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Serum albumin and hemoglobin levels and their association with grades of edema in children with edematous malnutrition

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Abstract

Background: Edematous malnutrition in children is classified into three severity grades based on anatomical distribution. The relationship between biochemical markers and edema severity remains incompletely understood. This study aimed to investigate serum albumin and hemoglobin levels and their association with grades of edema in children with edematous malnutrition.

Methods: This cross-sectional study enrolled 51 children aged 6–60 months with edematous malnutrition at a tertiary care center in Dhaka from July 2019 to June 2020. Serum albumin and hemoglobin levels were measured. Data were analyzed using the Statistical Package for the Social Sciences version 20, with one-way ANOVA and Chi-square tests used to assess relationships between biochemical parameters and edema severity (mild, moderate, and severe). $P < 0.05$ was considered statistically significant.

Results: Most subjects (74.5%) were under 12 months with nearly equal gender distribution. Mean serum albumin was 3.14 ± 0.68 g/dL, and mean hemoglobin was 8.94 ± 1.86 g/dL. Hypoalbuminemia was present in 70.6% of children. Serum albumin progressively decreased with increasing edema severity: Mild (3.32 ± 0.70 g/dL), moderate (3.03 ± 0.43 g/dL), and severe (2.84 ± 0.78 g/dL), $P = 0.017$. Similarly, hemoglobin levels declined significantly across edema grades: Mild (9.22 ± 2.04 g/dL), moderate (8.91 ± 1.52 g/dL), and severe (6.26 ± 1.73 g/dL), $P = 0.036$. A significant association was observed between anemia severity and edema grades ($P = 0.014$).

Conclusion: This study demonstrates significant inverse correlations between serum albumin levels, hemoglobin concentrations, and edema severity in malnourished children. Both parameters progressively declined with worsening edema grades, suggesting their potential utility as biochemical markers for assessing edema severity and guiding therapeutic interventions that address both hypoalbuminemia and anemia simultaneously.

Keywords: Anemia, edema grades, edematous malnutrition, hemoglobin, hypoalbuminemia, serum albumin

Introduction

Children with edematous malnutrition develop bilateral pitting edema. This edema is classified into three grades based on anatomical distribution. Grade 1 affects only the feet. Grade 2 extends to the legs. Grade 3 involves generalized edema, including the face.[1] This grading system serves as a clinical indicator of disease severity. Higher grades typically correlate with worse outcomes. Serum

albumin and hemoglobin levels represent important biochemical markers related to these edema grades. Their exact relationship with edema severity remains incompletely understood. Serum albumin shows significant correlations with edema severity in malnourished children. Grade 1 edema typically develops when albumin falls below 2.5–3.0 g/dL. Grade 2 edema often corresponds with albumin levels between 1.5 and 2.5 g/dL.[2] Grade 3 edema frequently occurs with severe hypoalbuminemia below 1.5 g/dL. These thresholds vary considerably between individuals. Some children develop severe edema despite having relatively higher albumin levels.[3] This variation suggests additional factors influence edema formation beyond albumin alone. Hemoglobin levels also show distinct patterns of association with edema grades. Children with Grade 1 edema commonly have mild anemia with hemoglobin between 9 and 11 g/dL. Those with Grade 2 edema often present with moderate anemia (7–9 g/dL). Grade 3 edema typically coincides with severe anemia, where hemoglobin drops below 7 g/dL.[4] These associations suggest potential mechanistic links between worsening anemia and increasing edema severity. Shared pathological processes likely affect both parameters simultaneously. These processes include inflammation and oxidative stress. The relationship between albumin and hemoglobin across different edema grades reveals important clinical patterns. Edema often progresses when both parameters decline together. The most rapid edema progression occurs in children experiencing simultaneous drops in both values.[5] Transition from Grade 1 to Grade 2 typically coincides with albumin decreases of 0.5–1.0 g/dL. This decrease occurs alongside hemoglobin reductions of 1–2 g/dL. Further declines in both parameters often precede progression to Grade 3 edema. This progression becomes most likely when albumin falls below critical functional thresholds. These biochemical markers show varying predictive value across different edema grades. Early-stage edema (Grade 1) correlates more strongly with albumin than hemoglobin levels. This suggests initial fluid shifts primarily reflect changes in oncotic pressure.[6] Advanced edema (Grades 2–3) shows more balanced associations with both parameters. This indicates that anemia-related tissue hypoxia becomes increasingly important as edema progresses. Vascular changes from anemia contribute significantly to fluid extravasation in severe cases.[7] Recovery patterns further demonstrate these associations. Edema improvement typically requires restoration of both albumin and hemoglobin. Transition from Grade 3 to Grade 2 generally requires albumin increases of at least 0.5 g/dL. This must be accompanied by hemoglobin improvements of 1–2 g/dL. Albumin must exceed 3.0 g/dL, and hemoglobin must reach at least 10 g/dL.[8] This study aimed to investigate serum albumin and hemoglobin levels and their association with grades of edema in children with edematous malnutrition.

