs advocated for children with unoperated congenital heart defects and hence a tendency to worsening nutritional status of these patients. Mechanisms for growth impairment in congenital heart disease are multifactorial [3], but may include: associated chromosomal anomalies/genetic syndromes, inadequate nutrition due to feeding difficulties, poor nutritional absorption from the digestive tract in chronic congestive cardiac failure, effects of drugs on appetite, absorption and excretion of nutrients e.g. the zincuric tendency of angiotensin converting enzyme inhibitors [7]. Increased caloric support is required to sustain increased myocardial, respiratory, and neuro-humoral functions in these patients [3].

Unlike developed countries, cardiac defects are not promptly repaired in resource limited nations due to lack of financial and structural capabilities [8]. Management is therefore mainly supportive while awaiting surgical interventions. This study was therefore conducted to determine the prevalence of under-nutrition among children with un-operated congenital structural heart defects and the relationship between types of heart defects and the nutritional status of the patients.

Methods

Study Design

A cross sectional study was conducted among children with unoperated congenital heart diseases attending the Pediatric Cardiology Clinic of the University of Abuja Teaching Hospital Gwagwalada, Abuja, Nigeria.

Institutional patient care practices

Patients with structural congenital heart diseases are followed up in the weekly Pediatric Cardiology Clinic. Patients are given routine care, which comprises of health education, control of cardiac failure, nutritional support and infection prevention. Definitive treatment of the cardiac lesion is provided locally by irregular overseas voluntary mission or by referral to hospitals in overseas for the few supported by humanitarian aid.

Patient's enrollment and eligibility

All children whose caregiver gave an informed consent were recruited. Children with other chronic diseases such as TB, haemoglobinopathies, renal or liver diseases, neurological abnormalities such as cerebral palsy or mental retardation were excluded.

Measurements

Anthropometric measurements were done following standard procedure after assuring the patients of the safety of the techniques. Weight was measured using a SECA® weighing scale and readings were recorded to the nearest 0.1 kilogram. Standing height was obtained in children 2 years and above using a stadiometer, while recumbent length was done for those less than 2 years, and readings taken to the nearest 0.5 centimeter. Types of cardiac lesion was determined by transthoracic echocardiography. The serum protein was analyzed using Biuret method and read at 280 nm spectrophotometrically. The serum albumin was estimated using Bromocresol green and read at 620 nm spectrophotometrically. The results were calculated using Beer Lamberts Law in grams per litre.

Statistical analysis

The data collected were entered into STATA 14 statistical software (StatCorp, LP, College Station, TX, USA), cleaned and analyzed. Descriptive statistics were reported as median and interquartile range. The Chi square test of independence (or Fisher's exact, where expected cells were less than 5) was used to test the difference in number of observations in indices of malnutrition between the various categories of congenital heart defects. The difference in median values of the various parameters of malnutrition was tested using Mann-Whitney U test. The Pearson's correlation coefficient was used to access the linear relationship between weight-for-age percentile, height-for-age percentile, weight-for-height Z score and serum albumin as well as patient's age. A p valve of <0.05 was set as level of statistical significance.

Results

Sixty-three patients were enrolled but 13 (20.6%) were excluded from analysis due to incomplete data. Of the 50 patients analyzed, 29 (58%) were males and 21 (42%) females. The age range of the patients was 2 months to 10 years, median age being 24 months (IQR, 8-62). 32% were less than 1 year of age, 44% falls between 1 and 4 years while 24% were between 5 and 10 years. The median weight was 7.4kg (IQR, 5-13) and the median length/height was 70.5cm (IQR, 58.5-90.8); 75% of the weight-for-age scores and 60% of the height-for-age scores were below the 5^{th} percentile.

Weight-for-height Z score was normal in 14 (28%) patients, 15 (30%) had weight-for-height Z score <-3SD while 11 (22%) was <-2SD but >-3SD. Stunting (height-for-age Z score <-2SD) was found in 27 (54%) patients. Simple cardiac defects (defects that do not threaten patient's life such as ventricular septal defect, VSD) were recorded in 39 (78%) while 11(22.0%) patients had complex defects (defects with severe life-threatening symptoms). 38 (76%) patients had acyanotic heart defects. VSD (9, 23.7%) dominated the acyanotic group while Tetralogy of Fallot, TOF (5, 41.7%) predominated in the cyanotic category. Distribution of the spectrum of structural heart diseases is shown in Table 1.

