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Underweight, Stunted, and Wasted among Children with Congenital Heart Disease: Acyanotic versus Cyanotic

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Abstract

BACKGROUND: Children with congenital heart disease (CHD) are at increased risk of being underweight, stunted, and wasted. Wasted is a reflection of acute malnutrition, stunted is a reflection of chronic malnutrition while underweight is a reflection of both.

AIM: The aim of the study was to investigate the prevalence of underweight, stunted, and wasted in children with acyanotic and cyanotic CHD.

METHODS: An observational study with a cross-sectional design was conducted in children under 5 years old with initial diagnosed CHD in Sanglah Hospital, Bali from January 2017 to July 2020. Data were collected from medical records. Anthropometric z-scores based on the World Health Organization 2006 reference ranges were generated for each child. Diagnosis of CHD was retrieved based on echocardiography examination. The significances of the anthropometric status differences between acyanotic and cyanotic groups were assessed using Pearson's Chi-square.

RESULTS: Out of 200 cases of CHD, 160 (80%) cases were acyanotic CHD and 40 (20%) cases were cyanotic CHD. The prevalence of underweight, stunted, and wasted in acyanotic versus cyanotic CHD were: Underweight (57.5% vs. 40.0%, p = 0.047), stunted (47.5% vs. 65%, p = 0.048), and wasted (67.5% vs. 50%, p = 0.039).

CONCLUSION: The prevalence of underweight, stunted, and wasted among children with acyanotic and cyanotic CHD were high. The proportion of underweight and wasted were significantly higher in acyanotic CHD, while stunted was significantly higher in cyanotic CHD.

Introduction

The infant malnutrition that is associated with being underweight, stunted, and wasted frequently resulting in morbidity and mortality of children under 5 years has remained static and has been an ongoing public health priority in Indonesia [1]. It is responsible for widespread stunted and adverse health and social consequences throughout the life span [2]. The prevalence of underweight, stunted, and wasted in children with congenital heart disease (CHD) is very high [3]. Those can increase their risk of infections, death, and poor growth in children which are associated with delayed mental development, poor school performance, and reduced intellectual capacity [4]. Risk factors for malnutrition among children with CHD include the type of heart disease (acyanotic or cyanotic), heart failure, hypermetabolism and the increased energy expenditure, gastrointestinal dysfunction, inadequate nutritional intake due to feeding difficulties, delayed corrective surgery, anemia, pulmonary hypertension, and presence of comorbidities or syndromes such as Down Syndrome and Turner Syndrome[5], [6].

Some previous studies had proven that cyanotic CHD patients are affected in growth, depending on the severity of tissue hypoxemia and the degree of physiological adaptation. Acyanotic lesions were related to acute malnutrition that is reflected in wasted, whereas cyanotic lesions were related to chronic malnutrition reflected in stunted [7]. Research in Nigeria found that the prevalence of nutritional disorders in children with CHD was 90.4% compared to healthy children without CHD was 21.1%, with a prevalence of acute malnutrition in acyanotic CHD was 58.3% and chronic malnutrition in cyanotic CHD was 68.0% [5]. Research in Jakarta on CHD children found that the prevalence of malnutrition was 51.1% [7].

To the best of our knowledge, no study to date had been conducted to know the prevalence of underweight, stunted, and wasted among children with CHD in Sanglah Hospital, Denpasar Bali. Therefore, we aimed to describe the prevalence of underweight, stunted, and wasted among children with acyanotic and cyanotic CHD in Sanglah Hospital.

Methods

This study was an observational study with a cross-sectional design using secondary data collected from the registry of pediatric patients with CHD in Sanglah Hospital, Bali from January 2017 to July 2020. Inclusion criteria were patients aged 0–5 years old with initial diagnosis of CHD confirmed by echocardiography examination. Subjects with incomplete medical record data were excluded from the study. The sampling technique used total sampling with total samples was 200 patients. Data were collected on sociodemographic characteristics, clinical assessments of the children including gender, age, birth weight, gestational age, heart failure, cardiac diagnosis, and anthropometric status.

Anthropometric status used the World Health Organization (WHO) z-scores to classify the nutritional status of the children. A child was classified as underweight if the weight-for-age WHO z-score was < −2 SD, stunted if height-for-age z-score was < −2 SD, and wasted if weight-for-height WHO z-score was < −2 SD. The severity of heart failure was graded using the modified Ross score; children were grouped into four categories based on a Ross score 0–2 (no heart failure), a Ross score of 3–6 (mild heart failure), a Ross score of 7–9 (moderate heart failure), and a Ross score 10–12 (severe heart failure) [4].

