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Risk Factors Associated with Severe Dehydration in Children with Acute Diarrhea in Emergency Settings

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Abstract: Background: Acute diarrhea is a leading cause of emergency care to children hospital globally and it still makes a significant contribution to the under-five morbidity and mortality. The most life-threatening complication is severe dehydration that has to be identified and treated immediately. Knowledge of clinical and socioeconomic predictors in the emergency situation plays a crucial role in selecting prevention initiatives.

Aim: To identify the prevalence and independent predictors of severe dehydration in children that report to emergency departments with acute diarrhea.

Methods: It was a hospital-based analytical cross-sectional study that was done in three tertiary emergency departments that were based in pediatric units with a 12 months period. Four hundred and twenty children aged between 1-59 months old diagnosed with acute diarrhea underwent enrolment in consecutive sampling. The level of dehydration was categorized by the WHO. The sociodemographic and nutrition, clinical, and home-management variables were obtained by interviewing caregivers and examining these factors by the doctor. The logistic regression analysis showed the multivariate predictors of severe dehydration with adjusted odds ratio (AOR), and 95% confidence interval (CI) being evaluated.

Aim: 128 children were found to have severe dehydration (30.5%). Independent predictors were lack of oral rehydration therapy (AOR = 3.82; 95% CI: 2.156788), later presentation >48 hours (AOR = 3.12; 95% CI: 1.885.16), stool frequency>8/day (AOR = 2.91; 95% CI: 1.704.98), moderate/severe malnutrition (AOR = 2.74; 95)

Conclusion: In emergency departments in almost a third of cases of children with acute diarrhea, severe dehydration was found. The clinical severity indicators as well as modifiable home-care practices both posed a significant risk. Rehydration therapy at an early stage, breastfeeding and timely treatment are significant measures to decrease emergency complications and avoid death.

Keywords: Acute diarrhea; Severe dehydration; Risk factors; Pediatric emergency; Oral rehydration therapy; Malnutrition.

1. Introduction

Acute diarrhea refers to the passing of three or more loose or watery stools in less than 14 days in a period of 24 hours (1). Although the world has made strides in child health, diarrhea is the number two cause of death among children under the age of five years across the world (2). In 2019, 1.5 million deaths were estimated as a result of diarrheal diseases, with the highest profits occurring in South Asia and sub-Saharan Africa (3).

The most threatening complication of acute diarrhea is severe dehydration setting the stage of most diarrhea-related deaths (4). The loss of fluids causes hypovolemia, acidosis of the metabolism, electrolyte deficiency, shock, and even death in case of untimely treatment (5).

A number of risk factors have been cited to indicate susceptibility of children to severe dehydration and they are: younger age, malnutrition, absence of breastfeeding, low maternal education, bad sanitation, late visits to health care facility and oral rehydration therapy (68). Children are often presented in patients at advanced stages in emergency departments because of the delay in referral or improper home care (9).

Acute diarrheal diseases continue to rank among the leading causes of pediatric emergency department visits in Iraq and other middle-income countries especially during seasonal outbreaks as well as in regions with limited access to clean water (10). It is important to identify the modifiable risk factors in the emergency spaces to adopt specific preventive measures.

Thus, the aim of the present research was to identify risk factors that are linked to severe dehydration among children who come with an acute diarrhea in the emergency departments.

2. Patients and Methods

2.1 Study Design and Setting

In this research, the analytical cross-sectional design was used to establish the risk factors related to severe cases of dehydration in children who presented with acute diarrhea in emergency departments. The research was done in the three tertiary teaching in-patient hospitals within the pediatric emergency departments during a twelve-month period, i.e., between January 2025 and December 2025. These are large referral centers and also offer emergency services to pediatric patients in the urban and rural regions. The emergency departments also receive a significant number of pediatric cases per day, which is why they are the right environments to detect clinical and environmental risk factors relating to severe cases of dehydration.

2.2 Study Population

The population sample of the study was children between 1 month and 59 months who presented to the emergency departments with the symptoms of acute diarrhea. The acute diarrhea was determined as the occurrence of three or more liquid or soft stools per 24 hours lasting less than 14 days according to the World Health Organization (WHO) criterion (12). Pediatric physicians who participated in the study were trained on how to assess the severity of dehydration in children and they were clinically assessed when presented.

