



ORIGINAL RESEARCH ARTICLE

Anthropometric and Nutritional Status Assessment of Children with Congenital Heart Disease Attending a Tertiary Care Paediatric Cardiology Clinic

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Abstract

Background: Children with congenital heart disease (CHD) are at increased risk of malnutrition and growth failure, arising from a combination of increased metabolic demand, feeding difficulty, and recurrent respiratory infection, with cyanotic lesions generally considered to confer greater nutritional risk than acyanotic lesions.

Objectives: To assess the anthropometric and nutritional status of children with CHD attending a tertiary care paediatric cardiology clinic, and to compare the prevalence of undernutrition between children with cyanotic and acyanotic CHD.

Methods: A cross-sectional observational study was conducted on 152 children with echocardiographically confirmed CHD. Anthropometric measurements were obtained and converted to WHO z-scores, and nutritional status was compared between children with cyanotic and acyanotic CHD.

Results: Ventricular septal defect was the most common lesion (35.5%). Underweight was present in 46.1% of children overall, with a significantly higher prevalence among children with cyanotic CHD (57.6%) compared with acyanotic CHD (39.6%). Similar patterns were observed for stunting and wasting. Recurrent lower respiratory tract infection (44.7%) and feeding difficulty (40.1%) were the most common associated factors.

Conclusion: Undernutrition is highly prevalent among children with CHD in this population, with cyanotic lesions associated with significantly greater nutritional compromise than acyanotic lesions, underscoring the importance of routine, structured nutritional assessment and early intervention in this vulnerable group.

Keywords: Congenital heart disease, malnutrition, anthropometry, growth failure, paediatrics.

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1 | INTRODUCTION

Congenital heart disease (CHD) is among the most common groups of congenital malformations, affecting approximately 8 to 9 per 1000 live births worldwide, and remains an important cause of childhood morbidity, particularly in settings where access to timely corrective surgery is limited. (1–3) Beyond its direct cardiovascular effects, CHD is strongly associated with malnutrition and growth failure in affected children, a relationship first systematically described several decades ago and consistently reaffirmed in subsequent clinical studies across diverse populations. (4, 5)

The mechanisms underlying growth failure in CHD are multifactorial, encompassing increased resting energy expenditure related to increased cardiac and respiratory work, reduced caloric intake due to feeding difficulty and fatigue during feeds, malabsorption related to chronic venous congestion of the gut, and recurrent respiratory infections that further compromise nutritional intake and increase metabolic demand. (4) Cyanotic lesions, characterised by chronic hypoxaemia, have generally been associated with more severe growth failure than acyanotic lesions, reflecting the additive nutritional impact of chronic tissue hypoxia alongside the shared mechanical and infective contributors common to both lesion types. (5, 6)

Indian and other regional studies have consistently documented a high prevalence of malnutrition among children with CHD, with some series reporting rates exceeding 50%, considerably higher than background population rates of undernutrition in the same settings, underscoring the specific nutritional vulnerability conferred by underlying cardiac disease itself. (7, 8) Given the well-established association between preoperative nutritional status and postoperative outcomes following corrective cardiac surgery, accurate and routine nutritional assessment remains an important, though sometimes underemphasised, component of the comprehensive care of children with CHD. (9, 10)

This study was undertaken to assess the anthropometric and nutritional status of children with CHD attending a tertiary care paediatric cardiology clinic,

and to compare the prevalence and severity of undernutrition between children with cyanotic and acyanotic CHD.

Beyond its relevance to surgical outcome, characterising the nutritional burden associated with CHD carries broader clinical and public health value, as growth failure in this population may go unrecognised or under-prioritised relative to the primary cardiac diagnosis, particularly in busy specialist clinics focused predominantly on cardiological assessment. Systematic documentation of nutritional status alongside cardiac diagnosis can help ensure that growth failure receives appropriate clinical attention and timely intervention throughout the course of a child's cardiac care journey, from initial diagnosis through to corrective surgery and beyond. (11)

2 | MATERIALS AND METHODS

2.1 | Study Design and Setting

This was a hospital-based, cross-sectional observational study conducted in the Department of Paediatrics, in association with the paediatric cardiology clinic, of a tertiary care teaching hospital.

