

Original Research Article

Serum electrolyte levels and their association with edema severity in pediatric edematous malnutrition

Mohammad Nasir Uddin^{1*}, Farhana Sultana², Mohammad Mizanoor Rahman³,
Zamil Ahmed Manik¹, Ifthakhar Ahmed¹, Joheb Imtiaz Jamil¹

¹Department of Pediatrics, Institute of Child and Mother Health (ICMH), Dhaka, Bangladesh

²Department of Obstetrics and Gynecology, Institute of Child and Mother Health (ICMH), Dhaka, Bangladesh

³Department of Anesthesiology, Institute of Child and Mother Health (ICMH), Dhaka, Bangladesh

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*Correspondence:

Dr. Mohammad Nasir Uddin,

E-mail: nasirsbmc30@gmail.com

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ABSTRACT

Background: Edematous malnutrition, a severe and acute malnutrition, still remains one of the main causes of morbidity and mortality among children under five years of age, particularly in low- and middle-income countries. Edematous malnutrition in children is usually combined with fluid retention and electrolyte disturbance that, if not treated early, can lead to life-threatening complications. The purpose of this study is to evaluate the trend and magnitude of serum electrolyte level and their association with edema severity in children with edematous malnutrition.

Methods: It was a cross-sectional study conducted in the Department of Paediatrics Inpatient, Institute of Child and Mother Health (ICMH), Dhaka, Bangladesh from July 2019 to June 2020. There were 51 children aged between 6 months to 5 years with edematous malnutrition who were included via purposive sampling. Data were cleaned and analyzed using SPSS (version 20).

Results: In the current study, most of the children were severely underweight (78.4%) and nearly half (47.1%) were severely stunted, while 31.4% were severely wasted. Mild oedema was detected in 51% of the children, followed by moderate (27.4%), and severe oedema (21.6%). The mean serum sodium, potassium, and chloride were 139.39 ± 4.23 mEq/l, 4.24 ± 0.59 mmol/l, and 105.09 ± 3.27 mEq/l, respectively. A significant association was found between serum sodium levels and the severity of oedema, with children having severe oedema showing significantly lower mean sodium levels compared to those with mild oedema ($p=0.036$).

Conclusions: This study demonstrates that among children with edematous malnutrition, serum sodium level showed a significant association with the severity of edema, with markedly lower sodium values observed in those with severe edema. In contrast, serum potassium and chloride levels did not vary significantly across different grades of edema.

Keywords: Serum electrolyte, Edematous malnutrition, Children, Hyponatremia

INTRODUCTION

Severe acute malnutrition with nutritional oedema (also known as kwashiorkor or edematous malnutrition) is a major cause of illness and death in children under the age of five years in low- and middle-income countries and is a global public health priority. Prevention and programmatic treatment of wasting and nutritional oedema are a priority according to existing WHO

guidelines because of their large contribution to child mortality and long-term damage to development.¹ Edematous malnutrition has distinct biochemical and clinical features compared to non-edematous malnutrition, and among them are fluid distribution abnormalities characteristic and profound disturbances of electrolyte and mineral homeostasis.² Electrolyte disturbances in SAM are common and clinically significant: body stores of potassium and magnesium are

depleted despite plasma concentrations appearing to be at or near normal, oedema occurs in part due to potassium deficiency and sodium retention, and such dyselectrolytemia can be worsened on refeeding or with acute infection if unsuspected and treated.^{3,2} Various hospital-based research has established high rates of hypokalemia, hypocalcemia, hyponatremia, and hypomagnesemia among hospitalized children with SAM, with hypokalemia always being the most frequent abnormality.^{4,7} A cross-sectional hospital study reported electrolyte derangements in over 90% of the admitted SAM children, including hypokalemia in approximately 70-80% of the cases, and large percentages also showing hypocalcemia and hyponatremia.^{4,6} Dyselectrolytemia not treated in malnourished children has serious clinical consequences. Hypokalemia and hypomagnesemia induce cardiac and respiratory disturbances, slow the recovery of muscular function, and are associated with increased inpatient mortality; observational reports indicate that SAM patients with hypokalemia have very higher case-fatality ratios than normokalemic controls.^{3,8} SAM hyponatremia is complex: excess sodium in the body can coexist with reduced plasma sodium concentration, so inappropriate high-sodium fluids or diuretics are fatal—a factor accounted for in WHO and inpatient pocket-book advice for low-sodium rehydration and standard potassium/magnesium supplementation in rehabilitation.³ While guidelines advise electrolyte screening, few programs include electrolyte screening in routine for children with edematous malnutrition, and the pattern of electrolyte imbalance may vary with comorbidity (e.g., diarrhoea, sepsis) and local feeding/rehydration practices.^{4,6} Current systematic reviews and clinical overviews highlight the importance of context-specific data to inform triage, fluid management, and formulary choice in nutritional rehabilitation units and children's wards.⁹ The aim of this research is to determine the severity and pattern of serum electrolyte disturbances among children with edematous malnutrition and their correlation with edema severity.

