ORIGINAL ARTICLE

FACTORS AFFECTING PHYSICAL GROWTH AMONGST CHILDREN WITH CONGENITAL HEART DISEASE: A CASE-CONTROL STUDY IN A TERTIARY CARDIAC CARE CENTER IN ETHIOPIA

[1] Addis Ababa University, Department of Pediatrics and Child Health
Corresponding author: Tamirat Moges aklilutamirat09@gmail.com
[2] Addis Ababa University, Department of Pediatrics and Child Health
[3] Federal Ministry of health of Ethiopia

Tamirat Moges [1], Etsegenet Gedlu[2] , Tilahun Teka[3]

ABSTRACT

Introduction : *Children of sub-Saharan African (SSA) born with congenital heart disease (CHD) in whom corrective surgery is not done may suffer poor physical growth either due to the prevalent under nutrition in the region or the effect of their cardiac disease .The current study aimed to see factors of poor physical growth among these group.*

Objective : *to determine factors of poor growth among children with un-corrected congenital heart disease.*

Materials and methods **:** *this is a case-control study conducted in a tertiary pediatric cardiac care center in Addis Ababa. -. The study subjects were CHD cases with affected growth parameters while the controls were : CHD cases with normal growth parameter. Data were analyzed using SPSS and WHO ANTHRO software.*

Results **:** *The median age was 42 months. Stunting, underweight and wasting occurred in 52%, 79% and 62% respectively. Odds of exposure to low socioeconomic class, congestive heart failure, pulmonary hypertension, recurrent chest infection, cyanosis, were significantly higher in cases than in controls with p-value < .004,<.001, <.000, < .006,and <.025 respectively. When regression analysis were made on binary logistic model, only congestive heart failure (<.04), recurrent chest infection (<.04) and low socioeconomic class (< 0.01) remain significantly associated.*

Conclusion and recommendation: *hemodynamic factors of un-corrected cardiac disease and being low socioeconomic class remain factors of poor physical growth in children with congenital heart disease-: Circumventing severe growth failure in children with CHD is a call for urgent action. Key words:-, congenital heart disease, Growth Failure, Congestive heart Failure, pulmonary hypertension, physical growth*

INTRODUCTION

Congenial heart disease is a structural abnormality of the heart a child may be born with. Infants and children with Congenital Heart Disease (CHD), appear to have increased prevalence of malnutrition and growth failure. The cause of growth retardation in CHD is multifactorial; however, inadequate caloric intake is reported to be the most important cause of growth failure (1,2).

Patients with congenital heart disease may have increased mortality postoperatively in relation to infection and malnutrition when hypo-albuminemia and impaired cell-mediated immunity increases rates of clinical infection (3,4,5). In patients with congenital heart disease, malnutrition affects also emotional and behavioral responses, leading to apathy, which impairs functional recovery and further leads to anorexia. The cost to health care is also increased because of prolonged intensive care unit and hospital stays (6).

The pattern of malnutrition in CHD varies as reported by different authors. Bashir reported that stunting was proportionately higher in acyanotic CHD cases than in cyanotic once, while wasting was predominantly reported in the latter. Diametrically, Meherizi and Drash from Turkey reported that wasting is more common in acyanotic CHD (7,8,2,9).

Approach to patients with CHD-related malnutrition, were suggested by many. Balu et al recommended that irrespective of severity of CHD-related malnutrition, direct corrective intervention of cases as early as possible (10). On the other hand reports from the developed countries recommend prior intensive preoperative nutritional supplementation in order to optimize good operative outcome (11). By the same token, B.Varan indicated that delay in surgical repair of congenital heart lesions may produce worsening of malnutrition proportionately to the delay in intervention (12).

Incidence of CHD-related malnutrition varies in different countries and ranges from 27%- to 90.4% (7). In Ethiopia the prevalence of poor physical growth and factors that determine poor physical growth in children with congenital heart disease has not yet been reported.

The objective of our study is to determine factors of poor physical growth among infants and children with un operated congenital heart disease.

MATERIALS AND METHODS

STUDY DESIGN: This was a case-control study, comparing Paediatric patients with and without poor physical growth with in a population of children having symptomatic congenital heart disease in the year November 2014 to March 2015.

