

Anthropometric Profile of Children with Cyanotic and Noncyanotic Congenital Heart Disease

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ANTHROPOMETRIC PROFILE OF CHILDREN WITH CYANOTIC AND NONCYANOTIC CONGENITAL HEART DISEASE

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ABSTRACT

10 Impaired nutritional status is a frequent complication of congenital heart disease (CHD). Non cyanotic congenital heart disease (NC-CHD) have problem with lung overflow and heart failure. Consequences of Cyanotic congenital heart disease (C-CHD) are decrease pulmonary blood flow and prolong hypoxia. These conditions can have effect on nutritional status and outcome of surgery. This study aimed to compare anthropometric profiles of children with C-CHD and NC-CHD. Cross-sectional study conducted in 66 children, age 3 months until 5 years old who met inclusion criteria in Pediatric Cardiology Outpatient Unit Dr. Soetomo Hospital Surabaya in November 2012. A total of 66 children, consisted of 26 children with C-CHD and 40 children NC-CHD included in study. We measure weight, length/height, head circumference, upper arm circumference, and skin fold thickness. We used Chi Square test for statistical analysis with Confidence Interval 95%. Mean age of both groups was 27.82 ± 16.63 months. Majority of NC-CHD was Ventricular Septal Defect (28.6%) and C-CHD was Tetralogy of Fallot (21.4%). There were no significant difference from weight for age, length for age weight for length, head circumference for age, mid upper arm circumference for age, mid upper arm circumference for age, and skin fold thickness for age between children with C-CHD and NC-CHD ($p=0.80; 0.98; 0.54; 0.29; 0.80; 0.53$ respectively). There were no difference in anthropometric profiles among children with cyanotic congenital heart disease and non-cyanotic congenital heart disease in this study.

Keywords: anthropometric, children, non-cyanotic, cyanotic, congenital heart disease

INTRODUCTION

Impaired nutritional status is a complication that often occurred in children with congenital heart disease (CHD) (Kumar & Tynan 2005). Malnutrition is very common in children with CHD and is predicted by presence of congestive heart failure, older age at correction and lower growth potential. Heart surgery in children in developing countries is often delayed as a result of limited economic, tools and human resources. While long time waiting for surgery, complications arise. (Kumar & Tynan 2005). These conditions cause high incidence of nutritional status impairment (Vaidyanathan et al., 2002). Contrary corrective intervention significantly improves nutritional status on short term follow-up (Vaidyanathan et al., 2008). Prevalence of underweight in non-cyanotic CHD was greater than in cyanotic CHD (83,16% vs 72%). Prevalence of stunting in non-cyanotic CHD was greater than in cyanotic CHD (60,39% vs 48%) (Rubia et al., 2018).

Children with congenital heart disease are at increased risk for poor growth. Several factors

may play a role in poor growth including feeding difficulties, increased caloric requirements, and the effects of cardiac lesion on growth regulation. Children with CHD experience early simultaneous decreases in growth trajectory across weight, length, and head circumference. The simultaneous decrease suggests a role for altered growth regulation in children with CHD (Daymont et al., 2013). Children with CHD develop severe undernutrition and growth failure. The significant contributing factors are mean age at presentation and age appropriate dietary adequacy. However pulmonary hypertension appear to be the most important factor, and cyanotic patients with pulmonary hypertension are the most severely affected (Arodiwe et al., 2015).

Malnutrition is a very common problem in children with symptomatic CHD and predicted by the presence of low hemoglobin level, low arterial oxygen saturation, heart failure, poor dietary history, and pulmonary hypertension (Hassan et al., 2015). The purpose of this study is to analyze the difference anthropometric profile in children

with cyanotic and non cyanotic congenital heart disease.

METHODS

Study Design

A cross-sectional study was conducted in 66 children with C-CHD and NC-CHD in the Outpatient Clinic of Division of Cardiology Child Health Department, Dr. Soetomo Hospital, Surabaya in November 2012. Sample size was calculated. Subject were collected by consecutive sampling. Diagnosis of C-CHD and NC-CHD were based on clinical condition and echocardiography examinations. Subjects were aged 3 months until 5 years old who met inclusion and exclusion criteria.

Inclusion and Exclusion Criteria

Inclusion criteria were patients with cyanotic and non-cyanotic CHD with moderate and severe lesion, aged 3 months to 5 years old, never did operation before and parents or guardian signed inform consent. Patients with another congenital syndrome (Down syndrome, turner syndrome and other trisomy), chronic disease (TB, malabsorption), and neurological abnormalities (cerebral palsy, hydrocephalus) were excluded.

