ORIGINAL RESEARCH PAPER
Volume - 13 | Issue - 10 | October - 2024 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

SERUM IRON PROFILE IN CHILDREN WITH CONGENITAL HEART DISEASE: TERTIARY CARE HOSPITAL EXPERIENCE

Pediatrics

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ABSTRACT

Background: Children with congenital heart disease (CHD) are at an increased risk for nutritional deficiencies, including iron deficiency that increases morbidity and mortality in such patients. The present study was undertaken to study the iron profile in children with CHD in a tertiary care centre. **Method:** A total of 92 patients with CHD between 2 months to 12 years of age were enrolled and divided into Acyanotic and Cyanotic Heart Disease. The anthropometry and iron profile were studied in these groups. **Results:** Mean hemoglobin, RBC count, and hematocrit were significantly higher in cyanotic groups compared to acyanotic. Lower serum iron and transferrin saturation in acyanotic group, lower serum ferritin and higher total iron binding capacity (TIBC)in cyanotic group .Overall, 43.48% of children had iron deficiency. All iron-deficient children were under 5 years, predominantly infants with male predominance. Age significantly affected iron stores in acyanotic children 67.86% of acyanotic and 56.52% of cyanotic children with deficient iron stores had inadequate diets. Statistical significance found between weight for age and iron stores in acyanotic children ($p=0.004$). Lower weight for height was significant in iron deficient acyanotic children ($p<0.001$).Mean MCH and MCHC were significantly lower in acyanotic children with iron deficiency. Significant differences in serum ferritin values between iron sufficient and deficient groups in both heart disease types ($p<0.001$). **Conclusion:** Iron status differed significantly between acyanotic and cyanotic groups. Iron deficiency was prevalent affecting nutritional status and growth, indicating a critical need for early intervention, and tailored nutritional strategies in these populations.

KEYWORDS

Congenital heart disease; Iron profile; Acyanotic; Cyanotic;Anthropometry; Iron deficiency

INTRODUCTION

Congenital Heart Disease (CHD) is a structural anomaly of the heart present since birth that can manifest with a variety and severity. It is the most frequently occurring congenital disorder, responsible for 28% of all congenital birth defects (1). In India, for a population of 1.2 billion, it can be expected that there would be approximately 1,80,000 new-borns born each year with CHD requiring some form of intervention early in life (3,4).

CHD may be broadly classified into Acyanotic and Cyanotic heart disease. Children with CHD have been documented to have poor nutritional status. Factors responsible for this include genetic predisposition, pre-natal factors, increased metabolic demands in the presence of heart failure, poor oxygenation and reduced availability, intake, and absorption of nutrients. In addition to macronutrient deficiency, they also suffer from micronutrient deficiency in the form of iron deficiency (6). If left untreated,it keep the body in a state of constant hypoxia, triggering a physiological increase in erythropoietin release to produce more red cells to increase the body's oxygen carrying capacity and hence, improving oxygen delivery to the tissues. This unabated production leads to increased demand for iron, leading to iron deficiency with or without anaemia (7).

The high proportion of malnutrition and anaemia among children with CHD warrants proper evaluation and early intervention which may improve the outcome.This study was conducted as an attempt to assess the prevalence of iron deficiency in this vulnerable group and to analyse erythrocytic indices and iron profile to aid early detection, thus facilitating prompt intervention.

MATERIALS AND METHODS

After obtaining Institutional Ethical Committee approval and written informed consent from all the parents/ guardian, cross-sectional observational study was conducted on 92 patients of 1 month to 12 years of age attending the Pediatric OPD and/or patients admitted in the Pediatric ward and ICU with 2D echocardiography findings confirming diagnosis of a CHD in a tertiary care centre over a period of 18 months. Children who had undergone definitive surgery and who received iron supplements in the three months prior to presentation were excluded.

