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Original Research Article

Assessment of plasma electrolytes like sodium, potassium, and chloride in severely malnourished children: a cross-sectional study

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ABSTRACT

Background: Malnutrition is defined as an imbalance between the supply of nutrients and energy and the body's demand for normal growth and development. The most serious kind of undernutrition is known as severe acute malnutrition (SAM). Children who are malnourished frequently develop electrolyte imbalances. Therefore, this study aimed to assess the plasma electrolytes (sodium, potassium, and chloride) in severely acute malnourished children.
Methods: This was a cross-sectional study conducted in the Department of Biochemistry, Mymensingh Medical College in collaboration with the Department of Paediatrics, Mymensingh Medical College, and Community Based Medical College Bangladesh, Mymensingh, Bangladesh for a period of 1 year from July 2008 to June 2009. This study included 50 children as the cases of malnourishment, and 50 healthy children were taken as control group.
Results: The mean age of cases and controls were 3.7±1.3 years and 4.1±0.9 years respectively. The mean±SD of serum sodium between Group I (case) and Group II (control) were 134.2±2.6 and 138.4±4.1 with a p-value of <0.001 respectively. The mean±SD of serum potassium and chloride between Group I and Group II were 4.2±0.4 and 4.5±0.4 and 101.1±2.9 and 102.6±3.2 respectively. The electrolyte levels were significantly lower in Group I than in Group II.
Conclusions: This study found a significant ($p<0.05$) decrease in the mean ± SD of blood electrolyte levels (sodium, potassium, and chloride) in the case group as compared to the controls.

Keywords: Children, Chloride, Malnourishment, Potassium, Sodium

INTRODUCTION

Malnutrition is defined as an imbalance between the supply of nutrients and energy and the body's demand for normal growth and development. Malnutrition manifests itself in a variety of ways, including undernutrition, stunting in children, wasting in children, micronutrient deficiencies, being overweight in adults, and obesity in adults.[1] Malnutrition remains a major public health issue throughout the developing world, particularly in southern Asia and Sub-Saharan Africa. The high frequency of bacterial and parasitic illnesses in underdeveloped nations contributes significantly to malnutrition. Malnutrition, on the other hand, increases one's susceptibility to and severity of infections, making it a major cause of illness and mortality from these diseases. Approximately 3,000,000 deaths occur annually as a direct result of malnutrition, and approximately 500,000 deaths in young children globally are indirectly caused by it.[2] The World Health Organization (WHO) estimates that South Asian nations, specifically Bangladesh, India, and Pakistan, account for over 50% and 38.8% of the world's stunted and wasted child populations, respectively.[3]

In Bangladesh, two-thirds of children under five suffer from malnutrition. Malnutrition is a contributing factor in 240,000 fatalities among children under 5 years old annually (more than 600/day). According to the national child nutrition study, which was carried out in 2000, 52% of children under the age of seventy-one months and roughly 49% of stunted children were wasted. Based on surveys conducted between 1990 and 2000, the prevalence of wasting was determined to be 11.6% in Bangladesh, 18% in India, 11% in Pakistan, 11% in Nepal, 14% in Sri Lanka, 4% in Bhutan, and 17% in the Maldives among South Asian nations.[4]

The most serious kind of undernutrition is known as severe acute malnutrition (SAM). Children who are malnourished frequently develop electrolyte imbalances. A combination of diarrheal illnesses and electrolyte imbalance increases the risk of morbidity and mortality in children.[5,6] Most children with severe malnutrition and edema have excess total body sodium (Na) even though their serum sodium levels are low. This means that the low serum sodium levels conceal the sodium overload.[5,7] Even at normal serum levels, the body's total stores of potassium (K), calcium (Ca), and magnesium (Mg) are depleted.[7,8] Muscle weakness, apathy, paralytic ileus, hypotonia, and cardiac arrhythmias are common symptoms of hypokalemia.[5]

Previous research has shown that malnourished children frequently suffer from hyponatremia and hypokalemia. The incidence of these electrolyte abnormalities rises in the presence of diarrhea.[5,9,10]

Malnutrition encompasses several illnesses, including marasmus, kwashiorkor, and the intermediate condition marasmic-kwashiorkor. Several biochemical parameters are changed in various diseases. Significant risk factors in Marasmus and Kwashiorkor include serum electrolyte changes like as hypokalemia and hypernatremia, as well as metabolic acidosis, which is defined as intracellular sodium retention.[11,12] Malnourished children have higher serum Na+ levels, but they have lower contents due to water resorption, which hides Na+ levels, whereas K+ levels are lower in marasmus and kwashiorkor.[13]

Even though electrolyte imbalance in SAM has been the subject of numerous local and international studies, only a small number of electrolyte components have been examined; some have just examined Na and K levels, while others have examined Na, K, and Ca levels.

