

# Electrolyte Imbalances in Malnourished Under-5 Children with or without Diarrhoea

GHULAM SHABIR LAGHARI<sup>1</sup>, ABDUL HAMEED RADHAN<sup>2</sup>, SAEED AHMED SHAIKH<sup>3</sup>, NOOR U DDIN KHATTI<sup>4</sup>, ZAMIR AHMED QAMBRANI<sup>5</sup>, KHUDA BUX KHOSO<sup>6</sup>

<sup>1</sup>Associate Professor of Paediatrics, Liaquat University of Medical and Health Sciences Jamshoro

<sup>2</sup>Assistant Professor Paediatrics, Liaquat University of Medical and health sciences Jamshoro

<sup>3,4</sup>Consultant Paediatrician, Liaquat university Hospital Hyderabad.

<sup>5,6</sup>Senior Registrar of Paediatrics, Liaquat University of Medical and Health Sciences Jamshoro

Correspondence to Dr. Abdul Hameed Radhan, Email: [abdul\\_hameed82@hotmail.com](mailto:abdul_hameed82@hotmail.com), Cell: 0336-6895241

## ABSTRACT

**Background** A significant public health issue, malnutrition affects 50 to 150 million children under the age of five globally. An increase in morbidity and mortality has been linked to malnutrition, a serious public health problem.

**Aim:** To determine whether malnourished children under the age of five with or without diarrhea have electrolyte disturbances in their serum.

**Methodology:** 100 malnourished children under the age of five were randomly selected from Liaquat University Hospital Jamshoro/Hyderabad. It took place between January 2019 and December 2020. They were malnourished in varying degrees, with or without diarrhea. Their histories, examinations, and measurements were used to divide them into two groups: 56 malnourished patients with diarrhea and 44 malnourished patients without diarrhea. In both groups, serum electrolytes were compared and data were analyzed in SPSS version 21.

**Results:** According to electrolyte findings, group A had more hyponatremia and hypokalemia than group B. respectively. 43 patients (79.6%) in group A had hyponatremia, but 36 in group B (78.2%). Hypokalemia affected 27 patients (50.0%) in group A, but 10 (21.7%) of those in group B (p-value 0.02).

**Conclusion:** Electrolyte changes were common in moderately and severely malnourished children, particularly those who presented with diarrhea. Morbidity and mortality can be reduced if these changes are detected in time.

**Keywords:** Malnutrition, Diarrhoea, Electrolyte imbalances

## INTRODUCTION

Nutritional deficiency is the result of an imbalance between the body's demand for nutrients and energy and the body's ability to supply them. Many forms of malnutrition exist, such as stunting in children and wasting among young children; micronutrient deficiencies; and being overweight or obese in adults.<sup>1</sup> An increase in morbidity and mortality has been linked to malnutrition, a serious public health issue. Poor diet and repeated diarrhea are common factors that lead to malnutrition<sup>1</sup>.

Many factors contribute to low birth weight, such as unsanitary circumstances and ineffective breastfeeding techniques, and low socioeconomic status for women make South Asia the most severely affected region in Asia. Pakistan is the fifth country having higher cases of Severe Acute Malnutrition<sup>2</sup>. Severe acute malnutrition leads to major complications in the body along with electrolyte imbalances which may worsen with diarrhea<sup>3</sup>.

It is estimated that South Asian countries Bangladesh, India, and Pakistan account for approximately half of the world's stunted children and 38.8% of the world's obese children, according to the WHO.<sup>1</sup> About 35% of all deaths among children under five in Pakistan are due to malnutrition<sup>1</sup>.