2.3 Inclusion and Exclusion Criteria

The children under the age of 1 to 59 months with acute diarrhea and who had an informed consent of their caregivers were involved in the study. Children were not included in case of more than 14 days of chronic diarrhea, underlying severe comorbid medical conditions like congestive heart disease or chronic kidney disease, acute surgical abdomen, or because of the refusal of the caregivers. These exclusion criteria were adopted in order to have proper assessment of dehydration in acute diarrheal illness.

2.4.1 Sample Size Determination

The standard formula was used to estimate the sample size of the cross-sectional studies:

$$\mathbf{n = Z^2P(1-P)/d^2}$$

The estimated minimum sample size (350 children) was obtained using a prevalence of 35% of severe dehydration in the region as assumed in the past (13,14), a 95% confidence level (Z = 1.96), and a 5% margin of error. Another 20 percent was added to account the possible non-response and incomplete data and this gave a total of 420 children as the final sample size. A total of 468 children were evaluated during the study period, and 420 of them were enrolled in the study because they fitted the inclusion criteria.

2.4.2 Sampling Technique

The sampling technique was a consecutive sampling type, all eligible children who reported to the emergency departments throughout the study period were recruited until the target population was met. This was effective in reducing selection bias and representing the population of emergency patients.

2.5 Data Collection Procedure

A structured questionnaire and clinical assessment form have been constructed according to the WHO guidelines and other related literature used to gather data. Interest group Caregivers were surveyed in order to acquire data on sociodemographic factors, feeding patterns, oral fluid consumption, breastfeeding behaviour, oral rehydration salts (ORS) administration, diarrhea tenure, and health-seeking behaviour. Attending pediatric physicians were requested to assess clinical data such as stool frequency, vomiting frequency, presence of fever, nutritional status, and the severity of dehydration.

The nutritional status was measured based on weight-age measurement and clinical examination and categorized as per the WHO child growth standards. The practice of feeding was classified as either exclusive, mixed or artificial/bottle feeding. The data on the use of fluid and ORS before presentation were noted.

2.6 Assessment of Dehydration Severity

Severity of dehydration was assigned based on the WHO clinical severity scale to severe and non-severe dehydration (which was further divided into mild and moderate dehydration). Severe dehydration was defined by two or more of the following clinical signs; lethargy or unconsciousness, the sunken eyes, inability to drink, or poor intake, and delayed skin pinch-up (>2 seconds) (12).

2.7 Study Variables

The dependent variable in this study was the presence or absence of severe dehydration. Independent variables included age, sex, nutritional status, feeding practices, breastfeeding status, ORS use, stool frequency, vomiting frequency, fever, maternal education level, residence, and socioeconomic status.

2.8 Statistical Analysis

The data were entered and analyzed with the help of Statistical Package for the social sciences (SPSS) version 26. Demographic and clinical characteristics were summarized based on the use of descriptive statistics that represented frequencies, percentages, means, and standard deviations. The Chi-square test was applied to determine the associations between categorical variables and severity of dehydration. Bivariate analysis showed variables (p-value less than 0.05) to be included in the multivariate analysis of logistic regression to determine independent predictors of severe dehydration. Adjusted odds ratios (AOR) were used with 95% confidence interval (CI), and $p = 0.05$ was taken as the statistical significance.

2.9 Ethical Considerations

The health director of the Central Teaching Hospital of Pediatrics was contacted to give ethical approval. Before the enrolment, informed consent was obtained in relation to the mothers as written consent. During the investigation, anonymity and confidentiality were noted too. The study preserved confidentiality and anonymity of the information of the participants. They were all voluntary, and the caregivers were free to pull out any time without any kind of intervention in the medical care of their children.

3. Results

Table 1. Sociodemographic Characteristics of the Study Population (N = 420)

Variable	Total (N=420) n (%)	Severe Dehydration (n=128)	Non-Severe (n=292)	p-value
Age <12 months	180 (42.9%)	76 (59.4%)	104 (35.6%)	<0.001
Male sex	228 (54.3%)	70 (54.7%)	158 (54.1%)	0.91
Rural residence	197 (46.9%)	73 (57.0%)	124 (42.5%)	0.006
Low maternal education	198 (47.1%)	82 (64.1%)	116 (39.7%)	<0.001
Poverty (low income)	184 (43.8%)	78 (60.9%)	106 (36.3%)	<0.001

Cases of severe dehydration among children were significantly higher in infants (under 12 months), low maternal education, rural and poor (p <0.01). The best demographic association was with age below 12 months old.