Therefore, in this study, we aimed to assess the plasma electrolytes (sodium, potassium, and chloride) in severely acute malnourished children.

METHODS

This was a cross-sectional study conducted in the Department of Biochemistry, Mymensingh Medical College in collaboration with the Department of Paediatrics, Mymensingh Medical College, and Community Based Medical College Bangladesh, Mymensingh, Bangladesh for a period of 1 year from July 2008 to June 2009. In our study, we included a total number of 100 children selected for the study from a slum area near Mymensingh Medical College. Out of them, 50 children were cases of malnourishment named group I, and 50 children were taken as control named group II.

Inclusion criteria

Inclusion criteria's were: a) Severely malnourished children (weight-for-age Z-score less than -3 or percentage of desired body weight for age and sex below 60%) were taken as cases; b) Children with weight-for-age Z-score more than -1 or percentage of desired bodyweight for age and sex above 90% were taken as controls; c) Children ranging from 18 months to 5 years irrespective of sexes; d) Children who got permission to participate were included in the study.

Exclusion criteria

Children with known endocrinological diseases; children with known genetic disorders; children with any history of acute illness (e.g., renal or pancreatic diseases, ischemic heart disease, asthma, COPD etc.) were excluded from this study.

Sample collection

Blood samples were collected from the subjects with all the aseptic precautions. From each subject, 4 ml of blood was collected by a 5 ml sterile disposable syringe attached with a butterfly needle. The collected blood was transferred to a dry screw-capped test tube immediately after the removal of the butterfly needle from the nozzle. The blood was poured in a linear stream along the side of the test tube by a gentle push of the piston. Test tubes were kept in a standing position until clot formation. Then the test tubes were centrifuged. The obtained sera were kept in Eppendorf after proper labeling. Serum electrolytes (sodium, potassium, and chloride) were determined by the ion-selective electrode (ISE) method.

Statistical analysis

Data were collected using a structured questionnaire containing all the variables of interest. The subjects' guardians were informed about the nature and purpose of the study and consent was taken from them. All data were recorded systematically in the preformed data collection form. Quantitative data was expressed as mean and standard deviation and qualitative data was expressed as frequency distribution and percentage. The differences between groups were analyzed by descriptive statistics and students' unpaired t-tests. A p value <0.05 was considered as significant. Statistical analysis was performed by using SPSS 10 (Statistical Package for Social Sciences) for Windows version 10. The study was approved by the

Ethical Review Committee of Mymensingh Medical College.

RESULTS

Table 1 demonstrates that most of our patients were aged 4-5 years in the control group (70%) compared to the case group (60%). Age below 3 years in the case group was somewhat higher than in the control group (22% vs. 8%). The mean age of cases and controls were 3.7±1.3 years and 4.1±0.9 years respectively. There was no significant difference between the groups in terms of age (p = 0.157). Most of the study participants were male (64% and 56%) in group I and II respectively.

Table 1: Comparison of age and gender between two groups (n = 100).

	Group-I		Group-II		P value
	n=50	P (%)	n=50	P (%)	
Age (years)					
<2	6	12.0	2	4.0	
2-3	5	10.0	2	4.0	
3-4	9	18.0	11	22.0	
4-5	30	60.0	35	70.0	
Mean±SD	3.7±1.3		4.1±0.9		0.157
Gender					
Male	32	64.0	28	56.0	
Female	18	36.0	22	44.0	

Group I = Case (malnourished children); Group II = Control (healthy children)

In Table 2, the mean weight of Group I (case) was significantly (p<0.05) decreased compared with the weight of Group II (control). In group I, the mean±SD of weight was 10.64±2.13 and in group II, the mean±SD of weight was 14.22±2.26, (p<0.001). The mean height and BMI also decreased in group I compared to group II. There was a significant difference between the two groups in terms of height and BMI (p<0.001).

Table 2: Comparison of weight, height and BMI between groups.

Clinical characteristics	Group I	Group II	P value
Weight (kg)	10.64±2.13	14.22±2.26	<0.001
Height (cm)	94.47±14.87	97.16±18.36	<0.001
BMI (kg/m^2)	11.04±3.27	12.17±3.06	<0.001

Table 3 shows the mean serum electrolytes (sodium, potassium, and chloride) of the children between case and control. The mean±SD of serum sodium between Group I (case) and Group II (control) were 134.2±2.6 and 138.4±4.1 with a p value of <0.001 respectively. The result was significantly (p<0.05) lower in Group I than in Group II. The mean±SD of serum potassium between Group I and Group II were 4.2±0.4 and 4.5±0.4, p = 0.006 respectively. The result was significantly (p<0.05) lower in Group I than in Group II. The mean ± SD of serum chloride in between Group I and Group II were 101.1±2.9 and 102.6±3.2, p = 0.017 respectively. The result was also significantly (p<0.05) lower in Group I than in Group II.