Table 1: Distribution of cardiovascular defects among the study population.

Category of cardiac defects	Types of cardiac defects (N=50)	Number	Percentage of N
Single acyanotic heart defect (n=29)	Ventricular septal defect	9	18%
	Atrial Septal Defect (ASD)	3	6%
	Patent Ductus Arteriosus (PDA)	4	8%
	Pulmonary Stenosis (PS)	6	12%
	Atrioventricular septal defect	4	8%
	Coarctation of the Aorta (COA)	3	6%
Multiple acyanotic heart defect (n=9)	ASD+PDA	4	8%
	ASD+PDA+VSD	1	2%
	PDA+COA	2	4%
	PDA+VSD	1	2%
	PS+COA	1	2%
Cyanotic heart defects (n=12)	Tetralogy of fallot	5	10%
	Transposition of great arteries	2	4%
	Total anomalous pulmonary venous return	2	4%
	Partial anomalous pulmonary return	2	4%
	Single ventricle	1	2%

The median age for patients with acyanotic heart defect was 19.5 months (IQR, 7-36) while that of the cyanotic heart defects was 60 months (IQR, 13-87), p=0.0367. Seven (63.6%) of the patients that had complex cardiac defects and 19 (48.7%) patients with simple cardiac defects had a weight-for-height Z score of <-2SD. Severe acute malnutrition (weight-for-height Z score <-3SD) tended to be more prevalent in patients with complex heart defects than in the simple defects group: 45.6% vs. 25.6%, but the observed difference fell short of statistical significance, p=0.220.

Table 2 shows the pattern of undernutrition among the patients studied, which also show that all under-five patients with complex and cyanotic heart diseases had a mid-arm circumference of less than 13.5 cm. Though malnutrition is widespread, patients with simple cardiac defects were heavier than those with complex cardiac defects, p=0.038 (Table 3). Stunting (height-for-age Z score <-2SD) occurred more commonly in patients with the complex heart defects than in those with simple heart defects: 81.8% vs. 35.9%, p=0.026 (Table 2). The presence of cyanosis did not alter the prevalence of malnutrition, p=0.55.

Table 2: Pattern of weight-for-height, height-for age, weight-for-age Z scores and mid-arm circumference in the various types of cardiac defects in the patients.

Parameters	Types of cardiac lesions		Total	p-value	Types of cardiac lesions		Total	p-value
	Simple n=39 (%)	Complex n=11 (%)	N=50(%)		Cyanotic N=12(%)	Acyanotic N=38 (%)	N=50(%)	
WHZ<-3SD	10 (25.6)	5 (45.6)	15 (30.0)	0.448	5(41.7)	10(26.3)	15 (30.0)	0.599
WHZ<-2SD	9 (23.1)	2 (18.2)	11 (22.0)	0.642	4(33.3)	7 (18.4)	11 (22.0)	0.554
WHZ<-1SD	10 (25.6)	0	10 (20.0)	0.172	0	10 (26.3)	10 (20.0)	0.139
WHZ>-1SD	10 (25.6)	4 (36.4)	14 (28.0)	0.783	3(25.0)	11(28.6)	14 (28.0)	0.965
HAZ<-2SD	14 (35.9)	9(81.8)	23 (46.0)	**0.026**	10 (83.3)	13 (34.2)	23 (46.0)	**0.012**
HAZ>-2SD	25 (64.1)	2 (18.2)	27 (54.0)	**0.026**	2(16.7)	25(65.8)	27 (54.0)	**0.012**
WAZ<-2SD	16 (41.0)	9 (81.8)	25 (50.0)	0.058	10 (83.3)	20 (52.6)	30 (60.0)	0.167
WAZ>-2SD	23 (59.0)	2 (18.2)	25 (50.0)	0.058	2 (16.7)	18 (47.4)	20 (40.0)	0.167
MAC<13.5	12 (36.4)[a]	8 (100)[b]	20 (51.3)[c]	**0.005**	6 (100)[d]	14 (43.8)[e]	20 (52.6)[f]	**0.041**

WAZ: Weight-for-Age Z Score; HAZ: Height-for-Age Z Score; WHZ: Weight-for-Height Z Score; MAC: Mid Arm Circumference in children below 5 years of age; a: denominator is 33, b: denominator is 8, c: denominator is 39, d: denominator is 6, e: denominator is 32, f: denominator is 38.