It's common to have low sodium and potassium levels when children have diarrhea, according to previous research<sup>4-6</sup>. If malnourished infants with and without diarrhea had abnormal serum electrolyte levels, we wanted to know about it so that we could manage them to lessen the risk of death or impairment. There is an increase in the frequency of the aforementioned electrolyte disturbances in the environment. Dietary inadequacy and/or consumption of nonnutritious foods are the result of overpopulation and, as a result, malnutrition<sup>7</sup>. For children in impoverished nations, malnutrition, and diarrhea constitute a vicious spiral that leads to a high morbidity rate and high mortality rate. In malnourished children, diarrhea is more severe and more prolonged. In malnourished children, diarrhea is 5-7 times more common and 3-4 times more severe than it is in healthy children<sup>4</sup>. In the body, sodium is one of the key electrolytes and is

responsible for some important processes including fluid and water regulation. The sodium range is 135 to 145 mEq/L. Hyponatremia is defined as a sodium level below 135 milliequivalents per liter (mEq/L).

Potassium levels should be between 3.5 and 5.4 mmol/L. If your serum potassium level is less than 3.5 mmol/L, you have hypokalemia, which is a medical condition. A low serum potassium level can be caused by a decrease in oral intake, an increase in renal or gastrointestinal potassium loss, or a shift in potassium concentration within the body's fluid compartments (from outside the cell where it should be, to inside the cell). Patients with hypokalemia often experience weakness and arrhythmias such as the heartbeat speeding up (ventricular tachycardia).<sup>8</sup>

In a healthy child, a sodium-potassium pump exists, which maintains the potassium concentration in the cell by pumping sodium out and potassium into the cell. When a child is suffering from Severe Acute Malnutrition, the sodium-potassium movement becomes impaired. The level of sodium inside the cell became high and potassium is lost. When the child is treated, Na<sup>+</sup>, K<sup>+</sup> levels are maintained. Therefore, feeding must be very slow otherwise it will cause fluid overload, metabolic disturbances, and the system will be disturbed. Magnesium is essential for potassium to enter the cell. Potassium and magnesium are recommended according to World Health Organization (WHO) 3-4mmol/kg/day and 0.4-.6mmol/kg/day respectively<sup>9</sup>.

The children suffering from Severe Acute Malnutrition may have low serum levels of potassium (hypokalemia), high levels of sodium (hypernatremia), and altered levels of calcium. Rehydration Solution for Severely Malnourished Children (ReSoMal) is recommended which is less in sodium and more in potassium. Serum electrolyte imbalances in SAM children can be due to numerous reasons but are more evident during diarrhea<sup>10</sup>.

The malnourished children are more susceptible to morbidities and mortalities related to electrolyte balance. This study will help to find out the extent of electrolyte changes in children suffering from SAM and further researches can be conducted for detailed analysis. The purpose of the current study was to analyze whether malnourished children under the age of

Received on 03-05-2021

Accepted on 29-09-2021

five with or without diarrhea have electrolyte disturbances in their serum

## MATERIAL AND METHODS

These findings were the result of a descriptive and cross-sectional investigation that took place from January 2015 to December 2017 after permission from Ethical Review Board. One hundred patients hospitalized at the Liaquat University Hospital Jamshoro, Hyderabad were studied for protein-energy deficiency. In this study, researchers enrolled malnourished children aged 6 months to 5 years who had diarrhea and those who had no diarrhea but excluded malnourished children less than 6 months and more than 5 years whose examinations had not been completed. Each kid was evaluated by obtaining a full medical history from the mother and undergoing a physical.

**Anthropometric measurements:-** The infantometer measures height from 6 months to 2 years old in a sleeping posture, whereas the stadiometer measures height from 2 to 5 years old standing. Without shoes and heels together, knees straight, and buttocks and shoulders in touch with a vertical wall were used to measure heights.

In addition, the children's bodies and legs were held as straight as possible, with the knees forced straight. The height of each person was measured to the closest millimeter and the results were compared. Little clothing was required of the children as they were asked to stand in the weighing machine with little clothing on, no shoes, and no weight in their hands or catching or touching anything else other than the weighing machine's weight. Asking your parents or checking your birth certificate/hospital records for proof of your age. Weight for height (wasting) and height for age (stunting) was used to determine the nutritional status of these children, according to the WHO criteria.

