DOI: https://doi.org/10.61841/ya26r131 Publication URL: https://nnpub.org/index.php/MHS/article/view/2314

PREVALENCE AND MANAGEMENT OF MALNUTRITION IN CHILDREN WITH CONGENITAL HEART DISEASE: A COMPREHENSIVE SYSTEMATIC REVIEW

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ABSTRACT

Background: *Congenital heart disease is a congenital abnormality that affects the structure of the heart walls and vessels. Malnutrition has a significant impact on the likelihood of infection in children with congenital heart disease, which leads to poor treatment outcomes.*

The aim: *The aim of this study to show about prevalence and management of malnutrition in children with congenital heart disease.*

Methods: *By the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020, this study was able to show that it met all of the requirements. This search approach, publications that came out between 2014 and 2024 were taken into account. Several different online reference sources, like Pubmed, SagePub, and Sciencedirect were used to do this. It was decided not to take into account review pieces, works that had already been published, or works that were only half done.*

Result: *Five publications were found to be directly related to our ongoing systematic examination after a rigorous three-level screening approach. Subsequently, a comprehensive analysis of the complete text was conducted, and additional scrutiny was given to these articles.*

Conclusion: *Nutrition is crucial in the treatment of chronic illness. It's one of the most important factors affecting patients' recovery after surgery and lowering the risk of infection in children with congenital heart disease.*

Keyword: *Heart disease, congenital, malnutrition, children.*

INTRODUCTION

Congenital Heart Disease (CHD) are often associated with malnutrition and failure to thrive. Growth failure has been calculated with a prevalence of 64% in CHD patients in developed countries being more severe in the developing regions, where malnutrition is common even in otherwise healthy children.[1,2]

Mechanisms for growth deficiency in CHD are multifactorial including associated chromosomal anomalies/genetic syndromes, inadequate nutrition due to feeding difficulties, and poor nutritional absorption from the digestive tract in chronic congestive heart failure (CHF). Also, increased caloric support is required to sustain the increased myocardial, respiratory, and neuro-humoral functions in CHD-related heart failure. Chronic CHF and chronic under-oxygenation in CHD impair cellular metabolism and cell growth, while repeated chest infections demand an increased metabolism.[1]

Malnutrition poses a burden not only on the health system, but the entire socio-cultural aspect of the country. Malnutrition can be defined as a state of nutrition where the weight for age, height for age and weight for height indices are below -2 Z-score of the NCHS reference. It constitutes a major public health problem in developing world and serves as the most important risk factor for the burden of disease especially among children.[3]

Malnutrition occurs among children with congenital heart disease, irrespective of the nature of the cardiac defect and the presence or absence of cyanosis Children with congenital heart disease (CHD) are prone to malnutrition for several reasons including decreased energy intake, increased energy requirements, or both. For instance, children with malnutrition due to ventricular septal defects (VSD) have been shown to have a 40% elevation in total energy expenditure (TEE). Children with CHD in which there is congestive heart failure or an increase in after load (coarctation of the aorta or pulmonary hypertension) often present with increased energy expenditure. This is because the heart must work much harder in order to pump an adequate blood for body metabolism.[3,4]

Across the globe, congenital heart disease (CHD) is the most prevalent birth defect and ranks the 7th leading cause of infant mortality, with the prevalence rising from 4.5 per 1,000 births in 1970–1974 to 9.4 per 1,000 births in 2010–2017. Despite the fact that disability-adjusted life years (DALY) of CHD children aged under 10 years decreased by 41.6% from 1990 to 2019, which is mainly attributed to the advancement and wide application of neonatal surgical interventions, as well as perioperative care, preoperative undernutrition is emerging as a global problem among CHD children, affecting their long-term outcomes.[5,6]