2.2 | Study Population

A total of 152 children with echocardiographically confirmed CHD attending the paediatric cardiology clinic were enrolled after obtaining informed parental consent.

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2.3 | Inclusion Criteria

Children aged 0 to 12 years with echocardiographically confirmed CHD, either previously uncorrected or awaiting corrective intervention, were included.

2.4 | Exclusion Criteria

Children who had already undergone complete corrective cardiac surgery, those with a known chromosomal or syndromic disorder independently associated with growth failure, and those unwilling to provide consent were excluded from the study.

2.5 | Anthropometric Assessment

Weight was measured using a calibrated digital weighing scale, and length or height was measured using a stadiometer or infantometer as age-appropriate, following standard technique. Weight-for-age, height/length-for-age, and weight-for-height z-scores were calculated using WHO Child Growth Standards reference data. Underweight, stunting, and wasting were defined as the respective z-score falling below -2 standard deviations.

2.6 | Clinical Classification

Children were classified as having cyanotic or acyanotic CHD based on echocardiographic diagnosis and clinical assessment of oxygen saturation. Additional clinical data, including history of recurrent respiratory infection, feeding difficulty, congestive cardiac failure, birth weight, and age at diagnosis, were recorded using a structured proforma.

2.7 | Operational Definitions

Recurrent lower respiratory tract infection was defined as three or more episodes requiring medical attention within the preceding twelve months. Feeding difficulty was defined as caregiver-reported prolonged feeding time exceeding 30 minutes per feed, feed refusal, or diaphoresis during feeding. Congestive cardiac failure was diagnosed based on standard clinical criteria, including tachypnoea, tachycardia, hepatomegaly, and poor weight gain. Delayed diagnosis was defined as an interval exceeding six

months between the onset of suggestive symptoms or signs and echocardiographic confirmation of CHD.

2.8 | Statistical Analysis

Data were entered into a spreadsheet and analysed using descriptive statistics. Categorical variables were expressed as frequencies and percentages, and nutritional parameters were compared between children with cyanotic and acyanotic CHD. Results were tabulated and represented graphically using multiple chart formats, including a detailed schematic illustration of growth impact and underlying cardiac anatomy.

3 | RESULTS

Of the 152 children studied, 84 (55.3%) were male and 68 (44.7%) were female. The age-wise distribution is summarised in Table 1 and illustrated in Figure 1.

The 1–2 year age group accounted for the largest proportion of cases (25.0%), reflecting the typical age at presentation to paediatric cardiology services in this setting, often following recognition of feeding difficulty, recurrent respiratory infection, or a murmur on routine examination.

