



The Association between Cyanotic and Acyanotic Congenital Heart Disease with Nutritional Status

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Abstract

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BACKGROUND: Congenital heart disease (CHD) is one of the most common birth anomalies in the 1st year of life. The incidence of CHD in developed and developing countries is varied, between 6 and 10 cases per 1000 live birth. Some factors contribute to the nutritional status of CHD patients, such as nutrient inputs, energy requirements, and dietary components. Irrespective of the nature of the cardiac defect and the presence or absence of cyanosis, malnutrition is a common finding in children with congenital heart anomalies. Recent studies have tried to investigate malnutrition development based on the type or category of CHD.

AIM: This study aims to investigate the association between cyanotic and acyanotic CHD with nutritional status.

METHODS: A cross-sectional study was conducted from January to March 2018 in the pediatric cardiology outpatient clinic of the Haji Adam Malik General Hospital, Medan, Indonesia.

RESULTS: During the study period, 58 children were admitted, consisting of 31 (53.4%) males and 27 (46.6%) females, with a mean age of 57 months. There was no significant sex predilection found in the study ($p = 0.207$). The proportion of patients who developed malnutrition was 70.7% (mild-moderate = 48.3% and severe = 22.4%). There was an association between cyanotic and acyanotic CHD with nutritional status ($p = 0.015$). Wasting was found in 33 children (56.8%) that had a significant association with the type of heart defects ($p = 0.001$). Patients with cyanotic CHDs were found to have a lower risk for malnutrition compared to the acyanotic group (prevalence odds ratio = 0.218, and prevalence risk = 0.661; $p = 0.015$).

CONCLUSIONS: There is an association between cyanotic and acyanotic CHD with nutritional status.

Introduction

Congenital heart disease (CHD) is the most common form of birth anomalies in the 1st year of life. The incidence of CHD in developed countries and developing countries ranges from 6 to 10 cases per 1000 live birth [1].

Irrespective of the nature of the cardiac defect and the presence or absence of cyanosis, malnutrition is a common finding in children with congenital heart anomalies. The National Center for Health Statistics growth reference defines malnutrition as a state of nutrition where the weight for age, height for age, and weight for height indices are below -2 Z-score [2]. Malnutrition is further classified as mild-moderate and severe malnutrition if the patient's weight is 90–70% and <70% of ideal weight for length, respectively, based on the CDC 2000 standard for child above 5 years old. Those values are equal with <-2 SD >-3 , and <-3 SD based on the WHO 2006 standard for children below 5 years old [3]. Despite significant advances in surgical techniques and improved timing

of corrective cardiac surgery, recent studies show that malnutrition remains a common finding in CHD [4].

Many aspects of CHD make children prone to be malnourished, such as an increase in caloric needs, difficulties in feeding because of limitations secondary to ductal-dependent disease or need for vasopressor support, increased risk of necrotizing enterocolitis, and fluid limitations [5], [6]. Furthermore, children with congenital heart anomalies often struggle with vomiting and feeding tolerance and consequently develop an oral aversion. Some well-understood post-operative risk factors for malnutrition in children with CHD are frequent interruptions of feeding, vocal cord dysfunction, chylothorax, and those with single ventricle disease that is at risk for experiencing a protein-losing enteropathy [7].

Poor growth with underweight for age, decreased length/height for age, and underweight for height is relatively frequent in children with CHD.

The underlying causes of this growth failure may be multifactorial, including innate growth potential, the severity of heart diseases, increased energy requirements,

decreased nutritional intake, malabsorption, and poor utilization of absorbed nutrition. These factors are particularly frequent and severe in countries with low-income or middle-income status [8], [9].

The feeding goal for infants and children with CHD is to provide adequate energy and protein accounting the increased needs, promote optimal weight gain and growth rate, and promote oral feeding as able. Chronic illness or prolonged hospitalization may result in oral feeding problems and maintaining normal or near-normal electrolyte levels. Children need to be monitored closely for abnormalities, particularly if the child is on highly concentrated enteral feedings or taking certain medications [10], [11].