Detailed history including demographic details, dietary intake by 24 hour recall and clinical examination were noted in a pre-designed case record form. Detailed anthropometry and nutritional assessment was done and participants were accordingly classified based on the WHO z score for age and gender.

The study group was further divided into acyanotic and cyanotic heart disease based on the diagnosis. Subsequently, blood samples were collected with all aseptic precautions. 2 ml of venous blood was collected in a plain and EDTA bulb and following laboratory parameters were studied:

1. Complete Blood Count: Haemoglobin and Red Cell Indices were estimated by automated the haematology analyser- Sysmex KX-21 coulter.Anaemia was defined as a haemoglobin concentration or red blood cell mass less than the 5th percentile for age. The following age-based norms were used to classify anaemia.

Age	Anaemia	Mild	Moderate	Severe
6 months -59 months	<11.0	10-10.9	7.0-9.9	<7.0
5-11 years	<11.5	10-11.4	7.0-9.9	<7.0
12-14 years	<12.0	10-11.9	7.0-9.9	<7.0

2. Red cell indices included the following:

a) Mean Corpuscular Volume (MCV): It is expressed as volume of red cells

MCV (fl) =Hct * 10/RBC (10^6/µl)

Normal range: Normocytic 75-100 fl. In iron deficiency it is microcytic and < 72 fL in children.

b) Mean Corpuscular Hemoglobin (MCH): It is the amount of haemoglobin per red blood cell

MCH (pg) =Hb *10/ RBC (10^6/µl)

Normal range: 30 +/-4 pg. In iron deficiency anaemia it is < 31 pg

c) Mean Corpuscular Haemoglobin Concentration: It is the average concentration of haemoglobin in the red cells.

Age	MCV (fL)	MCH (pg)	MCHC (gm/dl)
1-23 months	72-78	24-30	32-36
2 years- 9 years	76-90	25-31	
10-17 years	78-95	26-32	

d) Red Cell Distribution Width (RDW): Red cell distribution width is the variability in the red cell volume. In iron deficiency anaemia it is > 14.5 %. It is more sensitive (90-100%) and less specific (50-70%) (8).

Ferritin was used as a gold standard for measuring iron stores.

Prevalence of iron deficiency was calculated as proportion of children with ferritin values below -2SD of the reference mean. The table below shows the cut-off levels of ferritin for iron deficiency as defined by WHO (9).

	Normal range
Serum Iron	22-184ug/dl
Serum Ferritin	0-6wks: 0-400ng/dl
	7wks-1year: 10-95ug/dl
	1-9years: 10-60ug/dl
	10-18years male: 10-300ng/dl Female: 10-70ng/dl
Serum TIBC	Infants: 100-400ug/dl
	Thereafter:250-400ug/dl
Transferrin saturation	20-50%
Age cut-off	**Ferritin levels for iron deficiency**
<5 years	<12ng/ml
>5 years	<15ng/ml
Any age with infection	<30ng/ml

The various parameters like age, sex, haemoglobin, haematocrit, MCV, MCH, MCHC, RDW, Platelet count, serum iron, total binding capacity, transferrin saturation and serum ferritin were compared between the iron deficient and iron sufficient group.

The iron profile was correlated with the 1) Anthropometry and diet in such children; 2) Red blood cell indices in assessing iron deficiency; 3) The type and severity of heart disease.

Statistical Analysis

Data was analysed using SPSS V15.0 package (Statistical Package for Social Sciences, Version 15.0). Data was calculated as Mean ± SD for continuous data & median and range for non-normal data, number and percentage for categorical data. Comparison of mean between 2 groups was carried out by Student's unpaired t test for numerical normal data. Mann Whitney U test was applied for comparison for non-normal data. Fisher Exact Probability test or Chi square tests was applied to compare percentages for categorical data between 2 or more groups. Alpha (α) Level of Significance was taken as $P \leq 0.05$.

