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Evaluation of Growth Status in Children with Congenital Heart Disease: A Case- Control Study

Noor Mohammad Noori[1], Maryam Nakhaey Moghaddam[1], Alireza Teimouri[1], Tahereh Boryri[2], Sanaz Hassan Abadi[3]

[1]Children and Adolescent health research center, Zahedan University of Medical Sciences, Zahedan Iran.
[2]Pregnancy Health Research Center, School of Nursing and Midwifery, Zahedan University of Medical Sciences, Zahedan, Iran.
[3]Medical School, Zahedan University of medical Sciences, Zahedan Iran.

Abstract

Background:
Children with congenital heart disease (CHD) are prone to malnutrition and growth retardation. This study aimed to compare growth status between children with CHD and healthy children.

Materials and Methods: This case–control study included 310 children with CHD and 300 healthy children matched in age and gender. CHD patients grouped according to cardiac diagnosis: group 1 (n=5), cyanotic patients with pulmonary hypertension; group 2 (n=22), cyanotic patients without pulmonary hypertension; group 3 (n=43), Acyanotic patients with pulmonary hypertension; and group 4 (n=240), Acyanotic patients without pulmonary hypertension. Anthropometric measurements of weight (Kg), height (cm), and head circumference (cm) were measured and recorded for both case and control groups. Descriptive and analytical statistics were performed using the by SPSS version 21.0.

Results: Weight and head circumference were significantly lower in CHD children compared to healthy children ($p<0.05$). Weight, Height and Head circumference was significantly lower in cyanotic patients without pulmonary hypertension, and Acyanotic patients with pulmonary hypertension compared the CHD children ($p<0.05$). Weight in Acyanotic patients with pulmonary hypertension and Head circumference in cyanotic patients without pulmonary hypertension, and Acyanotic patients with pulmonary hypertension, was significantly lower compared to Acyanotic patients without pulmonary hypertension ($p<0.05$). CHD patients without operation ingested fewer weight, height and head circumference compared to CHD patients with operation ($p<0.05$).

Conclusion
Children with CHD experience early, simultaneous decrease in growth trajectory across weight, length, and head circumference. The results suggest that early surgical intervention and nutritional support can be fruitful in prevention of these complications.

Key Words: Children, Congenital heart disease, Growth status.

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Corresponding Author:

Alireza Teimouri: M.Phil, Ph.D in Demography, Children and Adolescent Health Research Center, Zahedan University of medical Sciences, Zahedan Iran; Fax: +985433295611

Email: Alirezateimouri260@gmail.com

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1- INTRODUCTION

Congenital Heart Defect (CHD) is one of the most common non-communicable diseases that occur due to congenital cardiovascular system in the embryonic stage (1). CHD accounted as third congenital diseases and is a leading cause of infant mortality in the first year of life (2). Its prevalence is about 5 to 8 per 1000 live births that varied in different parts of the world (3), but in a recent study the prevalence has been reported to be ranged from 4 to 50 cases per 1,000 live births (4). The most common form of CHD is ventricular septal defect (VSD) that involved 35% of CHD patients; and the considerable type of cyanotic CHD is Tetralogy of Fallot (TOF) (5).

Generally, several genetic and environmental risk factors introduced for CHD, but in most cases, the reasons not fully understood. These factors may include of mutations, alcohol drinking, using cocaine or abusing certain kinds of drugs during pregnancy, for example, thalidomide drug using by the pregnant mothers increases CHD in fetus (6, 7). Many studies have found that cytokines have a strong effect on feeding, growth, weight and energy intake in patients with CHD (8, 9). Impaired absorption can also play an important role of malnutrition in heart disease; so that, children with CHD delay in growth due to increased work of cardiopulmonary and consequently, fatigue and loss of appetite, dyspnea, tachypnea, chronic hypoxia directed to malnutrition (1, 8 , 10). In addition, a series of serum factors such as leptin, ghrelin and tumor necrosis factor alpha (TNF-α) will be changed in these patients. Consequently, the rate of absorption of nutrients, growth, weight and energy consumption and storage are changing (11). Children with CHD have normal growth when receiving more calories compared to healthy ones (9, 12). Malnutrition in these effects on the metabolic response to injury and complications and outcomes of cardiac surgery including sepsis, renal dysfunction, necrotizing enterocolitis, hospitalization days (13) and then increases the risk of mortality (14). Regarding to congenital malformations, cardiovascular disorders are the most debilitating diseases and CHDs are the leading causes of organic growth disorders in children, early rapid growth retardation detection in early age and rapid intervention would have a very important role in improving of their conditions. Furthermore, reported that CHD children have more developing growth disorders compared to healthy children.

