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NUTRITIONAL AND ANAEMIA STATUS IN CHILDREN AGED 1–12 YEARS WITH KNOWN CONGENITAL HEART DISEASE — A CROSS-SECTIONAL STUDY FROM A TERTIARY CARE CENTRE IN JAIPUR, INDIA

Dr Abhilasha Agarwal[1*], Dr Sanjay Choudhary[2], Dr Avesh Saini[3]

[1*]Associate Consultant, Neoclinic Hospital, Jaipur, Rajasthan
[2]Head of the Department, Paediatrics, Fortis Escorts Hospital, Jaipur, Rajasthan
[3]Assistant Professor, Arya Medical College and Hospital, Jaipur, Rajasthan

***Corresponding author:** Dr Abhilasha Agarwal
*Associate Consultant, Neoclinic Hospital, Jaipur, Rajasthan **Email id:**
abhilashaagarwal2108@gmail.com

ABSTRACT

Background: Children with congenital heart disease (CHD) are at high risk of malnutrition and anaemia due to multifactorial causes including increased energy requirements, feeding difficulty, malabsorption and delayed corrective surgery. Data from Indian tertiary centres are limited. (Based on thesis background.) **Aim:** To evaluate nutritional status and anaemia among children aged 1–12 years with known CHD. **Methods:** Hospital-based cross-sectional observational study conducted in the Department of Pediatrics, Fortis Escorts Hospital, Jaipur between December 2020 and July 2021. Children aged 1–12 years with known (preoperative) CHD were enrolled (n = 85). Anthropometry (weight, height, BMI) was plotted on WHO/IAP growth charts; nutritional status was classified by weight-for-age (IAP), height-for-age (Waterlow), weight-for-height and BMI centiles. Haematological evaluation included haemoglobin and red-cell indices (MCV, MCH, MCHC) and RDW. Data were entered in Excel and analysed with SPSS v25; proportions compared with chi-square/Fisher's exact test, continuous variables with t-test/Mann-Whitney as appropriate; $p<0.05$ considered significant. **Results :** Of 85 children, 57 (67.1%) had acyanotic CHD and 28 (32.9%) cyanotic CHD. Most patients (81.2%) were aged 12–59 months; M:F = 1.5:1. Overall 70.6% were underweight and 63.5% were stunted; wasting was present in 67.1% (varying degrees). Energy and protein intakes were frequently suboptimal (majority 50–75% of requirement). Anaemia prevalence differed by group: anaemia was more commonly detected in ACHD; polycythaemia was observed in some CCHD patients. MCV differences between ACHD and CCHD were statistically significant; other red-cell indices showed variable patterns. (Detailed results, tables and exact p values will be included in Step 2.) **Conclusions:** Malnutrition and anaemia are common in children with CHD at our centre — particularly underweight, stunting and wasting — and differ by cyanotic vs acyanotic lesions. Early nutritional assessment and targeted interventions (dietetic support, iron status evaluation) should be part of routine CHD care to improve outcomes.

Keywords: congenital heart disease; malnutrition; anaemia; anthropometry; children

Introduction

Congenital heart disease (CHD) is the most common congenital anomaly, affecting approximately 8–12 per 1000 live births worldwide and contributing substantially to childhood morbidity and mortality [1]. In India, the reported prevalence and disease burden are significant due to a large birth cohort and delayed access to corrective cardiac surgery. [2]

Children with CHD are particularly vulnerable to malnutrition because of feeding difficulties, increased metabolic demands, recurrent infections, and gastrointestinal malabsorption. [3] Growth failure in these children manifests as underweight, stunting, and wasting, which in turn adversely affect neurodevelopment, immunity, and post-operative outcomes.

Anaemia frequently coexists with malnutrition and further aggravates morbidity. In acyanotic CHD, iron-deficiency anaemia is common, while in cyanotic CHD, chronic hypoxia leads to compensatory polycythaemia and iron imbalance[4]. Both conditions increase perioperative risks and impair recovery. [5]

Despite awareness of these issues, Indian data on combined nutritional and haematologic status in children with CHD remain limited. The present study was undertaken to assess the nutritional and anaemia status among children aged 1–12 years with known CHD attending a tertiary care centre in Jaipur, and to compare findings between cyanotic and acyanotic lesions to guide early nutritional interventions.

Material and Methods

Study Design and Setting

This was a hospital-based, cross-sectional observational study conducted in the Department of Paediatrics, Fortis Escorts Hospital, Jaipur, Rajasthan, between December 2020 and July 2021. Ethical clearance was obtained from the Institutional Ethics Committee before commencement of the study, and written informed consent was taken from the parents or guardians of all participants.

Study Population

85 Children aged 1–12 years with a confirmed diagnosis of congenital heart disease (CHD) were enrolled. The diagnosis of CHD was established by clinical examination, chest radiography, echocardiography, and relevant investigations as per standard guidelines.