## RESULTS

A total of 100 children with malnutrition aged 6 months to 5 years old were enrolled, with or without diarrhea after permission from Ethical Review Board. There were 58(58%) males and 42(42%) females among the hundred children. Of the total children, 18(18%) children had mild malnutrition, 32(32%) had moderate malnutrition, and 50(50%) (Table 1).

On the other hand, there were two groups. Group A consists of 54 malnourished children with diarrhea, while Group B consists of 46 malnourished children without diarrhea. 79(79%) children experienced hyponatremia (serum sodium 135 meq/l), of which 43 were in group-A and 27 were in group-B (p0.0001). When it came to hypokalemia (serum potassium 3.5 meq/l), 27 malnourished youngsters were in group-A and 10 were in group B (Table 2).

It is shown in Table 3 that 41 children had isonatremic malnutrition, of which 7 had mild malnutrition, 12 had moderate malnutrition and 22 had severe malnutrition. 79 malnourished children were found to have hyponatremia: 20 had mild malnutrition, 21 had moderate malnutrition, and 38 had severe malnutrition. There were 57 normal-weight children, 10 of them had mild malnutrition, 17 had moderate malnutrition, and 30 had severe malnutrition. 37 malnourished children had hypokalemia, of which 7 had mild malnutrition, 12 had moderate malnutrition, and 1 had severe malnutrition.

Table 1: Distribution of malnutrition status in gender (n = 100)

Malnutrition status	Male (n = 58)	Female (n = 42)	Total
Mild	12(20.6%)	06(14.2%)	18(18.0%)
Moderate	19(32.7%)	13(30.9%)	32(32.0%)
Severe	27(46.5%)	23(54.7%)	50(50.0%)

Table 2: Distribution of Hyponatremia and Hypokalemia in both groups (n=100)

Electrolyte changes	Group A (n = 54)	Group B (n = 46)	Total	P-value
Hyponatremia	43(79.6%)	36(78.2%)	79(79.0%)	<0.0001*
Hypokalemia	27(50.0%)	10(21.7%)	37(37.0%)	<0.02*

Table 3: Electrolyte changes according to the grading of malnutrition (n=100)

Malnutrition status	Mild	Moderate	Severe
Isonatremia(n=41)	7	12	22
Hyponatremia (n=79)	20	21	38
Normokalemia (n=57)	10	17	30
Hypokalemia (n=37)	7	12	18

## DISCUSSION

Electrolyte abnormalities are widespread among malnourished people and are still a serious health issue in developing countries. Serum electrolyte levels, rather than total body content, describe the circulating concentration of electrolytes in malnutrition. This study was carried out to determine whether malnourished children under the age of five years with or without diarrhea have electrolyte disturbances in their serum at Liaquat University Hospital Jamshoro/Hyderabad.

This study found that children who had diarrhea had higher rates of hypokalemia and hyponatremia than people who didn't have diarrhea but previous studies included 55% and 13.7% cases of hypokalemia.<sup>9,11</sup> When compared to hypernatremia, the occurrence of hyponatremia was strongly related to the degree of malnutrition and a major consequence of diarrhea, with a case fatality rate of 10.1%. Current results included higher cases of hyperkalemia and hypernatremia as compared to previous studies.<sup>11,12</sup> Earlier studies have reported similar results: 61.1% hypokalemia in children with malnutrition was seen in the study of Zulqarnain et al.<sup>9</sup>, while Memon et al.<sup>4</sup> found that hypokalemia was more common in malnourished persons with diarrhea (62.5%) than in malnourished individuals without diarrhea (22.22%). According to a study by Gangaraj et al.<sup>9</sup>, hypokalemia was observed in 61.22% of children who had diarrhea and 33% of the children who had no diarrhea. Gangaraj et al.<sup>6</sup> identified hyponatremia in 40.8% of diarrhea cases and 14.8% of non-diarrhea cases. A further 31.1% of patients experienced hyponatremia, according to Zulqarnain et al.<sup>9</sup>, and 13.88% of patients with diarrhea and no diarrhea, respectively.

