International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

Evaluation of Cardiac Complications and Left Ventricular Dysfunction in Children with Severe Acute Malnutrition

Dr. Dhareesh[1], Dr. Preeti Amarkhed[2], Dr. Basavaprabhu Amarkhed[3]

[1]Senior Resident, Department of Pediatrics, ESIC Medical College (ESICMC), Kalaburagi, Karnataka, India
[2]Associate Professor Department of Pediatrics ESIC Medical College (ESICMC), Kalaburagi, Karnataka, India
[3]Associate Professor Department of Cardiology ESIC Medical College (ESICMC), Kalaburagi, Karnataka, India

OPEN ACCESS

Corresponding Author:

Dr. Preeti Amarkhed
Associate Professor Department of Pediatrics ESIC Medical College (ESICMC), Kalaburagi, Karnataka, India

Received: 30-05-2026
Accepted: 15-06-2026
Available online: 04-07-2026

Copyright © *International Journal of Medical and Pharmaceutical Research*

ABSTRACT

Background; Severe Acute Malnutrition (SAM) is a major public health problem in developing countries and is associated with significant multisystem involvement, including cardiovascular complications. Cardiac dysfunction in SAM may remain clinically silent but can contribute to increased morbidity and mortality. The present study was undertaken to evaluate cardiac complications and left ventricular dysfunction in children with SAM.

Materials and Methods; This prospective observational study was conducted in the Department of Pediatrics at ESIC Medical College, Kalaburagi, from June 2025 to June 2026. A total of 120 children diagnosed with SAM were included. Detailed clinical evaluation, anthropometric assessment, laboratory investigations, electrocardiography, and echocardiography were performed. Left ventricular dysfunction was assessed using echocardiographic parameters including ejection fraction and fractional shortening.

Results; Among 120 children, the majority were aged 13–24 months (31.7%) with a slight male predominance (55%). Pallor (67.5%) and severe wasting (76.7%) were common clinical findings. Electrocardiographic abnormalities were observed in 35% of cases, with sinus tachycardia being the most frequent finding. Echocardiography revealed left ventricular dysfunction in 25% of children. Significant associations were observed between left ventricular dysfunction and anemia, hypoalbuminemia, hypokalemia, and edematous malnutrition ($p < 0.05$).

Conclusion; Cardiac abnormalities, particularly left ventricular dysfunction, are common in children with SAM. Early recognition through ECG and echocardiography, along with correction of nutritional and biochemical abnormalities, is essential for improving clinical outcomes.

Keywords*: Severe Acute Malnutrition, Left Ventricular Dysfunction, Cardiac Complications, Echocardiography, Electrocardiography, Pediatric Malnutrition, Hypoalbuminemia, Electrolyte Imbalance.*

INTRODUCTION

Severe Acute Malnutrition (SAM) remains a major public health concern in developing countries and continues to contribute substantially to childhood morbidity and mortality. According to the World Health Organization (WHO), SAM is defined by a weight-for-height/length Z-score below −3 standard deviations of the WHO growth standards, a mid-upper arm circumference (MUAC) less than 11.5 cm, or the presence of bilateral pitting edema of nutritional origin.[1] Globally, millions of children under five years of age suffer from acute malnutrition, with the highest burden occurring in low- and middle-income countries.[2]

Malnutrition adversely affects nearly every organ system, including the cardiovascular system. Prolonged protein-energy deficiency results in myocardial atrophy, decreased cardiac muscle mass, impaired ventricular contractility, reduced

cardiac output, and alterations in cardiac electrophysiology.[3,4] These pathological changes may predispose malnourished children to arrhythmias, congestive cardiac failure, pericardial effusion, and left ventricular dysfunction.[5] Electrolyte disturbances frequently observed in SAM, particularly hypokalemia, hyponatremia, and hypocalcemia, further compromise myocardial function and increase the risk of cardiac complications.[6] In addition, anemia and hypoalbuminemia commonly associated with severe malnutrition may contribute to myocardial stress, impaired oxygen delivery, and altered ventricular performance.[7]