According to World Health Organization (WHO), undernutrition refers to deficiencies in a child's intake of energy and/or nutrients, affecting 15%–64% of children with cardiac anomalies, and the proportion is higher in developing countries. A case-control study in Nigeria indicated that preoperative CHD children were at higher risk of undernutrition than healthy counterparts (90.4% vs. 21.1%). Based on our previous meta-analysis published in 2022, 27.4%, 24.4%, and 24.8% of preoperative CHD children globally suffered from underweight, wasting and stunting, respectively. Apart from general causes of undernutrition such as insufficient caloric intake and growing energy demand, several disease-related causes may be explanatory, including hypoxia (primary concern for cyanotic CHD), congestive heart failure (commonly seen in acyanotic CHD), pulmonary hypertension, and gastrointestinal dysfunction as a result of complications.[5]

Children with congenital heart disease (CHD) are at greater risk for failure to thrive and are considered part of a nutritional high-risk group. Undernutrition can manifest in different forms, namely wasting, stunting, underweight and micronutrient deficiencies. Wasting, stunting and underweight are defined as a child's weight for height (or BMI), height and weight, respectively, being more than two standard deviations below the median for the international reference population of the same age. The reasons for undernutrition in children with CHD are many and of different nature, including hemodynamic instability, inadequate nutritional intake due to feeding fatigue, poor absorption of nutrients, fluid restriction, increased metabolic demands secondary to CHD physiopathology, heart failure and polycythemia due to chronic hypoxia. Malnutrition entails loss of lean mass, including those of the heart and respiratory muscles, which compromise the myocardial and ventilatory functions.[7,8]

METHODS

PROTOCOL

By following the rules provided by Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020, the author of this study made certain that it was up to par with the requirements. This is done to ensure that the conclusions drawn from the inquiry are accurate.

CRITERIA FOR ELIGIBILITY

For the purpose of this literature review, we compare and contrast prevalence and management of malnutrition in children with congenital heart disease. It is possible to accomplish this by researching or prevalence and management of malnutrition in children with congenital heart disease. As the primary purpose of this piece of writing, demonstrating the relevance of the difficulties that have been identified will take place throughout its entirety.

In order for researchers to take part in the study, it was necessary for them to fulfil the following requirements: 1) The paper needs to be written in English, and it needs to determine about prevalence and management of malnutrition in children with congenital heart disease. In order for the manuscript to be considered for publication, it needs to meet both of these requirements. 2) The studied papers include several that were published after 2014, but before the time period that this systematic review deems to be relevant. Examples of studies that are not permitted include editorials, submissions that do not have a DOI, review articles that have already been published, and entries that are essentially identical to journal papers that have already been published.

SEARCH STRATEGY

We used " prevalence and management of malnutrition in children with congenital heart disease." as keywords. The search for studies to be included in the systematic review was carried out using the PubMed, SagePub, and Sciencedirect databases by inputting the words: *(("Malnutrition"[MeSH Subheading] OR " Children"[All Fields] OR "Congenital" [All Fields]) AND ("Heart disease"[All Fields] OR " Risk factor"[All Fields]) AND ("Management"[All Fields]) OR ("Prevalence" [All Fields]))* used in searching the literature.

DATA RETRIEVAL

After reading the abstract and the title of each study, the writers performed an examination to determine whether or not the study satisfied the inclusion criteria. The writers then decided which previous research they wanted to utilise as sources for their article and selected those studies. After looking at a number of different research, which all seemed to point to the same trend, this conclusion was drawn. All submissions need to be written in English and cannot have been seen anywhere else.