Table 3: Comparison of median indices of nutritional status, total serum protein and albumin in the studied population.

Parameters	Cyanotic Heart Defects Median (IQR)	Acyanotic Heart Defects Median (IQR)	p-value	Complex Heart Defects Median (IQR)	Simple Heart Defects Median (IQR)	p-value
WAZ	-3.2 (-4.8, -1.1)	-2.0 (-4.7, 0.4)	0.661	-4.3(-4.8, -2.3)	-1.8 (-4.0, 0.4)	0.066
WAP	0 (0, 4)	1 (0, 11)	0.381	0 (0, 1)	2 (0, 11)	**0.038**
HAZ	-1.9 (-4.8, -0.8)	-1.6 (-3.8, -0.1)	0.331	-1.9 (-4.8, -1.4)	-1.6 (-3.8, -0.1)	0.125
HAP	3 (0, 21)	4 (0, 41)	0.331	1 (0, 3)	6 (2, 46)	0.086
WHZ	-2.3 (-4.0, -0.7)	-1.6 (-3.3, -0.6)	0.798	-2.7 (-3.8, -0.5)	-1.6 (-2.9, -0.5)	0.263
Total Prot, g/l	72 (64.5, 79.0)	68 (60, 74)	0.153	68 (64, 75)	64 (59, 75)	0.509
Serum Alb, g/l	35 (34, 39)	42 (37, 48)	0.063	39 (34, 40)	43 (37, 48)	0.103

WAZ: Weight-for-Age Z Score; WAP: Weight-for-Age Percentile; HAZ: Height-for-Age Z Score; HAP: Height-for-Age Percentile; WHZ: Weight-for-Height Z Score; Total Prot: Total Serum Protein; Serum Alb: Serum Albumin; IQR: Interquartile Range

Pattern of biochemical markers of nutritional status in children with congenital heart diseases

Total protein was higher in children with HAZ >-2SD than in the stunted group (HAZ <-2SD): 70.2±8.9 g/l vs 65.0±7.6 g/l, p=0.03. Hypoproteinemia (total serum protein <60 g/l) was found in 10 (27.8%) undernourished patients while none of the well-nourished patients had low protein level. Similarly, hypoalbuminemia (serum albumin <35 g/l) occurred in 8 (22.2%) undernourished as against only one case (7.1%) among the well-nourished. Overall, serum albumin level showed a positive correlation with patient's weight-for-age percentile (r=0.3767, p=0.008) (Figure 1a) and weight-for-height Z score, p=0.026 (Figure 1b). The height-for-age percentile had weak positive correlation with serum albumin level.

