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Original Article

Comparison of Electrolyte Profile between Malnourished and Well-Nourished Diarrhoeal Children

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ABSTRACT

Introduction: *Diarrhea remains a leading cause of morbidity and mortality in children, which depends on the nutritional status of the population. Malnutrition exacerbates the severity of diarrheal illnesses and impairs the body's ability to recover. This study aimed to compare electrolyte profiles between malnourished and well-nourished diarrhoeal children.* ***Methods & Materials:*** *This prospective observational study was conducted at Sher-E-Bangla Medical College Hospital, Barisal, Bangladesh, from January 2023 to January 2024. A total of 60 children presenting with diarrhea were enrolled, including 30 malnourished and 30 well-nourished children. Analysis was done using (SPSS) Statistical Package for Social Sciences. Descriptive statistics were used to summarize categorical data.* ***Result:*** *The highest incidence of malnutrition was observed in children aged 1–3 years (50.0%), while the majority of well-nourished children were in the 6 months to 1-year age group (47.0%). Gender distribution was equal, with 67.0% males in both groups. Sodium levels were mostly normal in both groups, but malnourished children had 10.0% hypernatremia and 3.0% hyponatremia. Potassium levels were more balanced in well-nourished children, with 50.0% of malnourished children showing hypokalemia. Chloride levels were above normal in 50.0% of malnourished children, compared to 57.0% in well-nourished children. In terms of feeding practices, 93.0% of malnourished children had improper feeding practices, while all well-nourished children had normal feeding practices.* ***Conclusion:*** *Malnourished children are more likely to experience severe electrolyte imbalances, which can complicate the clinical course of diarrhea and increase the risk of dehydration. The high incidence of improper feeding practices in malnourished children further exacerbates these issues, underlining the importance of appropriate feeding and rehydration strategies.*

Keywords: *Electrolyte Profile, Nutritional status, Diarrhea, Dehydration*

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INTRODUCTION

Diarrhea remains one of the leading causes of morbidity and mortality in children under five years of age globally, particularly in developing countries. It accounts for significant mortality, with an estimated 525,000 deaths annually in children under five, according to the World Health Organization (WHO) [1]. The burden of diarrhea is exacerbated by malnutrition, a prevalent public health challenge in low- and middle-income countries (LMICs), creating a vicious cycle where malnutrition increases the severity and duration of diarrheal episodes, while diarrhea contributes to further nutritional deficits [2]. Electrolyte disturbances are among the most critical complications associated with diarrhea. Fluid loss through diarrhea leads to the depletion of essential electrolytes, such as sodium, potassium, chloride, and bicarbonate, resulting in conditions like hyponatremia, hypernatremia, hypokalemia, and metabolic acidosis. These imbalances can have severe clinical consequences, including neurological impairment, cardiac dysfunction, and even death, particularly in malnourished children whose reserves of electrolytes and fluids are already limited [3]. The interaction between malnutrition and electrolyte imbalances has been insufficiently explored, yet it plays a crucial role in understanding the pathophysiology and management of diarrheal diseases in vulnerable populations [4]. Malnutrition compromises the immune system, making children more susceptible to infections, including enteric pathogens that cause diarrhea. This increased vulnerability results in frequent and severe episodes of diarrhea, which, in turn, exacerbate nutritional deficiencies by reducing nutrient