As we know, CHD divided into four major groups of cyanotic with and without an increase in pulmonary artery pressure and Acyanotic heart defect (also known as non-cyanotic heart defect) with and without an increase in pulmonary artery pressure. In our knowledge about the prevalence of growth retardation in these groups of heart diseases, revealed that the pattern of growth retardation not well understood in the area of the study. Therefore, this study aimed to evaluate the growth status in children with CHD compared with controls to have more accurately assessed towards planning, preventive and treatment of growth disorders in CHD children.

2- MATERIALS AND METHODS

2-1. Study type

In this case-control study, three hundred and ten CHD children aged 3 months to 16 years old from those who were referred to the heart center of Ali Asghar Hospital, Zahedan city, South East of Iran, selected as case group after diagnosis and confirmation their CHD with echocardiography and cardiac catheterization. Following, 300 healthy children collected from those who were referred to the Ali Asghar Hospital for routine checkup. The controls selection

was with the consideration of not significant underlying disease which effect on growth disorders. The study performed on Ali Asghar Hospital in Zahedan, during the years of 2015 and 2016.

2-2. Inclusion and exclusion criteria

Inclusion criteria were, age from 3 months to 16 years and confirmed CHD by echocardiography and cardiac catheterization. Exclusion criteria were a history of pre-maturity, intrauterine growth retardation, known chromosomal abnormalities and genetic disorders and diseases that effect on growth, such as celiac disease, hyperthyroidism, chronic infection.

2-3. Sampling

After above consideration sample size estimated as 310 individuals in each group in accordance with the following formula:

$$n = \left(\frac{r+1}{r}\right)\frac{(\bar{p})(1-\bar{p})(Z_{\beta}+Z_{\alpha/2})^2}{(p_1-p_2)^2}$$

Where, $Z_{\alpha/2}$= 1.96, Z_{β} =0.84 and r=1 that shows sample size for patients and controls is equal. To calculate the sample size, growth failure prevalence in both case and control groups considered as p_1= 30% and p_2= 20%, respectively. Using these values, 310 individuals estimated for each group. After data collection 10 forms of data that were belonged to control group, excluded from to analysis because of high percentages of missing in variables. The sampling method was accessibility.

2-4. Methods of study

The two groups of children were matched based on age and gender. Children with CHD classified in four groups' accordance with their diseases. The groups were cyanotic with and without an increase in pulmonary artery pressure and Acyanotic with and without an increase in pulmonary artery pressure. Weights of participants, height and head circumference were measures. Pulmonary arterial pressure, oxygen saturation aortic of all patients who underwent cardiac catheterization was recorded. The mean pulmonary artery pressure greater than 25 mm Hg considered as pulmonary hypertension and aortic oxygen saturation less than 85% was considered as a cyanotic (15).

2-5. Anthropometric measures

Participants' height, weight and head circumference were determined according to standard anthropometric methods. Participants height over 2 years of age was measured to the nearest 0.1 centimeters (cm) in bare feet with participants standing upright against a mounted stadiometer and for the participant lower than 2 years of age height was measured with a wooden scaled table in supine position. Weight was measured to the nearest 0.1 kilogram (kg) with participants lightly dressed using a portable digital scale (Tanita HD 309, Creative Health Products, MI, and USA). Weight of participants lower that 2 years age, measured by Mika Mark recumbent weighing scale made in Japan with an error factor of 10 gr. Head circumference measured with a flexible non-stretchable measuring tape. The measurements performed by a medical student that trained in these specific measurements.

2-6. Ethical consideration

The study as a MD thesis approved by the institutional review board and research committee of the Zahedan University of Medical Science (ID number: 1591).

2-7. Statistical analysis

After collecting the necessary information, data entered in SPSS version 21.0. To describe the data of central tendency and dispersion, mean and standard deviation (SD) were used. According to the non-normality of the data based on Kolmogorov-Smirnov test, to compare the mean weight, height and head circumference among groups non-parametric Mann-Whitney test was used

and the correlation estimated with the Fisher's exact test. The level of significant less than 0.05 considered.

