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Incidence And Outcome of Various Types of Dehydration in Children of Acute Gastroenteritis

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Abstract

Objective: To determine the incidence and outcome of various types of dehydration in children with acute gastroenteritis.

Study Design and Setting: A descriptive case series was conducted in the Department of Pediatrics at Fauji Foundation Hospital, Lahore, from 25 June 2024 to 10 July 2025.

Methodology: A total of 227 children aged 1 month to 10 years with acute watery diarrhea were included through non-probability consecutive sampling. Patients with dysentery, prior fluid therapy, or chronic illnesses affecting sodium levels were excluded. After obtaining informed consent, demographic data were recorded, and serum sodium levels were measured to classify dehydration as isonatremic (135–145 mEq/L), hyponatremic (<135 mEq/L), or hypernatremic (>145 mEq/L). The outcome was recorded as the response to rehydration therapy within 24 or 48 hours.

Results: Isonatremic dehydration was the most common type, observed in 140 children (61.7%), followed by hyponatremic in 70 (30.8%) and hypernatremic in 17 (7.5%). A total of 148 patients (65.2%) responded to therapy within 24 hours, while 79 (34.8%) responded within 48 hours. A statistically significant association was found between age group and type of dehydration ($p = 0.0001$), while the association with gender and response time was not statistically significant.

Conclusion: Isonatremic dehydration is the predominant biochemical type in pediatric gastroenteritis, and early biochemical assessment, particularly serum sodium measurement, is essential for timely and effective management to reduce complications and improve outcomes.

Introduction

Acute gastroenteritis, one of the most prevalent childhood disorders, causes notable morbidity and mortality worldwide, and is linked with electrolyte imbalances, some of which can be fatal.[1, 2] Acute gastroenteritis is the most common cause of death in children under 5 years in the developing world.[3] Diarrhea causes 525,000 deaths of children less than 5 years of age yearly, the reason being the electrolyte losses and fluid deprivation in diarrhea.[4] Dehydration, especially from gastroenteritis, is a

childhood emergency. Therefore, anticipative detection and immediate intervention of fluid loss and electrolyte instability in the pediatric age group is important.[5]

Biochemically, on the basis of serum sodium levels, we can classify dehydration as isonatremic (serum sodium level 135 to 145meq/L), hyponatremic (serum sodium level below 135meq/L), and hypernatremic (serum sodium level above145meq/L).[6] Isonatremic dehydration is the most common type of dehydration in children with acute diarrhea, in which there is equal loss of water and salts.[7] Hyponatremia is believed to be the second common electrolyte imbalance in hospitalized children and is linked with serious consequences if not treated vigorously.[8] Hyponatremia, if not timely managed, is linked with lengthy hospital stays, poor outcomes, and increased mortality rates due to an imbalance in the intracellular and extracellular concentration of sodium, and proper correction of hyponatremia decreases mortality in admitted patients.[9]

Hypernatremia (being the least common electrolyte imbalance of sodium) in patients of acute gastroenteritis can cause neurological complications ranging from irritability and tone disturbances to seizures and coma, and this is usually linked with the extent of dehydration that occurs before presenting to the hospital. The timely assessment of the hydration status of children presenting with acute watery diarrhea is the most important step in the management of these patients.[10]

A study conducted in 2019 at the Department of Paediatrics, GSL Medical College & General Hospital, Rajahmundry, India in patients attending OPD and inpatients given acute diarrhea between 1 month and 5 years of age showed that Hyponatremic dehydration was present in 33% cases, isonatremic dehydration in 59.8% and hypernatremic dehydration in 7.2% cases.[11] In another study conducted in the Department of Pediatrics, Sharif Medical City, Lahore, 61.30% children had isonatremic dehydration, 30.86% children had hyponatremic dehydration, and 7.82% children had hypernatremic dehydration. 90.86% children showed a response to rehydration therapy within 24 hours, and 9.13% children showed a response to rehydration therapy within 48 hours.[12]

Given the high prevalence of gastroenteritis and its associated electrolyte disturbances in pediatric emergency and outpatient settings, this study aims to evaluate the frequency and outcomes of biochemically classified dehydration based on serum sodium levels. Timely identification and intervention are vital to minimize neurological complications, reduce hospital stay, and prevent mortality. The present study aimed to find out the frequency and outcome of biochemical dehydration in children presenting with acute gastroenteritis.