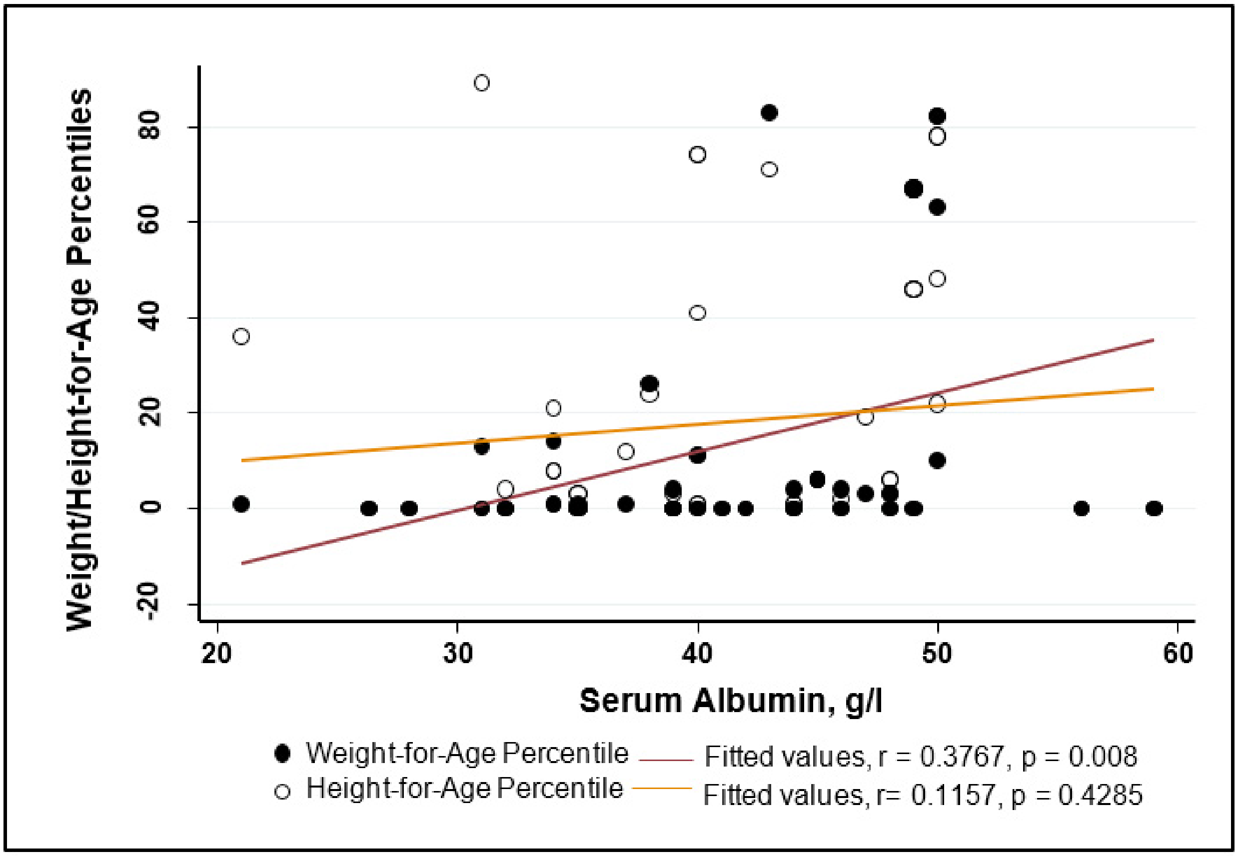

Figure 1a: Pearson correlation of weight-for-age and height-for-age percentiles with serum albumin level showing a positive correlation particularly between serum albumin level and weight-for-age percentile, p=0.008.