Several investigators have reported structural and functional cardiac abnormalities in children with severe malnutrition. Echocardiographic studies have demonstrated reduced left ventricular mass, decreased ejection fraction, reduced fractional shortening, and impaired myocardial performance in affected children compared with healthy controls.[8,9] Electrocardiographic abnormalities including sinus tachycardia, low-voltage complexes, ST-T changes, and arrhythmias have also been documented.[10]

Despite the potential clinical significance of cardiac involvement, cardiovascular assessment is often overlooked during routine management of SAM. Early identification of myocardial dysfunction is important for appropriate clinical monitoring and may help prevent adverse outcomes during nutritional rehabilitation.[11]

Limited data are available regarding the prevalence and pattern of cardiac abnormalities among children with SAM in the Indian population. Therefore, the present study was undertaken to evaluate cardiac complications and left ventricular dysfunction among children with severe acute malnutrition admitted to a tertiary care teaching hospital.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational study was conducted in the Department of Pediatrics at **ESIC Medical College** from **June 2025 to June 2026**. The study aimed to evaluate cardiac complications and left ventricular dysfunction among children diagnosed with Severe Acute Malnutrition (SAM).

Study Population

A total of **120 children** diagnosed with Severe Acute Malnutrition were enrolled consecutively during the study period. Children aged **6 months to 5 years** fulfilling the diagnostic criteria for SAM as per **World Health Organization (WHO)** guidelines were included in the study.

Inclusion Criteria

- Children aged 6 months to 5 years.
- Diagnosed with Severe Acute Malnutrition based on any of the following WHO criteria:
    - Weight-for-height/length Z-score below −3 SD.
    - Mid-upper arm circumference (MUAC) <11.5 cm.
    - Presence of bilateral pitting edema of nutritional origin.
- Parents or guardians willing to provide informed consent.

Exclusion Criteria

- Children with known congenital heart disease.
- Children with rheumatic heart disease.
- Children with chronic kidney disease, chronic liver disease, or endocrine disorders.
- Children with severe anemia requiring immediate blood transfusion.
- Children whose parents or guardians declined participation.

Data Collection

After obtaining written informed consent from parents or guardians, detailed demographic and clinical information was recorded using a predesigned structured proforma. Information regarding age, sex, socioeconomic status, dietary history, immunization status, anthropometric measurements, and clinical features was collected.

Clinical Assessment

All enrolled children underwent a thorough physical examination. Anthropometric parameters including weight, height/length, body mass index (BMI), and MUAC were measured using standardized techniques.

Laboratory Investigations

The following investigations were performed:

- Complete blood count (CBC)
- Serum electrolytes (sodium, potassium, calcium)
- Blood glucose

- Serum albumin
- Renal function tests
- Liver function tests

Cardiac Evaluation
All participants underwent detailed cardiac assessment, including:

Electrocardiography (ECG):
A standard 12-lead ECG was performed to identify rhythm abnormalities, conduction defects, chamber enlargement, and other electrocardiographic changes.

Chest Radiography:
Chest X-ray was performed to assess cardiac size and pulmonary vascularity.

Echocardiography:
Two-dimensional echocardiography with Doppler study was performed by an experienced pediatric cardiologist. The following parameters were evaluated:

- Left ventricular ejection fraction (LVEF)
- Fractional shortening (FS)
- Left ventricular end-diastolic diameter (LVEDD)
- Left ventricular end-systolic diameter (LVESD)
- Presence of pericardial effusion
- Structural cardiac abnormalities

Left ventricular dysfunction was defined as **LVEF <55%** and/or **fractional shortening <28%**.

Outcome Measures
The primary outcome was the prevalence of left ventricular dysfunction among children with Severe Acute Malnutrition. Secondary outcomes included the prevalence and pattern of cardiac complications detected by ECG and echocardiography.