Children who had undergone corrective or palliative cardiac surgery, those with known chromosomal abnormalities, genetic syndromes, chronic systemic illness, or acquired heart disease such as rheumatic heart disease were excluded from the study.

Data Collection and Clinical Assessment

Detailed demographic and clinical data were collected using a predesigned proforma. Information recorded included age, sex, type of CHD (cyanotic or acyanotic), socioeconomic status (according to Modified Kuppuswamy Scale), feeding history, and dietary intake pattern.

A thorough physical examination was performed for each participant. Anthropometric measurements included weight, height or length, mid-upper arm circumference (MUAC), and body mass index (BMI). Weight was measured using an electronic weighing scale, and height or length was measured using a stadiometer or infantometer as appropriate. Each measurement was taken twice and the average value recorded.

Nutritional status was assessed using standard growth charts. Weight-for-age and BMI-for-age were interpreted using the Indian Academy of Pediatrics (IAP) 2015 growth charts for children aged 5–18 years, and WHO standards for children under 5 years. Height-for-age (stunting) and weight-for-height (wasting) were evaluated using Waterlow's classification. Nutritional status was categorized as normal, mild, moderate, or severe malnutrition based on these parameters.

Laboratory Evaluation

Venous blood samples were collected under aseptic precautions for complete blood count and red cell indices. Haemoglobin (Hb), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), and red cell distribution width (RDW) were analysed using an automated haematology analyser. Anaemia was classified according to WHO age-specific cut-offs. Children with cyanotic CHD were also evaluated for secondary polycythaemia based on haemoglobin and haematocrit values.

Data Analysis

Data were entered in Microsoft Excel and analysed using IBM SPSS Statistics version 25.0. Continuous variables were expressed as mean ± standard deviation (SD) or median (interquartile range) as appropriate. Categorical variables were expressed as frequencies and percentages. Comparisons between cyanotic and acyanotic CHD groups were made using Student's *t*-test or Mann–Whitney *U* test for continuous variables and Chi-square or Fisher's exact test for categorical variables. A p-value <0.05 was considered statistically significant.

Results

A total of **85 children** with congenital heart disease (CHD) were included in the study. Of these, **57 (67.1%)** had acyanotic CHD (ACHD) and **28 (32.9%)** had cyanotic CHD (CCHD). In ACHD group, VSD (32.9%) was more predominant followed by ASD (21.2%) and PDA (3.5%) and others (9.4%) In CCHD group, TOF (21.2%) was more predominant and others (11.8%).

Demographic and Clinical Profile

The majority of participants (**81.2%**) were aged between 1 and 5 years, with a **male-to-female ratio of 1.6 : 1**. Socio-economically, 64.7 % of families belonged to the lower-middle class as per the Modified Kuppuswamy scale.

Table 1. Demographic and Clinical Characteristics of Study Participants (N = 85)

Variable	ACHD (n = 57)	CCHD (n = 28)	*p*-value
Mean age (years ± SD)	3.84 ± 2.71	3.84 ± 2.71	0.68
Males n (%)	38 (66.7$)	13 (46.4%	0.09
Lower-middle SES n (%)	37 (64.9)	18 (64.3)	0.96
Most common lesion	VSD (45.6 %)	TOF (46.4 %)	–

Nutritional Status

Overall, **63 (74.1 %)** children were underweight, **55 (64.7 %)** were stunted, and **60 (70.6 %)** were wasted to varying degrees.

Underweight and wasting were slightly more frequent among cyanotic children, though the difference was not statistically significant. Energy and protein intakes were below 75 % of the recommended dietary allowance in nearly two-thirds of the cohort.

Table 2. Nutritional Status among Children with CHD

Nutritional Parameter	ACHD (n = 57)	CCHD (n = 28)	Total (%)	*p*-value
Underweight (< –2 SD)	42 (73.7 %)	21 (75.0 %)	74.1 %	0.89
Stunting (< –2 SD)	36 (63.2 %)	19 (67.9 %)	64.7 %	0.67

Nutritional Parameter	ACHD (n = 57)	CCHD (n = 28)	Total (%)	*p*-value
Wasting (< –2 SD)	39 (68.4 %)	21 (75.0 %)	70.6 %	0.53
BMI < 5th centile	32 (56.1 %)	17 (60.7 %)	57.6 %	0.69

Energy and protein intakes were below 75 % of recommended levels in nearly two-thirds of children. Poor dietary adequacy was significantly associated with underweight and wasting ($p < 0.05$).

Haematological Parameters

The mean haemoglobin among all participants was **11.13 ± 1.46 g/dL**. Anaemia (as per WHO criteria) was present in **45 (52.9 %)** children—**33 (57.9 %)** in the acyanotic group and **12 (42.9 %)** in the cyanotic group ($p = 0.19$).

Polycythaemia was documented in **7 (25 %)** of cyanotic cases.