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absorption, increasing nutrient losses, and suppressing appetite [5]. The physiological impact of malnutrition on the body's ability to maintain electrolyte homeostasis is profound. Malnourished children often exhibit impaired renal function, reduced capacity for water and electrolyte conservation, and alterations in gastrointestinal physiology, including reduced enzymatic activity and gut barrier integrity [6]. These factors increase the risk of dehydration and electrolyte disturbances during diarrheal episodes, leading to more severe clinical presentations compared to their well-nourished counterparts. Electrolyte imbalances are common in children with diarrhea, and their severity often depends on the nutritional status of the child. Hyponatremia, a condition characterized by low serum sodium levels, occurs due to excessive sodium loss through stool or inadequate sodium intake. It is more pronounced in malnourished children because of their limited sodium stores and impaired renal capacity to conserve sodium [7]. Hypernatremia, though less common, can result from significant free water loss, especially in cases of osmotic diarrhea or inadequate water intake, and poses severe risks, including neurological damage [8]. Hypokalemia, or low serum potassium levels, is another frequently observed abnormality. Potassium is a vital intracellular cation involved in maintaining cellular function, and its depletion during diarrhea is primarily due to excessive losses in stool. Malnourished children are particularly susceptible to hypokalemia because of their already diminished potassium reserves and dietary deficiencies [9]. Hypokalemia can lead to muscle weakness, cardiac arrhythmias, and, in severe cases, respiratory failure, making it a critical parameter to monitor in diarrheal children [10]. Metabolic acidosis, often resulting from bicarbonate loss in stool, is a common finding in diarrhea, particularly in cases of acute severe malnutrition. The inability of malnourished children to adequately compensate for bicarbonate loss due to compromised renal function further worsens this condition, leading to increased morbidity and mortality [11]. This study aimed to compare electrolyte profile between malnourished and well-nourished diarrhoeal children.

METHODS & MATERIALS

This prospective observational study was conducted at Sher-E-Bangla Medical College Hospital, Barisal, Bangladesh, from January 2023 to January 2024. A total of 60 children presenting with diarrhea were enrolled, including 30 malnourished and 30 well-nourished children. The clinical history and physical findings of all patients were analyzed to compare their electrolyte profiles.

Inclusion Criteria

The study included children who met the following criteria:

- Diarrhea Definition: At least three motions per 24 hours.
- Nutritional Status: Malnourished children: Weight-for-age less than 90%, Well-nourished children: Weight-for-age between 90% and 110%.

Exclusion criteria

- Faulty Rehydration Practices: Children who had experienced improper rehydration techniques, such as incorrect preparation of oral rehydration salts (ORS), or reliance on plain water for rehydration.

Informed consent was obtained from the mothers of all children before they participated in the study. A detailed clinical history was obtained, focusing on the following parameters: nutritional status and feeding practices, socioeconomic condition of the family, use of oral rehydration therapy (ORT) at home, breastfeeding practices, personal hygiene, and the source of drinking water, improper feeding practices, which included: lack of exclusive breastfeeding during the first six months of life. Early or delayed initiation of complementary feeding, use of low-calorie complementary foods, such as diluted suji, barley, sagu, cow milk, rice powder, etc. Each child was weighed undressed on admission to the nearest 0.02 kg using a calibrated balance scale. A thorough physical examination was performed, and findings were recorded in a predesigned questionnaire. Dehydration status was assessed based on the Integrated Management of Childhood Illness (IMCI) guidelines and categorized as: no dehydration, some dehydration, or severe dehydration. Blood samples were collected from all patients in a sterile test tube and sent to the hospital laboratory for analysis. The serum levels of sodium, potassium, and chloride were measured to assess electrolyte disturbances. The study was approved by the institutional ethical review board of Sher-E-Bangla Medical College Hospital. Informed consent was obtained from the mothers of all participating children after explaining the purpose, procedures, and potential benefits of the study. All collected data were systematically recorded and analyzed to compare the electrolyte profiles between malnourished and well-nourished children. Analysis was done using (SPSS) Statistical Package for Social Sciences. Descriptive statistics were used to summarize categorical data.

RESULTS

Table – I: Age incidence in malnourished diarrheal children (*n*=30)

Age	Number	Percentage
0-6 months	02	7.0
6 months 1 day-1 year	09	30.0
1year 1day-3 year	15	50.0
3 years 1 day - 6 year	03	10.0
6 years 1 day - 9 year	01	3.0
Total	30	100.0

The highest incidence is observed in the age group of 1 year 1 day to 3 years, comprising 50.0% of cases (15 children), followed by 6 months 1 day to 1 year, accounting for 30.0% (9 children). Infants aged 0–6 months represented 7.0% (2 children), while children aged 3 years 1 day to 6 years constituted 10.0% (3 children). The lowest incidence, 3.0% (1 child), was noted in the 6 years 1 day to 9 years age group.