METHODS

This cross-sectional study was conducted in the Department of Paediatrics Inpatient, Institute of Child and Mother Health (ICMH), Dhaka, Bangladesh from July 2019 to June 2020. A total of 51 children aged 6 months to 5 years with edematous malnutrition were included by purposive sampling, based on the following criteria: bilateral pedal edema and/or weight-for-length/height Z-score <-3 SD and/or MUAC <115 mm. Children with edema due to nephrotic syndrome, heart failure, or chronic liver disease were excluded. Participants were categorized according to edema grade as mild (+) (feet/ankles), moderate (++) (feet, legs, hands/lower arms), and severe (+++) (generalized, including face). Weight was measured using a Salter scale, length by infantometer, and MUAC by Shakir's tape. After obtaining informed written consent from legal guardians, venipuncture was performed for blood

collection. Relevant clinical and laboratory data were recorded in a pre-designed data sheet. SPSS version 20 was employed to preprocess and analyze the data. Categorical data were shown in frequency and percentage, whereas continuous data were shown as mean \pm standard deviation, and correlation was tested by Chi-square test for categorical and one-way ANOVA for continuous variables, with $p < 0.05$ considered to be statistically significant. Ethical approval was obtained from institutional review board (IRB) of ICMH.

RESULTS

Figure 1 shows the mean age of the study population was 11.45 ± 6.46 (SD) months with a range of 6 months to 28 months. Children were aged below 12 months (74.50%), aged 13-20 months 17.60% and aged >24 months 7.80%.

Figure 2 shows that about 51% children were female and 49% children were male.

Table 1 shows the mean age of mothers, 21.96 ± 4.75 , mothers' education below primary, 15.7%, primary, 52.9%, secondary, 27.5%, HSC 2% and graduation 2%. Fathers' education below primary 25.5%, primary 43.1%, secondary 23.5%, HSC 5.9% and graduation 2%. Socioeconomic status: poor 37.3%, middle 39.2% and rich 23.5%.

Table 2 shows that the mean weight of the studied children was 6 ± 1.55 (SD) kg, and the mean height was 64.80 ± 6.04 (SD) cm. Mean MUAC was 114.16 ± 28.98 (SD) mm.

Figure 3 shows that according to the WAZ score, 78.40% ($n=40$) were severely underweight, 15.70% ($n=8$) were moderate underweight, and 5.90% ($n=3$) had normal weight. According to the HAZ score, 47.10% ($n=24$) had severe stunting, 33.30% ($n=17$) had moderate stunting, 9.80% ($n=5$) had mild stunting, and 9.80% ($n=5$) had normal height. According to the WLZ score, 31.40% ($n=16$) had severe wasting, 23.50% ($n=12$) had moderate wasting, 19.60% ($n=10$) had mild wasting, and 25.50% ($n=13$) had no wasting.

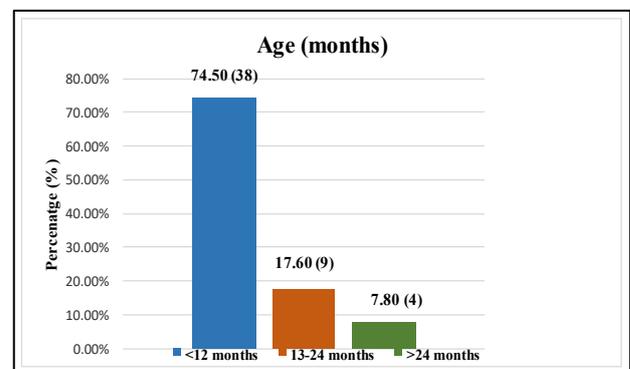


Figure 1: Age group distribution of study children, (n=51).