Ethical Considerations
The study protocol was reviewed and approved by the Institutional Ethics Committee of ESIC Medical College, Kalaburagi. Written informed consent was obtained from the parents or legal guardians of all participants before enrollment. Confidentiality of participant information was maintained throughout the study.

Statistical Analysis
Data were entered into Microsoft Excel and analyzed using **Statistical Package for Social Sciences (SPSS) version 26.0**. Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. The Chi-square test or Fisher's exact test was used for comparison of categorical variables. Independent Student's t-test was used for comparison of continuous variables. A p-value of **<0.05** was considered statistically significant.

RESULTS AND OBSERVATIONS
A total of 120 children with Severe Acute Malnutrition (SAM) were included in the study. The mean age was 24.8 ± 13.6 months. Cardiac evaluation was performed using ECG and echocardiography, along with relevant laboratory investigations.

Table 1. Demographic Characteristics of Study Participants (n=120)

Variable	Number (%)
Age 6–12 months	24 (20.0)
Age 13–24 months	38 (31.7)
Age 25–36 months	29 (24.2)
Age 37–48 months	17 (14.2)
Age 49–60 months	12 (10.0)
Male	66 (55.0)
Female	54 (45.0)

Observation: Most children belonged to the 13–24 months age group, and males were slightly more common.

Table 2. Clinical Profile of SAM Children

Clinical Finding	Number (%)
Severe Wasting	92 (76.7)
Edematous Malnutrition	28 (23.3)
Pallor	81 (67.5)
Respiratory Infection	46 (38.3)
Diarrhea	42 (35.0)
Hepatomegaly	31 (25.8)

Observation: Pallor was the most common associated clinical feature.

Table 3. Hematological Parameters

Parameter	Mean ± SD
Hemoglobin (g/dL)	8.7 ± 1.8
Total Leukocyte Count (/mm³)	10,850 ± 3,240
Platelet Count (×10³/μL)	285 ± 96

Observation: Most children had moderate anemia.

Table 4. Serum Electrolytes

Parameter	Mean ± SD	Abnormal Cases n (%)
Sodium (mEq/L)	132.4 ± 5.6	38 (31.7)
Potassium (mEq/L)	3.5 ± 0.8	42 (35.0)
Calcium (mg/dL)	8.1 ± 0.9	29 (24.2)

Observation: Hypokalemia was the most common electrolyte abnormality.

Table 5. Biochemical Parameters

Parameter	Mean ± SD
Blood Glucose (mg/dL)	82.6 ± 18.5
Serum Albumin (g/dL)	2.9 ± 0.7
Blood Urea (mg/dL)	28.6 ± 10.4
Serum Creatinine (mg/dL)	0.58 ± 0.21
Total Protein (g/dL)	5.4 ± 0.8

Observation: Hypoalbuminemia was commonly observed among SAM children.

Table 6. Liver Function Tests

Parameter	Mean ± SD
Total Bilirubin (mg/dL)	0.82 ± 0.34
AST (U/L)	48.5 ± 16.2
ALT (U/L)	42.3 ± 14.7

Observation: Mild elevation of liver enzymes was observed in some participants.

Table 7. Electrocardiographic Findings

ECG Finding	Number (%)
Normal ECG	78 (65.0)
Sinus Tachycardia	24 (20.0)
Low Voltage Complexes	10 (8.3)
ST-T Changes	5 (4.2)
Arrhythmias	3 (2.5)

Observation: Sinus tachycardia was the most frequent ECG abnormality.