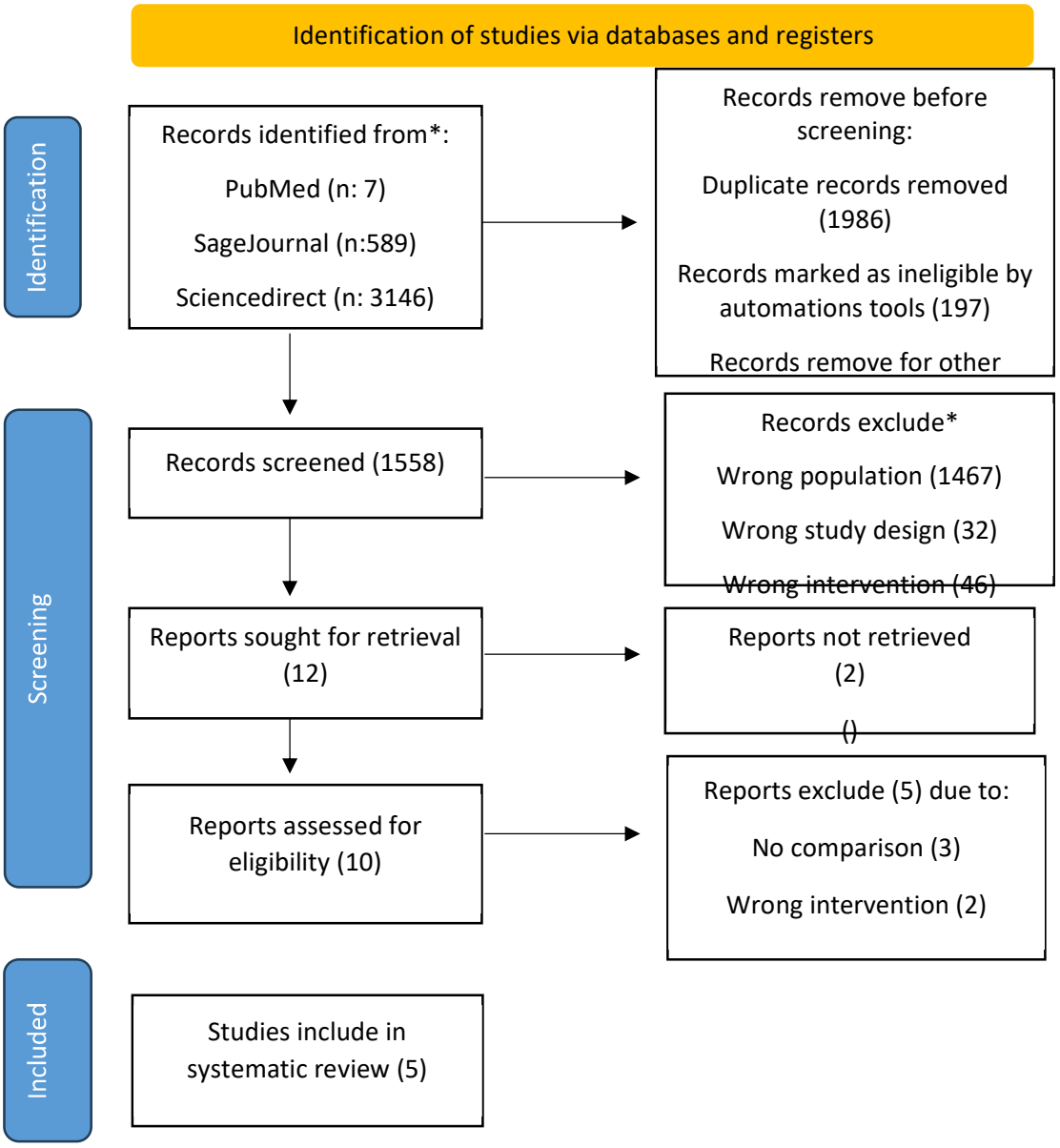

Figure 1. Article search flowchart

Only those papers that were able to satisfy all of the inclusion criteria were taken into consideration for the systematic review. This reduces the number of results to only those that are pertinent to the search. We do not take into consideration the conclusions of any study that does not satisfy our requirements. After this, the findings of the research will be analysed in great detail. The following pieces of information were uncovered as a result of the inquiry that was carried out for the purpose of this study: names, authors, publication dates, location, study activities, and parameters.

QUALITY ASSESSMENT AND DATA SYNTHESIS

Each author did their own study on the research that was included in the publication's title and abstract before making a decision about which publications to explore further. The next step will be to evaluate all of the articles that are suitable for inclusion in the review because they match the criteria set forth for that purpose in the review. After that, we'll determine which articles to include in the review depending on the findings that we've uncovered. This criteria is utilised in the process of selecting papers for further assessment. in order to simplify the process as much as feasible when selecting papers to evaluate. Which earlier investigations were carried out, and what elements of those studies made it appropriate to include them in the review, are being discussed here.