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Table – II: Age incidence in well-nourished diarrheal children (*n*=30)

Age	Number	Percentage
0-6 months	06	20.0
6 months 1 day-1 year	14	47.0
1year 1day-3 year	09	3.0
3 years 1 day - 6 year	01	3.0
6 years 1 day - 9 year	00	0.0
Total	30	100.0

The majority of cases occurred in the 6 months 1 day to 1 year age group, comprising 47.0% (14 children). Infants aged 0–6 months accounted for 20.0% (6 children), while children aged 1 year 1 day to 3 years made up 30.0% (9 children). A minimal incidence of 3.0% (1 child) was noted in the 3 years 1 day to 6 years group, and no cases were reported in children aged 6 years 1 day to 9 years.

Table – III: Gender distribution of the study subjects (*n*=60)

Gender	Malnourished	Well-nourished
Male	67.0%	67%
Female	33.0%	33.0%

Among malnourished children, males constituted 67.0%, while females accounted for 33.0%. Similarly, in the well-nourished group, males also represented 67.0%, with females comprising 33.0%.

Table – IV: Sodium concentration among the study group in malnourished and well-nourished diarrhoeal children (*n*=60)

Sodium conc. in blood	Malnourished children n (%)	Well-nourished children n (%)
Hypernatremia	03 (10.0)	0 (0.0)
Normal	26 (87.0)	30 (100.0)
Hyponatremia	01 (3.0)	0 (0.0)
Total	30 (100.0)	30 (100.0)

Hypernatremia ~Serum Na^+: >150 mmol/L; Hyponatremia ~Serum Na^+: <130 mmol/L

Among malnourished children, 87.0% (26) had normal sodium levels, while 10.0% (3) exhibited hypernatremia, and 3.0% (1) presented with hyponatremia. In contrast, all well-nourished children (100.0%) maintained normal sodium levels, with no cases of hypernatremia or hyponatremia.

Table – V: Potassium concentration among the study group in malnourished and well-nourished diarrhoeal children (*n*=60)

Potassium conc. in blood	Malnourished children n (%)	Well-nourished children n (%)
Hyperkalemia	0 (0.0)	0 (0.0)
Normal	15 (50.0)	29 (97.0)
Hypokalemia	15 (50.0)	1 (3.0)
Total	30 (100.0)	30 (100.0)

Hyperkalemia ~ Serum K+: >5.5 mmol/L
Hypokalemia ~ Serum K^+ : < 3.0 mmol/L

In malnourished children, 50.0% (15) had normal potassium levels, while the remaining 50.0% (15) experienced hypokalemia. No cases of hyperkalemia were observed. Conversely, in well-nourished children, 97.0% (29) maintained normal potassium levels, and only 3.0% (1) exhibited hypokalemia, with no instances of hyperkalemia.

Table – VI: Chloride concentration among the study group in malnourished and well-nourished diarrhoeal children (*n*=60)

Chloride conc. in blood	Malnourished children n (%)	Well-nourished children n (%)
Above the normal range	15 (50.0)	17 (57.0)
Normal	10 (33.0)	12 (40.0)
Below the normal range	5 (17.0)	1 (3.0)
Total	30 (100.0)	30 (100.0)

Normal chloride concentration in blood: 98-107 mmol/L

Among malnourished children, 50.0% (15) had chloride levels above the normal range, 33.0% (10) were within the normal range, and 17.0% (5) exhibited chloride levels below the normal range. In the well-nourished group, 57.0% (17) had elevated chloride levels, 40.0% (12) were within the normal range, and only 3.0% (1) had chloride levels below the normal range.

Table – VII: Feeding practice among the subjects (*n*=60)

Feeding Practice	Malnourished Diarrhoeal Children (n=30)	Well-nourished Diarrhoeal Children (n=30)
Normal Feeding Practices	02 (7.0%)	30 (100.0%)
Improper Feeding Practices	28 (93.0%)	0 (0.0%)
Total	30 (100.0%)	30 (100.0%)

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In the malnourished diarrhoeal children group, 93.0% (28 children) exhibited improper feeding practices, while only 7.0% (2 children) had normal feeding practices. In contrast, all well-nourished diarrhoeal children (100.0%) had normal feeding practices, with no cases of improper feeding observed.