Setting: The study was conducted within the department of paediatrics congenital paediatric cardiac clinic of TikurAnbessa Hospital in Addis Ababa. The clinic gives service five days per week, and provides care to 1500-2500 cases of CHD annually.

Study subjects: Cases and controls were selected from the population of CHD patients aged from 1 month to 14 years, who were under follow up in the clinic. Sample size was calculated based on the standard formula for case-control study. In order to calculate the proportion of cases exposed we used prevalence of stunting in hospital visiting children as proportion of controls exposed. After getting the proportion of controls and cases exposed, we calculated sample size to be 293, (146 cases and 147 controls).

Cases were selected from consecutive follow up list only if they fulfill the inclusion criteria. For each case, age and sex matched controls were selected from consecutive follow up cases of CHD based on the inclusion criteria for controls.

Sample size calculation is done by the sample size calculation method for case-control study based on the standard recommendation (13).

> According to a national nutritional survey in underfive children in Ethiopia, the prevalence of stunting is stated to be 44 % (10). Another hospital data among hospitalized malnourished children done at Zewditu Memorial Hospital showed that stunting occurred in 69% of hospitalized malnourished children ((14). Both data may not be representative of stunting in hospital visiting children, the first represents data in the general population, the second represents data of severely malnourished cases. So we opted to use the average of the national and the hospital data.

Inclusion criteria for cases: congenital heart disease cases with growth affection where a weight-for-age or a height-for-age parameter falls < 5^{th} percentile on the WHO/CDC growth curves.

Inclusion criteria for Controls: CHD cases with un-affected growth parameter, age and sex matched congenital heart disease) where weight-for-age and height-for-age falls >15th percentile on the WHO/CDC growth curves.

Exclusion criteria: Infants with a history of prematurity, known genetic malformations, dysmorphic features and neurologic disability, catheter or surgically palliated cases,

HIV infection, active tuberculosis, syndromic anomalies, chronic illnesses other than CHD associated with visible/demonstrable oedema, and any serious on going acute illness requiring hospitalization were excluded.

Data were collected using questionnaires forms which were developed using survey monkey tool for congenital heart disease (15). They were modified to fit the desired purpose. Each questionnaire was appropriately pretested to determine appropriate information. Nurses with advanced diploma and BSC degree were trained on how to fill questionnaire forms and how to appropriately measure anthropometric data. Detail history of cardiac illnesses, information on socio-demographic profile, nutritional history, family history of cardiac and other illness were inquired. Questionnaires on soscio-economic class were constructed on the basis of Kappuwamys recommendation for urban population after modification to suite our own condition (16). The socioeconomic status was classified in to upper (16-25), Middle (upper middle (11-15), and lower middle (5-10) Lower class (<5). Socioeconomic status Scales are based on three major Social variables (parental education, parental occupation and Family income) each of these variables again were re- categorized in to 7 grades.

Each of these 7 grades was given a score. The total scores from each major social variable were added up to give the final grade which determines the socio-economic status (16, 17). Adequacy of breast feeding was assessed based on the integrated management of newborn and child illness (IMNCI) feeding guideline (18). Data collectors feel the nutritional assessment checklist. Finally the pediatrician decides weather nutritional history is adequate or not. Data were entered into SPSS Version 20 New york USA soft ware, (19) and were validated by manual proof reading. The data were described using simple summary statistics. Standardized Z score values of anthropometric measurements were generated using the WHO ANTHRO version 1.01 software package. Binary logistic regression analysis model was used to test associations of independent variables (patient characteristics) with the presence or absence of growth failure, as outcome variable. Odds ratios with their corresponding 95% confidence intervals (CI) were calculated. Results were considered statistically significant when p value < 0.05.

Operational definition: Stunting, wasting and underweight is defined as WHO z-score for Height for age (HAZ) weight for age (WAZ), weight for height (WHZ). Moderate malnutrition is defined when Z-score value falls < -2SD from the mean re-

Inadequate nutritional history is defined as any one or more inappropriate feeding practice present for that particular age as listed on the assessment form. Ethics approval:The study was approved by the Institutional Review Board (IRB) of College of Health Sciences of Addis Ababa University. Before data collection, parents of patients were given consent form to give their willingness of participation in the study. Patients above the age of 7 year were also asked for assent.