Variable Measurement

Body weight were measured using digital scale. Baby body length was measured with baby lay down and stretch measuring tape from top of the head to bottom of the heel. Children body height was measured with stand back to the wall in an upright position, barefoot, hands hanging freely, and eyes looking straight ahead. The measurement results were in centimeter. Weight and length/height subjects were measured during outpatient clinic time. Measuring the head circumference by placing a tape measurement around the head through glabella on the forehead and the back of the head (occipital protuberantia). The tape was in a tight state. The measurement results were expressed in centimeters. Head circumference measurements was to know reduction in head dimensions in children performed who are

suffering from CHD indicates the reduction in growth of brain (Safikhani et.al., 2007).

Measurement of skin fold thickness (SFT) using skinfold caliper. Measurement were made by pinching the skin apart from the muscles and then the skin folds were measured by caliper. The measurement results were expressed in millimeters. Z-scores (standard deviation scores) is the best system for analysis and presentation of anthropometric data. In this database, weight-for-height, height-for-age, and weight-for-age are interpreted by using the Z-score classification system. Z score between -2SD to +2SD classified as normal nutrition, Z-score <-2SD= low W/A=low H/A=low W/H classified as moderate to severe undernutrition. Weight-for-height Z-score <-3SD classified as severe undernutrition dan >+2SD classified as overweight (WHO 2006).

Statistical Analysis

Statistical analysis used was descriptive methods with calculating mean, standard deviation, and analytic methods Chi square test for the difference between the 2 groups.

Ethical Clearance

Ethical clearance was issued by the ethics committee of health research, Dr. Soetomo Hospital, Surabaya, Indonesia (No. 1829/105/XI/2019.)

RESULTS AND DISCUSSION

A total of 66 children, consisted of 26 children with C-CHD and 40 NC-CHD. The characteristic of the groups were not significantly different. The mean age of both groups was 27.82 ± 16.63 months old. There was no difference in sex distribution intra and inter group. Male and female ratio in C-CHD and NC-CHD were 50%:50% and 47.5%:52.5% respectively. There were a small number of the subject with history of low birth CHD. The subjects with the history of born with prematurity only found in NC-CHD group (12.5%). Majority of family income were moderate to very high, C-CHD 69.2%, and NC-CHD 70%. There was no significant difference in family income between 2 groups. Pulmonary hypertension found

Table 1. The Characteristics of Subject

Variable	C-CHD	NC-CHD(%)	p
Sex			
Male	13 (50.0)	19 (47.5)	1.00
Female	13 (50.0)	21 (52.5)	
Birth weight			
< 2500 g	1 (3.8)	3 (7.5)	0.48
2500-4000 g	25 (96.2)	37 (92.5)	
>4000 g	0 (0.0)	0 (0.0)	
Prematurity			
Yes	0 (0.0)	5 (12.5)	0.14
No	26 (100.0)	35 (87.5)	
Family income			
Low income	8 (30.8)	12 (30.0)	1.00
Moderate-high	18 (69.2)	28 (70.0)	
Pulmonary hypertension			
Yes	1 (3.8)	2 (5.0)	1.00
No	25 (6.2)	38 (95.0)	

Table 2. The Diagnosis of Congenital Heart

Disease	Diagnosis	n (%)
Cyanotic		
	Single ventricle	2 (2.8)
	Double outlet left ventricle	1 (1.4)
	Double outlet right ventricle	2 (2.8)
	Critical pulmonary stenosis	1 (1.4)
	Supracardiac TAPVD	1 (1.4)
	Tricuspid atresia	1 (1.4)
	Tetralogy of Fallot	15 (21.4)
Non cyanotic		
	Atrial septal defect	13 (14.3)
	Patent ductus arteriosus	9 (11.4)
	Ventricular septal defect	21 (28.6)

Note: TAPVD=Total Anomalous Pulmonary Veins drainage

only 3.8% in C-CHD group and 5% in NC-CHD group.

