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ELECTROLYTE IMBALANCES IN MALNOURISHED CHILDREN OF 1-36 MONTHS OF AGE WITH ACUTE GASTROENTERITIS

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Abstract

Background: *Malnutrition entails an imbalance between the supply of nutrients and energy and their demand by the body for adequate growth and development. Acute gastroenteritis is defined as a diarrheal disease of rapid onset, with or without nausea, vomiting, fever, or abdominal pain. Electrolyte imbalance is one of the prognostic factors in malnutrition especially with acute gastroenteritis.*

Objective: *To determine the frequency of serum electrolyte imbalance in children with malnutrition aged 1-36 months of age in children with malnutrition with acute gastroenteritis.*

Material & Methods*: This was cross sectional study on 100 children with malnutrition presenting with acute diarrhea, at Paediatric Medicine Department of Shaikh Zayed Hospital, Lahore, Pakistan (Patients in OPD and Stabilization centre), from March 2024 to August 2024.*

A self-made questionnaire consisting of demographic data (Age, Gender, and Name) with anthropometric assessment (Weight, height, MUAC, Weight/Height or Length Ratio) along with known complications of malnutrition was included in the study.2ml of blood sample was taken. Electrolyte imbalance was recorded and managed as per hospital protocols. All data was computed and analyzed by using SPSS version 25. Descriptive statistics like age and anthropometric measures was measured as mean and standard deviation. Frequencies and percentages were recorded for gender, family income, father's and mother's education and electrolyte imbalance. Stratification of electrolyte imbalance was done with regards to age groups, gender, place of living, socioeconomic status, family income, father's and mother's education, diabetes and type of family. Chi square test was applied and p-value less than 0.05 was considered as statistically significant.

Results: *Electrolyte imbalance was found in 91% children with acute diarrhea in back ground of malnourishment.*

Conclusion*: Electrolyte imbalance in children with acute diarrhea in back ground of malnourishment was very common finding was almost already available statistics. On stratification analysis, the frequency of Electrolyte imbalance was not statistically different in studied sub-groups*

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INTRODUCTION

Malnutrition entails an imbalance between the supply of nutrients and energy and their demand by the body for adequate growth and development [1] Malnutrition is expressed in many forms, including under nutrition, stunting in under-fives, wasting in under-fives, micronutrient deficiencies, being overweight in adults, and obesity in adults. It is the big contributor of illness in children worldwide. South Asia alone contributes to 50% and 38.8% of the world's population of wasted and stunted children, respectively. In Pakistan, malnutrition is the leading cause of childhood mortality, accounting for nearly 35% of all deaths under five years of age. Severe acute malnutrition (SAM), the most severe form of malnutrition, is often associated with electrolyte imbalance. [2] Malnutrition especially under nutrition is the cause of mortality and morbidity and results in 45% of child mortality (under 5 years of age) worldwide [3].

Acute gastroenteritis is defined as a diarrheal disease of rapid onset, with or without nausea, vomiting, fever, or abdominal pain. [4] About 80% of deaths from diarrhea occur in the first two years of life. Malnourished children are at increased risk of complications due to gastroenteritis, comorbidity and electrolyte imbalances (especially hyponatremia and hypokalemia). [5] Diarrhea is the most common cause of complication of malnutrition. [6] Serum electrolyte disturbances in malnourished children may be sub clinical but become obvious during diarrheal illness. [7]

Electrolyte imbalance is one of the prognostic factors in severe malnutrition. [8] All children with malnutrition present with potassium and magnesium deficiencies and must be managed with supplementary potassium and magnesium added to their diet. [9] In severely malnourished edematous conditions, most children have excess total body sodium (Na) despite low serum sodium levels; low levels of serum sodium, thus, masks the sodium overload. [10] Hypokalemia often presents with muscle weakness, hypotonia, apathy, paralytic ileus, and cardiac arrhythmias. [11]. Clinical characteristics of hypocalcaemia are often subtle. However, hypocalcaemia can lead to fatal seizures in children when accompanied by hypomagnesaemia. [12] Magnesium is essential for bioenergetic reactions, membrane stabilization, and nerve conduction; its deficiency can cause convulsions and cardiac arrhythmias [13] The frequency of electrolyte imbalance in malnourished children were 93.5%. [1]