We found that the frequency of hypokalemia and hyponatremia was lower than reported by Fatima et al.<sup>6</sup> as well as Bilal and Kamberi<sup>11</sup> and Kamberi et al.<sup>12</sup>. Sameen and Moorani conducted a cross-sectional investigation at the National Institute of Child Health (NICH) and found that metabolic abnormalities such as hyponatremia and hypokalemia were most commonly found in children with SAM (less than 59 months)<sup>5</sup>.

The cases of hypocalcemia in the current study were much higher than in the previous studies<sup>12</sup>. This also indicated that the samples enrolled in our study were at much higher risk for complications regarding hypocalcemia<sup>5</sup>. In contrast to our findings, Zulqarnain et al.<sup>9</sup> found that only 13.3% of underweight children had hypocalcemia. Chisti et al.<sup>13</sup> reported a 26% frequency of hypocalcemia among severely malnourished under-five children in a case-control study done in Bangladesh, whereas hypomagnesemia was found in only 3.3% of cases. Hypomagnesemia was found in 27% (17/62) of malnourished children in Indian research<sup>14,15</sup>. Hypokalemia impairs the function of multiple organs, with the cardiovascular system, neurological system, muscle, and kidneys being the most affected. Muscle paralysis can occur with severe potassium shortage<sup>16</sup>. In a case series, Ortuno et al. observed hypokalemic caused paralysis due to acute diarrhea<sup>17</sup>. Our findings also show that when diarrhea is present, hypokalemia is more pronounced. Rehana discovered that 37% of children with severe diarrhea were hypokalemic in a study<sup>18</sup>.

This research, however, is subject to limitations, the primary limitation was the short time duration of six months, due to which random sampling technique was used. All the patients registered at the hospital during those six months, fulfilling the inclusion criteria were recruited. A study done for a longer period may include more samples and provide more concrete results to strengthen the findings of this study. According to the findings of

this study, in severe acute malnutrition, hypokalemia and hyponatremia were significant risk factors for acute diarrhea.

## CONCLUSION

Electrolyte changes were common in moderately and severely malnourished children, particularly those who presented with diarrhea of varying duration. Electrolyte abnormalities in malnourished children may be subclinical, but they become apparent after a diarrhoeal episode, and serum electrolyte estimate is useful for prompt medication to avert a serious life-threatening disease. To reduce mortality and morbidity, electrolyte profiles of children with severe acute malnutrition admitted to stabilization centers in Pakistan should be determined.

