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ORIGINAL ARTICLE

# Anthropometric assessment of children with un-operated congenital heart disease presenting at Faisalabad Institute of Cardiology, Faisalabad.

**Abdul Razzaq Mughal[1], Rubina Tousif[2], Motia Javed[3], Asma Riaz[4], Tahir Mahmood[5], Muhammad Usman Zia[6]**

**ABSTRACT… Objective:** To assess the anthropometric and nutritional status of children with un-operated congenital heart disease. **Study Design:** Prospective, Cross-sectional study. **Setting:** Pediatric Cardiology Department of Faisalabad Institute of Cardiology (FIC). **Period:** July 2025 to December 2025. **Methods:** 355 children (6 months to 10 years of age) having an echocardiographic confirmed diagnosis of CHD were enrolled . Anthropometric measurements including mid-upper arm circumference (MUAC), body mass index (BMI), weight-for-age, height-for-age, and weight-for-height were recorded by standard technique and nutritional status assessed. Data was analyzed using SPSS version 22, with p value <0.05 considered statistically significant. **Results:** Of 355 participants, 53% were female (n=188). The largest age group was 2-5 years (42.8%, n=152). Cyanotic CHD was present in 20.6% (n=73) while remainder had acyanotic CHD. Overall, 85.9% of study subjects were malnourished. Malnutrition was seen in 89% of Cyanotic CHD (n=65) children while 85.1% of acyanotic CHD were malnourished (n=240). BMI was significantly lower in cyanotic patients (p=0.03). Height-for-age and weight-for-height also showed significant differences (p=0.04 and p=0.03, respectively), with cyanotic patients showing greater degree of wasting and malnutrition while stunting was slightly more common in acyanotic CHD. Weight-for-age did not differ significantly (p=0.06). **Conclusion:** Children with cyanotic CHD exhibit more severe malnutrition than those with acyanotic CHD. Early nutritional screening and targeted interventions are crucial to improve growth and reduce complications in this vulnerable population.

**Key words:** Acyanotic, Anthropometric Measurements, Congenital Heart Disease, Cyanotic, Malnutrition.

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## INTRODUCTION

Congenital heart disease (CHD) is a manifestation of structural defects that affect the well-being and development of pediatric patients.[1] The reported incidence of CHD is between 0.8-1%[2], and CHD has been linked to high morbidity and mortality. The prevalence of CHD in Asia is 9.3 per 1000 live births.[3] CHD is clinically divided into cyanotic and acyanotic lesions. Cyanotic defects like Tetralogy of Fallot (TOF) having a right-to-left shunt lead to hypoxia and visible cyanosis while acyanotic lesions, such as ventricular septal defect (VSD), have a left to right shunt resulting in no systemic oxygen deficiency.[4]

In low- to middle-income Asian countries, the incidence of malnutrition in children of CHD is up to 86%.[5] This has been attributed to low caloric intake, lesion spectrum and severity, high metabolic needs, frequent infections, chronic anemia, as well as chronic hypoxemia.[6] The CHD leads to feeding complications and impaired uptake of nutrients increasing the likelihood of malnutrition, worsening clinical outcomes and increasing morbidity in both cyanotic and acyanotic forms.[7-9] Therefore, such children often have low muscle mass and a weak immune system, which makes them more vulnerable to various infections and postoperative complications. Some of the common anthropometric deviations in such children are reduced weight-for-age, height-for-age, and body-mass index.[10]

More severe malnutrition has been reported in cyanotic CHD patients, which can be explained by the limitation of oxygen supply provided to the body, thus reducing the feeding capacity and development rate.[11] The type and severity of lesions of the body are key factors in determining the nutritional status

1. MBBS, FCPS (Pediatric Cardiology), FCPS (Pediatric Medicine), Associate Professor Pediatric Cardiology, FIC, Faisalabad.
2. MBBS, FCPS (Pediatric Medicine), Assistant Professor Pediatric Cardiology, CPEIC, Multan.
3. MBBS, FCPS (Pediatric Cardiology), FCPS (Pediatric Medicine), Assistant Professor Pediatric Cardiology, FIC, Faisalabad.
4. PHD Scholar, Assistant Professor Applied Psychology, Government College University, Faisalabad.
5. MBBS, FCPS (Pediatric Medicine), Professor Pediatrics, Abwa Medical College, Faisalabad.
6. MBBS, FCPS (Pediatric Medicine), Senior Registrar Pediatric Cardiology, FIC, Faisalabad.