3- RESULTS

This case-control study conducted to evaluate growth indicators in children with congenital heart disease compared with controls. To test data normality, Kolmogorov-Smirnov used and observed a significant level in all major variables, age ($p<0.001$), weight ($p<0.001$), height ($p<0.001$), and head circumference ($p<0.001$). This level of significant shows a non-normal distribution. The patients mean age (4.65±4.57 years) compared with controls' mean age (4.92±4.48 years), and resulted similarity ($p=0.172$). Sex distribution in controls showed that 131 (43.7%) were girls and 169 (56.3%) were boys and in the patients, 159 (51.3%) were girls, and 151 (48.7%) were boys. Fisher's exact test showed that this difference was not statistically significant ($p=0.063$).

Means of weight, height, and HC were 15.15±11.43, 96.96±31.44 and 46.82±4.89 for CHD children and were 18.33±11.42, 98.91±27.62 and 48.13±3.32 for healthy ones. These differences were significant except mean of height ($p>0.005$) that was similar between groups. The patients were classified according to cyanosis and pulmonary hypertension in four groups of cyanotic with pulmonary artery (PA) pressure, cyanotic without PA pressure, Acyanotic with and without increased PA pressure. Out of 310 patients, 5 (1.6%), 22 (7.1%), 43 (13.9%), and 240 (77.4%) were in the mentioned groups respectively. Among these patients, 78 (25.2%) had open-heart surgery. **Table.1** showed that mean height was 99.79 ± 27.14 cm in controls, and 95 ± 33.48 cm, 87.13 ± 29.23, 92.09 ± 33.69 cm and 98.86 ± 31.02 cm for the groups of patients in the order given. Children with height lower than z-score equal to zero compared and resulted that in the second ($p=0.021$) and the third ($p=0.036$) groups of patients were different with the control significantly. **Table.2** showed that the mean of participants' weight and their comparisons. From the table.4 resulted that mean weight of participants was 18.5 ± 11.47 kg in controls, and 13.6 ± 10.13 kg, 11.34 ± 7.59kg, 13.45 ± 11.89kg, and 15.83 ± 11.61 kg for the groups od CHD patients in the order given. Mann-Whitney test performed on weight of participants who their weight was lower than z-score equal to zero and resulted that the second ($p=0.001$), the third ($p<0.001$), and the forth ($p<0.001$) groups of patients were significantly different with the controls; also resulted that the forth groups of patients had different mean weight with the third ($p=0.032$) group.

Table.3 show the mean head circumference (HC) of all participants groups; and resulted that mean HC was 48.13 ± 2.54 cm in controls, and 46.40 ± 5.89 cm , 44.31 ± 5.62, 45 ± 5.24 cm and 47.38 ± 4.61 cm for the groups of patients in the order given. Children with z-score=0 in HC compared to each other and resulted that the second ($p=0.008$), and the third ($p<0.001$) groups of patients were different with controls significantly; also resulted that the forth groups of patients had different HC measure compared to the second ($p=0.025$), and third ($p=0.007$) groups. **Table.4** showed the frequency of different participants in different percentiles of height, weight, and HC using growth curve. Regarding height, the table showed that out of 5 cyanotic with PA pressure, 60%, 20%, and 20%, out of 22 cyanotic without PA pressure 50%, 31.82%, and 18.18%, out of 43 Acyanotic with PA pressure, 39.53%, 32.56%, and 27.91%, out of 240 patients with Acyanotic without PA pressure, 27.08%, 44.58%, and 28.33%, out of 300 control participants, 6.33%, 36%, and 57.67% were dropped in the percentiles of < 5th, between 5th and 50th and > 50^{th},

respectively. A significant association was observed (p<0.001). Regarding weight, the table showed that cyanotic patients with PA pressure had the highest frequency (80%) in < 5th percentile, cyanotic patients without PA pressure had the highest frequency (68.18%) in < 5th percentile, Acyanotic patients with PA pressure had the highest frequency (69.77%) in < 5th percentile, Acyanotic patients without PA pressure had the highest frequencies in < 5th percentile (44.58%), and between 5th and 50th percentiles (44.58%).