Continuous data will be presented in mean and deviation standard if normally distributed, or median and range if not normally distributed. Categorical data will be presented in frequency and percentage. Normality test was using Kolmogorov–Smirnov. Pearson's Chi-square was done to measure the significance of the anthropometric status differences between acyanotic and cyanotic groups. This study was approved by the Research Ethics Committee of the School of Medicine, Universitas Udayana/Sanglah Hospital, Denpasar and written informed consent was obtained from all subjects before the study.

Results

From January 2017 to July 2020, we found 200 cases that meet our inclusion criteria. Acyanotic CHD was found predominantly in 160 cases (80%) with the most common diagnosis was ventricle septal defect (VSD) (43%), followed by patent ductus arterious (PDA) (34%), other acyanotic CHD (13.7%), and atrial septal defect (ASD) (9.3%). Out of the remaining 40 cases (20%) with cyanotic CHD, the most common diagnosis was tetralogy of fallot (40%), followed by transposition of the great arteries (TGA) (15%), double outlet of right ventricles (DORV) (12.5%), total anomalous pulmonary venous return (TAPVR) (10%), pulmonary atresia (7.5%) truncus arteriosus (7.5 %), and others cyanotic CHD (7.5 %). Patient demographic characteristic is listed in Table 1.

Table 1: The characteristics of study cases

Demographic characteristic	Acyanotic CHD (n = 160)	Cyanotic CHD (n = 40)	P-Value
Age, median (range), months	5 (1-60)	5 (1-60)	0.8
Gender, n (%)			
Male	64 (40.0)	25 (62.5)	0.01
Parity, n (%)			
Multiparity	150 (93.7)	38 (95.0)	0.76
Birth weight, n (%)			
< 2500 g	36 (22.5)	7 (17.5)	0.49
Gestational age, n (%)			
Preterm	35 (21.9)	11 (27.5)	0.49
Referral status, n (%)			
Yes	128 (80.0)	30 (75.0)	0.26
Heart failure (based on Ross Score), n (%)			
Moderate/severe	13 (8.1)	7 (17.5)	0.09
No HF/mild	147 (91.7)	33 (88.5)	

The proportion of underweight, stunted, and wasted among children with acyanotic and cyanotic CHD in this study were investigated and shown in Table 2.

Table 2: The proportion of underweight, stunted, and wasted among children with acyanotic and cyanotic CHD

Variables	Overall (n = 200)	Acyanotic CHD (n = 160)	Cyanotic CHD (n = 40)	p-value
Weight for Age Z-score, n (%)				
< –2 SD	108 (54.0)	92 (57.5)	16 (40.0)	0.047
≥ –2 SD	92 (46.0)	68 (42.5)	24 (60.0)	
Height for Age Z-score, n (%)				
< –2 SD	102 (51)	76 (47.5)	26 (65.0)	0.048
≥ –2 SD	98 (49)	84 (52.5)	14 (35.0)	
Weight for Height Z-score, n (%)				
< –2 SD	128 (64.0)	108 (67.5)	20 (50.0)	0.039
≥ –2 SD	72 (36.0)	52 (32.5)	20 (50.0)	

*Pearson Chi-square.

Discussion

CHD indicates the presence of abnormality in heart and vascular structure and function at birth that have a multifactorial nature of inheritance. It is the interaction that resulted from multiple factors such as heredity and environment. The known risk factors include harmful substances exposure, smoking and drinking, viral infections at the early stage of pregnancy, diabetes mellitus, history of unhealthy pregnancy, and advanced maternal age [8]. Its clinical consequences are extremely serious that can be an important cause of miscarriage, stillbirth, neonatal death, and children, adolescents, and adults with disabilities [9].

In this study, VSD is found to be the most common acyanotic CHD (43%) and this is higher than what was reported in another study that the prevalence showed 25–30% of all CHD [2]. The different results may be due to the difference in genetic makeup and ethnicity between countries. This finding was similar to a study from Iceland that reported VSD (45.7%) as the most diagnosed heart defect, followed by ASD (12.2%) and aortic stenosis (AS) (1.5%) among 338 patients [10]. Similar findings from Saudi Arabia reported VSD in 32.5% of patients, PDA in 15.8%, and ASD in 10.4% [11].

Malnutrition occurs among children with CHD, irrespective of the nature of the cardiac defect, and the presence or absence of cyanosis. Children with CHD are prone to have malnutrition for several reasons including decreased energy intake, increased energy requirements, or both. Children with CHD in which there is congestive heart failure (CHF) or an increase in afterload (coarctation of the aorta or pulmonary hypertension) often present with increased energy expenditure. This is because the heart must work much harder to pump adequate blood for body metabolism. Another reason for the increased metabolic rate seen in children with CHD is their body composition. This is because decreased caloric intake and greater energy expenditure will make less energy available for fat deposition. As a result, they will have an elevated percentage of lean body mass which tends to increase their basal metabolic rate [12].