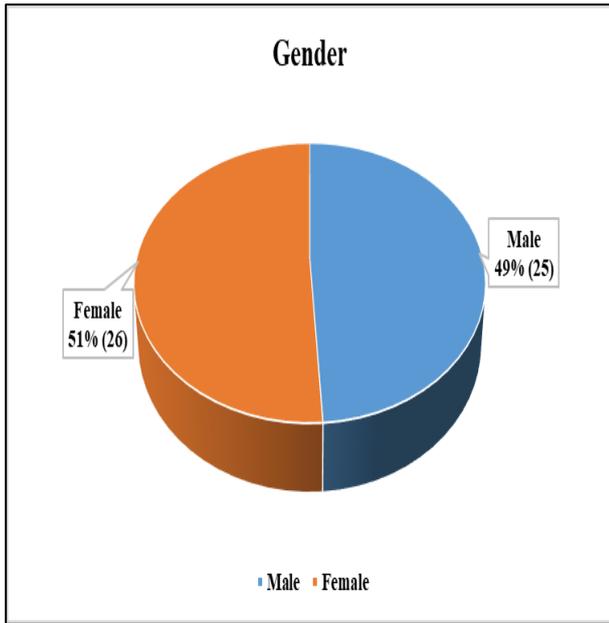


Figure 2: Gender distribution of study children, (n=51).

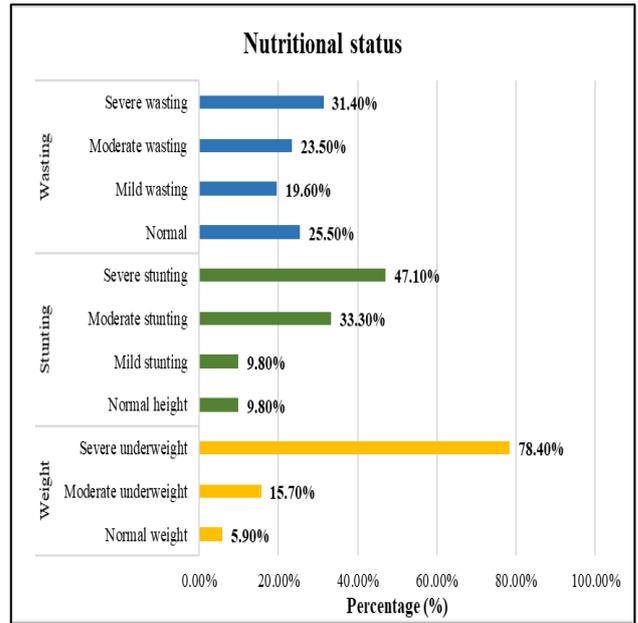


Figure 3: Nutritional status of study children according to Z score, (n=51).

Table 1: Socio-demographic characteristics of study children, (n=51).

Variables	N (%)	
Mothers' age (mean±SD) (in years)	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)
Socio-economic status	Poor <7500 Tk	19 (37.3)
	Middle income group 7501-15000 Tk	20 (39.2)
	Rich >15000 Tk	12 (23.5)

Table 2: Anthropometric measurement of study children, (n=51).

Variables	Mean± SD
Weight (kg)	6±1.55
Height (cm)	64.80±6.04
MUAC (mm)	114.16±28.98

Figure 4 shows that about 51% children had mild oedema, 27.40% had moderate oedema, and 21.60% had severe oedema.

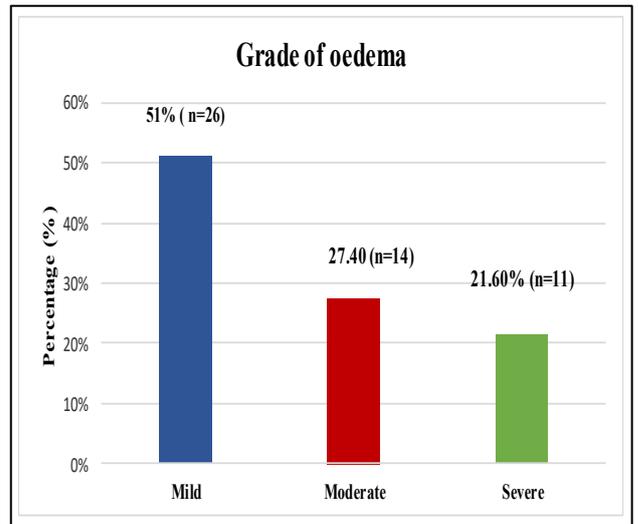


Figure 4: Grades of oedema of study children, (n=51).