Tetralogy of Fallot was the predominant in C-CHD group (21,4%) while VSD was the predominant in NC-CHD group (28,6%) as seen in table 2. Nutritional status of the subjects between groups were described in Table 3. The characteristic of subjects in this study were comparable between C-CHD and NC-CHD. This study found most subjects were age 27 months, similar to the study conducted in Jakarta with most subjects in the age range from 0.49 to 24 months, likewise a study conducted in Turkey

Table 3. Nutritional status of C-CHD and NC-CHD

Variable	n (%)	n (%)	p
Weight-for-Age (W/A)			
Severe under-nutrition	11(42.3)	17(42.5)	0.80
Moderate-severe undernutrition	9(34.6)	10(25.)	
Normal	6(23.1)	12(30.0)	
Overweight	0(0.0)	1(2.5)	
Length-for-Age (L/A)			
Severe stunting	7(26.9)	14(35.0)	0.98
Stunting	7(26.9)	7(17.5)	
Normal	12(46.2)	19(38.0)	
Weight-for-Length (W/L)			
Severe under-nutrition	11(42.3)	9(22.5)	0.54
Moderate-severe undernutrition	2(7.7)	13(32.5)	
Normal	12(46.2)	17(42.5)	
Overwright	1(3.8)	1(2.5)	
Head Circumference-for-Age (HC/A)			
Microcephaly	8(30.7)	20(50.0)	0.29
Normocephaly	18(69.2)	20(50.0)	
Mid Upper Arm Circumference-for-Age (MUAC/A)			
Severe under-nutrition	8(30.8)	11(27.5)	0.80
Moderate-severe undernutrition	7(26.9)	13(32.5)	
Normal	11(42.3)	16(40.0)	
Overweight	0(0.0)	0(0.0)	
Skinfold Thickness-for-Age (SFT/A)			
Severe under-nutrition	4(15.4)	2(5.0)	0.53
Moderate-severe undernutrition	2(7.7)	5(12.5)	
Normal	20(76.9)	33(80.0)	
Overweight	0(0.0)	0(0.0)	

(Sjarif *et al.*, 2011; Arodiwe *et al.*, 2015). Age is an important factor for CHD natural history that would affect the progression of complications of CHD. There were no significant difference in sex distribution, history of birth weight, history of prematurity, family income and the presence of pulmonary hypertension. Study in Thailand found no significant difference sex distribution in C-CHD and NC-CHD with malnutrition (Ratanachu, 2011). Choudhury (2018) in Bangladesh also found no significant difference in sex distribution children with cyanotic and acyanotic CHD. Low birth weight and prematurity are the important risk factors for the occurrence of nutritional disorder (Arodiwe *et al.*, 2015). Malnutrition in children

23 is one of the global health problems, most in poor family. Low family income or poverty is the important factor responsible for poor health and nutritional status (Arora *et al.*, 2014). Most of the patients of cyanotic and acyanotic CHD in Bangladesh belonged to middle class socioeconomic status, and no significant difference between the groups (Choudhury, 2018). The presence of pulmonary hypertension is the important factor to malnutrition and growth failure in children with CHD. Pulmonary hypertension had impact on growth and nutrition, both in cyanotic and acyanotic CHD. Patients with cyanotic and pulmonary hypertension were more affected than patients with acyanotic and pulmonary hypertension (Arodiwe, 2015). Cyanotic patients without pulmonary hypertension and acyanotic patients with pulmonary hypertension had significantly lower weight, height, and head circumference compared to CHD children. Compared to acyanotic patient without pulmonary hypertension, weight and head circumference in acyanotic patients with pulmonary hypertension were significantly lower (Noori *et al.*, 2017).

Tetralogy of Fallot was the predominant in C-CHD group (21.4%) while VSD was the predominant in NC-CHD group (28.6%). The same result with our study, the common type of C-CHD and NC-CHD in Bangladesh were Tetralogy of Fallot (63.3%) and VSD (53.3%) respectively but the prevalence were higher (Choudhury, 2018). This showed that there was differences in distribution of the kind of CHD between countries.