The rationale behind this study is to estimate the burden of electrolyte imbalance in children with SAM taking Na, K, Ca, and Mg as components of electrolytes to establish strategies for prompt treatment and to prevent lethal complications in such children. Although there are multiple studies, local as well as international, on electrolyte imbalance in SAM, only a few electrolyte components were studied, some evaluated Na and K levels only, whereas others assessed Na, K, and Ca levels.

OBJECTIVE:

To determine the frequency of serum electrolyte imbalance in children with malnutrition aged 1-36 months of age in children with malnutrition with acute gastroenteritis.

OPERATIONAL DEFINITIONS: :

1-Acute Gastroenteritis: Diarrheal disease of rapid onset, with or without nausea, vomiting, fever, or abdominal pain less than 14 days.

2-Malnutrition: Gomez Classification: Expected weight for age:

>90% is normal,
76–90% is mild (first degree) malnutrition
61–75% is moderate (second degree) malnutrition
< 60% is severe (third degree) malnutrition

3-Electrolyte Imbalance:

Hyponatremia	
Hypernatremia	
Hypokalemia	

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Hyperkalemia	
Hypocalcaemia	
Hypercalcaemia	
Hypomagnesemia	
Hypermagnesemia	

4-Mid-upper-arm circumference (MUAC):
(measured on a straight left arm, mid-way between the tip of the shoulder and the tip of the elbow)
<12.5cm (severe acute malnutrition)
12.5-13.5cm (moderate acute malnutrition)
>13.5cm (no malnutrition)

MATERIAL AND METHODS:
Study Design: Cross-Sectional Study

Setting: Paediatric Medicine Department of Shaikh Zayed Hospital, Lahore, Pakistan (Patients in OPD and Stabilization centre)

Duration of Study: March 2024 to August 2024

Sample Size: Sample size of 100 patients was calculated with 95% confidence level and 5.0% margin of error using and expected prevalence 93.5% [1]

Sampling Technique: Non-probability consecutive sampling

Inclusion Criteria: All children with malnutrition under 3 years of age, both genders, presenting with acute gastro-enteritis according to the operational definition after taking informed consent from parents.

Exclusion Criteria: All children with malnutrition under 3 years of age, both genders with bloody diarrhea, chronic diarrhea, not willing to give consent, or in immunocompromised state were excluded from the study. Children with inborn error of metabolism or congenital adrenal hyperplasia/adrenal insufficiency and CLD were also the part of exclusion criteria.

Data Collection Procedure: A self-made questionnaire consisting of demographic data (Age, Gender, and Name) with anthropometric assessment (Weight, height, MUAC, Weight/Height or Length Ratio) along with known complications of malnutrition was included in the study.2ml of blood sample was taken. Electrolyte imbalance was recorded and managed as per hospital protocols.

Data Analysis Procedure: All data was computed and analyzed by using SPSS version 25. Descriptive statistics like age and anthropometric measures was measured as mean and standard deviation. Frequencies and percentages were recorded for gender, family income, father's and mother's education and electrolyte imbalance. Stratification of electrolyte imbalance was done with regards to age groups, gender, place of living, socioeconomic status, family income, father's and mother's education, diabetes and type of family. Chi square test was applied and p-value less than 0.05 was considered as statistically significant.