The objective of this study is to investigate the association between cyanotic and acyanotic CHD with nutritional status.

Methods

Study design

Across-sectional study was conducted between January and March 2018 in the pediatric cardiology outpatient clinic at the Haji Adam Malik General Hospital, Medan. The sampling method was purposive sampling with defined inclusion and exclusion criteria. Patients were categorized based on cardiac diagnosis from echocardiography: cyanotic and acyanotic CHD. Patients younger than 18 years old, diagnosed with CHD from echocardiography, were included in the study. Patients with other accompanying congenital anomalies were excluded from the study. Informed consent was obtained from parents or guardians for participation in the study.

Assessments

Standardized measurements of weight and length obtained by the nurse were classified as mild-moderate and severe malnutrition when patient weight was 90–70% and <70% of ideal weight for length or height, respectively, based on the CDC 2000 standard for child above 5 years old.

Statistical analysis

Data were analyzed using SPSS version 26.0. The quantitative variable was expressed as means and standard deviations. The categorical variables were described by their absolute (n) and relative (%) frequencies. Chi-square was used to analyze the association between cyanotic, acyanotic CHD, and nutritional status. $p < 0.05$ was considered statistically significant.

This study was approved by the Ethics Committee of the Faculty of Medicine Universitas Sumatera Utara.

Results

During the study period, 58 patients met the inclusion criteria and were eligible for analysis. Of the 58 patients in this study, 53.4% were males. However, this higher number was not significant to conclude the existence of sex predilection ($p = 0.207$). The proportion of patients who developed malnutrition was 70.7%. Mild-moderate malnutrition was found in 48.3% of subjects, and severe malnutrition in 22.4% cases.

Acyanotic CHDs was accounted for 48.3% of all cases, while 44.2% was cyanotic in nature. Tetralogy of Fallot (TOF) was the most common cardiac lesion found among all cases of CHD (39.7%). In comparison, ventricular septal defect (VSD) was the most frequent acyanotic defect among all cases of CHD (25.9%) (Table 1).

Table 1: Patients characteristics based on gender and type of congenital heart disease

Variables	n (%), mean \pm SD
Mean age (SD), months	57 (50.7)
Gender, n (%)	
Male	31 (53.4)
Female	27 (46.6)
Diagnosis, n (%)	
Acyanotic	
VSD	15 (25.9)
ASD	4 (6.9)
PDA	9 (15.5)
Cyanotic	
TOF	23 (39.7)
DORV	3 (5.2)
PA-VSD	4 (6.9)
Nutritional status, n (%)	
Normal nutrition	17 (29.3)
Malnutrition	41 (70.7)
Mild-moderate	28 (48.3)
Severe	13 (22.4)
Stunting	27 (46.6)
Wasting	33 (56.8)

VSD: Ventricular septal defect, ASD: Atrial septal defect, PDA: Patent ductus arteriosus, TOF: Tetralogy of Fallot, DORV: Double outlet right ventricle, PA-VSD: Pulmonary atresia with ventricular septal defect.

Stunting was found in 27 patients (46.6%), but there was no significant relationship found between the type of CHD and stunting ($p = 0.26$). On the other hand, wasting was found in 33 children (56.8%) that had a significant association with the type of heart defects ($p = 0.001$) (Table 1). Cyanotic patients were less prone to wasting compared to acyanotic ones (prevalence odds ratio [POR] = 0.98; $p = 0.001$).

The number of children with malnutrition was greater in acyanotic group amounting for 24 cases (50%). In comparison, 17 (29.3%) subjects were found to have malnutrition in cyanotic patients. Patients with cyanotic CHDs were found to have a lower risk for malnutrition compared to the acyanotic group (POR = 0.218, prevalence risk [PR] = 0.661; $p = 0.015$) (Table 2).