Table 3: Comparison of serum electrolytes between groups.

Status of serum electrolytes	Group I (n=50)	Group II (n=50)	P value
Sodium	134.2±2.6	138.4±4.1	<0.001
Potassium	4.2±0.4	4.5±0.4	0.006
Chloride	101.1±2.9	102.6±3.2	0.017

DISCUSSION

This cross-sectional study was designed to estimate the plasma electrolytes (sodium, potassium, and chloride) in children. A total number of 100 subjects were included in this study. Of them, fifty severely malnourished children (weight-for-age Z-score less than -3) aged between 18 months to 5 years were taken as cases and the rest fifty healthy children of the same age were taken as control.

The mean age of cases and controls were 3.7±1.3 years and 4.1±0.9 years respectively. Fatima et al found the mean age was 23.56±3.80 months, Bilal et al found 1.9±1.4 years; and similar to our study, Zulqarnain et al found 3.28±1.2 years.[14,15,6]

Out of 100 children in our study, 60% were males and 40% were females. Several other studies found a similar male-dominant pattern. There were 57% males in a study by Memon et al, 64.4% in a study by Zulqarnain et al, 62% males in a study by Fatima et al, and 61.3% males in a study by Bilal et al.[5,6,14,15]

In this study, we estimated serum sodium, potassium, and chloride concentrations in Group I (case) and Group II (control). There was a significant (p<0.05) decrease in serum sodium, potassium, and chloride concentration in cases compared to that of the control. Similar to our study, Taiwoo, OO and Thomas KD also reported that the serum sodium, potassium, and chloride levels were significantly (p<0.05) higher after treatment.[16] This study findings are also in agreement with the results of several studies.[17-19] Monte CMG and Etukudo et al found that the plasma sodium and potassium levels were significantly lower in the malnourished group than in the control group (p<0.05).[20,21]

According to Zin-Thet-Khine et al, undernourished children experience severe diarrhea with a worse sodium balance and lose more salt through their urine and stool, which lowers their sodium balance overall.[22] Garrow et al also agree with our study and expressed that loss of potassium with nitrogen, potassium is lost in diarrhoea resulting in a cellular deficit.[23] A study by Samadi et al in Bangladesh reported that the incidence of hyponatremia was directly related to the degree of malnutrition.[24]

In another study, Yasmeen Memon et al also reported that hyponatremia and hypokalemia were more frequent in malnourished children with or without diarrhoea.[25] Black RE et al. found that malnutrition affects the severity of diarrhoea much more than it affects the incidence of diarrhoea.[26] Doherty et al expressed that, sodium and chloride are the major ions contributing to the osmolarity of extracellular fluid while potassium is in low concentration but is essential for normal cell function. In malnutrition serum electrolytes do not reflect the body content but only the circulating concentration.[27]

Similar results with low serum potassium were obtained from studies conducted by Gehri et al and Majeed et al expressed that hypokalemia may be subclinical in malnourished children but during diarrhoeal illness, it becomes obvious clinically and manifests as hypotonia, abdominal distension, paralytic ileus, cardiac arrhythmia and respiratory distress.[28,29]

Like this study result, Manary MJ and Brewster DR found that most severely malnourished children have deficiencies in potassium. Low concentrations of intracellular potassium promote sodium and water retention, reduce myocardial contractility, and affect the transport of ions across cell membranes.[30] Chandra RK, 1991 expressed that malnutrition could affect the incidence or severity of infection, including disruption of epidermal integrity and various components of the immune system.[31]

Our study reveals that due to improper intake of electrolytes, the mean serum values of K+ and Na+ are decreased as compared to control groups. A previous study done by Shaheen et al also showed that the mean serum values of Na+, and K+ were notably decreased in malnourished cases when compared to the control group which is similar to our study.[32]

This study has few limitations. We took a small sample size due to our short study period. After evaluating those children, we did not follow up with them for the long term and did not know other possible interference that may happen in the long term with these children.

CONCLUSION

In our study, we found a significant ($p<0.05$) decrease in the mean±SD of blood electrolyte levels (sodium, potassium, and chloride) in the case group (Group I) as compared to the controls (Group II). The results of the current study demonstrate that children experiencing severe malnutrition exhibit shortages in electrolytes, including potassium, sodium, and chloride. To optimize these children's growth potential, management requires an additional supply of these electrolytes in addition to their diets. So, further study with a prospective and longitudinal study design including a larger sample size needs to be done to validate the findings of our study.

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