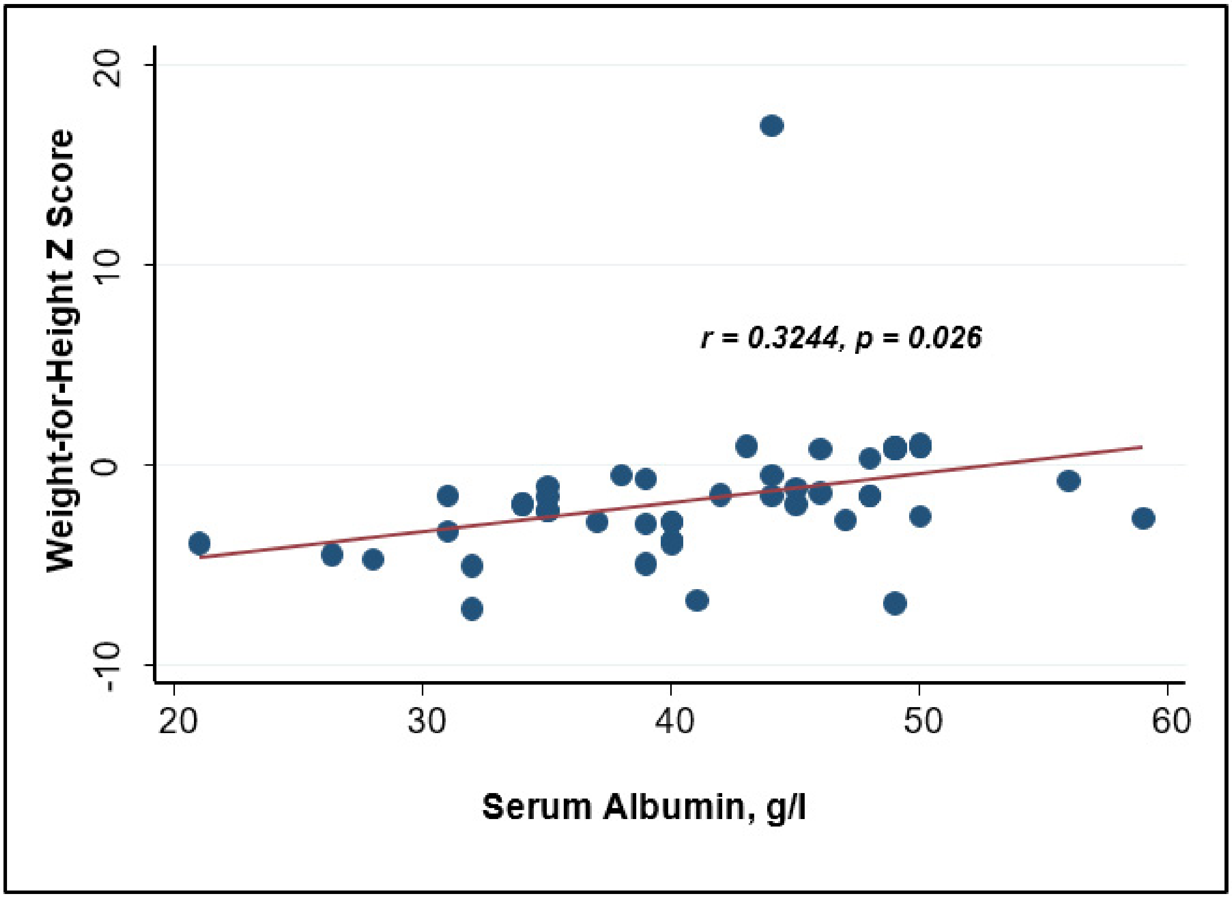

Figure 1b: Pearson correlation of weight-for-height Z score with serum albumin level indicating a positive correlation between serum albumin level and weight-for-height Z score.

Influence of types of cardiac lesions on the markers of nutritional status

Patients with acyanotic heart defects demonstrate a weight-for-age Z scores that increases with the age of the patients, r=0.3592, p=0.0211 (Figure 2). In the cyanotic category however, the weight-for-age Z score had a negative correlation with patient's age. The trend in the height-for-age Z score is similar in both the cyanotic and acyanotic groups. However, the weight-for-age Z score improves as patients get older in the acyanotic group (p=0.011) whereas it is static in the cyanotic group (Figure 3).

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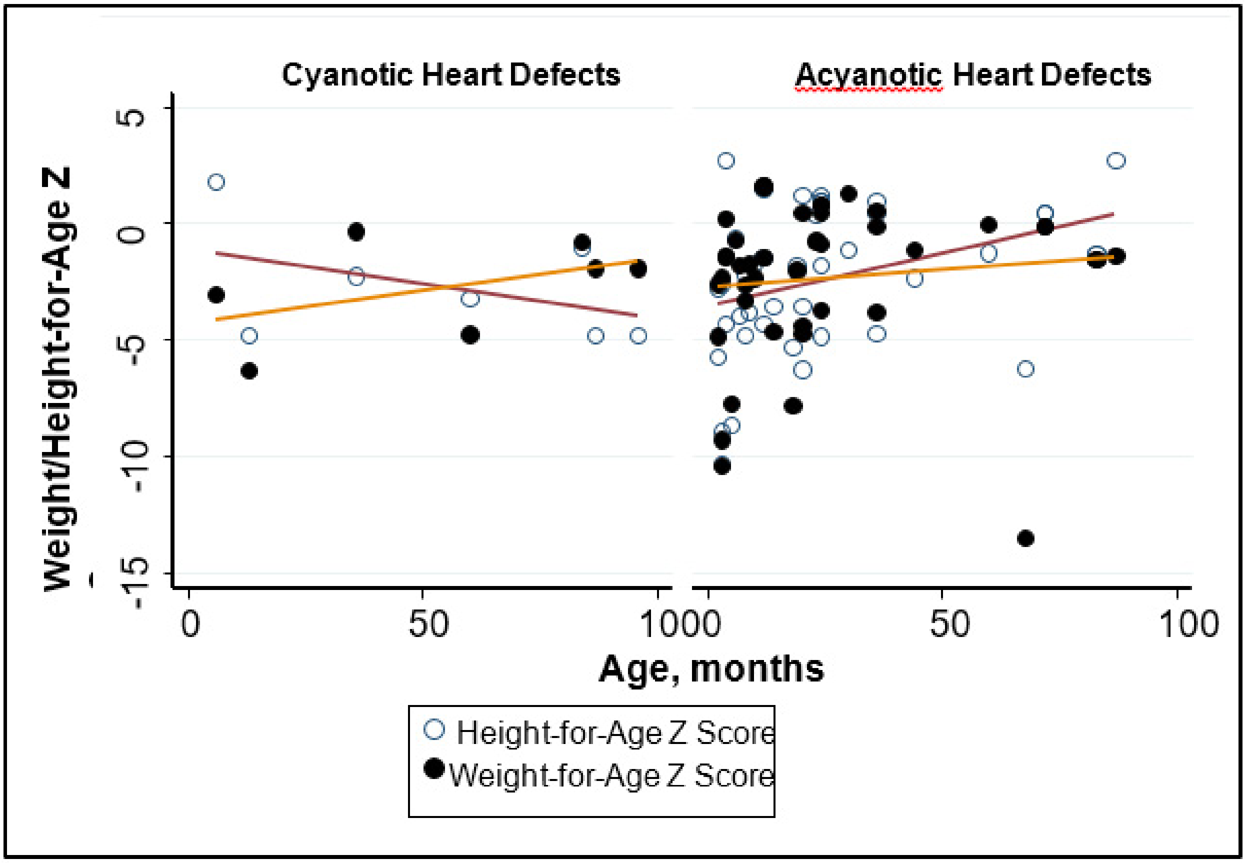