Methodology

This descriptive case series was conducted in the pediatric ward of Fauji Foundation Hospital, Lahore, from 25 June 2024 to 10 July 2025 following the approval of the synopsis. A total of 227 patients were included, with the sample size calculated using a 95% confidence level, a 3.5% margin of error, and an expected percentage of hypernatremic dehydration of 7.82%.[12]

The sampling technique employed was non-probability consecutive sampling. Children aged between 1 month and 10 years of both genders who presented with acute watery diarrhea of less than 14 days' duration and exhibited no to severe dehydration were included in the study, provided they had no prior history of treatment. Patients were excluded if they presented with dysentery, had already received intravenous fluid therapy, or suffered from metabolic or chronic conditions known to influence serum sodium levels, such as nephrotic syndrome or renal failure.

After obtaining approval from the hospital's ethical committee and review board, eligible patients presenting to the emergency department and outpatient clinic with

acute watery diarrhea were enrolled. Information, including name, age, gender, and residential address, was recorded. Serum sodium levels were measured using standard laboratory methods and noted in mEq/L. The type of dehydration was categorized biochemically based on sodium levels: isonatremic (135–145 mEq/L), hyponatremic (<135 mEq/L), and hypernatremic (>145 mEq/L). The outcome was assessed in terms of the patient's response to rehydration therapy within 48 hours, defined by the correction of dehydration.

Acute gastroenteritis was diagnosed clinically based on the presence of at least one watery stool or two to three loose stools softer than usual, often accompanied by vomiting. Diarrhea was defined as at least one watery stool or two to three loose stools in a day. Dehydration was initially classified according to WHO guidelines as none, some, or severe; however, for this study, classification was based on biochemical findings as mentioned above. Effective treatment was defined as successful correction of dehydration within 48 hours following rehydration therapy.

Data were analyzed using SPSS version 26. For quantitative variables such as age and sodium levels, the mean and standard deviation were calculated. For qualitative variables, including gender, types of dehydration, and treatment outcomes, frequencies and percentages were determined. Effect modifiers such as age, weight, and gender were controlled through stratification. The Chi-square test and Fisher's Exact Test were applied to assess significance, with a p-value of less than 0.05 considered statistically significant.

Results

The study included a total of 227 participants, with a mean age of 51.26 ± 48.8 months, reflecting a wide age distribution among children presenting with acute gastroenteritis. The mean serum sodium level observed in the study population was 138.1 ± 7.1 mEq/L, which falls within the normal physiological range, though variation was noted across different types of dehydration. In terms of gender distribution, 56.4% of participants were male, while 43.6% were female, indicating a slightly higher representation of males in the study sample. (Table 1)

Table 1: Descriptive Statistics of Study Participants (n = 227)

Variable	**Mean ± SD / n (%)**
Age (months)	51.26 ± 48.8
Serum Sodium (mEq/L)	138.1 ± 7.1
Gender	
Male	128 (56.4%)
Female	99 (43.6%)

Among the 227 children included in the study, isonatremic dehydration was the most frequently observed type, present in 140 participants (61.7%). This form of dehydration occurs when water and sodium are lost in proportion, maintaining normal serum sodium levels (135–145 mEq/L), and is typically associated with milder clinical symptoms and better outcomes when managed promptly. Hyponatremic dehydration was identified in 70 children (30.8%), indicating a disproportionate loss

of sodium relative to water, resulting in serum sodium levels below 135 mEq/L. This type is clinically significant due to its potential to cause cellular swelling and neurological symptoms if not corrected in time. The least common was hypernatremic dehydration, found in 17 children (7.5%), characterized by serum sodium levels above 145 mEq/L. Although less frequent, it carries a higher risk of serious complications, including seizures and altered mental status, especially in cases of delayed presentation and severe fluid loss. (Figure 1)