RESULT

Using reputable resources like Science Direct, PubMed, and SagePub, our research team first gathered 3742 publications. A thorough three-level screening strategy was used to identify only five papers as directly relevant to our ongoing systematic evaluation. Next, a thorough study of the entire text and further examination of these articles were selected. Table 1 compiles the literature that was analyzed for this analysis in order to make it easier to view.

Table 1. The litelature include in this study

Author	Origin	Method	Sample Size	Result
Woldesenbet, R et al., 2021[9]	Ethiopia	Institutional based cross sectional study among 373 children aged under15 years was conducted from February to March; 2021G.c.	373	A total of 373 children were participated in this study. The prevalence of wasting and stunting was 144(38.6%) and 134(35.9%) respectively. The prevalence of underweight and malnutrition in children under 10 years was 143(43.1%). Most of the children were diagnosed with VSD (36.7%). Children age group of 13 months-5 years were associated with wasting and underweight [AOR = 0.434, 95%CI: (0.231, 0.816)] and [AOR = 0.360, 95%CI: (0.183, 0.711)] respectively. Children diagnosed with PAH were 1.885 times more likely to be underweight [AOR = 1.885, 95%CI: (1.094, 3.246)]. When the hemoglobin level increases by every unit per g/dl the chance to be wasting and underweight decreases by 13.1 and 18.6%[AOR = 0.869, 95%CI: (0.792, 0.955)] and [AOR = 0.869, 95%CI: (0.792, 0.955)] respectively. The level of SPO2 is associated with stunting and underweight [AOR = 0.970, 95%CI: (0.943, 0.998)] and [AOR = 0.970, 95%CI: (0.943, 0.998)] respectively.
Murni, IK et al., 2023[10]	Indonesia	A prospective cohort study was conducted among children with CHD at Dr.	1149	We recruited 1,149 children with CHD, of those, 563 (49%) were underweight, 549 (47.8%) were stunting, and 361 (31.4%) were wasting. In the

		Sardjito Hospital, Yogyakarta, Indonesia during February 2016 to June 2018.		multivariate analysis, cyanotic CHD, delayed diagnosis, congestive heart failure, pulmonary hypertension, syndrome, young maternal age, history of low birth weight, and being first child were independently associated with undernutrition. Underweight and stunting were significantly associated with increased mortality with OR of 3.54 (95% CI: 1.62–7.74), $p<0.001$ and OR 3.31 (95% CI: 1.65–6.64), $p<0.001$, respectively.
Tsega, T et al., 2022[4]	Ethiopia	A cross sectional analytical study conducted over a period of 6 months (Feb to Jul 2020). A total of 228 subjects with congenital heart disease who visited the cardiac center during the study period where included until the calculated sample size attained.	228	A total of 228 children ranging from 3month to 17yrs of age with mean age of 4.7 years (SD = 3.8 years) were included in the study. Most of the subjects had acyanotic heart disease accounting for 87.7%. The overall prevalence of wasting, underweight and stunting were 41.3%, 49.1% and 43% respectively. Children with congenital heart disease and having pulmonary hypertension, were found more likely to develop wasting compared to those without pulmonary hypertension with an odds of 1.9 (95% CI: 1.0–3.4) and also have greater chance of stunting with an odds of 1.9 (95% CI: 1.0–3.4). Children 5 to 10 years of age were 2.3 times more likely to be underweight.
Robyn, S et al., 2024[11]	South Africa	Children 30 months and younger, with their mothers, were included in this prospective observational descriptive study.	30	Forty mother-child pairs were included at baseline. Most children ($n = 30$) had moderate disease severity, with eight children having cyanotic defects. A quarter of the children had Down syndrome (DS). Twenty-eight children underwent corrective cardiac surgery at a median age of 7.4 months. Most children ($n = 27$) were underweight before cardiac surgery [mean z-score − 2.5 (±1.5)], and many ($n = 18$) were stunted [mean z-score − 2.2 (±2.5)]. A quarter ($n = 10$) of the children had feeding difficulties. By 6-months post-cardiac surgery there were significant improvements in weight ($p = 0.04$) and head circumference ($p = 0.02$), but complete catch-up growth had