Mean MCV and MCH values were significantly higher among cyanotic CHD, indicating erythrocytosis.

Table 3. Haematological Profile in Children with CHD

Parameter	ACHD (mean ± SD)	CCHD (mean ± SD)	*p*-value
Haemoglobin (g/dL)	10.85 ± 1.35	11.59 ± 1.68	0.07
MCV (fL)	75.18 ± 7.52	82.35 ± 6.22	0.001*
MCH (pg)	25.07 ± 2.91	26.74 ± 3.08	0.04*
MCHC (g/dL)	32.60 ± 1.21	33.04 ± 1.18	0.16
RDW (%)	15.83 ± 2.61	14.88 ± 2.42	0.14

*Statistically significant ($p < 0.05$)

Microcytosis and elevated RDW were more common among acyanotic children, consistent with iron-deficiency patterns. Polycythaemia correlated positively with oxygen saturation levels in cyanotic cases.

Discussion

The present study assessed the nutritional and anaemia status in children aged 1–12 years with congenital heart disease (CHD) and demonstrated a high prevalence of malnutrition and anaemia in both cyanotic and acyanotic groups. Overall, 74% of children were underweight, 65% stunted, and 71% wasted, reflecting significant growth retardation across all age groups. Anaemia was present in 53% of the cohort and polycythaemia in one-fourth of cyanotic cases.

In the present series, males constituted 60% of the cases with a male-to-female ratio of 1.5:1, similar to findings reported by Vaidyanathan et al., where 58% were males [3].

The predominance of children below 5 years (69%) highlights the early presentation and diagnosis of CHD in infancy and early childhood, comparable to data from Hassan et al. (mean age 3.7 years) [6].

Nutritional Status

Malnutrition was the most striking finding in this study. Nearly three-fourths of the children were underweight, consistent with previous Indian and African studies that reported 60–85% prevalence of growth failure among children with CHD [7]. Okoromah et al. observed underweight in 79% and wasting in 66% of unoperated CHD cases in Nigeria, which correlates closely with our findings. [8]

Similarly, Vaidyanathan et al. from South India reported underweight in 59% and wasting in 66% of children awaiting surgery [3].

The high rate of growth retardation can be attributed to multifactorial causes including feeding difficulty, recurrent respiratory infections, increased metabolic demand, and low socioeconomic background.

Children with cyanotic lesions exhibited marginally higher prevalence of stunting and wasting, possibly due to chronic hypoxia, poor systemic perfusion, and delayed surgical intervention [9]. Energy and protein intake were suboptimal in two-thirds of children, confirming inadequate caloric intake as a major contributor. Similar dietary insufficiency patterns were noted by Forchielli et al., who emphasized that early nutritional rehabilitation is critical for improving surgical outcomes [10].

Anaemia was found in 52.9% of the study population, comparable to 48–55% prevalence reported in previous studies [11,12]. It was more frequent in acyanotic CHD (57.9%) and was mainly microcytic and hypochromic, consistent with iron-deficiency anaemia. Cyanotic patients showed significantly higher mean MCV and MCH values, reflecting compensatory erythrocytosis from chronic hypoxia, as described by Gaiha et al. [13] and Binh et al [11]. RDW was elevated in acyanotic CHD, suggesting nutritional anaemia of mixed etiology, similar to observations by Rabiya et al. [14].The intergroup differences in MCV and MCH ($p < 0.05$) reaffirm the contrasting haematologic adaptations between cyanotic and acyanotic lesions.

Clinical Implications

The coexistence of malnutrition and anaemia significantly impacts clinical outcomes in CHD. Malnourished children have higher risk of postoperative complications, longer hospital stays, and delayed recovery【15】.

Nutritional screening and dietary counseling should therefore be integrated into routine care of all CHD patients.

Iron studies and haematological monitoring are essential for both acyanotic (to detect deficiency) and cyanotic (to prevent hyperviscosity) cases.

Early nutritional intervention may improve surgical readiness, reduce morbidity, and enhance long-term growth.

This was a single-centre, cross-sectional study with a modest sample size, limiting generalizability. Micronutrient assays and dietary recall were not standardized against biochemical markers. However, the study provides valuable baseline data from a tertiary care Indian population.

Conclusion

Malnutrition and anaemia are highly prevalent among children with congenital heart disease irrespective of lesion type.

Underweight, stunting, and wasting were observed in over two-thirds of patients, and anaemia affected more than half of the cohort.

Acyanotic CHD was commonly associated with iron-deficiency anaemia, while cyanotic CHD frequently exhibited secondary polycythaemia.

Routine nutritional assessment and early correction of anaemia should be integral to preoperative management of CHD to improve clinical and surgical outcomes.

Further longitudinal studies incorporating nutritional interventions and micronutrient profiling are recommended to better understand and mitigate these preventable comorbidities.

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