OBSERVATIONS AND RESULTS

Among total 92 children, 56 (60.86%) had Acyanotic and 36 (39.14%) had Cyanotic Heart Disease. Age and gender distribution in acyanotic and cyanotic heart disease are shown in table 1. 95.66% patients of the study group belonged to the lower socioeconomic strata by modified Kuppuswamy Classification. Only 4% were from the lower middle-class families. A total of 78 (84.78%) patients were pre-term and 14 (15.22%) were term gestation. 59 (64.13%) of the 92 patients had normal birth weights. 31 (33.69%) had a low birth weight while 1 patient each (1.09%) was found to have very low birth weight and extremely low birth weight.

Table 1: Age and gender distribution in acyanotic and cyanoticheart disease.

Age	Acyanotic Heart Disease (n=56)		Cyanotic heart disease (n=36)	
	Male	Female	Male	Female
2-12 months	19 (55.88%)	13 (59.09%)	13 (72.22%)	12 (66.67%)
>1 year to 5 years	15 (44.11%)	07 (31.82%)	04 (22.22%)	06 (33.33%)
>5 years	00 (0.0%)	02 (9.09%)	01 (5.56%)	00 (0.0%)
P value	0.162		0.486	

In children with acyanotic heart disease, ventricular septal defect (VSD) was the most common heart lesion (33.92%%) followed by atrial septal defect (ASD) (28.57%).50% patients in the group with cyanotic heart disease had Tetralogy of Fallot, (Figure 1). Overall, the prevalence of VSD was 20.66% followed by tetralogy of fallot (19.56%).

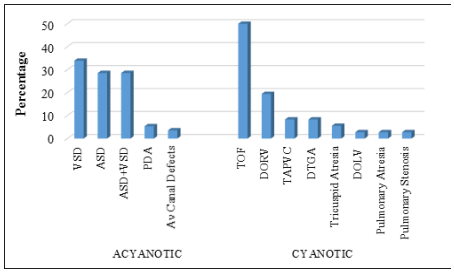

Figure 1: Prevalence of heart disease as per classification in the study group

In children with acyanotic heart disease, breathlessness (69.64%) was the most common presentation followed by fever (66.07%) and cough (53.57%).

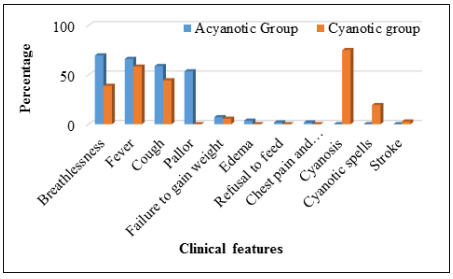

Figure 2: Clinical features in Acyanotic and Cyanotic Heart Disease

Maximum i.e., 78.58% patients with acyanotic heart disease and 80.56% patients with cyanotic heart disease were found to be underweight. Height for age was more affected in children with cyanotic heart disease (p value: 0.001).Children with acyanotic heart disease were more wasted (58.94%) compared to those with cyanotic heart disease (19.44%), (Table 2).

Table 2: Comparison of anthropometric status in Acyanotic and Cyanotic Heart Disease