				not yet occurred. Malnutrition (undernutrition) was strongly associated (p = 0.04) with poorer motor development [Mean Bayley-III motor score 79.5 (±17.5)] before cardiac surgery. Growth in children with cyanotic and acyanotic defects, and those with and without DS were comparable.
Asrade, M et al., 2021[12]	Ethiopia	This hospital-based cross-sectional study included children with cardiac disease presenting to the pediatric outpatient clinic at University of Gondar Hospital, Ethiopia.	269	A total of 269 patients participated in the study. 177 (65.7%) were undernourished, of whom 96 (54.5%) were underweight, 70 (39.7%) were stunted, and 95 (53.9%) were wasted. Pulmonary hypertension (adjusted odds ratio [AOR] = 3.82, 95%CI 1.80–8.10), NYHA/modified Ross class III and IV heart failure (AOR = 4.64, 1.69–12.72) and cardiac chamber enlargement (AOR = 2.91, 1.45–5.66) were associated with undernutrition.

Woldesenbet, R et al (2021)[9] showed the prevalence of wasting, underweight and stunting among children with congenital heart disease in this study was found to be high. Child's age, bottle feeding, being sick in the prior 2 weeks of the study, pulmonary hypertension, level of hemoglobin, level of SPO2 was the factors in this study which were found to be associated with malnutrition. Hence the prevalence of wasting, stunting and underweight is high in children with CHD in the study settings. Therefore a need to action regarding to early intervention (surgery), giving a focused care for children under age of 12 months and children presented with other comorbidities. This will help decrease prevalence of malnutrition in children with CHD. Studying nutrient deficiency by using different types of dietary assessment techniques and including further laboratory investigations will help in getting a good result to know the severity.

Murni, IK et al (2023)[10] showed a considerable burden of undernutrition among children with CHD and this was significantly associated with increased risk of death. Factors associated with underweight, wasting and stunting are cyanotic CHD, delayed diagnosis, CHF, PH, presence of syndrome, history of low birth weight, and being first child. Accurate assessment of nutritional status is mandatory to obtain baseline and ongoing information on nutritional status in children with congenital heart disease.

Tsega, T et al (2022)[4] showed malnutrition is a major problem in children with congenital heart disease. This indicates that proper and routine nutritional assessment should be part of the care while dealing with such patients and appropriate measures need to be undertaken this problem. Subsequent studies with larger sample size may strengthen the findings in this research and also the impact of malnutrition in such patients can further be studied in detail.

Robyn, S et al (2024)[11] showed most children with CHD in central South Africa are malnourished (undernourished) prior to cardiac surgery, which in turn negatively impacted their motor development. Despite significant catch-up growth occurring postoperatively, complete catch-up growth had not yet taken place by 6-months post-cardiac surgery. A diagnosis of CHD therefore warrants regular monitoring of all growth indices by the cardiac care team to identify those children at risk for or presenting with growth failure, facilitating referral to a dietician for nutritional education and support. Likewise feeding skills should also be assessed by a speech therapist where feeding difficulties are suspected to identify those children likely to benefit from feeding therapy to optimize nutritional status and postoperative outcomes. Furthermore, regular monitoring of catch-up growth after cardiac surgery for a period of at least 12 months is recommended to identify children who persist with poor growth.

Asrade, M et al (2021)[12] showed undernutrition is common among children with cardiac disease in our setting. Advanced congestive heart failure, pulmonary hypertension, and cardiac chamber enlargement are associated with undernutrition. Nutritional management should be considered for all patients with cardiac disease, and prioritized for those with echocardiographic risk factors. In addition to this we recommend every effort to be made for early and definitive corrective measures to be performed including surgery.