Results

Two hundred ninety three cases were enrolled. Cases were congenital heart disease patients with growth affection where a weight-for-age or a height-for-age parameter falls < 5^{th} percentile on the WHO/CDC growth curves. Controls are CHD cases with un-affected growth parameter, age and sex matched congenital heart disease where weight-for-age and height-for-age falls >15^{th} percentile on the WHO/CDC growth curves.

Age ranged from 1month to 170 months with median age of 42 months (IQR 17-84 months). Female sex accounted for 53%. Sixty-Seven percent of the cases were under five years of age. Fifty one percent of cases were from Addis Ababa. Sixty-seven percent of study subjects came from lower socioeconomic class. Figure 1 showed the age distribution of study subjects, displaying a

skewed curve towards younger age groups. The pattern of the prevalence of wasting, underweight and stunting in the cases is displayed in Figure 2 thus severe form of wasting, underweight and stunting accounted for 21, 41 and 29 cases respectively while moderate wasting, underweight and stunting accounted for 70, 75 and 48 of the cases respectively. Figure 3 showed the relative frequency of congenital heart diseases in all study subjects thus the commonest acyanotic CHD were VSD followed by PDA and ASD respectively.

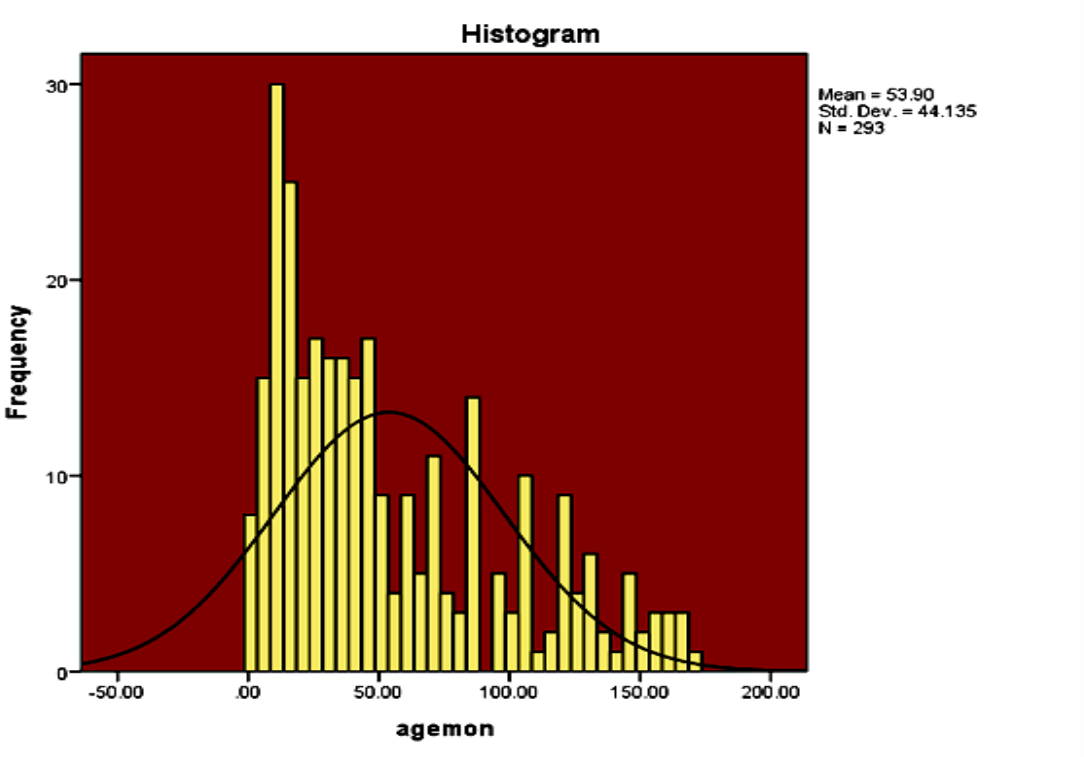

Figure 1-the age distribution of study subjects, displaying a skewed curve towards younger age groups. Poor physical growth in children with congenital heart disease at Tikur Anbessa Specialized Hospital 2017.