RESULTS AND TABLES:
The study was conducted on 100 children with malnourishment who presented with acute diarrhea. Mean age was 18.31±9.18 months, mean birth weight was 1.91±0.24 kg, mean expected weight for age was 62.68±10.17%, mean MUAC was 11.84±1.00 cm. (Table # 01)
Among all, 55% cases were male and 45% were female, 48% were in poor, 42% were in middle and 10% were in high socioeconomic status, 26% mothers were uneducated, 51% had only primary education, 18% had up to matric education and 5% had intermediate and above education, 44% fathers were uneducated, 42% had only primary education, 10% had up to matric education and 4% had intermediate and above education, 57% had rural residence and 43% had urban residence, 56% had nuclear family and 44% had joint family, 10% cases were diabetic, duration of diarrhea was up to 3 days in 54% cases and 4-14 days in 46% cases. (Table # 02-11)

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Electrolyte imbalance was found in 91% children with acute diarrhea in back ground of malnourishment. (Table # 12)

In our study, Hyponatremia was found in 29%, Hypernatremia was found in 25%, Hypokalemia was found in 41% and Hyperkalemia was found in 36% cases among children with malnourishment who presented with acute diarrhea. Hypocalcaemia was found in 45%, Hypercalcaemia was found in 5%, Hypomagnesemia was found in 57% and Hypermagnesemia was found in 10% cases among children with malnourishment who presented with acute diarrhea.

Electrolyte imbalance in children with acute diarrhea in back ground of malnourishment was stratified for age group (p=1.00), gender (p=0.51), family income (p=0.43), socioeconomic status (p=0.43), Mother's education (p=0.59), Father's education (p=0.83%), Place of living (p=0.49), Duration of diarrhea (p=0.17), Type of family (p=0.07) and Diabetes (p=0.04). (Table # 13-22)

Table-01: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Age (months)	100	2.00	34.00	18.31	9.18
Birth weight (kg)	100	1.50	2.50	1.91	0.24
Expected weight (%) for age	100	46.00	81.00	62.68	10.17
MUAC (cm)	100	10.10	13.20	11.84	1.00

Table-02: Distribution of Age groups

Age groups		Frequency	Percent
	Up to 1 year	26	26.0
	More than 1 year	74	74.0
	Total	100	100.0

Table-03: Distribution of Gender

Gender		Frequency	Percent
	Male	55	55.0
	Female	45	45.0
	Total	100	100.0

Table-04: Distribution of Family income

Family income		Frequency	Percent
	Up to 40000 rupees per month	48	48.0
	41000-100000 rupees per month	42	42.0
	More than 100000 rupees per month	10	10.0
	Total	100	100.0

Table-05: Distribution of Socioeconomic status

Socioeconomic status		Frequency	Percent
	Poor	48	48.0
	Middle	42	42.0
	High	10	10.0
	Total	100	100.0

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Table-06: Distribution of Mother's education

Mother's education		Frequency	Percent
	Nil	26	26.0
	Up to Primary	51	51.0
	Up to Matric	18	18.0
	Intermediate-post-graduation	5	5.0
	Total	100	100.0

Table-07: Distribution of Father's education

Father's education		Frequency	Percent
	Nil	44	44.0
	Up to Primary	42	42.0
	Up to Matric	10	10.0
	Intermediate-post-graduation	4	4.0
	Total	100	100.0

Table-08: Distribution of Place of living

Place of living		Frequency	Percent
	Rural	57	57.0
	Urban	43	43.0
	Total	100	100.0

Table-09: Distribution of Duration of diarrhea

Duration of diarrhea		Frequency	Percent
	Up to 3 days	54	54.0
	4-14 days	46	46.0
	Total	100	100.0

Table-10: Distribution of Type of family

Type of family		Frequency	Percent
	Nuclear	56	56.0
	Joint	44	44.0
	Total	100	100.0

Table-11: Distribution of Diabetes

Diabetes		Frequency	Percent
	Yes	10	10.0
	No	90	90.0
	Total	100	100.0

Table-12: Electrolyte imbalance

Electrolyte imbalance		Frequency	Percent
	Yes	91	91.0
	No	9	9.0
	Total	100	100.0

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Table-13: Distribution of Electrolyte imbalance with regards to Age groups