**Correspondence Address:**
Dr. Abdul Razzaq Mughal
Room# 8, Faisalabad Institute of Cardiology, Faisalabad
a.razzaq.cs@gmail.com

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of the body; serious cyanotic lesions can lead to severe underweighting and stunting, along with loss of muscle mass, unlike acyanotic lesions like atrial septal defect (ASD) or ventricular septal defect (VSD).[7,8] Less physical activity surrounding the cyanotic disease also contributes to the growth deficits. Even though malnutrition might also manifest in acyanotic CHD, generally at a less severe level, the formation of severe malnutrition can still be possible in case it is not managed.[12]

Malnutrition is a major modifiable factor influencing the prognosis of children with CHD. Early recognition and targeted nutritional interventions can improve clinical outcomes, enhance surgical recovery, and reduce complications.

In Pakistan, where delayed diagnosis and limited access to corrective surgery are common, un-operated children with CHD remain particularly vulnerable to growth failure. Despite this, there is limited local data assessing the anthropometric profile of these children, especially in tertiary cardiac centers. By identifying the extent of malnutrition in this population, strategies for timely nutritional and medical interventions can be designed. This study aims to assess the anthropometric and nutritional status of children with un-operated congenital heart disease presenting at Faisalabad Institute of Cardiology.

## METHODS

This was an institution-based, cross-sectional observational study conducted at the Pediatric Cardiology Department of Faisalabad Institute of Cardiology, over a period of six months from July 2025 to December 2025. Faisalabad Institute of cardiology is a tertiary cardiac care institute which provides care to all patients of congenital heart disease. A total of 355 patients were enrolled using a non-probability consecutive sampling technique. Children of any gender (Male/ Female), age between six months zero day to ten years having a confirmed diagnosis of congenital heart disease, on the basis of echocardiography done by the dedicated pediatric cardiologist of the institute were enrolled. Those children who were diagnosed as syndromic on the phonotypical features, Children with major chronic illnesses or co-morbidities, Children who had undergone surgical or palliative cardiac or major non-cardiac procedures, those having history of prematurity (gestational age <37 weeks) or those children whose parents/ guardians did not give consent were excluded from the study.

After approval from the institutional ethical review committee (2-2025/DME/FIC/FSD) and obtaining informed consent from parents/guardians, eligible patients were recruited from the outpatient department (OPD). There was no conflict of interest. The Demographic information including age (Months/ years), gender (male/female), dietary history, and Echocardiographic findings were noted. Anthropometric measurements including height/ length (centimeter), weight (Kilograms), Body mass Index (BMI), occipitofrontal circumference (OFC) and mid-upper arm circumference (MUAC) of the study subjects were recorded by the principal investigator in a dedicated comfortable outdoor clinic room of the department and entered in the predesigned dedicated Proforma.

### Anthropometric Measurements and Operational Definitions

#### Anthropometric Measurements

This included height, weight; occipitofrontal circumference (OFC), body mass index (BMI), and mid-upper arm circumference (MUAC)

#### Height/Length

The length was measured for children less than two years of age. The length was measured in the supine position using an infantometer. For children more than two years, standing height was measured with a stadiometer, without shoes, with the head in the Frankfurt plane. The value was recorded to the nearest 0.1 cm.

#### Weight

For infants, weight was measured on a digital baby scale, without clothes or with minimal clothing. For older children, weight was measured using a calibrated digital weighing scale, barefoot and with light clothing. The weight was recorded to the nearest 0.1 kg.

#### Body Mass Index (BMI)

The BMI was calculated as:

BMI= Weight (kg) / Height (m)2.

### Mid-Upper Arm Circumference (MUAC)

MUAC was measured using a non-stretchable measuring tape on the left arm, midway between the acromion and olecranon processes, with the arm relaxed. It was recorded to the nearest 0.1 cm.

### Occipitofrontal Circumference (OFC)

The OFC was measured with a non-stretchable tape placed around the head, passing above the eyebrows and over the most prominent part of the occiput. It was recorded to the nearest 0.1 cm.