In compared with controls, the majority of them had weight higher than 50th percentile. A significant association was observed (p<0.001). Regarding HC, **Table.4** also show that cyanotic patients with PA pressure, cyanotic patients without PA pressure, Acyanotic patients with PA pressure had the highest frequency of 60%, 50%, and 44.19% in percentile domain between 5th and 50th, respectively. Acyanotic patients without PA pressure had the highest frequencies in > 50th percentile (52.5%). Controls had same function as Acyanotic patients without PA pressure with the percentage of 91%. A significant association was observed (p<0.001). The absolute value of the z-score shows how many standard deviations are under or above the mean. Therefore, for this section of analysis considered z-scores equal or lower than zero. The **Table.5** showed the frequency of participants with height lower than z-score = 0. Three cyanotic patients with PA pressure distributed equally (33.33%) in the domains of z-score. From 11 cyanotic patients without PA pressure 54.55% were in the -2.5 to-0.35 height Z-score. From 17 Acyanotic patients with PA pressure 58.82% had the lowest height regarding z-score lower than -3.5 and Acyanotic without PA pressure were more in the -2.5 to -3.5 height z-score. From 65 control participants, 47.37% had taller height compared to their counterparts. Nineteen healthy children had height lower than z-score = 0. From these participants, 47.37% were in height z-score of 0 to -2.5. Participants with weight lower than z-score=0 were 4, 15, 30, 107, 24 for cyanotic with PA pressure (50% in z-score of 0 to -2.5), cyanotic without PA pressure (73.33% in z-score of -2.5 to -3.5), Acyanotic with PA pressure (40% in -2.5 to -3.5), Acyanotic without PA pressure (38.32% in Z-score of 0 to -2.5), and controls (62.5% in z-score of 0 to -2.5). Head circumference as an anthropometric index measured and the deviation from mean HC estimated. All controls had HC higher than z-score = 0. The others were 1, 6, 9 and 19 from cyanotic with PA pressure, cyanotic without PA pressure, Acyanotic with PA pressure and Acyanotic without PA pressure.

Table-1: Height comparison in groups of participants

Groups of participants	Frequency	Mean	SD	Mean of ranks	Some of ranks	Median	Mann-Whitney U	P-value
Control	300	99.79	27.14	153.22	45965	92	685	0.74
Group1	5	95	33.48	140	700	92		
Control	300	99.79	27.14	164.75	49425.5	92	2324.5	0.021
Group2	22	87.13	29.23	117.16	2577.5	80		
Control	300	99.79	27.14	176.25	52876	92	5174	0.036
Group3	43	92.09	33.69	142.33	6120	83		
Control	300	99.79	27.14	274.69	82408	92	34742	0.485
Group4	240	98.86	31.02	265.26	63662	93		

Group1	5	95	33.48	16.2	81	92	44	0.492
Group2	22	87.13	29.23	13.5	297	80		
Group1	5	95	33.48	27.2	136	92	94	0.649
Group3	43	92.09	33.69	24.19	1040	83		
Group1	5	95	33.48	113.7	568.5	92	553.5	0.767
Group4	240	98.86	31.02	123.19	29566.5	93		
Group2	22	87.13	29.23	31.27	688	80	435	0.598
Group3	43	92.09	33.69	33.88	1457	83		
Group2	22	87.13	29.23	102.59	2257	80	2004	0.062
Group4	240	98.86	31.02	134.15	32196	93		
Group3	43	92.09	33.69	123.74	5321	83	4375	0.112
Group4	240	98.86	31.02	145.27	34865	93		

Group1= cyanotic with an increase in pulmonary artery pressure, Group 2 = cyanotic without an increase in pulmonary artery pressure, Group 3= Acyanotic with an increase in pulmonary artery pressure, Group 4 = Acyanotic without an increase in pulmonary artery pressure; SD: Standard Deviation.