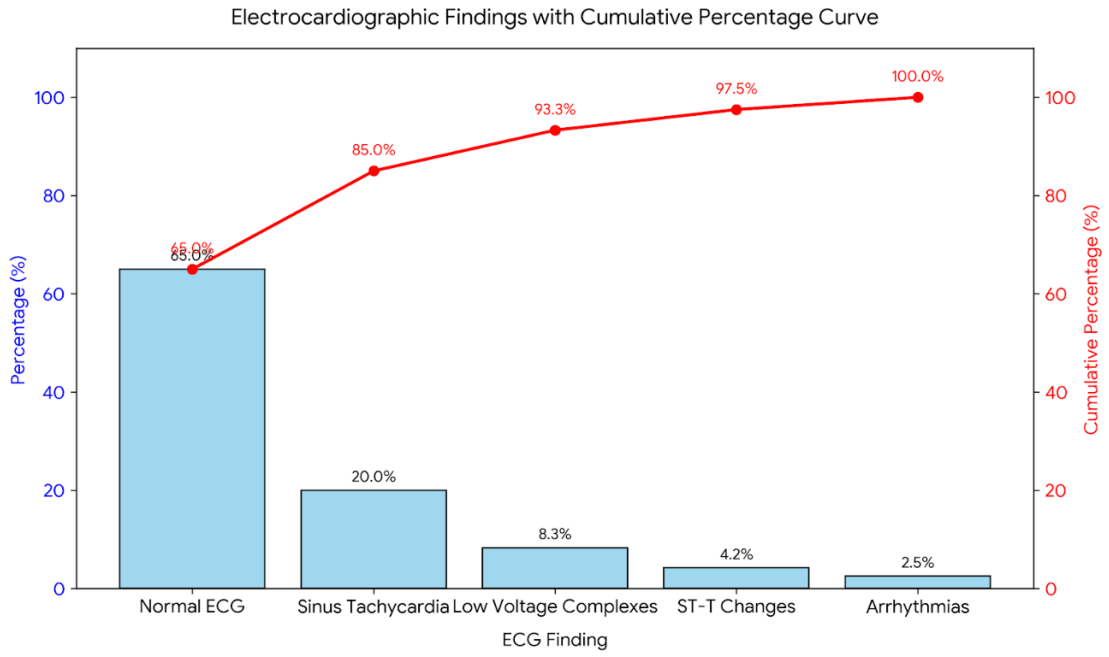


Table 8. Echocardiographic Findings

Finding	Number (%)
Normal Echocardiography	76 (63.3)
Left Ventricular Dysfunction	30 (25.0)
Pericardial Effusion	9 (7.5)
Dilated Cardiac Chambers	5 (4.2)

Observation: Left ventricular dysfunction was present in one-fourth of the study population.