### Growth Charts and Reference Standards

The measurements were plotted on WHO standardized growth charts (2006) for height-for-age (HAZ), weight-for-age (WAZ) and weight-for-height (WHZ). The study participants were labelled as normal, underweight, stunted, wasted and obese according to z score of WHO growth charts[13].

### Operational Definitions

### Congenital Heart Disease (CHD)

Anatomically structural and functional defect of the heart present at birth, either as a major or minor anomalies, confirmed by dedicated pediatric cardiologist with echocardiography

### Malnutrition

Severe acute malnutrition (SAM): MUAC less than 11.5cm
Moderate acute malnutrition (MAM): MUAC between 11.5-12.5cm
Normal nutritional status: MUAC more than 12.5cm

### Z-Scores

Z-scores were generated and participants were categorized accordingly.
Normal: Z-score between –2 SD and +2 SD on WHO growth charts.
Underweight: Weight-for-age Z-score < –2 SD.
Stunted: Height-for-age Z-score < –2 SD.
Wasted: Weight-for-height Z-score < –2 SD.
Obese: Weight-for-height Z-score > +2 SD.
Severe Malnutrition: Z-score < –3 SD for any of the indices.

### Data Analysis

Data were entered and analyzed using SPSS version 22. Categorical variables were summarized as frequencies and percentages, while continuous variables were presented as mean ± standard deviation (SD). Differences between groups were assessed using the Chi-square test for categorical variables and the independent t-test for quantitative variables. A p-value of <0.05 was considered statistically significant.

## RESULTS

A total of 355 patients who fulfilled the inclusion criteria were enrolled, of whom 53% were female and 47% male. As regard age, the majority (42.8%, n=152) were of 2–5 years old. Cyanotic CHD was present in 20.6% (n=73) of study subjects, while 79.4% (n=282) patients had acyanotic CHD. Figure-1 shows the baseline characteristics of the study population.

The congenital heart disease types were analyzed further which revealed that among Acyanotic CHD cases, VSD (46.8%) was most frequent, followed by ASD (27%) and PDA (18.8%) while among Cyanotic CHD, Tetralogy of Fallot (67.1%) was the most common. Table-I describes the distribution of study subjects according to type of CHD.

The malnutrition was detected in 85.9 % of the study subjects (Including both SAM and MAM). As regards anthropometric comparison among participants with acyanotic and cyanotic CHD, mid upper arm circumference (MUAC) showed distribution of severe acute malnutrition (SAM) and moderate acute malnutrition (MAM) as significant difference between these groups (p=0.01). The body mass index (BMI) also differed significantly (p=0.03), as shown in Table-II. The weight-for-age did not show a statistically significant difference (p=0.06) but most patients were severely underweight. Height-for-age showed a significant difference (p=0.04), with severe stunting both in cyanotic (72.6%) and acyanotic patients (75.5%). Weight-for-height also varied significantly (p=0.03) with severe wasting in cyanotic (75.3%) and acyanotic (72.3%) patients. Severe malnutrition, underweight, stunting, and wasting were common in both groups (Table-II).

**TABLE-I**

**Distribution of study subjects according to type of CHD**

| Type of Disease | No. of Patients (n=355) | Percentages (%) |
|---|---|---|
| Acyanotic CHD | 282 (79.4%) | |
| Ventricular Septal Defect (VSD) | 132 | 46.8% |
| Atrial Septal Defect (ASD) | 76 | 27.0% |
| Patent Ductus Arteriosus (PDA) | 53 | 18.8% |
| AV canal defect | 8 | 2.8% |
| Pulmonary Valve stenosis | 5 | 1.8% |
| Aortic valve stenosis | 5 | 1.8% |
| Coarctation of aorta | 3 | 1.0% |
| **Cyanotic CHD** | **73 (20.6%)** | |
| Tetralogy of Fallot (TOF) | 49 | 67.1% |
| Ebstein Anomaly | 3 | 4.1% |
| TAPVC | 4 | 5.5% |
| Transposition of great arteries (TGA) | 7 | 9.6% |
| Truncus arteriosus | 2 | 2.7% |
| Univentricular Heart | 4 | 5.5% |
| Congenitally corrected TGA | 4 | 5.5% |