The result showed that malnutrition in children with CHD was high. The previous reports showed that CHD-related growth faltering malnutrition is particularly common in developing countries. For instance, in Egypt, Hassan *et al*. reported the overall prevalence of malnutrition was 84.0% in patients with CHD [13]. Among all of the studied children, the prevalence of underweight, wasted, and stunted were 54%, 64%, and 51%, respectively. This result was in line with a study in Uganda that found the prevalence of underweight (42.5%), stunted (45.4%), and wasted (31.5%) [6]. A different result was found in Nigeria that reported prevalence of underweight, stunted, and wasted in CHD children were 28.8%, 20.5%, and 41.1%, respectively [4]. A study in Uganda reported a lower incidence of malnutrition as in the present study, which the prevalence of underweight (23%), stunted (21%), and wasted (18%) [6].

The prevalence of wasted was higher in acyanotic CHD compared to cyanotic CHD (67.4% vs. 52.5%). This result shows significant differences between the two groups. A similar result was found that 76.67% of children with acyanotic CHD had wasted [14]. Among them, 30% had moderate and 46.6% had severe wasted. Sjarif *et al*. also showed similar results regarding this that found 76.6% of children with acyanotic CHD children had wasted, whereas 54.2% had moderate and 22.2% had severe wasted [15].

The prevalence of underweight was also higher in acyanotic CHD compared to cyanotic CHD (57.5% vs. 40%). This result showed significant differences between the two groups. This result was similar to Zaman that found 89% of patients with acyanotic CHD and 87% of patients with cyanotic CHD had underweight [16]. Varan *et al*. found a different result that the prevalence of underweight in both groups was lower than in our result that in acyanotic group (31%) while in the cyanotic group (23%) [17].

The causes of the high prevalence of wasted as a reflection of acute malnutrition and underweight as a reflection of acute and chronic malnutrition in acyanotic CHD can be due to the presence of left to right shunt that caused a decrease in cardiac output goes to the systemic (truncated). Patients with congestive failure due to left-to-right intracardiac shunting, particularly those with right-heart failure and elevation of systemic venous pressure, may develop edema of the intestinal wall and mucosal surfaces that lead to impaired nutrient absorption and lymphatic drainage. Other factors contributing to low caloric intake and increased energy requirement include feeding difficulties associated with tachypnea, fatigue, and respiratory infections in patients with CHF. Restriction of fluid intake as a treatment for CHF may have the unintended effect of excessive caloric restriction. Diuretic therapy may produce anorexia from metabolic alkalosis and hypokalemia or may inhibit effective protein anabolism [4].

The prevalence of stunting in this study was 65% in children with cyanotic CHD and 47.5% in children with acyanotic CHD. It showed a significant difference between the two groups. These results were consistent with the study of Sjarif *et al*. that found 90% of children with cyanotic CHD were stunted and 79.4% of children with acyanotic CHD were stunted [15]. Zaman reported different results that 66.6% of children had stunted in cyanotic CHD and 62.68% had stunted in acyanotic CHD which showed no significant difference between cyanotic and acyanotic groups [16]. The cause of stunted children with cyanotic CHD may be associated with the presence of chronic hypoxia. Chronic hypoxia in CHD provides direct and indirect effects on reduced serum hormone insulin-like growth factor I (IGF-I) that can cause impairment of bone center and eventually impaired nutritional status and stunted growth. Delays in bone growth will lead to below normal body length. Children with CHD especially cyanotic CHD have a body length under normal than their age [18].

All of these studies indicate that the prevalence of underweight, stunted, and wasted are various in children with CHD in various countries. The heterogeneity exists from country to country implying differences in risk factors for malnutrition among children, in the different settings.

The limitations of this study were that we did not evaluate factors that are known to contribute to malnutrition in these children with CHD such as genetic disorders, pulmonary hypertension, and dietary intake of the children.

The future research should investigate the areas outlined above, as well as the short and long-term effects of nutritional intervention in children with CHD. In addition, micronutrient deficiencies in CHD must be investigated so that this child population can receive comprehensive nutritional supplementation.

Conclusion

The prevalence of underweight, stunted, and wasted among children with acyanotic and cyanotic

CHD were high. Proportion of underweight and wasted were significantly higher in acyanotic CHD, while stunted was significantly higher in cyanotic CHD.

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