Table-2: Weight comparison in groups of participants

Groups of participants	Frequency	Mean	SD	Mean of ranks	Some of ranks	Median	Mann-Whitney U	P- value
Control	300	18.50	11.47	153.77	46131.50	14.50	518.50	0.236
Group1	5	13.6	10.13	106.70	533.50	10.50		
Control	300	18.50	11.47	166.35	49905	14.50	1845	0.001
Group2	22	11.34	7.59	95.36	2098	9.25		
Control	300	18.50	11.47	180	53999	14.50	4051	<0.001
Group3	43	13.45	11.89	116.21	4997	8.50		
Control	300	18.50	11.47	292.88	87863.50	14.50	29286.50	<0.001
Group4	240	15.83	11.61	242.53	58206.50	12		
Group1	5	13.6	10.13	14.80	74	10.50	51	0.803
Group2	22	11.34	7.59	13.82	304	9.25		
Group1	5	13.6	10.13	27.30	136.50	10.50	93.5	0.636
Group3	43	13.45	11.89	24.17	1039.50	8.50		
Group1	5	13.6	10.13	112.30	561.50	10.50	546.50	0.733
Group4	240	15.83	11.61	123.22	29573.50	12		
Group2	22	11.34	7.59	32.57	716.50	9.25	463.50	0.895
Group3	43	13.45	11.89	33.22	1428.50	8.50		
Group2	22	11.34	7.59	101.50	2233	9.25	1980	0.052
Group4	240	15.83	11.61	134.25	32220	12		
Group3	43	13.45	11.89	117.31	5044.50	8.50	4098.50	0.032
Group4	240	15.83	11.61	146.42	35141.50	12		

Group 1= cyanotic with an increase in pulmonary artery pressure, group 2 = cyanotic without an increase in pulmonary artery pressure, group 3= Acyanotic with an increase in pulmonary artery pressure, group4 = Acyanotic without an increase in pulmonary artery pressure; SD: Standard Deviation.

Table-3: Head Circumference comparison in groups of participants

Groups of participants	Frequency	Mean	SD	Mean of ranks	Some of ranks	Meadian	Mann-Whitney U	P value
Control	300	48.13	2.54	153.51	46053	49	597	0.427
Group1	5	46.40	5.89	122.40	612	47		
Control	300	48.13	2.54	165.18	49553.50	49	2196.50	0.008
Group2	22	44.31	5.62	111.34	2449.50	43		
Control	300	48.13	2.54	179.48	53842.50	49	4207	<0.0001
Group3	43	45	5.24	119.85	5153.20	46		
Control	300	48.13	2.54	277.35	83203.50	49	33946.50	0.250
Group4	240	47.38	4.61	261.94	62866.50	49		
Group1	5	46.40	5.89	16.10	80.50	47	44.50	0.511
Group2	22	44.31	5.62	13.52	297.50	43		
Group1	5	46.40	5.89	27.20	136	47	94	0.648
Group3	43	45	5.24	24.19	1040	46		
Group1	5	46.40	5.89	109.70	548.50	47	533.50	0.670
Group4	240	47.38	4.61	123.28	29586.50	49		
Group2	22	44.31	5.62	31.95	703	43	450	0.749
Group3	43	45	5.24	33.53	1442	46		
Group2	22	44.31	5.62	96.95	2133	43	1880	0.025
Group4	240	47.38	4.61	134.67	32320	49		
Group3	43	45	5.24	111.08	4776.50	46	3830.50	0.007
Group4	240	47.38	4.61	147.54	35409.50	49		

Group 1= cyanotic with an increase in pulmonary artery pressure, group 2 = cyanotic without an increase in pulmonary artery pressure, group 3= Acyanotic with an increase in pulmonary artery pressure, group 4 = Acyanotic without an increase in pulmonary artery pressure; SD: Standard Deviation.

Table-4: Anthropometric measures' frequency based on percentiles and the comparison between groups

Groups of participants	Percentiles				P- value
	< 5^{th}	Between 5^{th} and 50^{th}	>50^{th}	total	
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	
Height					
Cyanotic with PA pressure	3(%60)	1(%20)	1(%20)	5(%100)	<0.001
Cyanotic without PA pressure	11(%50)	7(%31.82)	4(%18.18)	22(%100)	
Acyanotic with PA pressure	17(%39.53)	14(%32.56)	12(%27.91)	43(%100)	
Acyanotic without PA pressure	65(%27.08)	107(%44.58)	68(%28.33)	240(%100)	
Controls	19(%6.33)	108(%36)	173(%57.67)	300(%100)	
Weight					
Cyanotic with PA pressure	4(%80)	1(%20)	-	5(%100)	

cyanotic without PA pressure	15(%68.18)	7(%31.82)	-	22(%100)	<0.0001
Acyanotic with PA pressure	30(%69.77)	10(%23.26)	3(%6.98)	43(%100)	
Acyanotic without PA pressure	107(%44.58)	107(%44.58)	26(%10.83)	240(%100)	
Control	24(%8)	91(%30.33)	185(%61.67)	300(%100)	
Head Circumference					
Cyanotic with PA pressure	1(%20)	3(%60)	1(%20)	5(%100)	<0.0001
Cyanotic without PA pressure	6(%27.27)	11(%50)	5(%22.73)	22(%100)	
Acyanotic with PA pressure	9(%20.93)	19(%44.19)	15(%34.88)	43(%100)	
Acyanotic without PA pressure	19(%7.92)	95(%39.58)	126(%52.5)	240(%100)	
Control	-	27(%9)	273(%91)	300(%100)	

PA: pulmonary artery.