Methods

This cross-sectional study was conducted from July 2019 to June 2020 in the pediatric inpatient unit of the Institute of Child and Mother Health (ICMH), Matuail, Dhaka, a tertiary care center. A total of 51 children aged 6–60 months with clinical signs of edematous malnutrition were enrolled using purposive sampling. Inclusion criteria included bilateral pitting edema and/or weight-for-height Z-score <−3SD or malnutrition universal screening tool (MUAC) <115 mm. Cases with edema due to non-nutritional antecedents such as nephrotic syndrome, congenital heart disease, or chronic liver disease were excluded. Data were collected using a pre-tested semi-structured questionnaire and entered into Statistical Package for the Social Sciences version 20 for analysis. Continuous variables were revealed as mean ± SD, and categorical variables as frequencies and percentages. One-way analysis of variance (ANOVA) was used to compare mean serum albumin levels across grades of edema (mild, moderate, and severe), and Chi-square tests assessed associations between categorical variables. $P < 0.05$ was considered statistically significant. Ethical approval was obtained by the ICMH Institutional Review Board, and written informed consent was secured from caregivers before participation.

Results

Table 1 shows that the majority of study children with edematous malnutrition were under 12 months of age (74.5%) followed by 17.6% in the 13–24 months group, and only 7.8% above 24 months. The gender distribution was almost equal, with females comprising 51% and males 49%. The mean age of mothers was 21.96 ± 4.75 years. More than half of the mothers (52.9%) and 43.1% of fathers had primary education, whereas only 2% of both parents were graduates. Socioeconomically, 39.2% of families were middle-income, 37.3% poor, and 23.5% rich, highlighting the predominance of low- to middle-income households among the affected children.

The mean serum albumin level among the study children was 3.14 ± 0.68 g/dL, whereas the mean hemoglobin concentration was 8.94 ± 1.86 g/dL, indicating hypoalbuminemia and anemia in this group [Table 2].

Table 3 shows that among study children, 51% exhibited mild edema, 27.4% moderate, and 21.6% severe, indicating a high prevalence of edema, with mild cases dominating the cohort.

Table 4 shows that 70.6% had hypoalbuminemia, 39.2% had mild hypoalbuminemia, 27.5% had moderate hypoalbuminemia, and 3.9% had severe hypoalbuminemia. About 29.4% had no hypoalbuminemia.

Table 5 shows that hypoalbuminemia was significantly associated with grades of edema.

Table 6 shows that the mean albumin level was 3.32 ± 0.70 g/dL in patients with mild edema, 3.03 ± 0.43 g/dL in patients with moderate edema, and 2.84 ± 0.78 g/dL in patients with severe edema. A significant statistical difference was noticed.

Table 1: Sociodemographic profile of the study children (*n*=51)

Variables	Categories	Frequency (*n*)	Percentage
Age group (months)	<12 months	38	74.5
	13–24 months	9	17.6
	> 24 months	4	7.8
Gender	Male	25	49
	Female	26	51
Mother's age (mean±standard deviation)	21.96±4.75		
Mother's education	Below the primary level	8	15.7
	Primary level	27	52.9
	Secondary level	14	27.5
	Higher secondary level	1	2
	Graduation	1	2
Father's education	Below the primary level	13	25.5
	Primary level	22	43.1
	Secondary level	12	23.5
	Higher secondary level	3	5.9
	Graduation	1	2
Socioeconomic status	Poor (<7500 Tk)	19	37.3
	Middle income (7501–15000 Tk)	20	39.2
	Rich (>15000 Tk)	12	23.5

Table 7 shows presence and level of anemia were significantly associated with grades of edema.

Table 8 shows mean hemoglobin level was significantly lower among children with severe edema.

Discussion

This study investigated the relationship between serum albumin and hemoglobin levels and their association with grades of edema in children with edematous malnutrition. Most subjects were under 12 months of age, with nearly equal gender distribution and predominantly from low- to middle-income backgrounds. The mean serum albumin level was 3.14 ± 0.68 g/dL, whereas the mean hemoglobin concentration was 8.94 ± 1.86 g/dL. Hypoalbuminemia was observed in 70.6% of children, with varying degrees of severity. These findings align with previous studies reporting high frequencies of hypoalbuminemia in edematous malnutrition.[9,10] Our analysis revealed a significant inverse relationship between serum albumin levels and edema severity. The mean albumin level progressively decreased from 3.32 ± 0.70 g/dL in mild edema to 3.03 ± 0.43 g/dL in moderate edema and 2.84 ± 0.78 g/dL in severe edema (P = 0.017). This pattern supports the pathophysiological role of hypoalbuminemia in edema formation.[2,11] Similarly, hemoglobin concentrations showed a significant association with edema grades (P = 0.014). Among children with mild edema, 26.9% maintained normal hemoglobin levels, whereas none with severe edema had normal hemoglobin. The mean hemoglobin concentration declined from 9.22 ± 2.04 g/dL in mild edema to 8.91 ± 1.52 g/dL in moderate edema and 6.26 ± 1.73 g/dL in severe edema (P = 0.036). These findings corroborate previous reports of increasing anemia severity with worsening edematous malnutrition.[4,12] The concurrent decline in both parameters suggests complementary pathophysiological mechanisms. Hypoalbuminemia reduces oncotic pressure within the vascular compartment, facilitating