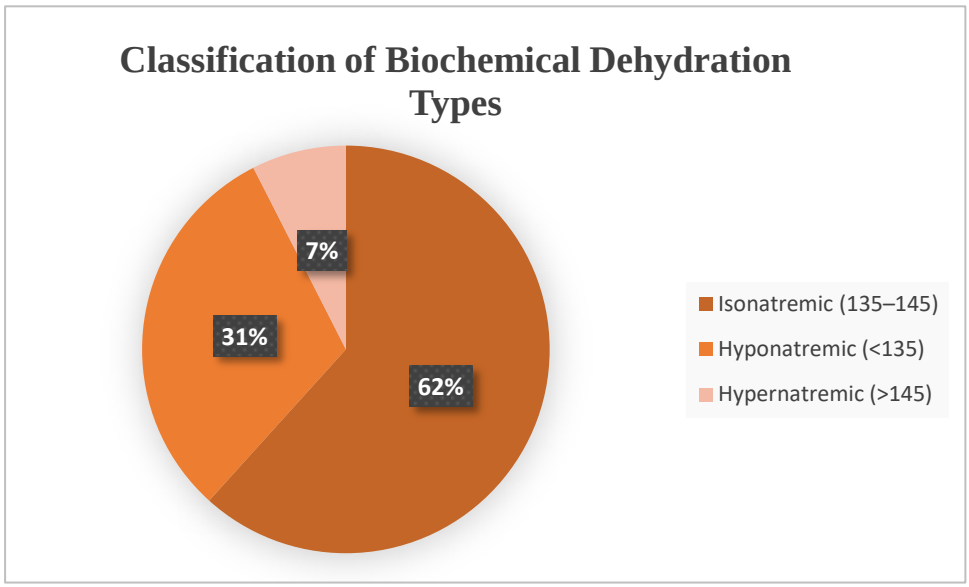

Figure 1: A graph showing the distribution of Classification of Biochemical Dehydration Types

Out of the 227 children included in the study, 148 (65.1%) responded to rehydration therapy within the first 24 hours, indicating a favorable and prompt clinical improvement. The remaining 79 children (34.8%) required up to 48 hours to show adequate response, suggesting either more severe dehydration, delayed presentation, or associated complications. Overall, the majority of patients improved within the 24-hour therapeutic window, reflecting the effectiveness of timely and appropriate rehydration management. (Figure 2)

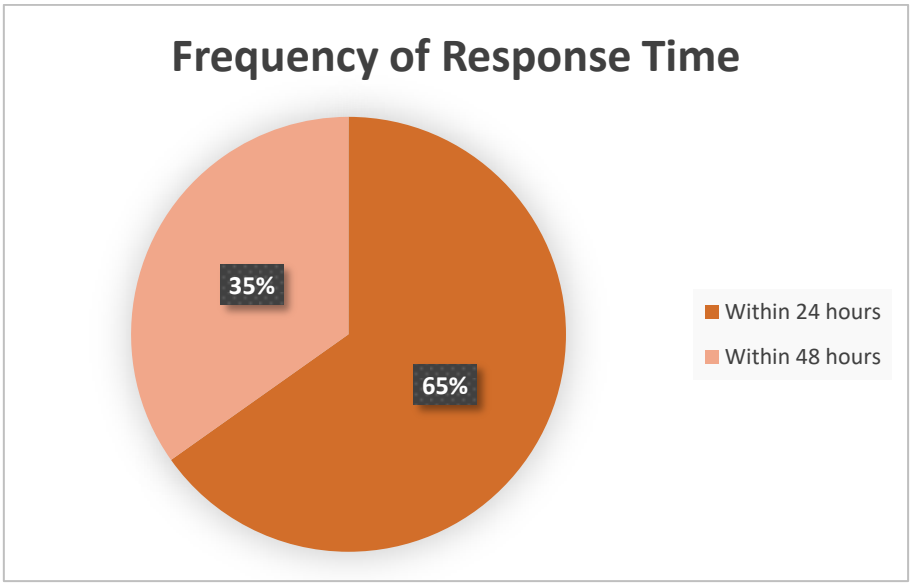

Figure 2: A Pie Chart Showing the Frequency of the Response to Rehydration Therapy within 48 Hours