**Conflict of interest:** Nil

## REFERENCES

1. Raza M, Kumar S, Ejaz M, Azim D, Azizullah S, Hussain A. Electrolyte Imbalance in Children With Severe Acute Malnutrition at a Tertiary Care Hospital in Pakistan: A Cross-Sectional Study. *Cureus*. 2020 Sep 19;
2. Khan S, Rubab Z, Ali I, Arshad R, Abbas A, Akhtar E. The Serum Electrolyte Imbalance in Children with Severe Acute Malnutrition. *Jiimc*. 2021;16(1):10–3.
3. Prost A, Nair N, Copas A, Pradhan H, Saville N, Tripathy P, et al. Mortality and recovery following moderate and severe acute malnutrition in children aged 6–18 months in rural Jharkhand and Odisha, eastern India: A cohort study. *Bhutta ZA, editor. PLOS Med*. 2019 Oct 15;16(10):e1002934.
4. Memon Y, Majeed R, Ghani MH, Shaikh S. Serum electrolytes changes in malnourished children with diarrhoea [Internet]. Vol. 23, *Pakistan Journal of Medical Sciences*. 2007 [cited 2021 Aug 31]. p. 760–4. Available from: <https://pjms.com.pk/issues/octdec107/article/article23.html>
5. Sameen I, Moorani KN. Morbidity patterns of severely malnourished children at tertiary care hospital [Internet]. Vol. 38, *Pakistan Paediatric Journal*. 2014 [cited 2021 Aug 31]. p. 3–8. Available from: [https://www.researchgate.net/publication/287242664\\_Morbidity\\_patter](https://www.researchgate.net/publication/287242664_Morbidity_patter)
6. ns\_of\_severely\_malnourished\_children\_at\_tertiary\_care\_hospital Gangaraj S, Das G, Madhulata S. Electrolytes and Blood Sugar Changes in Severely Acute malnourished Children and Its Association With Diarrhoea and Vomiting. *Int J Pharm Sci Invent*. 2013;2(5):33–6.
7. Siddiqui F, Salam RA, Lassi ZS, Das JK. The Intertwined Relationship Between Malnutrition and Poverty. *Front Public Heal*. 2020 Aug 28;8.
8. Ausmed. Electrolyte Imbalances + Normal Ranges & Disturbances for Common Electrolytes [Internet]. 2018 [cited 2021 Aug 31]. Available from: <https://www.ausmed.com/cpd/articles/normal-electrolyte-levels>
9. Zulqarnain A, Jaffar Z, Iqbal I. Malnourished Children With Diarrhea: To Assess the Frequency of Serum Electrolytes (Na+, K+ & Ca+) Disturbances. *Prof Med J*. 2015;22(5):610–4.
10. Girum T, Kote M, Tariku B, Bekele H. Survival status and predictors of mortality among severely acute malnourished children <5 years of age admitted to stabilization centers in Geddo Zone: a retrospective cohort study. *Ther Clin Risk Manag*. 2017 Jan;Volume 13:101–10.
11. Bilal A, Sadiq MA, Haider N. Frequency of hyponatraemia and hypokalaemia in malnourished children with acute diarrhoea. *J Pak Med Assoc*. 2016;66(9):1077–80.
12. Kamberi T, Azemi M, Avdiu M, Jaha V, Uka V. 675 Malnourished Children with Acute Diarrhea. *Arch Dis Child*. 2012 Oct 1;97(Suppl 2):A195–A195.
13. Chisti MJ, Salam MA, Ashraf H, Faruque ASG, Bardhan PK, Shahid ASMSB, et al. Prevalence, clinical predictors, and outcome of hypocalcaemia in severely-malnourished under-five children admitted to an Urban hospital in Bangladesh: A case-control study. *J Heal Popul Nutr*. 2014;32(2):270–5.
14. Javali NS, P S, Banu N, R R. Hypomagnesaemia in Protein Energy Malnutrition. *J Evid Based Med Healthc*. 2015 Jan 8;2(2):81–8.
15. Zin-Thet-Khine, Khin-Maung-U, Myo-Khin, Yi-Yi-Myint, Myat-Thi, Kyi-Kyi-May. Sodium Balance During Acute Diarrhoea in Malnourished Children. *J Trop Pediatr*. 1992 Aug 1;38(4):153–7.
16. Hoque MA, Alam HSK, Sayeed MA, Mamun MA Al, Islam MN. Electrolyte Changes in Malnourished under-5 Children with or without Diarrhoea. *J Shaheed Suhrawardy Med Coll*. 2021 Jan 24;12(1):50–3.
17. Ortuño Andrés F, Cabello Clotet N, de Diego Gamarra R, Salaverriá Garzón I, Vázquez Rizaldos S. [Hypokalemia-induced paraplegia secondary to acute diarrhea]. *An Med Interna*. 2002 Feb;19(2):76–8.
18. Majeed R, Shamsi HA, Rajar UDM. Clinical manifestations of hypokalemia. *J Liaquat Univ Med Heal Sci*. 2006 Aug 30;5(2):50–3