**TABLE-II**

**Comparison of anthropometric measurements and type of disease (n=355)**

| Anthropometrics | Cyanotic (n=73) | Acyanotic (n=282) | P-Value |
|---|---|---|---|
| **MUAC** | | | |
| SAM (<11.5cm) | 46 (63%; CI: 51.9–74.1) | 179 (63.5%; CI: 57.7–69.1) | 0.01 |
| MAM (11.5-12.5cm) | 19 (26%; CI: 15.96–36.1) | 61 (21.6%; CI:16.83–26.44) | |
| Healthy (>12.5cm) | 8 (11%; CI: 3.79–18.12) | 42 (14.9%; CI:10.74–19.05) | |
| **Body Mass Index (kg/m$^2$)** | | | |
| Underweight (<18.5) | 54 (74%; CI:63.9–84.0) | 185 (65.60%; CI:60.06–71.15) | 0.03 |
| Healthy (18.5-24.9) | 12 (16%; CI:7.94–24.94) | 58 (20.6%; CI:16.21–24.94) | |
| Overweight (>25) | 7 (10%; CI:3.39–16.61) | 39 (13.8%; CI:10.02–17.64) | |
| **Weight-for-Age (WFA)** | | | |
| Adequate WFA | 5 (6.8%; CI:0.26–10.70) | 24 (8.5%; CI:2.70–7.94) | 0.06 |
| Moderate underweight | 14 (19.2%; CI:12.4–31.4) | 60 (21.3%; CI:14.56–23.74) | |
| Severe underweight | 54 (74%; CI:63.9–84.0) | 198 (70.2%; CI:64.88–75.55) | |
| **Height-for-Age (HFA)** | | | |
| Adequate HFA | 4 (5.5%; CI:0.26–10.70) | 15 (5.3%; CI:2.70–7.94) | 0.04 |
| Moderate stunted | 16 (21.9%; CI:12.4–31.4) | 54 (19.1%; CI:14.56–23.74) | |
| Severe stunted | 53 (72.6%; CI:62.4–82.8) | 213 (75.55%; CI:70.51–80.55) | |
| **Weight-for-Height (WFH)** | | | |
| Adequate WFH | 3 (4.1%; CI:0.1–8.66) | 13 (4.6%; CI:2.16–7.06) | 0.03 |
| Moderate wasting | 15 (20.5%; CI:11.3–29.8) | 65 (23.0%; CI:18.13–27.97) | |
| Severe wasting | 55 (75.3%; CI:65.5–85.2) | 204 (72.3%; CI:67.12–77.56) | |
| N (%; 95% CI) | | | |

**FIGURE-1**

**Baseline characteristics of study subjects**

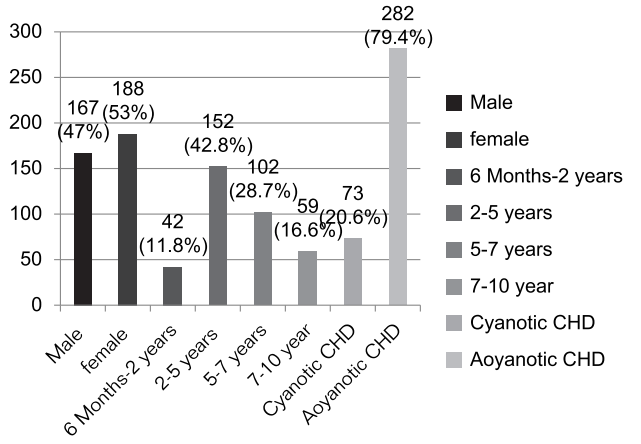


Table-III presents the mean ± SD distribution of nutritional status between participants with Cyanotic and Acyanotic Congenital Heart Disease (CHD). The average age of Cyanotic CHD patients showed no significant difference ($p>0.05$). However, weight differed significantly ($p<0.05$), with Cyanotic CHD patients having a mean weight of 9.85±2.12 kg compared to 10.48±3.31 kg in Acyanotic patients. The height in the two groups showed no significant difference ($p>0.05$). BMI was significantly higher in Cyanotic CHD patients than in Acyanotic CHD patients ($p<0.05$). Similarly, head circumference (OFC) and Mid-Upper Arm Circumference (MUAC) were both significantly lower in Cyanotic patients (OFC: 39.42±2.59 cm, MUAC: 10.5±1.15 cm) compared to Acyanotic patients (OFC: 40.13±3.19 cm, MUAC: 10.21±1.23 cm) ($p<0.05$). Z-scores for weight-for-age, height-for-age, and weight-for-height showed no significant differences between the groups ($p>0.05$).