In Table 3, mean serum sodium was 139.39±4.23 mEq/l, the mean serum potassium was 4.24±0.59 mmol/l, and the mean serum chloride was 105.09±3.27 mEq/l.

Table 3: Serum electrolytes of the study children, (n=51).

Investigations	Mean±SD
Serum sodium (mEq/l)	139.39±4.23
Serum potassium (mmol/l)	4.24±0.59
Serum chloride (mEq/l)	105.09±3.27

Table 4: Association of serum electrolytes in the study children with grades of oedema, (n=51).

Serum electrolyte parameters	Grade of oedema			P value*
	Mild, n=26	Moderate, n=14	Severe, n=11	
Serum Na (mEq/l)	140.65±4.06	139.28±4.46	137.09±3.34 ^s	0.036
Serum K (mmol/l)	4.14±0.56	4.17±.63	4.56±3.52	0.125
Serum Cl (mEq/l)	105.30±3.69	105.28±2.62	105.09±3.27	0.369

*p value was determined by one-way ANOVA. Post Hoc analysis by the Bonferroni method was done. ^sDenotes significant difference between children with mild oedema and children with severe oedema.

The mean sodium level was significantly lower among children with severe oedema.

DISCUSSION

The study was carried out in the inpatient department of paediatrics, Institute of Child and Mother Health, Matuail, Dhaka. A total of 51 children with oedematous malnutrition were enrolled in this study. The average age of the studied children was 11.45 months, with a range from 6 months to 28 months. Most of the children were below 12 months (74.50%). In a similar study, Rahman, Chowdhury, and Hossain found the mean age to be 29 months.¹⁰ A dissimilarity is being observed regarding the mean age of the present study with previous studies. The present study was conducted among the admitted patients of the study hospital, and it may not represent the generalized population. Moreover, the sample size was also very small. Regarding gender, female children (51%) were slightly predominant over male children (49%) in this study. Rahman, Chowdhury, and Hossain also found female predominance in their study.¹⁰ The majority of the studied children's mothers and fathers were studied up to primary school, with a percentage of 52.9% and 43.1% respectively. Monthly family income was <15,000 Tk in 76.5% parents. Despite all determinants and differentials of malnutrition, consciousness plays the most important role. Education builds this consciousness among mothers, which increases the mothers' and children's health care-seeking behavior.¹¹ The mean weight and height of the studied children were 6±1.55 (SD) kg and 64.80±6.04 (SD) cm. Mean MUAC was 114.16±28.98 (SD), and about 63% of children's MUAC was <115 mm. According to the Z score, 78.40% were severely underweight and 15.70% were moderately underweight. Severe stunting was observed in 47.10% patients, moderate stunting in 33.30% patients, and mild stunting in 9.80% patients. Severe wasting was observed in 31.40% patients, moderate wasting in 23.50% patients, and mild wasting in 19.60% patients. About 51% of the children had mild oedema, 27.40% moderate oedema, and 21.60% severe oedema. In the current study, the serum sodium concentration was significantly lower in children with severe oedema compared to those who had mild oedema (137.09±3.34 vs. 140.65±4.06 mEq/L, p=0.036). Raza et al reported the same findings, in which they identified a higher rate of hyponatremia in children who had severe oedematous malnutrition.⁴ Chand et al also found that serum sodium decreased with increasing severity of oedema, reflecting sodium retention and

dilutional hyponatremia due to altered renal handling.⁶ No significant differences were noted for potassium and chloride levels, consistent with previous reports.^{2,5}

Limitations

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

CONCLUSION

This study demonstrates that among children with edematous malnutrition, serum sodium level showed a significant association with the severity of edema, with markedly lower sodium values observed in those with severe edema. In contrast, serum potassium and chloride levels did not vary significantly across different grades of edema.

Recommendations

Regular measurement of serum electrolytes, particularly sodium, in all children presenting with edematous malnutrition, particularly those having severe oedema, should be done. Detection of hyponatremia at an early stage and appropriate correction of the same should be incorporated within the treatment protocols.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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