Undernutrition is common in children with CHD. We found C-CHD (42.3%) and NC-CHD (42.5%) with severe undernutrition. C-CHD (34.6%) and NC-CHD (25%) with moderate to severe undernutrition while overweight found only in 1.5% subjects. The prevalence were higher if compared to result of study by Ratanachu (2011) in Thailand. Which found 53% malnutrition, consist of 3% overweight, 28% under nutrition, 22% wasting and 16% with stunting condition, in children with CHD. In our study we found more children with CHD suffered from undernutrition. Many factors can cause the nutritional disorder in children with CHD. Hemodynamic factors, low growth potential as low birth weight, small

gestational age, lower parental anthropometric, and accompanied by other congenital abnormalities are the important predictor for the occurrence of nutritional disorders (Arodiwe *et al.*, 2015). Other risk factors are prematurity and genetic abnormalities or disorders beyond the heart may affect energy intake, gastrointestinal absorption, energy expenditure, and growth expectations are affected by genetic condition like Turner's or Down syndrome (Nydegger and Bines, 2006). Infant with complex CHD suffered from failure to grow is well documented include presence of associated chromosomal abnormalities, cyanosis, and cardiac failure adds to the complexity and challenge. The etiology of malnutrition etiology can be grouped into: inadequate intake, inefficient absorption and utilization, and/or increased energy needs (Rodica 2013). The difference growth disorders in patients with CHD compared with healthy children can be attributed to differences in the factors, including gender, age, cardiac abnormalities, simultaneous multiple congenital heart defects, and congestive heart failure (Noori *et al.*, 2017). Study in Iran have found that cytokines have a strong effect on feeding, growth, weight, and energy intake in patients with CHD (Noori *et al.*, 2016).

Anthropometric Z-score profiles both in C-CHD and NC-CHD in this study statistically found no significant differences in the impairment of nutritional status. This is influenced by various factors, including hemodynamic disturbances associated with cardiac physiological and degree of severity of the disease, inadequate food intake, malabsorption gastrointestinal, neurological disorders, increased energy expenditure, coupled with fluid loss as much as 10-15% compared with normal children because of circumstances tachypneu, less fluid, intake and the use of diuretics. C-CHD makes hypoxic hypoxia condition that lead to anorexia with concomitant decrease in body weight (De Onis *et al.*, 2009). This result come from both congestive heart failure and lack of oxygen. Heart failure, fluid and sodium overload, and cardiac haemodynamics disturb in NC-CHD lead to worsening heart failure and decreased intake and make inadequate individual overall nutrient intake. Anorexia will accompany with malnutrition and endangers the condition.

Dyspnea and tachypnea cause a tendency towards faster fatigue and decreasing intake. Growth is affected by chronic hypoxia.

Stunting found in 53,0% in both group. Stunting found more in NC-CHD than in C-CHD (31,8% vs 21,2%). A study found 66,67% children suffered from stunting in C-CHD children and 62,68% with stunting in NC-CHD children and there were no difference between groups (Harikrishnan & Handrasekharan, 2009). The exact cause of stunting in C-CHD children is not well explained yet. This may be cause by chronic cyanosis cause chronic malnutrition. Chronic hypoxia in CHD provide direct and indirect effects on reduced serum hormone **Insulin like growth factor I (IGF-I)** cause impaired of bone center and eventually impaired nutritional status and stunted growth. Delays bone growth will lead to below normal body length. Children with CHD have a body length under normal than their age.

Microcephaly found more in NC-CHD than in C-CHD children (50% vs 30.7%) but statistically no significant difference between groups. Children with CHD will experience widespread neurodevelopmental disorders. Microstructural brain abnormalities and metabolic disorders occur after birth due to insufficient of oxygen and delivery of essential substances in the brain. Abnormal brain growth is more common in infants with C-CHD compared with NC-CHD. In C-CHD, 30-40% of systemic blood back to the left heart without flowing into pulmonary circulation, causing systemic oxygen decline that eventually affects all organs including the brain. A reduction in systemic blood flow and brain blood flow cause abnormal growth of the brain (Raheem & Mohamed, 2012).

Nutritional status measurement based on circumference of upper arm found in C-CHD children were very thin and not significantly different with NC-CHD children. Nutritional status measurement based on skin fold thickness increased in line with increased **high-calorie intake or low-energy expenditure. Evaluation of nutritional status by skin fold thickness in children from a population with a low fat content would not sensitive.** Decrease in muscle mass can be seen in levels of creatinine and limb muscle mass measurement than using weight (White

et al., 2005). Measurement of muscle mass is a compensatory mechanism for the provision of amino acid gluconeogenesis and protein synthesis in liver.

Limitation of this study were this study have not included children without CHD which match age and sex as control subjects, and no laboratory examination to support this study.

CONCLUSION

Conclusion of this study was antropometric profiles of children with cyanotic congenital heart disease were statistically no significant difference with non cyanotic congenital heart disease.

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6