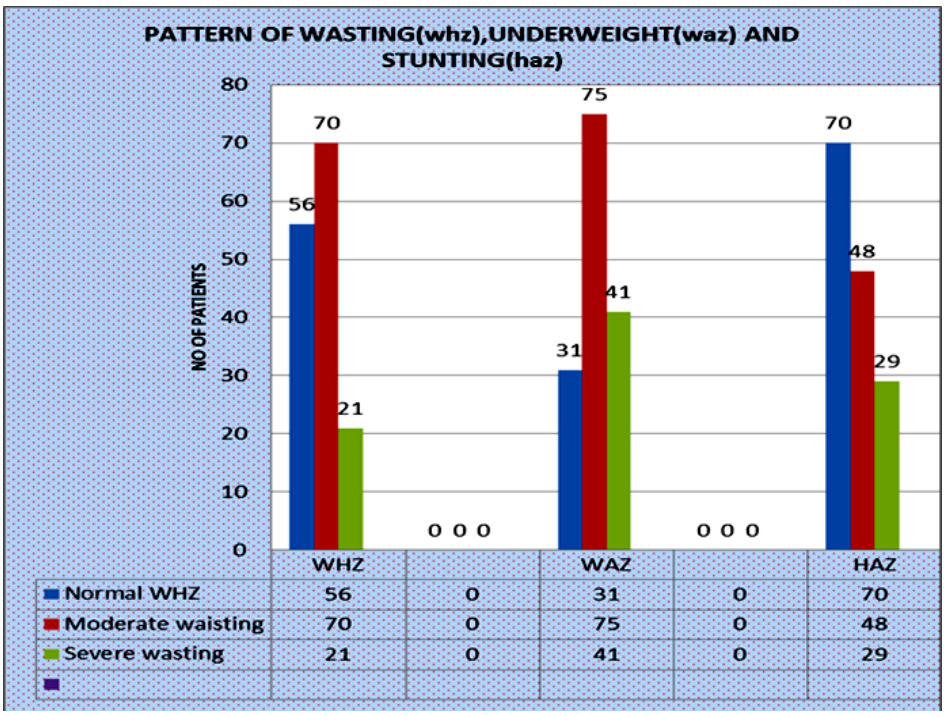

Figure 2-The pattern of the prevalence of wasting, underweight and stunting in the cases.poor physical growth in children with Congenital heart disease at Tikur Anbessa Specialized Hospital 2017

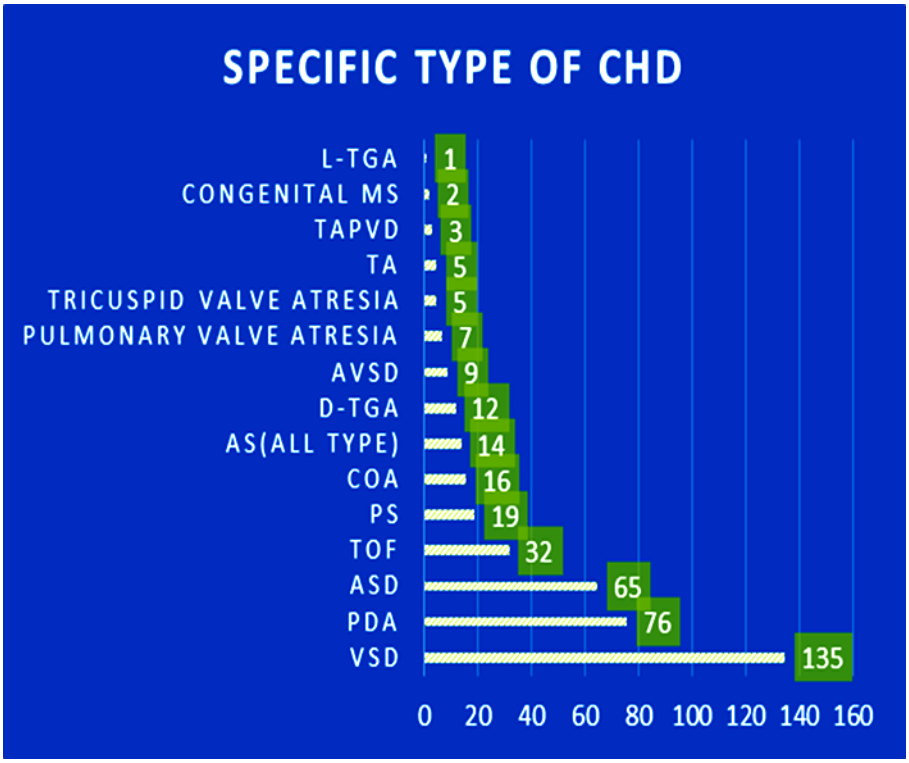

Figure 3 - Pattern of congenital heart disease in all study subjects, Tikur Anbessa specialized hospital 2017.