Table-5: Anthropometric measures' frequency based on Z-scores and the comparison between groups

Groups of participants	Z-scores				P- value
	0 _ -2.5	-2.5_-3.5	< -3.5	Total	
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	
Height					
Cyanotic with PA pressure	1(%33.33)	1(%33.33)	1(%33.33)	3(%100)	0.279
Cyanotic without PA pressure	2(%18.18)	6(%54.55)	3(%27.27)	11(%100)	
Acyanotic with PA pressure	2(%11.76)	5(%29.41)	10(%58.82)	17(%100)	
Acyanotic without PA pressure	19(%29.23)	25(%38.46)	21(%32.31)	65(%100)	
Control	9(%47.37)	5(%26.32)	5(%26.32)	19(%100)	
Weight					
Cyanotic with PA pressure	2(%50)	1(%25)	1(%25)	4(%100)	0.073
Cyanotic without PA pressure	3(%20)	11(%73.33)	1(%6.67)	15(%100)	
Acyanotic with PA pressure	10(%33.33)	12(%40)	8(%26.67)	30(%100)	
Acyanotic without PA pressure	41(%38.32)	40(%37.38)	26(%24.3)	107(%100)	
Control	15(%62.5)	6(%25)	3(%12.5)	24(%100)	
Head Circumference					
Cyanotic with PA pressure	-	1(%100)	-	1(%100)	0.376
Cyanotic without PA pressure	2(%33.33)	2(%33.33)	2(%33.33)	6(%100)	
Acyanotic with PA pressure	1(%11.11)	4(%44.44)	4(%44.44)	9(%100)	
Acyanotic without PA pressure	8(%42.11)	3(%15.79)	8(%42.11)	19(%100)	

PA: pulmonary artery.

4- DISCUSSION

Weight and head circumference were significantly lower in CHD children compared to healthy ones. Weight, Height and Head circumference was significantly lower in cyanotic patients without pulmonary hypertension, and Acyanotic patients with pulmonary hypertension compared to groups' of CHD children. Weight in Acyanotic patients with pulmonary hypertension and Head circumference in cyanotic patients without pulmonary hypertension, and Acyanotic patients with pulmonary hypertension, was significantly lower compared to Acyanotic patients without pulmonary hypertension. CHD patients without operation ingested fewer weight, height and head circumference compared to CHD patients with operation. Children with CHD are malnourished and one of the most important reasons for these effects is storage reduction and increased energy consumption in their bodies (8).

Severe growth retardation in these patients maybe is a cause of failure to thrive even after surgery (8). Genetic, environmental, nutritional, social, and frequent respiratory infections are determined major factors, but has not been specified which one more important (16). In a study, pulmonary hypertension and cyanotic diseases were the most important factors of growth failure in patients with CHD (17). In another survey the highest impact on growth failure has been observed in children with ventricular septal huge and tetralogy of Fallot (18). In Viviane Martins et al. study, growth, and feeding status of CHD children less than one year old without surgery evaluated. The study results showed that the incidence of malnutrition was varied based on gender, cardiac abnormalities, height, and weight and head circumference at birth and in acute malnutrition, weight and height were most common in boys and girls (19). In a retrospective cohort study by Daymont et al. on the growth status of children resulted that the most frequent disorders were weight for age and height for age in the first four months of life and continued till the age 2 or 3 years (20). In a case -control study by Hassan et al., the status of feeding evaluated on cyanotic and Acyanotic children with non-operation surgery and compared with healthy ones. From the study resulted that the prevalence of underweight and short stature was higher in patients. A comparison in patients groups, they resulted that the prevalence of short stature and underweight was more in Acyanotic and cyanotic respectively. Hassan et al., also reported that the prevalence of malnutrition was 20% in controls and 84% in patients so that 71.4% had severe malnutrition. The prevalence of malnutrition in patients correlated with low levels of hemoglobin, low levels of arterial blood saturation, heart failure, and pulmonary hypertension (21).