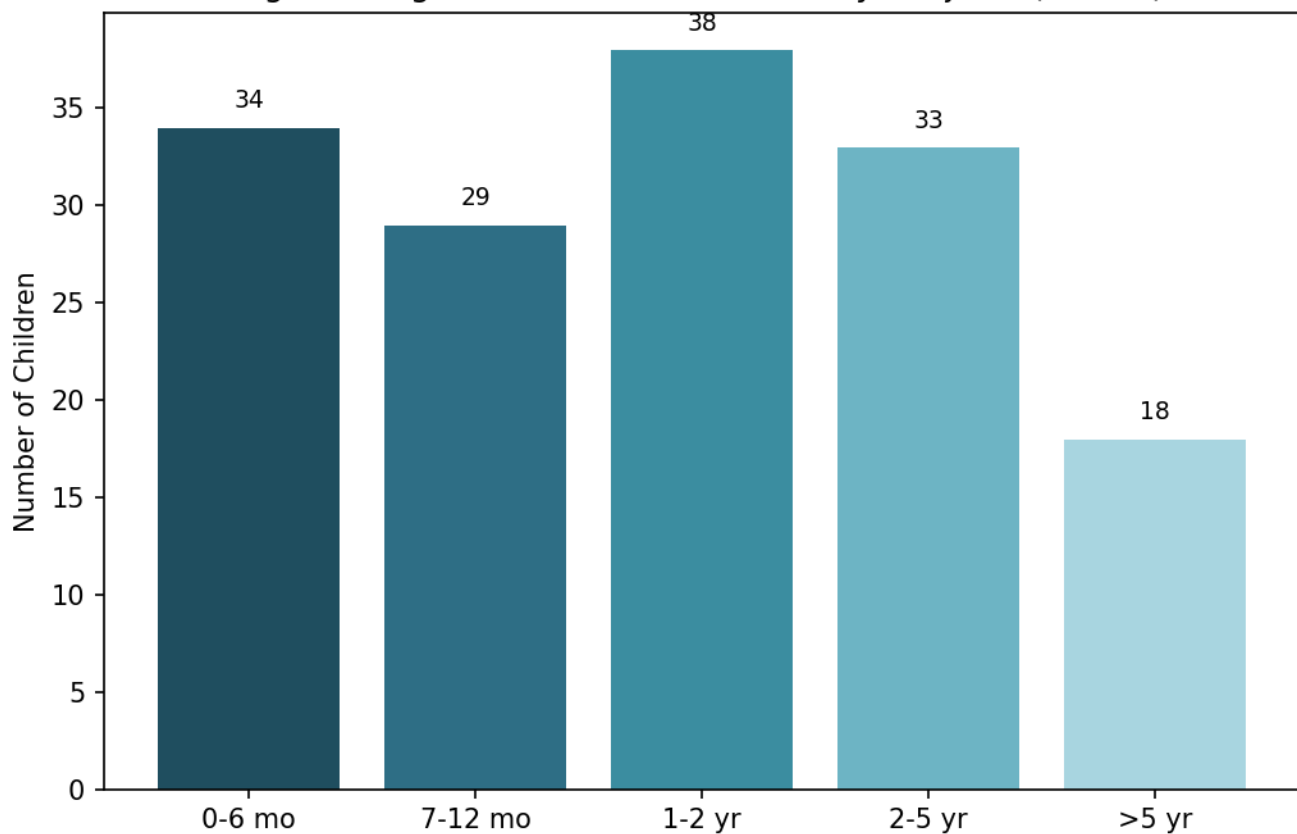
Ventricular septal defect was the most common lesion overall (35.5%), followed by atrial septal defect (20.4%) and patent ductus arteriosus (15.8%). Acyanotic lesions collectively accounted for 93 children (61.2%), while cyanotic lesions, predominantly tetralogy of Fallot, accounted for 59 children (38.8%).

As shown in Table 3 and Figure 3, all three nutritional parameters were significantly more prevalent among children with cyanotic CHD compared with acyanotic CHD: underweight (57.6% vs 39.6%), stunting (45.8% vs 29.7%), and wasting (40.7% vs 24.2%), consistent with the additive nutritional impact of chronic hypoxaemia in cyanotic lesions.

Recurrent lower respiratory tract infection (44.7%) and feeding difficulty (40.1%) were the most commonly associated factors, followed by congestive cardiac failure at presentation (27.6%) and delayed

TABLE 1: Age and Gender-wise Distribution of Study Subjects (n = 152)

Age Group	Male (n)	Female (n)	Total (n)	Percentage (%)
0–6 months	19	15	34	22.4
7–12 months	16	13	29	19.1
1–2 years	21	17	38	25.0
2–5 years	18	15	33	21.7
Above 5 years	10	8	18	11.8
Total	84	68	152	100.0

Figure 1: Age-wise Distribution of Study Subjects (n=152)**FIGURE 1:****TABLE 2: Distribution by Type of Congenital Heart Disease (Figure 2)**

Type of Congenital Heart Disease	Number (n)	Percentage (%)
Ventricular septal defect (VSD)	54	35.5
Atrial septal defect (ASD)	31	20.4
Patent ductus arteriosus (PDA)	24	15.8
Tetralogy of Fallot	19	12.5
Atrioventricular septal defect	12	7.9
Others	12	7.9