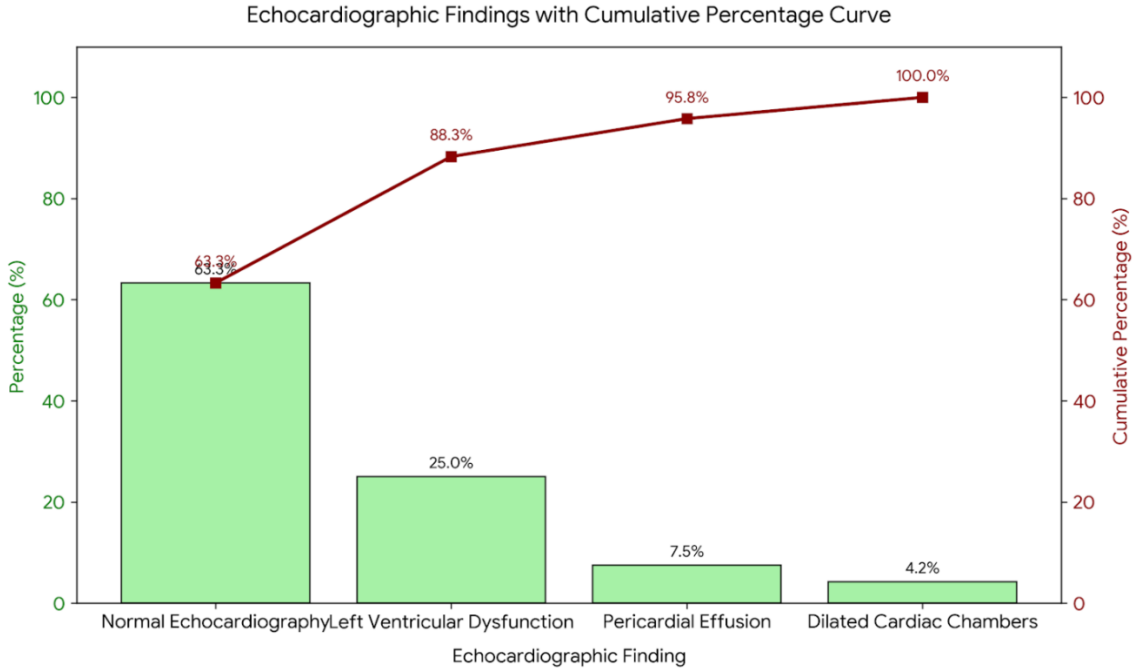


Table 9. Left Ventricular Ejection Fraction Distribution

LVEF Category	Number (%)
≥55% (Normal)	90 (75.0)
45–54% (Mild Dysfunction)	18 (15.0)
35–44% (Moderate Dysfunction)	9 (7.5)
<35% (Severe Dysfunction)	3 (2.5)

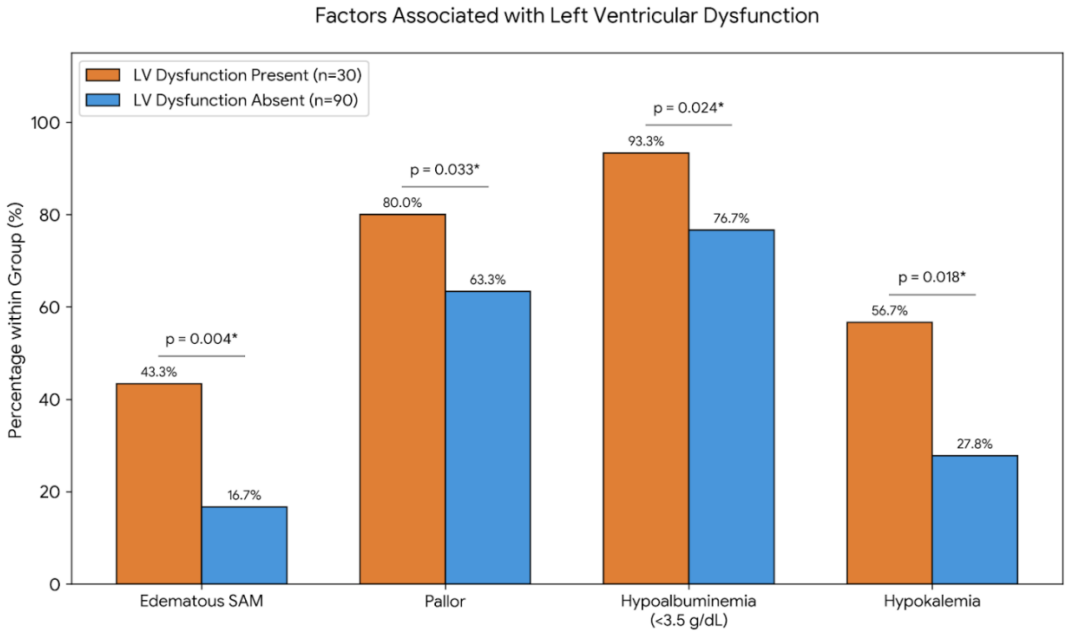
Observation: Mild LV dysfunction was the most common category among affected children.

Table 10. Factors Associated with Left Ventricular Dysfunction

Variable	LV Dysfunction Present n=30	LV Dysfunction Absent n=90	p-value
Edematous SAM	13	15	0.004*
Pallor	24	57	0.033*
Hypoalbuminemia (<3.5 g/dL)	28	69	0.024*
Hypokalemia	17	25	0.018*

*Statistically significant ($p < 0.05$)

Observation: Edematous malnutrition, anemia, hypoalbuminemia, and hypokalemia were significantly associated with left ventricular dysfunction.