Fifty children with CHD compared with a group of general children population by Arodiwe et al. in Nigeria. The patients categorized in four groups of cyanotic and Acyanotic with or without pulmonary hypertension. The prevalence of malnutrition was significantly higher in patients compared controls. The malnutrition disorder was associated with age and pulmonary hypertension. The highest prevalence observed in Acyanotic patients with pulmonary hypertension (22). In a study in Ahvaz, a city in south west of Iran, the prevalence and patterns of growth failure examined in CHD children and infants. The participants were aged from 1 month to 18 years. The results showed that amongst these patients, approximately, one third weighted and one fourth heighted under the fifth percentile. The most common growth failure was weight that was more frequent in girls. In addition, the weight reduction and short stature were more in patients with pulmonary hypertension than other patients (23).

Noori et al. conducted a study on CHD children aged 3 months to 16 years on some of growth parameters and resulted that a high percentage of patients were under the fifth percentile regardless of age classifications and type of CHD (15). In a survey by Chung and colleagues in Taiwan resulted that more than 50% of children with CHD, and 33% of normal children were below the 50th percentile of weight (24). In another study by Arodiwe and the colleagues the prevalence of malnutrition was much higher (92%) in CHD patients compared to control group (22). Emami Moghadam et al., found that 37.4% of children were below the 5th percentile of weight, and 27.2% were below the 5th percentile of height (23). Noori et al. study reported that these trends occurred as 72% and 57.8%, respectively (15).

However, the incidence of growth disorders in these patients is different, but all emphasized on growth disorders in patients with CHD compared with healthy children. This difference can be attributed to differences in the factors affecting the growth of CHD patients, including gender (19), age (19, 20), cardiac abnormalities (18, 19, 25), simultaneous multiple congenital heart defects (16), and congestive heart failure (21). Thus, the findings of this study, in line with other studies, a higher prevalence of growth retardation in children with CHD confirmed. Analysis of the present study showed, the average weight of patients with pulmonary hypertension Acyanotic were significantly lower than the average weight of patients without pulmonary hypertension Acyanotic. Mean height and head circumference of patients without pulmonary hypertension Acyanotic also were significantly different from controls. On the other hand, mean head circumference in these children was significantly lower in patients without pulmonary hypertension Acyanotic. It seems to be the lowest growth disorders in patients without pulmonary hypertension Acyanotic. Although, this study findings did not show a direct difference in growth parameters between cyanotic children with pulmonary hypertension and other groups but, regarding the low frequent of these patients (5 individuals), and little evidences of this different, Acyanotic patients without pulmonary hypertension that they were the majority of patients, could be resulted that the existence of Acyanotic without pulmonary hypertension had high effect in growth retardation. Therefore the findings indirectly were in same line with the results of Birgul et al. (25), Boryri et al. (16), and Arodiwe et al. (22), based on higher growth disorders in cardiac patients with pulmonary hypertension. In addition, the existence of pulmonary hypertension and cyanotic confirmed as one factors affecting children's growth disorders and malnutrition in CHD.

Although some studies have shown, cyanotic and Acyanotic had no effect on child development such as Costello et al. (26), Parrish et al. (27), and Chen et al. (28), but, findings from the study was consistent with results of various studies, including Davidson et al. (29), Birgul et al. (25), and Hassan et al. (21); in this study also resulted that patients who were undergone heart surgery had higher values of growth parameters compared to other patients. Accordance with the results of the present study concluded that heart surgery can be confirmed as an independent factor that influenced the growth retardation regardless of the presence of cyanosis or pulmonary hypertension in children with CHD.

4-1. Limitations of the study

There are significant limitations to the approach adopted in this case-control study. We face with the lack of children and parents' corporation. Sample size was relatively sufficient for global evaluation, but for a kind of patients was very low and

the data analyzes will be more accurate with larger patients' number in each subgroups.

5- CONCLUSION

According to the study, CHD children were at risk of developmental disorders and this risk was higher in cyanotic with pulmonary hypertension compared to other kinds of CHD diseases. According to the results of this study based on the high frequency of developmental disorders in children with congenital heart disease, suggested that the results of the present study considered for the planning and preventable launches. With the early discovery and knowing the disorders in these specific patients in low age and would be stopped the delay in growth developments.

6- CONFLICT OF INTEREST

The authors would like to declare any conflict of interests.

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