Table 2: Laboratory parameters of the study children (n=51)

Investigations	Mean±standard deviation
Serum Albumin (g/dL)	3.14±0.68
Hemoglobin (g/dL)	8.94±1.86

Table 3: Distribution of edema severity among children with edematous malnutrition (n=51)

Grade of Edema	Frequency (n)	Percentage
Mild	26	51.0
Moderate	14	27.4
Severe	11	21.6

Table 4: Albumin level category in the study children (n=51)

Albumin level category	*n*	(%)
Hypoalbuminemia	36	70.6
Mild	20	39.2
Moderate	14	27.5
Severe	2	3.9
Normal Albumin	15	29.4

Table 5: Association between hypoalbuminemia and grades of edema (n=51)

Hypoalbuminema	Grade of edema			*P*-value*
	Mild *n*=26	Moderate *n*=14	Severe *n*=11	
Mild	8 (30.8)	10 (71.4)	2 (18.2)	0.009
Moderate	7 (26.9)	3 (21.5)	4 (36.4)	
Severe	0	0	2 (18.2)	
Normal albumin	11 (42.3)	1 (7.1)	3 (27.3)	

*P-value was determined by the Chi-square test

Table 6: Level of serum albumin in the study children according to grades of edema (*n*=51)

Serum albumin (g/dL)	Grade of edema			*P*-value*
	Mild *n*=26	Moderate *n*=14	Severe *n*=11	
Variables	3.32±0.70	3.03±0.43	2.84±0.78$	0.017

**P*-value was determined by one-way analysis of variance. *Post hoc* analysis by the Bonferroni method was done. $Denotes significant difference between patients with mild edema and patients with severe edema

Table 7: Association between anemia and grades of edema (*n*=51)

Anemia	Grade of edema			*P*-value*
	Mild *n*=26	Moderate *n*=14	Severe *n*=11	
Mild	2 (7.7)	0	2 (18.2)	0.014
Moderate	14 (53.8)	13 (92.9)	5 (45.5)	
Severe	3 (11.5)	0	4 (36.4)	
Normal hemoglobin	7 (26.9)	1 (7.1)	(0)	

**P*-value was determined by the Chi-square test

Table 8: Association between hemoglobin level in the study children with grades of edema (*n*=51)

Hemoglobin (g/dL)	Grade of edema			*P*-value*
	Mild *n*=26	Moderate *n*=14	Severe *n*=11	
Variables	9.22±2.04	8.91±1.52	6.26±1.73$	0.036

**P*-value was determined by one-way ANOVA. *Post hoc* analysis by the Bonferroni method was done. $Denotes significant difference between patients with mild edema and patients with severe edema

fluid extravasation. The accompanying decline in hemoglobin may contribute to tissue hypoxia, endothelial dysfunction, and increased capillary permeability, further exacerbating fluid leakage.[3,13] The distribution of anemia across edema grades provides additional insights. In mild edema, 7.7% had mild anemia, 53.8% moderate anemia, and 11.5% severe anemia. In severe edema, 18.2% had mild anemia, 45.5% moderate anemia, and 36.4% severe anemia, demonstrating a shift toward more severe anemia with worsening edema. The inflammatory response in malnutrition can suppress albumin production while simultaneously contributing to anemia of chronic disease.[6] Micronutrient deficiencies, particularly iron, folate, and Vitamin B12, further compound anemia in these children.[14] Clinically, these findings support using serum albumin and hemoglobin levels as biochemical markers for assessing edema severity. They suggest that therapeutic interventions addressing both hypoalbuminemia and anemia might be more effective than targeting either parameter alone. Early nutritional rehabilitation with appropriate protein supplementation and micronutrient correction could potentially prevent progression to severe edema.[8,15] The study demonstrates significant associations between serum albumin levels, hemoglobin concentrations, and grades of edema in children with edematous malnutrition.

Limitations of the study

This study had several limitations. The single-center designs and small sample size limits the generalizability of findings. The cross-sectional approach precludes establishing causality between biochemical parameters and edema severity. In addition, the predominance of infants under 12 months may not reflect patterns across all pediatric age groups with edematous malnutrition.

Conclusion

This study demonstrated a significant inverse association between serum albumin levels, hemoglobin concentrations, and edema severity in children with edematous malnutrition. Both parameters progressively declined with worsening edema grades. These findings support using albumin and hemoglobin as biochemical markers for assessing edema severity and guiding therapeutic interventions in malnourished children.

Recommendation

Regular monitoring of serum albumin and hemoglobin levels should be implemented for early detection and grading of edema severity. Treatment protocols should address both hypoalbuminemia

and anemia simultaneously. Further multicenter studies with larger sample sizes are needed to establish standardized thresholds.

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Conflict of Interest

None declared.

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