Table 2: Risk estimate for malnutrition based on congenital heart disease category

Variables	Value	95% confidence interval	
		Lower	Upper
Prevalence odds ratio			
Cyanotic/Acyanotic	0.218	0.061	0.785
Prevalence risk			
Cyanotic/Acyanotic	0.661	0.467	0.936

We analyzed the relationship of type of cardiac defects, cyanotic and acyanotic, with malnutrition occurrence using Fisher exact test, since one of the subgroups was less than five, failing to meet Chi-square assumptions. The result indicated that there was an association between cyanotic, acyanotic CHD, and the nutritional status of patients ($p = 0.015$) (Table 3).

Table 3: Association between nutritional status and congenital heart disease

Variables	Nutritional status		p value (Fisher exact)
	Malnutrition	Normal	
Congenital heart disease			
Cyanotic	17	13	0.015
Acyanotic	24	4	

Discussion

The mean age of patients admitted was 4.7 years old (57 months). This finding was similar to other studies with a mean age range from 4 to 9 years old [1], [4], [11]. The gender of children mostly afflicted with CHD in this study was male. Nevertheless, the difference was not significant ($p = 0.207$). Similarly, research by Arodiwe *et al.* also showed this predilection with 22 patients (61%) although it was also not conclusive ($p = 0.21$) [2]. Washeel and Maaka found a significant relationship between weight for age index with the gender that male was found to be more susceptible ($p = 0.021$) [1]. Contrastly, our study did not find a significant difference in malnutrition cases between genders. These gender predilections need further investigation and possibly a larger study population to achieve more conclusive evidence.

The most common CHD found in this study is the TOF. Compared with other studies which investigate the relationship between CHD and malnutrition, the most common anomaly was the VSD. Nevertheless, TOF was still found in a significantly large number in other studies [1], [4], [9]. Some studies also had investigated specific cardiac diagnosis with nutrition or growth status that cyanotic CHDs (e.g., TOF) were associated with poor nutrition status [1], [4], [9]. The relationship between particular diagnoses with malnutrition was not established in our study. Still, we found that there was a significant association between the category, cyanotic, and acyanotic, with the nutrition status. Surprisingly, our finding was quite different from most of the recent research that acyanotic CHDs were more susceptible to malnutrition than cyanotic CHDs (POR = 0.218, PR = 0.661; $p = 0.015$ for cyanotic CHDs).

The number of patients afflicted with malnutrition was 41 from 58 patients admitted. Patients with acyanotic CHD were shown to have higher numbers, probably because of the better overall survival to childhood age. The prevalence of malnutrition in our study was 70.7%. Mild-moderate malnutrition was found in 48.3% of subjects, and severe malnutrition in 22.4% cases. The previous reports indicated that malnutrition caused by CHD was common in developing countries, but the prevalence varies from 27% up to 90.4%. Another study from Turkey reported that the prevalence of malnutrition in children with CHD was 27% [12], while a more recent Turkish study described a prevalence of 85% [13]. However, research in Nigeria found a higher number of malnutrition in children with uncorrected symptomatic CHD (90.4%) [14].

The cause of malnutrition in CHD is multifactorial [15]. Inadequate caloric intake, increased energy requirements caused by increased metabolism and malabsorption may all contribute. However, the most important cause of malnutrition in CHD is inadequate caloric intake [16]. Our study had this limitation since it did not analyze these contributing factors in detail. However, we made sure to exclude cases with other accompanying anomalies.

This study showed a significant relationship between the type of CHD, cyanotic, and acyanotic, with nutrition status. Despite our results depicted a more favorable nutrition status in cyanotic patients, further studies will still be needed to get better evidence. The considerable variation of age and non-probability sampling method may be less representative for a generalization. Furthermore, other factors that contribute to nutrition (e.g., poor feeding, infection, or other concomitant diseases) status is not investigated yet, whether they are all attributed solely to CHDs or are also associated with other problems. Finally, we admit that those limitations may lead to bias and may not represent real values.

Conclusions

In this study, we find that there is an association between cyanotic and acyanotic CHD with nutritional status.

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