			Electrolyte imbalance		Total	p-value
			Yes	No		
Age groups	Up to 1 year	Count	24	2	26	1.00
		% within Age groups	92.3%	7.7%	100.0%	
	More than 1 year	Count	67	7	74	
		% within Age groups	90.5%	9.5%	100.0%	
Total		Count	91	9	100	
		% within Age groups	91.0%	9.0%	100.0%	

Table-14: Distribution of Electrolyte imbalance with regards to Gender

			Electrolyte imbalance		Total	p-value
			Yes	No		
Gender	Male	Count	49	6	55	0.51
		% within Gender	89.1%	10.9%	100.0%	
	Female	Count	42	3	45	
		% within Gender	93.3%	6.7%	100.0%	
Total		Count	91	9	100	
		% within Gender	91.0%	9.0%	100.0%	

Table-15: Distribution of Electrolyte imbalance with regards to Family income

			Electrolyte imbalance		Total	p-value
			Yes	No		
Family income	Up to 40000 rupees per month	Count	44	4	48	0.43
		% within Family income	91.7%	8.3%	100.0%	
	41000-100000 rupees per month	Count	39	3	42	
		% within Family income	92.9%	7.1%	100.0%	
	More than 100000 rupees per month	Count	8	2	10	
		% within Family income	80.0%	20.0%	100.0%	
Total		Count	91	9	100	
		% within Family income	91.0%	9.0%	100.0%	

Table-16: Distribution of Electrolyte imbalance with regards to Socioeconomic status

			Electrolyte imbalance		Total	p-value
			Yes	No		
Socioeconomic status	Poor	Count	44	4	48	0.43
		% within Socioeconomic status	91.7%	8.3%	100.0%	
	Middle	Count	39	3	42	
		% within Socioeconomic status	92.9%	7.1%	100.0%	
	High	Count	8	2	10	
		% within Socioeconomic status	80.0%	20.0%	100.0%	

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Total	Count	91	9	100	
	% within Socioeconomic status	91.0%	9.0%	100.0%	

Table-17: Distribution of Electrolyte imbalance with regards to Mother's education

			Electrolyte imbalance		Total	p-value
			Yes	No		
Mother's education	Nil	Count	24	2	26	0.59
		% within Mother's education	92.3%	7.7%	100.0%	
	Up to Primary	Count	47	4	51	
		% within Mother's education	92.2%	7.8%	100.0%	
	Up to Matric	Count	15	3	18	
		% within Mother's education	83.3%	16.7%	100.0%	
	Intermediate-post-graduation	Count	5	0	5	
		% within Mother's education	100.0%	0.0%	100.0%	
Total		Count	91	9	100	
		% within Mother's education	91.0%	9.0%	100.0%	

Table-18: Distribution of Electrolyte imbalance with regards to Father's education

			Electrolyte imbalance		Total	
			Yes	No		
Father's education	Nil	Count	39	5	44	0.83
		% within Father's education	88.6%	11.4%	100.0%	
	Up to Primary	Count	39	3	42	
		% within Father's education	92.9%	7.1%	100.0%	
	Up to Matric	Count	9	1	10	
		% within Father's education	90.0%	10.0%	100.0%	
	Intermediate-post-graduation	Count	4	0	4	
		% within Father's education	100.0%	0.0%	100.0%	
Total		Count	91	9	100	

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		% within Father's education	91.0%	9.0%	100.0%	

Table-19: Distribution of Electrolyte imbalance with regards to Place of living

			Electrolyte imbalance		Total	
			Yes	No		
Place of living	Rural	Count	53	4	57	0.49
		% within Place of living	93.0%	7.0%	100.0%	
	Urban	Count	38	5	43	
		% within Place of living	88.4%	11.6%	100.0%	
Total		Count	91	9	100	
		% within Place of living	91.0%	9.0%	100.0%	

Table-20: Distribution of Electrolyte imbalance with regards to Duration of diarrhea

			Electrolyte imbalance		Total	
			Yes	No		
Duration of diarrhea	Up to 3 days	Count	47	7	54	0.17
		% within Duration of diarrhea	87.0%	13.0%	100.0%	
	4-14 days	Count	44	2	46	
		% within Duration of diarrhea	95.7%	4.3%	100.0%	
Total		Count	91	9	100	
		% within Duration of diarrhea	91.0%	9.0%	100.0%	