Figure 2: Distribution by Type of Congenital Heart Disease (n=152)

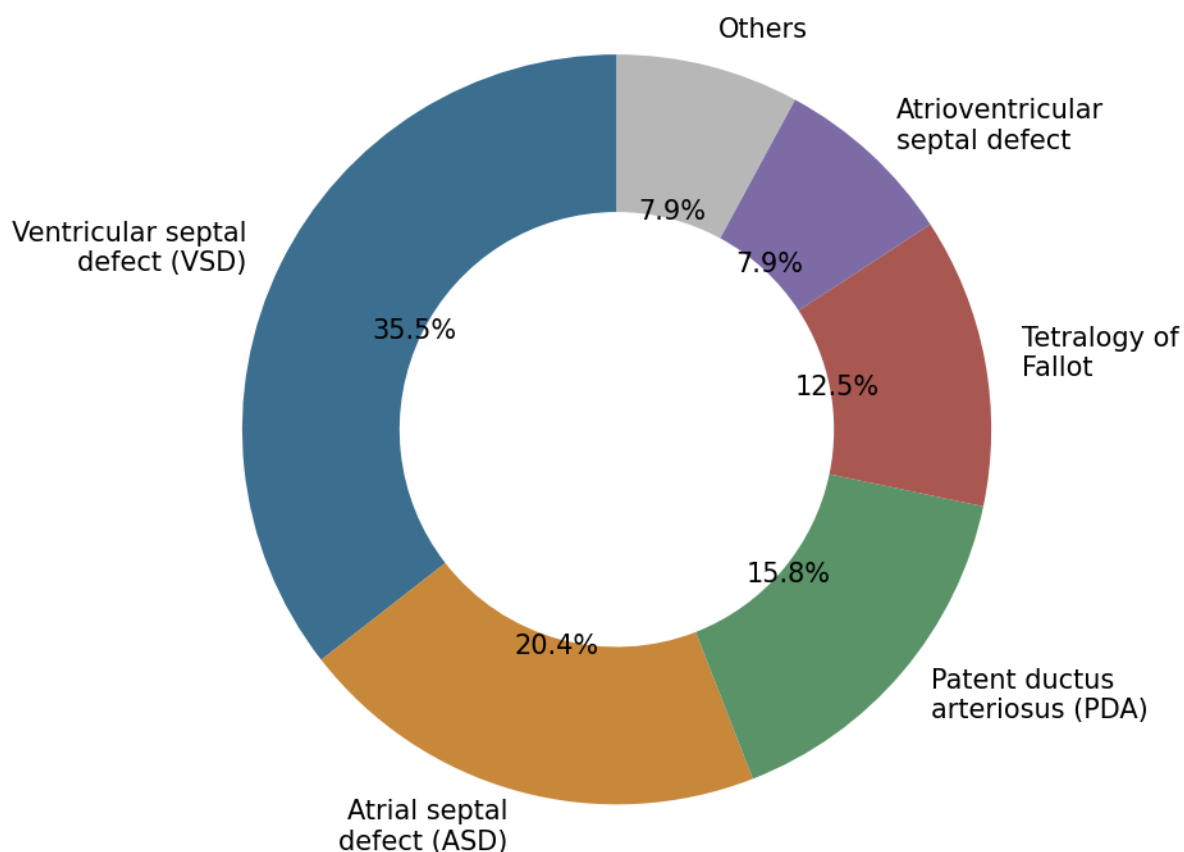


FIGURE 2:

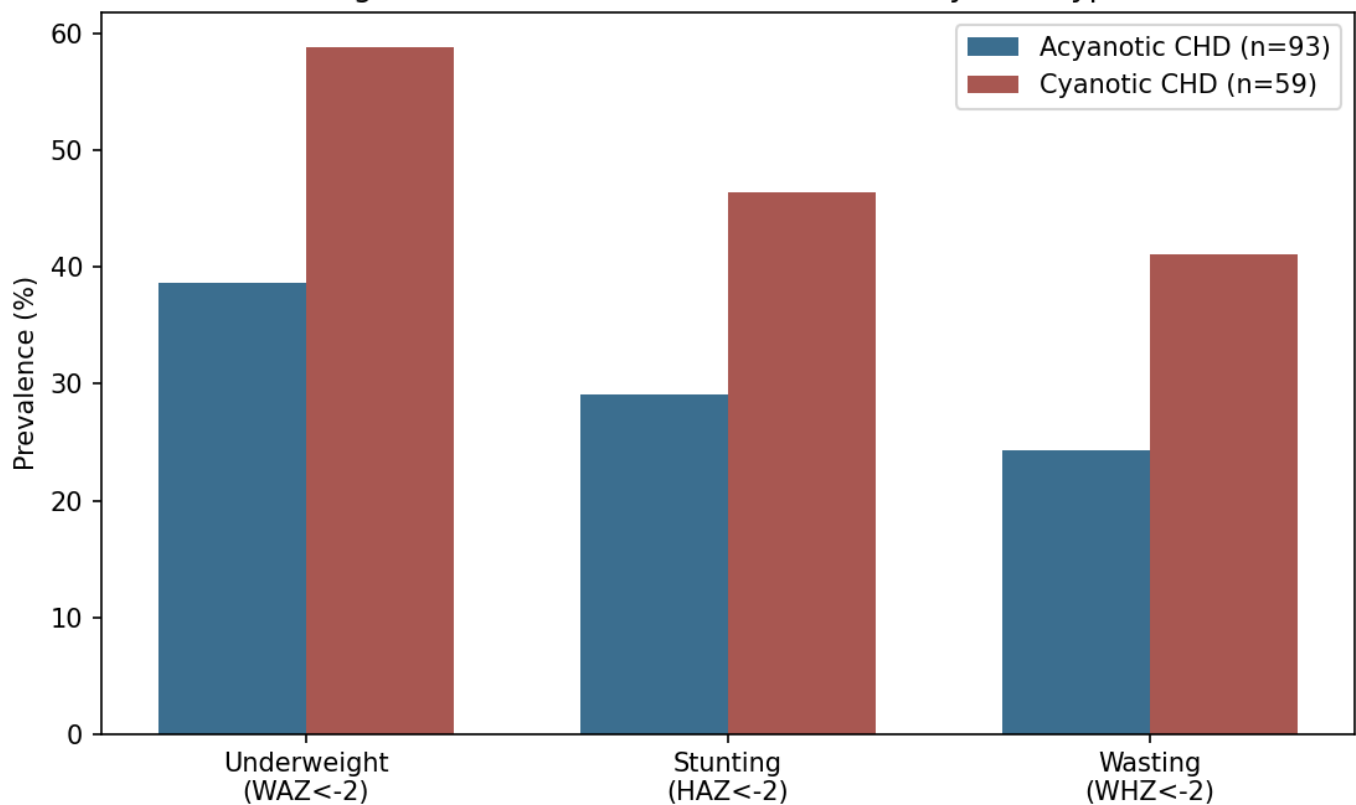
TABLE 3: Prevalence of Undernutrition by CHD Type (Figure 3)

Nutritional Parameter	Acyanotic n	Acyanotic %	Cyanotic n	Cyanotic %	Total n	Total %
Underweight (WAZ < -2)	36	39.6	34	57.6	70	46.1
Stunting (HAZ < -2)	27	29.7	27	45.8	54	35.5
Wasting (WHZ < -2)	22	24.2	24	40.7	46	30.3

TABLE 4: Factors Associated with Undernutrition

Associated Factor	Number (n)	Percentage (%)
Recurrent lower respiratory tract infection	68	44.7
Feeding difficulty / prolonged feeding time	61	40.1
Congestive cardiac failure at presentation	42	27.6
Delayed diagnosis (>6 months from symptom onset)	39	25.7
Low birth weight	33	21.7

Figure 3: Prevalence of Undernutrition by CHD Type

**FIGURE 3:**

diagnosis beyond six months from symptom onset (25.7%).