Weight for Age	**Acyanotic**	**Cyanotic**	**Total**
More Than -2SD (Normal)	12 (21.42%)	07 (19.44%)	19 (20.66%)
Less than -2 SD	44 (78.58%)	29 (80.56%)	73 (79.34%)
Between -3SD To -2SD (Underweight)	15 (26.79%)	10 (27.78%)	25 (27.17%)
Less Than -3SD (Severely Underweight)	29 (51.79%)	19 (52.78%)	48 (52.17%)
P value	0.996		
Height For Age	**Acyanotic**	**Cyanotic**	**Total**
More Than -2SD (Normal)	38 (67.86%)	12 (33.33%)	50 (54.34%)
Less than -2 SD	18 (32.14%)	24 (66.67%)	42 (45.66%)
Between -3SD To -2SD (Stunted)	06 (10.71%)	13 (36.11%)	19 (20.66%)
Less Than -3SD (Severely Stunted)	12 (21.43%)	11 (30.55%)	23 (25.00%)
P value	0.001		
Weight for Height (< 5 years)	**Acyanotic**	**Cyanotic**	**Total**
More Than -2SD (Normal)	21 (37.50%)	28 (77.78%)	49 (53.26%)
Less than -2 SD	33 (58.94%)	07 (19.44%)	40 (43.47%)
Between -3SD To -2SD (Wasted)	12 (21.44%)	05 (13.89%)	17 (18.47%)
Less Than -3SD (Severely Wasted)	21 (37.5%)	02 (5.55%)	23 (25.00%)
P value	0.386		
BMI (more than 5 years of age)	**Acyanotic**	**Cyanotic**	**Total**
More than -2SD (Normal)	01 (1.78%)	01 (2.78%)	02 (2.18%)
Between -2 SD to -3SD (Thinness)	00 (0.0%)	00 (0.0%)	00 (0.0%)
Less than -3SD (Severe thinness)	01 (1.78%)	00 (0.0%)	01 (1.09%)
Total	02	01	03

The mean haemoglobin, RBC count, platelet count and haematocrit in children with cyanotic heart disease was higher as compared to that of the acyanotic group. This was statistically significant as shown in table 3.

Table 3: Comparison of Hemogram between acyanotic and cyanotic heart disease

Parameter	Group		P Value
	Acyanotic Mean (SD)	Cyanotic Mean (SD)	
Hb (g/dl)	9.49 (1.96)	12.51 (3.21	<0.001*
RBC Count (*10^6/ul)	3.34 (0.63)	4.30 (1.39)	<0.001*
WBC Count	12003 (4784)	11412 (4315)	0.549

Platelet Count (*10^5/ul)	3.79 (1.67)	2.97 (1.39)	0.017*
HCT (%)	30.55 (6.31)	40.63 (10.40)	<0.001*
MCV (fL)	76.05 (10.30)	73.16 (11.68)	0.218
MCH (pg)	24.15 (4.15)	22.63 (4.66)	0.105
MCHC (g/dl)	31.21 (3.42)	30.34 (4.75)	0.313
RDW	16.22 (3.07)	17.60 (5.99)	0.150
Peripheral smear findings	**Acyanotic No. (%)**	**Cyanotic No (%)**	**P value**
Microcytic/ Hypocromic	33 (58.93%)	18 (50%)	0.283
Normocytic/ Normochromic	23 (41.07%)	18 (50%)	

The iron profile in children with acyanotic and cyanotic heart disease showed serum iron and transferrin saturation to be lower in acyanotic heart disease. Serum ferritin levels were lower and the total iron binding capacity (TIBC) higher in the cyanotic group as compared to the acyanotic group, (Table 4).

Table 4: Comparison of iron profile in acyanotic and cyanotic heart disease

Iron Profile	Group		P Value
	Acyanotic Mean (SD)	Cyanotic Mean (SD)	
Iron (ug/dl)	38.33 (28.59)	47.81 (40.62)	0.193
Ferritin (ng/ml)	36.20 (24.87)	32.00 (24.12)	0.426
Transferrin saturation (%)	12.22 (10.08)	13.49 (11.35)	0.576
TIBC (ug/dl)	344.77 (86.98)	369.44 (78.63)	0.172

The overall prevalence of iron deficiency was found to be 43.48%. In patients with acyanotic and cyanotic, 50% and 63.89% respectively, were found to have deficient iron stores as depicted in figure 3.