DISCUSSION

Children with congenital heart disease (CHD) are at an increased risk for wasting, underweight and stunting. Malnutrition among these children increases their risk to infections and the risk of death even after corrective surgery. In addition, malnutrition leads to poor growth in children which is associated with delayed mental development, poor school performance and reduced intellectual capacity. These outcomes significantly impair economic productivity in adult life.[13]

Risk factors for malnutrition among children with CHD include heart failure, cyanosis, multiple heart defects, delayed corrective surgery, anaemia and pulmonary hypertension. Furthermore, in children with CHD, poor nutrition is also attributed to inadequate nutritional intake due to feeding difficulties and the increased energy expenditure among these children. In developing countries, corrective surgery for congenital heart defects is delayed and this increases the likelihood of the children developing malnutrition.[13]

Congenital heart diseases are those diseases that occur at birth from abnormalities of cardiac structure due to aberration in development. The rising trend in the prevalence of congenital heart disease is variable. Denise et al. in a meta-analysis noted an increase in world prevalence from 0.6 per 1,000 live births in 1930 to 9.1 per 1,000 live births presently. Chinawa et al., in Enugu, Nigeria, noted a prevalence of 0.22% among 31,795 children that attended children outpatient clinics. Congenital heart disease has been a serious challenge to affected families and relations. This is as a result of a complex interplay between high medical bills, cost of surgery, and heavy nutritional burden. There is a high burden of frequent hospital admission, poor surgical outcome, and death caused by malnutrition in children with congenital heart disease.[14]

Regarding the clinical manifestations, CHDs are divided into two groups, namely cyanotic and acyanotic heart defects. The most common cyanotic defects include tetralogy of Fallot (TOF), pulmonary atresia (PA), transposition of great arteries (TGA), and tricuspid atresia (TA). Also, the common acyanotic defects include patent ductus arteriosus (PDA), ventricular septal defect (VSD), atrial septal defect (ASD), aortic stenosis (AS), coarctation of the aorta (COA), and pulmonary stenosis (PS).[15]

Malnutrition is of high prevalence among CHD infants and plays an important role in mortality, hospital infections, and increased length of stay (LOS) of such infants. Regarding the limited protein and fat reserves, high energy expenditure, and increased energy requirement for further growth, infants are more prone to malnutrition than adults. The newborn infants with CHD, particularly those with pulmonary hypertension (PH), will commonly have poor postnatal weight gain despite good birth weight.[15]

The degree of malnutrition may be associated with the characteristics of CHD, including the presence of cyanosis and PH. Infants with cyanosis are prone to retardation in both weight and length. Infants with acyanotic lesions have difficulty in gaining weight. Thus, cyanotic defects and PH are very high-risk conditions for these infants.[15]

Failure to thrive (FTT) is characterized by inadequate growth during childhood, typically defined as stunting or underweight with a standard deviation score (SDS) less than −2. Without intervention, FTT can lead to various physical, emotional, and behavioral issues. Among patients with congenital heart disease (CHD), FTT is highly prevalent, resulting in detrimental clinical outcomes such as prolonged hospitalization, increased risk of comorbidities, and elevated in-hospital mortality. CHD represents the largest category of congenital defects globally, with approximately 3.12 million live births and 195,000 deaths in 2019. Given the heightened susceptibility to FTT, CHD-related FTT presents a significant challenge, particularly in high-risk subgroups such as infants and those with complex CHD.[16]

Malnutrition may have acute health implications as well as a negative impact on the child's development. Majority of this vulnerable group of children will require surgery within the first few years of life. Pre- operative nutritional status is one of the major determinants of the magnitude of the metabolic response, recovery time following surgery, morbidity and the overall outcome. Early identification of children with feeding difficulties and early nutrition intervention results in improved nutritional status, surgical outcome and long term developmental outcome.[17]

Cardiac teams in low- and middle-income countries are frequently faced with children with CHD who are underweight, thin, and stunted. The first response should be to regard that as further evidence that the diagnosis of CHD is being delayed and to focus on interventions to improve early diagnosis and referral.[6]

CONCLUSION

Nutrition is crucial in the treatment of chronic illness. It's one of the most important factors affecting patients' recovery after surgery and lowering the risk of infection in children with congenital heart disease.

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