Figure 4 provides a detailed schematic illustration showing the typical growth trajectory of a child with CHD relative to WHO growth standards, alongside a simplified diagram of the anatomical basis of a ventricular septal defect.

4 | DISCUSSION

The overall prevalence of underweight (46.1%) observed in this study is consistent with, though somewhat higher than, rates reported in several other hospital-based series of children with CHD, reflecting the well-established nutritional vulnerability of this population and possibly also the relatively late age at presentation and diagnosis common in resource-limited settings. (9, 11, 12) The significantly higher prevalence of undernutrition observed among children with cyanotic compared with acyan-

otic CHD in this study closely mirrors the findings of earlier studies specifically examining the differential nutritional impact of cyanotic and acyanotic lesions, reinforcing the additive contribution of chronic hypoxaemia to growth failure beyond the shared mechanical and infective factors common to both lesion groups. (13, 14)

The strong association observed between recurrent lower respiratory tract infection and undernutrition in this study reflects the well-recognised bidirectional relationship between these two conditions in children with CHD, wherein increased pulmonary blood flow in left-to-right shunt lesions predisposes to recurrent respiratory infection, which in turn further compromises nutritional intake and growth. (14) Similarly, the substantial proportion of children reporting feeding difficulty is consistent with the well-documented mechanical and physiological challenges to adequate caloric intake faced by infants with CHD, including fatigue during feeding related to increased work of breathing and cardiac

ANTHROPOMETRIC AND NUTRITIONAL STATUS ASSESSMENT OF CHILDREN WITH CONGENITAL HEART DISEASE

Illustrative Diagrams: Growth Impact and Anatomical Basis of Acyanotic Congenital Heart Disease
(Schematic illustrations, not actual patient charts or imaging)

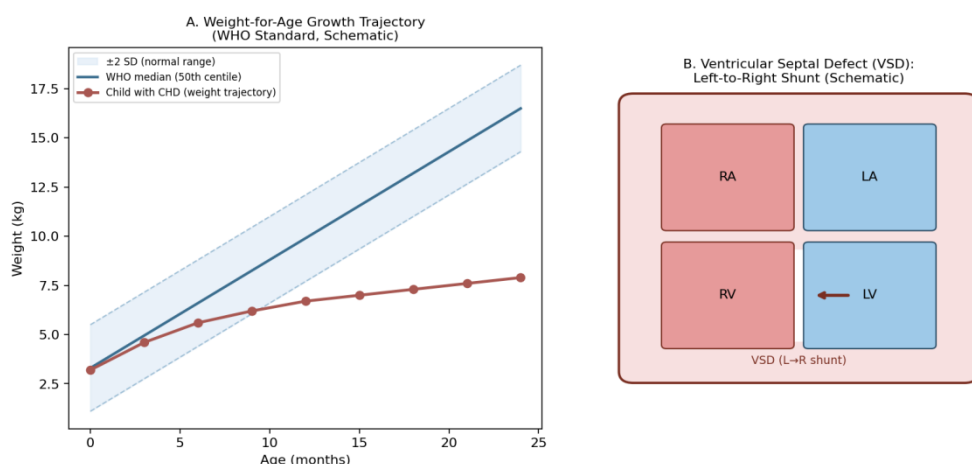


FIGURE 4:

output demands. (15, 16)

The association observed between delayed diagnosis and undernutrition in this study highlights the potential nutritional cost of late presentation to cardiology services, a pattern that has been similarly described in other resource-limited settings where access to paediatric cardiology expertise and diagnostic echocardiography may be geographically or economically constrained. This underscores the importance of early clinical suspicion and prompt referral for suspected CHD in primary care and general paediatric practice, given the potential to mitigate cumulative nutritional compromise through earlier diagnosis and intervention.