Table 1: Showed the relation-ship between exposure and outcome factors. Accordingly congestive heart failure, pulmonary hypertension, recurrent chest infections, cyanosis, poor feeding practice and low socioeconomic class appeared to be significant risk factors for development of poor physical growth (P <. 0018, P<. 000 , P<. 006 ,P<. 025 , P<. 004 , P<.004 respectively. The commonest cyanotic CHD were Tetralogy of Fallot followed by D-transposition of the great arteries (D-TGA).

Table 1-Association between exposure and an outcome factor, poor physical growth in children with congenital heart disease at TikurAnbessa specialized hospital 2017.

Exposure factor		**Cases**	**Controls**	**Odds ratio with 95% CI**	**P-value**
Congestive heart failure	yes	25	8	3.765 (95% CI- 1.639-8.648)	<. 0018
	no	122	147		
Pulmonary hypertension	yes	46	30	3.143 (95% CI- 1.872-5.275)	<. 000
	no	101	207		
Recurrent chest infections	yes	90	66	1.913 (95% CI-1.202-3.047)	<. 006
	no	57	80		
Cyanosis	yes	45	28	1.859 (95% CI-1.082-3.194)	<. 025
	no	102	118		
Feeding practice	adequate	96	72	1.973 (95% CI- 1.232-3.161)	<. 004
	Inadequate	50	74		
Low socioeconomic class	yes	111	87	2.091 (95% CI-1.267-3,449)	<.004
	no	36	59		

Congestive heart Failure is defined in the presence of tachypnea, tachycardia, tender hepatomegaly and cardiomegaly.(SI. 1996) Pulmonary hypertension is defined when trans tricuspid pressure gradient (VTR) is > 3.4m/s plus Mean RAP and/or PASP >50mmHg on Doppler echocardiography (Susanna Sciomer 2005, Echocardiography 2014). Recurrent chest infection was defined when more than two episodes of pneumonia diagnosis was made in one year or three episode in any time frame.

DISCUSSION

The present study showed that low socioeconomic class, congestive heart failure, pulmonary hypertension, recurrent chest infection, and cyanosis affect growth status significantly. Unlike previous studies on the topic, this study showed socioeconomic status to be strong predictor of poor physical growth in addition to the well known hemodynamic factors.

Most other studies compared children with CHD to healthy controls to compare prevalence of malnutrition (12). Still others compared pre- versus post-surgical intervention prevalence of malnutrition. The current study may represent the situation in the general population in view of the fact that study subjects came from all corners of the country. Although we have not used paired matching, study subjects were controlled for underlying cardiac disease, by age and sex matching.

The current study shared many similar findings in common with the previous reports. For example B. varan reported that Pulmonary hypertension appears to be most important factor, and cyanotic patients with pulmonary hypertension are the once most severely affected. We demonstrated the significance of cyanosis and pulmonary hypertension in the current report too. Shrivastava similarly reported that cyanosis is important determinant factor of growth failure in children with CHD (12, 21).

The current study differs in some of the findings with others, for example Christy AN Okromah from Nigeria reported Wasting to be more common in acyanotic CHD, while stunting in cyanotic CHD cases. Mohamed D also reported that wasting is affected more in acyanotic CHD (17,22) On the other hand IM Mitchell reported that children with congenital heart disease are frequently undernourished, irrespective of the nature of cardiac defect or presence or absence of cyanosis (23).

Cameron et al reported that left sided heart obstruction makes infants with CHD at high risk of malnutrition. We have not seen significant difference in growth due to left side heart obstruction. Mohamed Dallil from Iran reported lower weight in female sex and in those with cyanosis. We have not seen this effect in the current study may be because we have matched study participants for gender effect (17). It was reported that patients with acyanotic congenital heart disease, especially large left to-right shunts and pulmonary hypertension cases, had a greater growth deficit in weight, and those with cyanotic heart disease had a greater growth deficit in stature as demonstrated by both decreased height and weight (24).

In the current study the mean age of study subjects at diagnosis is 42 months. This is in contrast to most reports where mean age was less than 24 months. This implies that case are diagnosed so late in our setting (7, 12, 25,26,27).