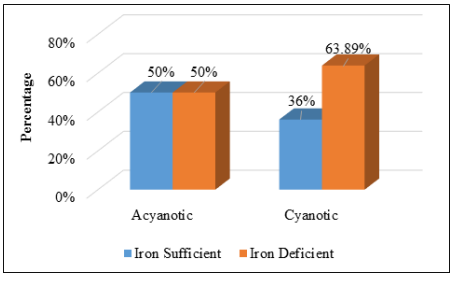

Figure 3: Correlation between Iron Stores in acyanotic and cyanotic heart disease

Of all the children with iron deficiency were less than 5 years of age, of which a large proportion of patients were infants in both acyanotic and cyanotic groups. In children with Acyanotic Heart Disease, age was a significant factor affecting the iron stores (p value: <0.001).67.85% males in the acyanotic group and 52.17% males in the cyanotic group were found to have deficient iron stores. It was seen that majority of the patients with iron deficiency had an inadequate diet. In children with deficient iron stores, 67.86% children with acyanotic and 56.52% with cyanotic heart disease had an inadequate diet. We found a statistical significance between weight for age and iron stores in acyanotic heart disease (p value: 0.004). On comparing height for age and iron status in acyanotic and cyanotic congenital heart disease, no statistically significant correlation was found. Children with iron deficient states in the acyanotic group had a lower weight for height. This was found to be statistically significant (p value: <0.001), (Table 5).

Table 5: Correlation of age, gender, dietary habits, weight for age, height for age, weight for height with iron status in acyanotic and cyanotic heart disease

Parameters		Acyanotic Heart Disease		Cyanotic Heart Disease	
		Iron sufficient	Iron deficient	Iron sufficient	Iron deficient
Age	2-12 months	13 (46.43%)	19 (67.86%)	10 (76.92%)	15 (65.22%)
	>1 to 5 years	13 (46.43%)	09 (32.14%)	02 (15.39%)	08 (34.78%)
	>5 years	02 (7.14%)	00 (0.0%)	01 (7.69%)	00 (0.0%)
	P value	<0.001*	0.216		
Gender	Male	15 (53.57%)	19 (67.85%)	06 (46.15%)	12 (52.17%)
	Female	13 (46.42%)	09 (32.14%)	07 (53.85%)	11 (47.83%)
	P value	0.273		0.728	
Dietary Habits	Adequate	12 (42.86%)	09 (32.14%)	08 (61.53%)	10 (43.48%)
	Inadequate	16 (57.14%)	19 (67.86%)	05 (38.46%)	13 (56.52%)
	P value	0.407		0.297	
Weight for age	Normal	11 (39.28%)	01 (3.58%)	04 (30.77%)	03 (13.04%)
	Underweight	06 (21.44%)	09 (32.14%)	04 (30.77%)	06 (26.09%)
	Severely underweight	11 (39.28%)	18 (64.28%)	05 (38.46%)	14 (60.87%)
	P value	0.004*		0.333	
Height for Age	Normal	22 (78.58%)	16 (57.14%)	05 (38.46%)	07 (30.44%)
	Stunted	02 (7.14%)	04 (14.28%)	05 (38.46%)	08 (34.78%)
	Severely Stunted	04 (14.28%)	08 (28.57%)	03 (23.08%)	08 (34.78%)
	P value	0.229		0.754	
Weight for height	Normal	14 (50%)	07 (25%)	10 (76.92%)	18 (78.27%)
	Wasted	04 (14.28%)	08 (28.57%)	02 (15.38%)	03 (13.04%)
	Severely wasted	08 (28.58%)	13 (46.43%)	00 (0.0%)	02 (8.69%)
	BMI > 5 Years				
	Normal	01 (3.57%)	00 (0.0%)	01 (7.69%)	00 (0.0%)
	Thinness	00 (0.0%)	00 (0.0%)	00 (0.0%)	00 (0.0%)
	Severe Thinness	01 (3.57%)	00 (0.0%)	00 (0.0%)	00 (0.0%)
	P value	0.041*		0.565	

On comparing the parameters of the hemogram with iron status, the mean MCH and MCHC was found to be statistically significant in acyanotic heart disease. MCH and MCHC can be used as an early indicator of iron deficiency status in those patients in whom iron deficiency anaemia is yet to manifest. In both children with acyanotic and cyanotic heart disease, a statistically significant difference was seen in serum ferritin values (p value: <0.001) between the iron sufficient and iron deficient groups. Other parameters such as serum iron, TIBC and transferrin saturation were affected in iron deficient states. However, no statistical significance was found, (Table 6).