In the 1–12 months age group, 8.1% of children had hypernatremic dehydration, 36.0% had hyponatremic dehydration, and 55.8% presented with isonatremic dehydration. Among children aged 13–60 months, 9.1% had hypernatremic, 30.9% had hyponatremic, and 60.0% had isonatremic dehydration. In the >60 months group, 5.8% were hypernatremic, 25.6% hyponatremic, and 68.6% isonatremic. The association between age group and type of dehydration was statistically significant with a p-value of 0.0001. (Table 2)

Table 2: Association of Dehydration Type with Age Group

Age Group	Hypernatremic	Hyponatremic	Isonatremic	Total (n)
1–12 months	7 (8.1%)	31 (36.0%)	48 (55.8%)	0.0001
13–60 months	5 (9.1%)	17 (30.9%)	33 (60.0%)	
>60 months	5 (5.8%)	22 (25.6%)	59 (68.6%)	
Total	17 (7.5%)	70 (30.8%)	140 (61.7%)	227

Among male participants, 59.2% had isonatremic dehydration, 28.4% had hyponatremic dehydration, and 10.8% had hypernatremic dehydration. In females, 63.0% were isonatremic, 33.0% were hyponatremic, and 3.0% had hypernatremic dehydration. Although a higher proportion of hypernatremia was observed in males, the association between gender and type of dehydration was not statistically significant (p = 0.076). (Table 3)

Table 3: Association of Dehydration Type with Gender

Gender	Isonatremic	Hyponatremic	Hypernatremic	Total (n)	P-value
Male	77 (59.2%)	37 (28.4%)	14 (10.8%)	130	0.076
Female	63 (63.0%)	33 (33.0%)	3 (3.0%)	99	
Total	140 (61.7%)	70 (30.8%)	17 (7.5%)	227	

Among children who responded to therapy within 24 hours, 7.4% had hypernatremic dehydration, 23.1% had hyponatremic dehydration, and 69.4% had isonatremic dehydration. In those who required up to 48 hours for clinical improvement, 7.6% were hypernatremic, 37.8% were hyponatremic, and 54.6% were isonatremic. Although a greater proportion of early responders were isonatremic, the association between dehydration type and response time approached but did not reach statistical significance (p = 0.051). (Table 4)

Table 4: Association Between Dehydration Type and Response to Therapy

Response	Hypernatremic	Hyponatremic	Isonatremic	Total	P-

Time (hrs)				(n)	value
Within 24 hours	8 (7.4%)	25 (23.1%)	75 (69.4%)	108	0.051
Within 48 hours	9 (7.6%)	45 (37.8%)	65 (54.6%)	119	
Total	17 (7.5%)	70 (30.8%)	140 (61.7%)	227	

Discussion

In our cohort of 227 children with acute gastroenteritis, isonatremic dehydration was most common (61.7%), followed by hyponatremia (30.8%) and hypernatremia (7.5%). This distribution aligns closely with findings from Arif et al. (2021) in Peshawar, where hyponatremia occurred in 30.8% of children under five with acute diarrhea, a frequency virtually identical to the present study.[13] Similarly, Ezuruikeet al. (2022) in Nawabshah reported a prevalence of hyponatremia in 55.3%, with hypernatremia in about 13%, somewhat higher hypernatremic rates compared to our 7.5%.[14]

A cross-sectional Karachi study (2023) by Dow et al. found no cases of hypernatremia, unlike our 7.5% incidence, although they noted significant hypokalemia but not sodium disturbances post-rehydration.[15] Meanwhile, a November 2024 Islamabad-based study reported hypernatremia in 16.4% of children, significantly higher than our cohort, and found it strongly associated with more severe dehydration ($p = 0.001$).[16]

Internationally, a Turkish ICU retrospective review (2021) of diarrhea-related electrolyte disturbances in 83 children found that appropriate fluid management corrected sodium levels typically within 34 to 35 hours, with mortality of about 6%.[17] Compared to our response-time findings (65.2% responding within 24 hours), their correction rates suggest effective individualized therapy, though the Turkish group had a higher severity of illness.