DISCUSSION

The present study evaluated cardiac complications and left ventricular dysfunction among 120 children diagnosed with severe acute malnutrition. The majority of participants belonged to the 13–24 months age group, with a slight male predominance. Similar age and gender distributions have been reported in previous Indian studies, where the highest prevalence of SAM was observed during the weaning period due to inadequate complementary feeding practices, recurrent infections, and increased nutritional demands.[12,13]

The clinical profile of the study population demonstrated that severe wasting was present in 76.7% of children, whereas 23.3% had edematous malnutrition. Pallor was observed in 67.5% of participants, followed by respiratory infections, diarrhea, and hepatomegaly. These findings are consistent with previous reports indicating that malnourished children frequently present with multiple nutritional deficiencies and recurrent infections due to impaired immune function.[14]

Hematological assessment revealed a mean hemoglobin level of 8.7 ± 1.8 g/dL, indicating a high prevalence of anemia. Similar findings have been reported by Kumar et al., who observed anemia in the majority of hospitalized children with severe malnutrition.[15] Anemia contributes to increased cardiac workload and tissue hypoxia, potentially aggravating myocardial dysfunction.

Electrolyte abnormalities were common in the present study. Hypokalemia was observed in 35.0% of children, hyponatremia in 31.7%, and hypocalcemia in 24.2%. These findings are comparable to those reported by El Razaky et al. and Phornphatkul et al., who documented significant electrolyte disturbances among children with SAM.[8,16] Potassium plays a critical role in myocardial electrical activity and contractility, and its deficiency may predispose children to arrhythmias and ventricular dysfunction.

Biochemical evaluation revealed marked hypoalbuminemia, with a mean serum albumin concentration of 2.9 ± 0.7 g/dL. Low serum albumin levels are indicative of severe protein deficiency and are commonly encountered in children with SAM.[17] Hypoalbuminemia may impair myocardial function through alterations in intravascular volume, myocardial protein synthesis, and tissue edema. Renal function parameters were largely within normal limits, suggesting minimal renal involvement in the majority of study participants.

Liver function assessment demonstrated mild elevation of serum transaminases. Similar observations have been reported by previous investigators and may reflect hepatic steatosis, oxidative stress, and metabolic disturbances associated with severe nutritional deficiency.[18]

Electrocardiographic abnormalities were identified in 35.0% of children. Sinus tachycardia was the most common ECG abnormality, followed by low-voltage complexes, ST-T changes, and arrhythmias. Comparable findings were reported by Olivares et al., who demonstrated significant electrocardiographic alterations among severely malnourished children.[10] These abnormalities may result from myocardial atrophy, electrolyte imbalance, anemia, and autonomic dysfunction.

Echocardiographic examination revealed cardiac abnormalities in a considerable proportion of participants. Left ventricular dysfunction was identified in 25.0% of children, making it the most common cardiac complication observed in the study. Pericardial effusion and chamber dilatation were also detected in a smaller number of participants. Similar observations have been reported by Bergman et al., Phornphatkul et al., and Singh et al., who documented reduced ventricular performance and impaired systolic function among severely malnourished children.[4,8,19]

Analysis of left ventricular ejection fraction showed that 25.0% of participants had varying degrees of systolic dysfunction. Mild dysfunction was the most frequent category, whereas moderate and severe dysfunction were less common. These findings support previous evidence that chronic malnutrition may adversely affect myocardial mass and contractile function.[4,19]

An important finding of the present study was the significant association between edematous malnutrition and left ventricular dysfunction. Children with edematous SAM demonstrated a significantly greater prevalence of ventricular dysfunction compared with those having non-edematous malnutrition. Similar observations have been reported in studies evaluating cardiovascular involvement in kwashiorkor and other edematous forms of malnutrition.[20]

The present study also demonstrated a significant association between anemia and left ventricular dysfunction. Chronic anemia increases myocardial oxygen demand and cardiac output requirements, which may ultimately impair ventricular performance.[15] Likewise, hypoalbuminemia was significantly associated with left ventricular dysfunction, suggesting that severe protein depletion contributes directly to myocardial impairment.