Table 6: Comparison of hemogram, iron profile with iron status in acyanotic and cyanotic heart disease

Parameters		Acyanotic Heart Disease		P value	Cyanotic Heart Disease		P value
		Iron sufficient Mean (SD)	Iron deficient. Mean (SD)		Iron sufficient. Mean (SD)	Iron deficient. Mean (SD)	
Hemogram	Hb (g/dl)	9.75 (2.24)	9.62 (1.66)	0.642	13.07 (3.68)	11.52 (1.88)	0.168
	RBC Count (*10^6/ul)	3.36 (0.75)	3.32 (0.51)	0.784	3.78 (0.65)	4.59 (1.62)	0.097
	WBC Count	11440(4233)	12567 (529)	0.383	11541 (5189)	11184 (2204)	0.816
	Platelet Count (*10^5/ul)	3.75 (1.50)	3.83 (1.86)	0.854	2.97 (1.47)	2.97 (1.29)	0.991
	HCT (%)	30.97 (7.43)	30.14 (5.06)	0.628	36.54 (4.74)	42.93 (12.01)	0.076
	MCV (fL)	76.88 (8.63)	75.21 (11.84)	0.547	74.87(11.96)	70.15 (10.96)	0.250
	MCH (pg)	25.03 (3.41)	23.28 (4.67)	<0.001*	23.05 (4.84)	21.89 (4.40)	0.481
	MCHC (g/dl)	32.22 (3.34)	30.21 (3.25)	0.027*	31.59 (6.20)	29.61 (3.61)	0.240
	RDW	15.80 (2.54)	16.63 (3.51)	0.315	17.79 (7.37)	17.26 (2.17)	0.806

Iron Profile	Iron (ug/dl)	45.75(26.32)	30.93(29.37)	0.052	51.30(27.39)	45.83 (46.95)	0.704
	Ferritin (ng/ml)	56.43(19.47)	15.96 (5.66)	<0.001*	58.77(20.40)	16.87 (6.01)	<0.001*
	Transferrin saturation (%)	14.20 (8.06)	10.24 (11.57)	0.143	14.48 (8.97)	12.93 (12.65)	0.701
	TIBC (ug/dl)	327.25 (57.59)	362.29 (107.05)	0.133	358.38 (76.63)	370.04 (81.44)	0.953

DISCUSSION

In the present study, there were 56.52% males and 43.48% females with a male: female ratio of 1.3:1. Majority of the patients were less than 5 years of age. 57.14% children with acyanotic heart disease and 69.44% children with cyanotic heart disease were infants. This was similar to the findings in the study done by Mukherjee et al (10). The most common heart lesion seen overall in the study was a VSD(20.65%) followed by TOF (19.56%). In the acyanotic group, VSD (33.92%) and ASD (28.57%) were the most common. In the cyanotic group, prevalence of TOF was the highest (50%) followed by DORV (19.44%). This was similar to the study done by Binh TQ et al (11). As our hospital caters mainly to patients from the lower socioeconomic class, hence a higher distribution in the lower socioeconomic strata was observed. In children with acyanotic heart disease, breathlessness (69.64%) was the most common presentation followed by fever (66.07%) and cough (53.57%) as children with acynotic congenital heart disease are more prone for recurrent respiratory tract infection and congestive cardiac failure. These findings are correlated with the previous studies (12, 13). 84.78% patients were term babies and 64.135% had a normal birth weight over all. In the acyanotic group, 85.71% were term and 62.50% had a normal birth weight. In the patients with cyanotic heart disease, 83.33% were full term and 66.67% had a normal birth weight. 84.78% of the study population was immunized appropriately for age which is comparable with the study conducted by Pejaver etal (14).