Congestive heart failure (CHF) has been described as predictor of malnutrition by various investigators. The prevalence of CHF in the current review is significant. The whole mark of CHF is low cardiac out put which is necessary for various body functions. In children with heart failure there is increased energy expenditure because of increased respiratory work and increased cardiac activity. In the face of low cardiac output such increased energy expenditure results in compensatory catabolic state. In addition patients with CHF have generally reduced appetite, poor oral intake, and poor intestinal absorption. In poor communities like ours where intake of fat and energy food is not optimal, the problem of poor oral intake made things worse.

Nearly a quarter of cases had pulmonary hypertension in the current study. The mechanism how pulmonary hypertension cause malnutrition is not yet established. However the reduced pulmonary blood flow especially in severe pulmonary hypertension significantly reduce the diastolic filling in the left side of the heart resulting in low cardiac output. The concomitant presence of hypoxia in severe pulmonary hypertension and subsequent release of hypoxia induced cytokines may reducing appetite and decrease in oral intake (28).

Low socio-economic status, significantly affected growth status in the current study. It was reported in one study, that the nutritional status of children from lower socio economic class was poor as compared to their counter parts in upper socio economic class (4). Infants born to low social class are less privileged to get food rich in fat and high protein. Minerals and vitamins are essential for maintaining the immune status of a child together with positive nitrogen balance. In low income families getting high protein diet as well as vegetables and mineral is not considered a priority. Poor parents give their children diluted, energy poor diet, often with out protein. Such infants are not only suffering from inadequate calories but also are prone to recurrent infections owing to hypo-albuminmia and other immunoglobulin's. Living in crowded and unhygienic environment, which is common in low socioeconomic families, contributes to frequent and severe infection. Thus in low socioeconomic families management of a child's feeding with-congenital heart disease is difficult. In the present study, recurrent chest infection occurred in fifty-three percent of subjects and was significantly associated with poor physical growth. It was suggested that in large left to right shunting of blood, via a septal defect or the arterial duct, there is pulmonary over-circulation and pulmonary edema. The pulmonary edema often becomes a nidus of infection for the lower respiratory tract (29).

CHD-cases with frequent chest infections are often anorexic, in increased metabolic rate. They are in catabolic state in order to generate energy for an increased energy requirement in state of cardiac failure. In the absence of supplementary feeding with high caloric diet or fat, they run in to severe

growth failure fast. Reports showed that different serum proteins level, have been low in cases of CHD with growth failure (30). However we have not looked for such data in the current study.

As limitation of this review we noticed that study subjects were not selected on random bases Instead, we took consecutive subjects during their routine follow up visit. Confounding factors like un-matching of cases by severity and by specific type of lesions might affect the quality of the study. As a case control study, it is also prone to recall bias.

Conclusion:- factors affecting physical growth among children with congenital heart diseases in our setting were not limited to hemodynamic factors such as CHF, PHT, Recurrent chest infection or cyanosis but also includes the level of low socio-economic class where adequate food consumption is not secured and infection rate is high.

Conflict of interest: The authors have no conflict of interest

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REFERENCE

1. Martin H. Lees, Richard W.Olmsted. Relative hypermetabolism in infants with congenital Heart disease and undernutrition. Pediatrics 1965; 36(2):183-91.
2. Salzer HR HF WM, Heil M, Schilling R. "Growth and nutritional intake of infants with congenital heart disease. Pediatr Cardiol 1989; 10:17 – 23.
3. Barker GM OBS, Welke KF, Jacobs ML, et al. Major infection after pediatric cardiac surgery: a risk estimation model. Ann Thorac Surg 2010; 89(3) 843-50.
4. ME S. Recalling a 63-year nutrition odyssey. Nutrition 2000: 16582- 5.
5. LEE KB. Pediatric Cardiac Surgery in Developing Countries of Africa: Current State and Future Direction.The University of Texas Southwestern Medical Center International Medical Exchange Program 2012-2013.
6. Simon P Allison MFc. Malnutrition, disease, and outcome. Nutrition July–August, 2000 Volume 16,(7-8):590–3.
7. Hassan BA, Ehab A. Albanna, Saed M. Morsy, et al. Nutritional status in children with unoperated congenital heart disease: an Egyptian center experience. Frontiers in Pediatrics 2015:3 (53).