Figure 2: Correlation of weight/Height-for-age Z Scores with patients' age. Patients with cyanotic heart diseases tended to have weight-for-age that correlate negatively with age, r=-0.4554, p=0.3044, whereas the acyanotic category demonstrates a positive correlation of weight-for-age with increasing age, **r=0.3592, p=0.0211.**

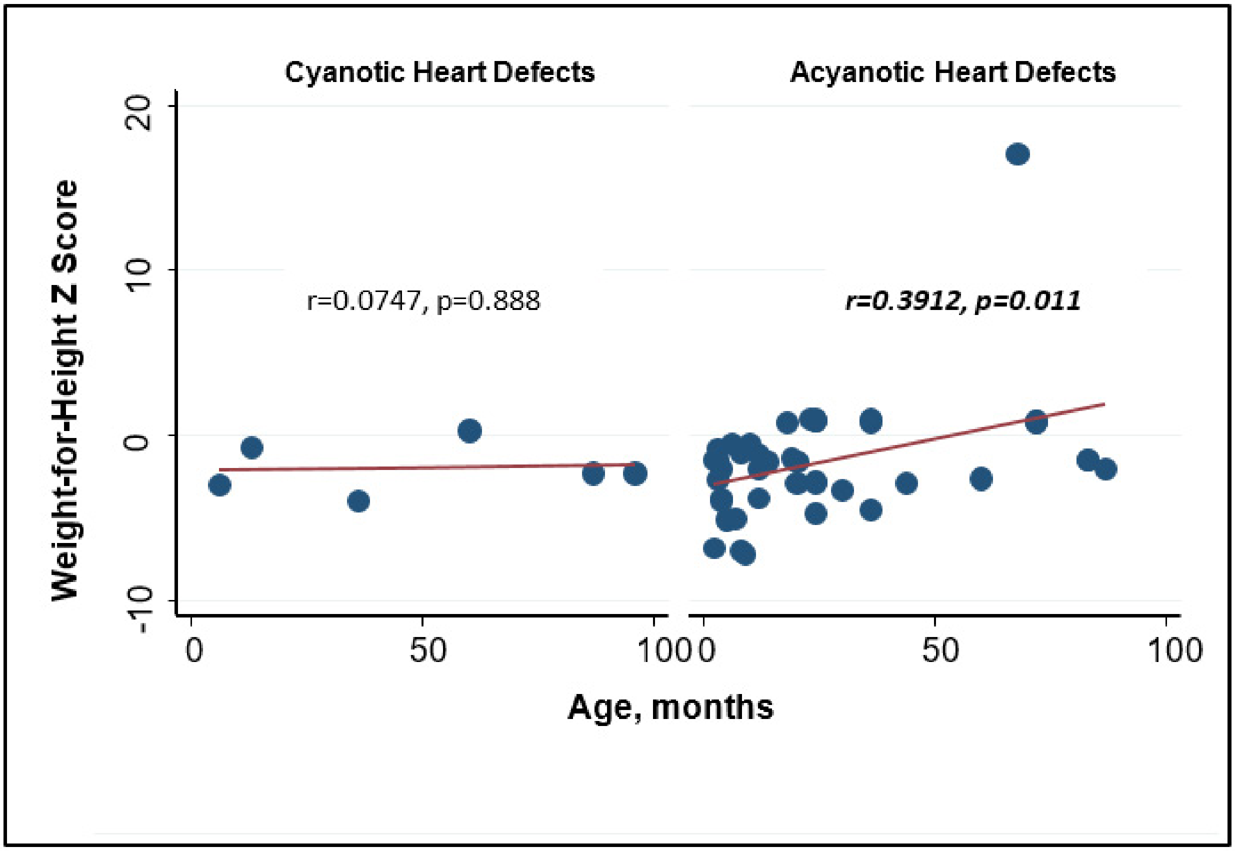

Figure 3: Weight-for-height Z Score in patients with cyanotic and acyanotic heart defects in relation to the patients' age. Those in the acyanotic category tend to improve in their weight pattern with age (*p=0.011*) unlike their cyanotic counterparts.