It was seen that both the groups were similarly affected in terms of weight for age parameters. 78.58% patients with acyanotic heart disease and 80.56% patients with cyanotic heart disease were found to be underweight. The difference between the two groups was not found to be statistically significant. (p value: 0.996). These findings correlate with the study done by Okoromah CA et al (15).The high prevalence of underweight in acyanotic heart disease may be attributed to the high incidence of recurrent infections, congestive cardiac failure, poor nutrition, and repeated hospital admissions.

Height for age was more affected in children with cyanotic heart disease may be due to the chronic hypoxic states with suboptimal dietary intake leading to growth failure and hence stunting. The difference between two groups was found to be statistically significant (p value: 0.001*).Similar results were obtained in the study by Mir et al (6) and Okoromah et al (15).

The comparison between both subgroups based on weight for height (for children up to 5 years of age) and BMI (for above 5 years of age) which are indicators of acute malnutrition. Children with acyanotic heart disease were more wasted (58.94%) compared to those with cyanotic heart disease (19.44%).This could be attributed to feeding difficulties, repeated respiratory infections, pulmonary hypertension, increased metabolic demands, and fluid loss secondary to tachypnoea and diuretics. There was no statistical difference between weight for age in BMI between the two groups, (p value: 0.386).These results are comparable with the other studies (6, 15).

The mean haemoglobin, RBC count and Haematocrit in children with cyanotic heart disease was higher as compared to that of the acyanotic group. This was statistically significant. The elevated levels of Haemoglobin, RBC count and Haematocrit may be explained by the fact that chronic hypoxic states in Cyanotic Heart Disease acts as a potent stimulator of erythropoiesis. It was found that 58.93% in the acyanotic group had a microcytic hypochromic picture while 41.07% had a normocytic normochromic picture. In the cyanotic group, equal number of patients had a microcytic, hypochromic and a normocytic, normochromic picture on the peripheral smear. There was no statistical difference between the two groups. (P value 0.283). Similar findings were also seen in the study by Mir et al (6) and Binh TQ et al (11).

The iron profile in children with acyanotic and cyanotic heart disease showed serum iron and transferrin saturation to be lower in acyanotic heart disease. Serum ferritin levels were lower and the total iron binding capacity (TIBC) higher in the cyanotic group as compared to the acyanotic group. However, there was no statistical significance in the two groups as similar to previous studies (7, 11).Ferritin measurements as an indicator of iron status, are prone to giving false negative results, as they are affected by many factors causing inflammation including infection. This leads to a falsely elevated ferritin level, hence underestimating the prevalence of iron depletion.

Iron sufficiency and deficiency were determined by the WHO criteria for ferritin. The prevalence of iron deficiency was found to be 43.48% in the study population. In patients with acyanotic and cyanotic heart disease, 50% and 63.89% respectively, were found to have deficient iron stores. However, there was no statistical difference between the two groups.These findings are similar to the study done by Mir et al (6) and Binh TQ et al (11). Cyanotic congenital heart disease is congenital heart defect with right to left shunting of desaturated blood. This results in decreased oxygen saturation in the systemic circulation which acts as a trigger for increase in erythropoietin production and secondary erythropoiesis to maintain tissue oxygenation. Polycythaemia causes haemoglobin and haematocrit to rise and the otherwise normal values for age are unable to reflect the iron-deficient status of these children on hemogram.