These findings collectively reinforce the importance of routine, structured nutritional assessment as an integral component of the clinical evaluation of children with CHD, alongside standard cardiological assessment, given the well-established relationship between preoperative nutritional status and postoperative surgical outcomes described in the broader literature. (16)

It is also worth considering that the relationship between undernutrition and CHD severity is likely bidirectional and self-reinforcing in many cases: chronic hypoxaemia and increased cardiac workload predispose to growth failure, while resulting undernutrition may in turn impair respiratory muscle function and immune competence, further increasing susceptibil-

ity to the recurrent respiratory infections that were so commonly observed in this study. Breaking this cycle through early nutritional intervention, even before definitive corrective surgery is feasible, may therefore have benefits extending beyond growth parameters alone to encompass reduced infection burden and improved overall clinical resilience in the period leading up to surgery.

5 | SUMMARY

This cross-sectional study of 152 children with CHD found that underweight was present in 46.1% overall, with significantly higher prevalence of underweight, stunting, and wasting among children with cyanotic compared with acyanotic CHD. Recurrent respiratory infection and feeding difficulty were the most commonly associated factors, and delayed diagnosis was associated with greater nutritional compromise.

Taken together, these findings position nutritional assessment not as a peripheral consideration but as a core element of comprehensive CHD care, meriting the same systematic attention within routine clinic workflows as haemodynamic and anatomical cardiac assessment itself.

6 | LIMITATIONS

This study has several limitations that merit consideration. First, its single-centre, hospital-based design may not fully represent the broader population of children with CHD in the community, particularly those who have not yet accessed specialist cardiology care. Second, the cross-sectional design precludes assessment of the trajectory of nutritional status over time or the temporal relationship between specific associated factors and the development of undernutrition. Third, this study did not include detailed dietary intake assessment, which would have provided additional insight into the specific contribution of inadequate caloric intake relative to increased metabolic demand in the observed growth failure.

Additionally, this study did not stratify the severity of individual cardiac lesions using standardised haemodynamic or anatomical severity scoring systems, which may have obscured additional heterogeneity in nutritional risk within the broad cyanotic and acyanotic groupings used. Future studies incorporating lesion-specific severity grading, alongside longitudinal anthropometric follow-up from diagnosis through to post-surgical recovery, would provide a more granular understanding of the evolving nutritional trajectory in this population.

7 | RECOMMENDATIONS

Based on the findings of this study, routine anthropometric assessment using WHO growth standards should be incorporated as a standard component of the clinical evaluation of all children with CHD at every clinic visit, with particular vigilance in children with cyanotic lesions given their significantly greater nutritional risk. Early referral for suspected CHD should be encouraged in primary care and general paediatric settings, given the association observed between delayed diagnosis and nutritional compromise. Structured nutritional support and feeding assessment should be integrated into the multidisciplinary care of children with CHD, particularly those awaiting corrective surgery, and larger, longitudinal studies would help further characterise the impact of early nutritional intervention on both growth and

postoperative outcomes in this population.

Paediatric cardiology clinics should consider establishing formal links with dietetic and nutrition rehabilitation services to ensure timely referral of children identified with growth failure, rather than relying solely on incidental recognition during routine cardiology follow-up. Caregiver education regarding feeding techniques adapted to the increased metabolic demands and feeding fatigue characteristic of CHD, including smaller, more frequent feeds and energy-dense feeding strategies, should be provided as a routine component of clinic counselling.

8 | CONCLUSION

Undernutrition is highly prevalent among children with CHD attending this tertiary care paediatric cardiology clinic, with cyanotic lesions associated with significantly greater nutritional compromise than acyanotic lesions. Recurrent respiratory infection, feeding difficulty, and delayed diagnosis were important associated factors, underscoring the importance of routine, structured nutritional assessment and early intervention as an integral part of comprehensive care for this vulnerable group of children.

Sustained clinical attention to nutritional status throughout the CHD care pathway, from initial diagnosis through pre-surgical optimisation to post-surgical recovery, offers a tangible and modifiable opportunity to improve both growth outcomes and broader clinical resilience in this population of children who already carry a substantial burden of underlying cardiac disease.

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