## DISCUSSION

This study was conducted to assess the nutritional status of children with unoperated congenital heart disease in Pakistan which is a lower-middle-income country, with scarce pediatric cardiac surgical resources contributing to prolonged disease burden and consequent growth impairment. Proper evaluation of growth parameters is of great significance in optimizing the outcomes in this particular population.

In the present study, females slightly outnumbered males (53% vs. 47%), a distribution consistent with Rubia and Kher (2018), who also reported a female predominance.[14] Most participants were under five years of age, reflecting early presentation and diagnostic referral patterns. Similar age distributions have been documented in studies from India and Nigeria[14,15,16], underscoring the global tendency for CHD to manifest clinically in early childhood.

The prevalence of malnutrition in congenital heart disease children varies across different regions of the world. At the Children's hospital, Cairo university seventy percent of children presenting with CHD were reported to be malnourished.[17] Sathio S[18] reported even higher prevalence with 79.6% of children with CHD being affected. Similar findings were reported by Umbo et al.[12]

**TABLE-III**

**Distribution of anthropometric measurements and type of congenital heart disease (n=355)**

| Variables | Cyanotic (Mean±SD) | Acyanotic (Mean±SD) | P-value |
|---|---|---|---|
| Age (years) | 3.97±0.76 (3.79–4.15) | 4.25±0.82 (4.15 – 4.34) | >0.05 |
| Weight (kg) | 9.85±2.12 (9.35–10.35) | 10.48±3.31 (10.09 – 10.87) | <0.05 |
| Height (cm) | 76.22±4.54 (75.2–77.3) | 79.17±5.12 (78.57 – 79.77) | >0.05 |
| BMI | 17.08±3.14 (16.4–17.8) | 16.79±2.98 (16.44 – 17.14) | <0.05 |
| OFC (cm) | 39.42±2.59 (38.8–40.02) | 40.13±3.19 (39.76 – 40.50) | <0.05 |
| MUAC (cm) | 10.5±1.15 (10.23–10.77) | 10.21±1.23 (10.07 – 10.36) | <0.05 |
| WFA Z-score | -3.2±0.22 (–3.25 – –3.15) | -3.3±0.23 (–3.33 – –3.26) | >0.05 |
| HFA Z-score | -3.4±0.31 (–3.47– –3.33) | -3.5±0.29 (–3.53 – –3.47) | >0.05 |
| WFH Z-score | -3.1±0.15 (–3.13 – –3.07) | -3.0±0.12 (–3.02 – –2.98) | >0.05 |

(95% Confidence interval)

In our study, the malnutrition was observed in 85.9 % of children which is considerably high. This may be attributed to Pakistan being a developing country where limited number of congenital cardiac surgeons are available for an approximated population of 240 million. The contributing factors include poverty, low education levels and poor Human Development Index (HDI). Furthermore, we are a single center of CHD surgery for a population of 8 million where surgical services for CHD children were initiated only eight years ago. The neonatal and infant surgery is still a challenge in an adult cardiology designed setup.

The present study also illustrates the distribution of types of disease and their associated clinical manifestations among study participants. Acyanotic CHD predominated (79.4%), with ventricular septal defect (VSD) being the most common lesion, followed by atrial septal defect (ASD) and patent ductus arteriosus (PDA). Among cyanotic cases, tetralogy of Fallot (TOF) was the leading diagnosis. These findings align with regional and international reports, suggesting consistency in the spectrum of CHD across populations.[19] Minor variations in prevalence of specific lesions across studies may reflect differences in referral patterns, diagnostic facilities, and sample sizes.

The presence of cyanosis has been attributed to the degree of malnutrition.[20,21] The current study also analyzed the anthropometric differences among the cyanotic and acyanotic patients with CHD. Both MUAC and BMI are pretty variable, but proportionately, there is a higher incidence of Cyanotic patients being more malnourished (89% for MUAC, 74% as underweight for BMI) as compared to Acyanotic patients (85.1% and 65.60%, respectively). Differences in weight-for-age were not significant at a statistical level (p=0.06), whereas height-for-age (p=0.04) and weight-for-height (p=0.03) had severe stunting with severe underweight status among the majority of patients from both groups. The findings are consistent with Murni IK[22] where stunting and wasting was more commonly associated with cyanotic CHD.