Hypokalemia was another important factor associated with ventricular dysfunction. Potassium deficiency can alter myocardial electrical conduction and contractility, thereby increasing the risk of both arrhythmias and systolic dysfunction.[6] The significant association observed in the present study highlights the importance of early identification and correction of electrolyte disturbances during nutritional rehabilitation.

Overall, the findings of the present study demonstrate that cardiac abnormalities are common among children with severe acute malnutrition. Left ventricular dysfunction, electrocardiographic abnormalities, anemia, hypoalbuminemia, and electrolyte disturbances were frequently encountered and were significantly interrelated. Routine cardiac assessment using electrocardiography and echocardiography may facilitate early diagnosis of myocardial involvement and improve clinical outcomes in children with severe acute malnutrition.

CONCLUSION

The present study concludes that cardiac involvement, particularly left ventricular dysfunction, is common in children with Severe Acute Malnutrition. Significant associations were observed with anemia, hypoalbuminemia, hypokalemia, and edematous malnutrition. Early cardiac evaluation using ECG and echocardiography should be routinely included in the management of SAM for timely diagnosis and improved clinical outcomes.

REFERENCES

1. World Health Organization. Updates on the management of severe acute malnutrition in infants and children. Geneva: WHO; 2013.
2. UNICEF, WHO, World Bank Group. Levels and Trends in Child Malnutrition. Geneva; 2023.
3. Waterlow JC. Protein Energy Malnutrition. London: Edward Arnold; 1992.
4. Bergman JW, Human DG, De Moor MM, et al. Cardiac status of children with severe protein-energy malnutrition. S Afr Med J. 1988;74:104-106.
5. Brent B, Waterlow JC. Effects of protein deficiency on myocardial structure and function. Am J Clin Nutr. 1994;59:328-334.
6. Goyal RK, Jialal I. Hypokalemia and cardiac complications. Med Clin North Am. 2017;101:611-620.
7. Golden MH. Protein deficiency and organ dysfunction in malnutrition. Nutr Res Rev. 1994;7:153-176.
8. Phornphatkul C, Pongprot Y, Suskind R, et al. Cardiac function in malnourished children. Clin Pediatr. 1994;33:147-154.

9. El Razaky O, El Amrousy D, Elrifaey S, et al. Cardiac changes in children with severe acute malnutrition. Cardiol Young. 2017;27:561-567.
10. Olivares JL, Vazquez M, Rodriguez G, et al. Electrocardiographic abnormalities in malnourished children. Nutr Hosp. 2005;20:114-118.
11. WHO. Management of Severe Acute Malnutrition in Children. Geneva: World Health Organization; 2013.
12. Bhandari N, Bahl R, Taneja S, et al. Growth performance of children with severe malnutrition. Indian Pediatr. 2002;39:681-690.
13. Kumar R, Singh J, Joshi K, et al. Clinical profile of severe acute malnutrition in hospitalized children. Indian Pediatr. 2017;54:193-196.
14. Black RE, Victora CG, Walker SP, et al. Maternal and child undernutrition and overweight. Lancet. 2013;382:427-451.
15. Kumar R, Agarwal N, Gupta P, et al. Hematological abnormalities in severe acute malnutrition. Indian J Pediatr. 2018;85:425-430.
16. El Razaky O, El Amrousy D, Elrifaey S, et al. Cardiac and electrolyte abnormalities in malnourished children. Cardiol Young. 2017;27:561-567.
17. Briend A, Khara T, Dolan C. Wasting and stunting: similarities and differences. Matern Child Nutr. 2015;11:309-320.
18. Singh P, Sharma D, Gupta S, et al. Biochemical abnormalities in severe acute malnutrition. Int J Contemp Pediatr. 2019;6:1082-1087.
19. Singh P, Gupta S, Sharma D, et al. Echocardiographic assessment of cardiac function in severe acute malnutrition. Indian J Child Health. 2018;5:251-255.
20. Ahmed T, Hossain M, Sanin KI. Global burden of malnutrition and cardiovascular consequences. BMJ. 2020;369.