All the children with iron deficiency were found to be less than 5 years of age as similar toreported in Lang'o et al study (7), and out of which a large proportion of patients were infants in both acyanotic and cyanotic groups. In children with Acyanotic Heart Disease, age was a significant factor affecting the iron stores (p<0.001). This high prevalence of iron deficiency in this age group may be due to the poor dietary intake compounded with rapid growth and increased demand to compensate for the effects of the heart lesion itself(16).67.85% males in the acyanotic group and 52.17% males in the cyanotic group were found to have deficient iron stores which was statistically significant, (P value 0.273). Lang'o et al reported similar results (7).It was seen that majority of the patients with iron deficiency had an inadequate diet. In children with deficient iron stores, 67.86% children with acyanotic heart disease and 56.52% with cyanotic heart disease had an inadequate diet.These findings are in accordance with the study done by Okoromah et al (15) and Arodiwe et al (17).This may be due to lack of awareness, faulty feeding practices, late initiation of complimentary feeds or extremely early initiation with top milk, predominantly milk-based diet beyond 1 year of age and the heart lesion itself which pushes them into malnutrition and iron deficiency.

The correlation between iron status and weight for age in the group with acyanotic heart disease, was found to be statistically significant (p value: 0.004). On comparing height for age and iron status in acyanotic and cyanotic congenital heart disease, no statistically significant correlation was found (p=0.333).This is in accordance with Lang'o et al study (7).However, stunting being an indicator of chronic malnutrition, may not reflect an iron deficient state in the younger age group. In current study, majority of the patients were infants. Hence, stunting, which is an indicator of chronic malnutrition and chronic iron deficiency, was not reflected in our anthropometry.Children with iron deficient states in the acyanotic group had a lower weight for height. This was found to be statistically significant (p value: <0.001). We did not observe a statistically significant correlation of weight for height and BMI with iron stores in the cyanotic group. The finding is consistent with the study by Lang'o et al (7).Malnutrition and therefore, iron deficiency, is often the rule in children with congenital heart disease. The type of cardiac anomaly is known to influence the nutritional status and the development of anaemia. Dietary inadequacy and the disease burden contribute to the current state. With optimal anti failures, nutritional rehabilitation, and supplementation with iron, eventual improvement in these patients is expected.

On comparing the parameters of the hemogram with iron status, the mean MCH and MCHC was found to be statistically significant in acyanotic heart disease. MCH and MCHC can be used as an early indicator of iron deficiency status in those patients in whom iron deficiency anaemia is yet to manifest. In both children with acyanotic and cyanotic heart disease, a statistically significant difference was seen in serum ferritin values (p<0.001) between the iron sufficient and iron deficient groups. Ferritin is one of the earliest indicators for depletion of iron stores before development of iron deficiency of anaemia. However, it can be elevated in case of infections which leads

to underestimation of anaemia. In current study, serum ferritin was found to be low in both acyanotic and cyanotic heart disease in the iron deficient group.Other parameters such as serum iron, TIBC and transferrin saturation were affected in iron deficient states. However, no statistical significance was found. These findings are correlated with the previous studies (6, 11).

CONCLUSION

The present study revealed significant disparities in the prevalence of heart lesions, hematological parameters, and iron profiles between children with acyanotic and cyanotic heart disease. Acyanotic children commonly exhibited ventricular septal defect, while tetralogy of fallot was prevalent in the cyanotic group. Notably, a high proportion of both groups, especially those under five years, displayed iron deficiency, affecting growth and nutritional status. These findings underscore the necessity of vigilant screening for iron deficiency and nutritional support in pediatric heart disease patients to mitigate potential growth and developmental impairments. Iron status differed significantly between these groups, with lower serum iron and transferrin saturation in the acyanotic group, and lower serum ferritin and higher total iron binding capacity in the cyanotic group. Iron deficiency was prevalent, particularly in children under 5 years, affecting nutritional status and growth, indicating a critical need for early intervention, and tailored nutritional strategies in these populations.

There is need for routine monitoring of hemogram and iron profile, especially in children with acyanotic heart disease, as they are vulnerable to recurrent infections and congestive cardiac failure which may push them into iron deficiency. Further studies with a larger sample size and over a longer duration of time are recommended.

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