Discussion

The prevalence of undernutrition among children with unoperated cardiac defects is high in the present study in which ¾ of the children were below the 5th centile for weight and 52% of the patients had a weight-for-height Z score of less than minus 2 standard deviation. This finding was collaborated by the report of Varan, et al. from Ankara, Turkey who demonstrated that about 2/3 of the patients with congenital heart diseases had weights below the 5th centile [8]. Similar high prevalence of undernutrition has been reported in studies from Ibadan (Nigeria) [5], Zagazig (Egypt) [6] and Kampala (Uganda) [4]. Factors underlining the high prevalence of malnutrition among children with congenital heart diseases in these studies may include the increase in metabolic need of these patients in the milieu of a decrease in caloric intake due to their inability to tolerate high volume of feeds in addition to the delay in obtaining definitive cardiac surgery, largely due to lack of the wherewithal to access the desired healthcare [10-12].

Both wasting (52%) and stunting (54%) are prevalent in these patients, occurring with similar prevalence, although with a slightly higher prevalence of stunting. In many reports from other clime stunting has also been shown to be more prevalent than wasting in children with congenital heart diseases, thus suggesting that linear growth is more affected by the metabolic abnormalities in congenital heart disease than horizontal growth [4,6-8].

The type of heart defects appeared to impact on the nutritional status of the patients studied. Children with simple heart defects were heavier and taller for their respective ages compared to those with complex cardiac defects. Besides, all the anthropometric indices were generally poorer for patients with complex heart diseases. The reason for this observation is not known but may be speculated to include the fact that the heart with simple defects may be better endowed to cope with the metabolic demand of the body (when the associated heart failure is adequately managed) than the heart with complex and multiple defects. Besides, the complex heart diseases in the present study were of the cyanotic type. Chronic hypoxia is detrimental to energy generation in the body and hence the increased propensity of patients with complex congenital heart diseases to malnutrition [13-15]. As revealed by the present study, 83.3% of children with cyanotic congenital heart defects were stunted as against 34.2% recorded among those without cyanosis, thus indicating a 2.5 times higher risk of stunting in the cyanotic group.

Age at recruitment is also an important determinant of the pattern of nutritional abnormalities documented in the present study. Majority of the patients with acyanotic heart diseases were much younger than those with cyanotic heart disease: 19.5 months versus 60 months for the cyanotic. Unlike the cyanotic group, heart failure is a major presentation in the acyanotic group and hence early presentation is likely. Tetralogy of Fallot, being the predominant cyanotic heart disease, rarely present in early infancy.

Hypoproteinemia and hypoalbuminemia occurred in 27.8% and 22.2%, respectively, in patients studied. Leite, et al. and Savluk, et al. have reported similar pre-operative levels of serum albumin in children with congenital heart defects. In the present study, the serum level of albumin paralleled the weight-for-age and height-for-age percentiles as well as weight-for-height Z score, thus signifying that albumin response in children with congenital heart diseases is similar to those of malnourished children with normal heart. It is however not certain if the type of cardiac defects has a unique pattern of relationship with serum albumin, this calls for further studies, particularly in the developing countries where prevalence of unoperated congenital heart defects is high. Pre-operative hypoalbuminaemia has been linked with surgical risk such as postoperative infections and mortality in children with congenital heart diseases; therefore, it should be sought and corrected before surgical intervention.

Limitations

The study was done in one centre and the sample size was small, therefore limiting the capacity for generalization of the research findings. In addition, factors known to cause undernutrition in children with congenital heart diseases were not explored.

Conclusion

The present study has brought to the fore that despite the technological advancement in surgical interventions for congenital cardiac defects, malnutrition is still prevalent even in the 21st century in this category of patients in resource-constrained communities. Therefore, aggressive nutritional rehabilitation should form an integral part of the wholistic management of children awaiting surgical intervention.

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