Finally, Iranian data (2022–2023) found hyponatremia in around 25%, hypernatremia in 11%, and significant overlap with malnutrition as a predisposing factor.[18] These figures broadly mirror our findings, especially in the hyponatremia-to-hypernatremia ratio. Compared to these studies, the present study sits within the mid-range for hyponatremia prevalence but at the lower end for hypernatremia rates. Our pattern underscores that isonatremic dehydration remains dominant in most settings, while regional and clinical differences (e.g. vaccination status, malnutrition, fluid practices) likely influence sodium imbalance patterns.

In addition, all studies highlight the critical importance of serum electrolyte monitoring, especially sodium levels, as both hyponatremic and hypernatremic dehydration carry notable risks. Across studies, young age, delayed presentation, and severe dehydration often correlate with increased hypernatremia, similar to our association of higher hypernatremia in infants (8.1%) compared to older children.[19, 20] Overall, our results reinforce existing literature from Pakistan and adjacent South Asian contexts, with slightly lower hypernatremia incidence than some centers but consistent prevalence of hyponatremia and predominance of isonatremic dehydration. Personalized rehydration, close electrolyte monitoring, and early intervention emerge consistently across studies as key to optimal outcomes.

The findings of this study emphasize the importance of early recognition and biochemical classification of dehydration in pediatric patients with acute

gastroenteritis. Given that isonatremic dehydration was the most common, followed by hyponatremia, clinicians should be cautious not to rely solely on clinical signs but also incorporate routine serum sodium assessment in management protocols, particularly in settings where dehydration severity may be underestimated. Incorporating serum electrolyte monitoring into the initial assessment workflow, especially in emergency departments, could allow more precise fluid therapy, reduce complication rates, and minimize the risk of neurological sequelae associated with severe sodium imbalances. Although hypernatremia, although less frequent, was associated with slower response to therapy, its early detection could guide the need for closer monitoring, slower correction protocols, and potentially inpatient care. Furthermore, the significant association between age groups and type of dehydration highlights the need for age-specific treatment strategies and possibly targeted caregiver education for early signs of dehydration in infants and toddlers.

This study has several limitations that must be acknowledged. Firstly, it was conducted at a single tertiary care hospital, which may limit the generalizability of the findings to other populations, particularly in rural or under-resourced settings. Secondly, non-probability consecutive sampling could introduce selection bias, and the study did not assess other potentially confounding factors such as nutritional status, comorbidities, or duration of symptoms prior to presentation, all of which can influence electrolyte disturbances.

Additionally, while the study measured outcomes based on response to rehydration within 48 hours, long-term outcomes, including complications or readmission rates, were not evaluated. The exclusion of patients who had received IV fluids prior to hospital presentation might have omitted more severe cases, potentially underestimating the prevalence of hypernatremia. Lastly, serum sodium levels were used as the sole marker for dehydration classification. Including additional biochemical parameters such as potassium, bicarbonate, and renal function markers could have provided a more comprehensive understanding of metabolic disturbances in these children.

Conclusion

In conclusion, this study highlights that isonatremic dehydration is the most prevalent biochemical subtype among children presenting with acute gastroenteritis, followed by hyponatremic and hypernatremic dehydration. Although the majority of patients responded to rehydration therapy within 48 hours, the type of dehydration was significantly associated with age and influenced treatment response. These findings underscore the importance of early biochemical assessment, particularly serum sodium measurement, to guide targeted fluid therapy and improve clinical outcomes. Implementing routine electrolyte monitoring in pediatric diarrheal cases can facilitate timely interventions, reduce complications, and support more effective, individualized care strategies.

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