8. MEHRIZI A DA. Growth disturbance in congenital heart disease. J Pediatr 1962; 61:418 – 29. Pubmed Central PMCID: PMID: 14472142
9. Cameron JW, Rosathal A., Olson A. D. Malnutrition in hospitalized children with congenitai heart disease. Archives of Pediatrics & Adolescent Medicine 1995.149
10. Balu vaidyanathanSbn, Kr sundaram,Uma k babu, et al. Malnutrition in Children with Congenital Heart Disease (CHD): Determinants and Short-term Impact of Corrective Intervention. Indian pediatrics 2008; 45.
11. Nutrition and Congenital Heart Disease.Childrens Health care of Atlanta.2015. Available from: from http://www.choa.org/~/media/CHOA/Documents/Services/Cardiac/Kids-at-Heart/CHD%20powerpoint.pdf.
12. Birgul Varan KT, Gonca Yilmaz. Malnutrition and growth failure in cyanotic andacyanotic congenital heart disease with and without pulmonary hypertension. Arch Dis Child 1999; 81:41-51.
13. Jaykaran Charan, Tamoghana Biswas. How to calculate sample size for different study designs in medical research? Indian Journal Psychol Med. 2013; 35(2):121-126 doi: 10.4103/0253-7176.116232
14. Moges T,HyderJ. Severely malnourished children admitted to Zewditu memorial hospital, a three year retrospective analysis East Afr J Public Health 2009 Aug; 6(2):162-7.
15. Loughan AR. Questionair survey in congenital heart disease. 2000. Available from: www.survaymonkeyCHD.com.
16. Mohan Bairwa MR, SandeepSachdeva. Modified Kuppuswamy's Socioeconomic Scale: Social Researcher Should Include Updated Income Criteria. Indian J Community Med 2013; 38 (3):185–6.
17. Mohammad Dalili SMM, Paridokht Davari, Mohammad Yousef Aarabi Moghaddam, A. V. Hooman Bakhshandeh Abkenar, and Akbar Shahmohammadi. Growth Status of Iranian Children with Hemodynamically Important Congenital Heart Disease.ActaMedicaIranica 2011; 49(2):103-8.
18. FMOHE/WHO/UNICF/USAID. IMCI integrategrated management of childhood illness.Atlanta Georgia WHO. 2005.
19. Armonk NIC. IBM SPSS Statistics for Windows, Version 20.0.IBM Corp. Released 2011.; Available from: http://www-01.ibm.com/support/docview.wss?uid=swg21476197.
20. Physical Status: The Use and Interpretation of Anthropometry. WHO Technical Report Series 1995.
21. Shrivastava S. Malnutrition in Congenital Heart Disease. Indian pediatrics 2008;45(7):535-6.

22. Okoromah CAN EE OO, Animasahun BA, Bastos MI. Structural heart disease in children in Lagos: profile, problems and prospects. Niger Postgrad Med J 2008; 15:82 – 8.
23. I M Mitchell RWL, J C S Pollock, M P G Jamieson.Nutritional status of children with congenital heart disease. Br Heart J 1995; 73:277-83.
24. MEHRIZI A DA. Growth disturbance in congenital heart disease. J Pediatr1962; 61:418 – 29.
25. Carrie Daymont AN, Aaron Prosnitz, Meryl S. Cohen, et al. Growth in Children With Congenital Heart Disease. Pediatrics 2013;131(1) e236-42 doi 10.1542/peds.2012-1157
26. Okoromah CAN EE OO, Animasahun BA, Bastos MI. Structural heart disease in children in Lagos: profile, problems and prospects. Niger Postgrad Med J 2008;15:82 – 8.
27. Monteiro FPM. Nutritional status of children with congenital heart disease. Rev Latino-Am Enfermagem 2012 (6): 1024-32.
28. Alexandra Groth BV, Matthias Brock, Rudolf Speich, Silvia Ulrich,Lars C Huber. Inflamatory cytokines in pulmonary hypertension. Respir Res 2014; 15(1):47.
29. Sadoh WE OW. Underlying congenital heart disease in Nigerian children with pneumonia African Health Sciences 2013; 13 (3):607 - 12.
30. Atiar Rahman MaHR. Serum iron and total iron binding capacity in severely malnourished children. Bangladesh J Pharmacol 2007; 2: 61-5.

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