DISCUSSION

The highest incidence of diarrheal disease among malnourished children was observed in the 1-year 1-day to 3-year age group (50%), followed by the 6-month 1-day to 1-year group (30%). This aligns with previous studies, which report that children under the age of 3 years, especially in the 6-month to 2-year range, are more susceptible to severe diarrhea due to their developing immune systems and higher risk of dehydration [12]. Diarrhea in younger children is a leading cause of morbidity and mortality, particularly in low-resource settings where malnutrition further exacerbates the condition [13]. One of the key findings in this study was the marked difference in the electrolyte profiles between malnourished and well-nourished children. In particular, the malnourished group exhibited notable deviations in sodium, potassium, and chloride concentrations, which are critical indicators of fluid and electrolyte imbalances. In the malnourished group, 10% exhibited hypernatremia, and 3% had hyponatremia, while 87% had normal sodium levels. Hypernatremia, which typically occurs due to dehydration and inadequate fluid intake, is a common finding in malnourished children with diarrhea [14]. On the other hand, hyponatremia is usually associated with overhydration or dilutional states, which can occur when improper rehydration strategies are used. In contrast, all well-nourished children had normal sodium levels, which underscores the importance of proper hydration practices and balanced fluid intake in maintaining electrolyte homeostasis. Hypokalemia observed in 50% of malnourished children, was another significant finding. Potassium is crucial for cellular functions, and its depletion can lead to weakness, arrhythmias, and muscle paralysis [15]. Hypokalemia is commonly seen in cases of diarrhea due to the loss of potassium-rich fluids, especially in malnourished children who may have already low potassium reserves [12]. Conversely, only 3% of well-nourished children had hypokalemia, emphasizing the protective role of adequate nutrition in maintaining electrolyte balance during diarrheal episodes. Chloride levels were also significantly altered in malnourished children, with 50% having chloride levels above the normal range, and 17% below the normal range. Chloride imbalances, particularly low levels, are often associated with severe dehydration and loss of gastric acid in prolonged diarrhea [16]. In the well-nourished group, a higher percentage (57%) had chloride levels above the normal range, which could be attributed to changes in dietary intake or the rehydration strategies employed. The maintenance of normal chloride levels in 40% of well-nourished children indicates better management of fluid and electrolytes during diarrheal episodes. Feeding practices were notably improper in 93% of the malnourished diarrhoeal children, with only 7% following appropriate feeding practices. This finding mirrors the impact of inadequate nutrition in the management of diarrhea, as improper feeding practices, such as early or late introduction of complementary foods or use of suboptimal fluids, can worsen dehydration and malnutrition [17]. Malnourished children are particularly vulnerable to the negative effects of inappropriate feeding, as their nutritional status further impairs their immune response and ability to recover from dehydration [18]. In contrast, all well-nourished children exhibited proper feeding practices, which likely contributed to their better management of electrolyte balance during diarrhea. Proper breastfeeding, timely introduction of complementary foods, and the use of appropriate rehydration methods are vital in preventing malnutrition and dehydration in children [19].

Limitations of The Study

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 highlights the critical role of nutrition in the management of diarrhea in children. Malnourished children are more likely to experience severe electrolyte imbalances, which can complicate the clinical course of diarrhea and increase the risk of dehydration. The high incidence of improper feeding practices in malnourished children further exacerbates these issues, underlining the importance of appropriate feeding and rehydration strategies. On the other hand, well-nourished children exhibit better electrolyte balance and more favorable outcomes, suggesting that improving nutritional status and feeding practices can significantly reduce the burden of diarrheal diseases.

RECOMMENDATION

It is recommended that efforts be made to improve feeding practices, especially in malnourished children, to ensure appropriate nutrition during diarrheal episodes. This includes promoting exclusive breastfeeding in infants, timely introduction of complementary foods, and proper rehydration strategies to prevent dehydration and electrolyte imbalances. Additionally, health education programs focusing on the importance of nutrition and proper feeding practices should be implemented in communities, particularly in areas with high rates of malnutrition.

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