Table-21: Distribution of Electrolyte imbalance with regards to Type of family

			Electrolyte imbalance		Total	
			Yes	No		
Type of family	Nuclear	Count	48	8	56	0.07
		% within Type of family	85.7%	14.3%	100.0%	
	Joint	Count	43	1	44	
		% within Type of family	97.7%	2.3%	100.0%	
Total		Count	91	9	100	
		% within Type of family	91.0%	9.0%	100.0%	

Table-22: Distribution of Electrolyte imbalance with regards to Diabetes

			Electrolyte imbalance		Total	
			Yes	No		
Diabetes	Yes	Count	7	3	10	0.05
		% within Diabetes	70.0%	30.0%	100.0%	
	No	Count	84	6	90	

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		% within Diabetes	93.3%	6.7%	100.0%	
Total		Count	91	9	100	
		% within Diabetes	91.0%	9.0%	100.0%	

DISCUSSION:

Acute gastroenteritis is defined as a diarrheal disease of rapid onset, with or without nausea, vomiting, fever, or abdominal pain. [4] Diarrhea is the most common cause of complication of malnutrition. [6] Serum electrolyte disturbances in malnourished children may be sub clinical but become obvious during diarrheal illness. [7] In our study, Electrolyte imbalance was found in 91% children with acute diarrhea in back ground of malnourishment.

Electrolyte imbalance is one of the prognostic factors in severe malnutrition. [8] All children with malnutrition present with potassium and magnesium deficiencies and must be managed with supplementary potassium and magnesium added to their diet. [9] In severely malnourished edematous conditions, most children have excess total body sodium (Na) despite low serum sodium levels; low levels of serum sodium, thus, masks the sodium overload. [10] Hypokalemia often presents with muscle weakness, hypotonia, apathy, paralytic ileus, and cardiac arrhythmias. [11]. Clinical characteristics of hypocalcaemia are often subtle. However, hypocalcaemia can lead to fatal seizures in children when accompanied by hypomagnesaemia. [12] Magnesium is essential for bioenergetic reactions, membrane stabilization, and nerve conduction; its deficiency can cause convulsions and cardiac arrhythmias [13] The frequency of electrolyte imbalance in malnourished children were found to be 93.5%. [1] Similarly in our study, frequency of electrolyte imbalance was very high (91%) in children with acute diarrhea in back ground of malnourishment.

A study conducted in Nigeria showed that sodium abnormality was present in 60.30% of cases while potassium abnormality was in 14.3% of children with acute gastroenteritis. [14] Another study conducted in India showed that hyponatremia was observed in total 15% cases of diarrhea in malnourished children. [15] Study conducted in Pakistan showed that children with acute gastroenteritis develop electrolyte imbalance. In that study, male children were 84 (62.6%) and were in majority while females comprising of 50(37.3%). Frequency of hypokalemia was 57 (42.5%). Children with acute diarrhea and dehydration have an increased risk of developing hypernatremia and hypokalemia. Significant correlations were found between electrolyte imbalance and mortality.[16] In our study, Hyponatremia was found in 29%, Hypernatremia was found in 25%, Hypokalemia was found in 41% and Hyperkalemia was found in 36% cases among children with malnourishment who presented with acute diarrhea. Hypocalcaemia was found in 45%, Hypercalcaemia was found in 5%, Hypomagnesemia was found in 57% and Hypermagnesemia was found in 10% cases among children with malnourishment who presented with acute diarrhea.

CONCLUSIONS:

Electrolyte imbalance in children with acute diarrhea in back ground of malnourishment was very common finding was almost already available statistics. On stratification analysis, the frequency of Electrolyte imbalance was not statistically different in studied sub-groups.

CONFLICT OF THE INTEREST:

There was no conflict of interest of any author involved in the study.

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