Rubia B et al[14] reported that underweight and stunting was more in acyanotic CHD cases (83.16% and 60.39 respectively) as compared to cyanotic CHD cases (72% and 48% respectively). However, this difference between the two groups was not statistically significant (P=0.11). Similarly, a study from Indonesia[23] showed that wasting was less common in cyanotic patients compared to acyanotic ones (prevalence odds ratio [POR] = 0.98; p = 0.001. Hassan BA[1] also reported similar results while Saithio[18] reported no statistically significant differences existed in different groups of CHD in terms of malnutrition The results differ from our study where wasting is common in both cyanotic and acyanotic patients with mild dominance in cyanotic CHDs. These discrepancies highlight the heterogeneity of nutritional outcomes in CHD and suggest that factors beyond cyanosis, such as sample size, study duration, age distribution, diagnostic and treatment facilities, and regional variations, may influence results.

This study demonstrates that children with congenital heart disease, whether cyanotic or acyanotic, face a high burden of malnutrition. While overall growth failure was evident in both groups, cyanotic patients showed greater deficits in weight, BMI, head circumference, and mid-upper arm circumference, reflecting the impact of chronic hypoxemia and increased metabolic demands. In contrast, acyanotic patients exhibited relatively better nutritional status. These findings emphasize that although malnutrition is universal in CHD, cyanotic children are particularly vulnerable to malnutrition and wasting, underscoring the need for early nutritional surveillance and targeted interventions.

## LIMITATIONS

This study has limitations. Being single-center and cross-sectional, it cannot establish causality or capture longitudinal growth trajectories. The absence of a healthy control group limits the strength of comparisons. Furthermore, reliance on anthropometry alone may underestimate subtle nutritional deficiencies that biochemical markers could reveal. Future research should adopt multicenter, longitudinal designs and incorporate biochemical and dietary assessments to provide a more comprehensive picture.

## CONCLUSION

The study reflects the existence of well-marked disparities in nutritional status and anthropometric measurements between children with Cyanotic and Acyanotic Congenital Heart Disease. Children with cyanotic CHD show greater degrees of malnutrition than those with acyanotic defects. Early nutritional screening and individualized dietary interventions should be integrated into pediatric cardiology care to improve outcomes.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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## REFERENCES

1. Hassan BA, Albanna EA, Morsy SM, Siam AG, Al Shafie MM, Elsaadany HF, et al. **Nutritional status in children with unoperated congenital heart disease: An Egyptian center experience.** Front Pediatr. 2015; 3:53.
2. Diao J, Chen L, Wei J, Shu J, Li Y, Li J, et al. **Prevalence of malnutrition in children with congenital heart disease: A systematic review and meta-analysis.** J Pediatr. 2022; 242:39-47.e4.
3. Van der Linde D, Konings EEM, Slager MA, Witsenburg M, Helbing WA, Takkenberg JJM, et al. **Birth prevalence of congenital heart disease worldwide.** J Am Coll Cardiol. 2011; 58(21):2241-7.
4. Rahman MA, Utamayasa IKA, Hidayat T, Irawan R, Elizabeth R. **Antropometric profile of children with cyanotic and non-cyanotic congenital heart disease.** Media Gizi Indonesia. 2020; 15(1):1-6.
5. Flynn J, Ketut Alit Utamayasa, Mahrus Abdur Rahman, Nur Aisiyah Widjaja. **Risk factors of malnutrition and growth faltering in children with congenital heart disease.** Journal of Medicinal and Pharmaceutical Chemistry Research. 2025(5):1026-37.
6. Nezami A, Heidari G, Tarhani F, Kariminia M. **Prevalence of congenital heart disease among children in Khorramabad (West of Iran).** Cardiovascular & Haematological Disorders-Drug Targets. 2021; 21(9):61-5.
7. Utomo MH, Hidayat T, Soebroto H. **Changes in nutritional status of children under five with acyanotic congenital heart disease left to right shunt type after defect closure by catheterization.** Cardiovascular and Cardiometabolic Journal (CCJ). 2024; 5(1):11-22.
8. Agustini W, Yantie NPVK, Gunawijaya E, Sidiartha GL, Pratiwi GAE. **Underweight, stunted, and wasted among children with congenital heart disease: Acyanotic versus cyanotic.** Open Access Maced J Med Sci. 2022; 10(B):610-3.
9. Ahmed H, VanderPluym C. Medical management of pediatric heart failure. Cardiovasc Diagn Ther. 2021; 11(1):323-35.
10. K Shuker Alghanimi, A Alyasiri A, F Musa R. **Effect of the congenital heart disease on growth and nutritional state of children.** Diyala J Med. 2018; 15(2):52-67.
11. Onalo R, Ajanaku IT, Dalili SM, Agbadi HE. **Impact of unoperated congenital heart diseases on the nutritional status of children in a depressed economy.** Cardiolog Res Cardiovasc Med. 2021; 6:167.
12. Umboh A, Rompies R, Umboh V. **Hubungan Status Gizi dan Anemia dengan Penyakit Jantung Bawaan pada Anak.** Sari Pediatri. 2022; 23(6):395.
13. WHO Multicenter Growth Reference Study Group. ***WHO Child Growth Standards: Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: Methods and development.** * Geneva: World Health Organization; 2006.
14. Rubia B, Kher A. **Anthropometric assessment in children with congenital heart disease.** Int J Contemp Pediatr. 2018; 5(2):634-9.
15. Mondal S, D'Souza JLP. **Anthropometric profiles of children with congenital heart disease.** Pediatr Rev Int J Pediatr Res. 2016; 3(8):572-9.
16. Okoromah CAN, Ekure EN, Lesi FEA, Okunowo WO, Tijani BO, Okeiyi JC. **Prevalence, profile and predictors of malnutrition in children with congenital heart defects: A case-control observational study.** Arch Dis Child. 2011; 96(4):354-60.
17. Atef Abdelsattar Ibrahim H, Mostafa FA, Sobhy R, Saad K, Abdelsalam Y, Mahmoud D, et al. **Patterns of malnutrition in infants and children with congenital heart diseases, an experience of a large tertiary hospital.** Nutrition and Health. 2025 Oct; 31(4):1797-804.
18. Sathio S, Hussain B, Rehman FU, Hussain M, Rehman MU, Siddiqui SU. **Malnutrition and growth failure in cyanotic and acyanotic congenital heart diseases with and without pulmonary hypertension.** Pak Armed Forces Med J. 2024; 74(5):1240-44.
19. Erbay R K, Akın A, Yılmaz K, Unal E, Ture M, Uc D. **Prevalence of malnutrition and influencing factors in children with congenital heart disease.** Dicle Tıp Dergisi / Dicle Med J. (2025) 52(1):7-16.
20. Sriwaningsi L, Oktadiputra E. **Prevalence and management of malnutrition in children with congenital heart disease: A comprehensive systematic review.** JARMHS [internet]. 2024 Jul. 1 [cited 2026 Apr. 12]; 10(7):1-8.
21. Blasquez A, Clouzeau H, Fayon M, Mouton JB, Thambo JB, Enaud R, et al. **Evaluation of nutritional status and support in children with congenital heart disease.** Eur J Clin Nutr. 2016 Apr; 70(4):528-31.

22. Murni IK, Patmasari L, Wirawan MT, Arafuri N, Nurani N, Sativa ER, et al. **Outcome and factors associated with undernutrition among children with congenital heart disease.** PLoS One. 2023 Feb 23; 18(2):e0281753.

23. Amelia P, Adriansyah R, Lubis B, Akil M. **The association between cyanotic and acyanotic congenital heart disease with nutritional status.** Open Access Maced J Med Sci. 2020 May 13; 8(B):245-48.

| AUTHORSHIP AND CONTRIBUTION DECLARATION | |
|---|---|
| 1 | **Abdul Razzaq Mughal:** Methodology, discussion. |
| 2 | **Rubina Tousif:** Study design, data collection. |
| 3 | **Motia Javed:** Data collection, abstract writing. |
| 4 | **Asma Riaz:** Data collection. |
| 5 | **Tahir Mahmood:** Methodology, critical analyzed results. |
| 6 | **Muhammad Usman Zia:** Proof reading. |