Table 2. Nutritional and Feeding Characteristics

Variable	Total n (%)	Severe (n=128)	Non-Severe (n=292)	p-value
Moderate/Severe malnutrition	110 (26.2%)	52 (40.6%)	58 (19.9%)	<0.001
Artificial/Bottle feeding	158 (37.6%)	68 (53.1%)	90 (30.8%)	<0.001
Withdrawal of breastfeeding	100 (23.8%)	46 (35.9%)	54 (18.5%)	0.001
Exclusive breastfeeding <6 months	160 (38.1%)	34 (26.6%)	126 (43.2%)	0.002

Severe dehydration was strongly linked to moderate-severe malnutrition, artificial/bottle feeding and withdrawal of breastfeeding (p ≤0.01). There was a protective effect of exclusive breastfeeding.

Table 3. Clinical Characteristics at Presentation

Variable	Total n (%)	Severe (n=128)	Non-Severe (n=292)	p-value
Stool frequency >8/day	204 (48.6%)	88 (68.8%)	116 (39.7%)	<0.001
Vomiting >2/day	216 (51.4%)	94 (73.4%)	122 (41.8%)	<0.001
Fever >38°C	216 (51.4%)	84 (65.6%)	132 (45.2%)	<0.001
Presentation >48 hours	177 (42.1%)	81 (63.3%)	96 (32.9%)	<0.001
Signs of lethargy	102 (24.3%)	60 (46.9%)	42 (14.4%)	<0.001

There were significant differences in high stool output (>8/day), vomiting (>2/day), fever (>38C), delayed onset, and lethargy in the severe dehydration group (p <0.001), showing a high level of clinical predictors.

Table 4. Home Management and Healthcare-Related Factors

Variable	Total n (%)	Severe (n=128)	Non-Severe (n=292)	p-value
No ORS use	202 (48.1%)	98 (76.6%)	104 (35.6%)	<0.001
Reduced fluid intake	188 (44.8%)	90 (70.3%)	98 (33.6%)	<0.001
Use of antibiotics before	124	44 (34.4%)	80 (27.4%)	0.16

presentation	(29.5%)			
Traditional remedies used	88 (21.0%)	40 (31.3%)	48 (16.4%)	0.001

Lack of ORS use and decreased home fluid intake was significantly linked to severe dehydration ($p < 0.001$), which shows the effectiveness of resorting to rehydration practices at an early age.

Table 5. Multivariable Logistic Regression Analysis of Independent Predictors of Severe Dehydration

Variable	Adjusted Odds Ratio (AOR)	95% CI	p-value
Age <12 months	2.38	1.40–4.05	0.001
Moderate/Severe malnutrition	2.74	1.55–4.83	<0.001
Stool frequency >8/day	2.91	1.70–4.98	<0.001
Vomiting >2/day	2.46	1.41–4.28	0.002
Withdrawal of breastfeeding	1.88	1.02–3.45	0.041
No ORS use	3.82	2.15–6.78	<0.001
Artificial/bottle feeding	2.11	1.21–3.69	0.009
Fever >38°C	1.67	1.01–2.76	0.046
Presentation >48 hours	3.12	1.88–5.16	<0.001

Following the adjustment, the strongest independent predictors of the severe dehydration were lack of ORS use (AOR = 3.82), delayed presentation (AOR = 3.12), and high stool frequency (AOR = 2.91).

Table 6. Significant Risk Factors Ranked by Strength of Association

Rank	Risk Factor	AOR
1	No ORS use	3.82
2	Presentation >48 hrs	3.12
3	Stool frequency >8/day	2.91
4	Malnutrition	2.74
5	Vomiting >2/day	2.46
6	Age <12 months	2.38
7	Artificial feeding	2.11
8	Withdrawal of breastfeeding	1.88
9	Fever >38°C	1.67

Home-care variables could be changed with the greatest level of risk, with the strongest focus put on the preventable causes of grave dehydration.

The forest plot indicates that the absence of ORS use, below presentation (>48 hours), and high stool frequency (>8/day) were the best independent predictors of severe dehydration as all the confidence intervals were less than unity.

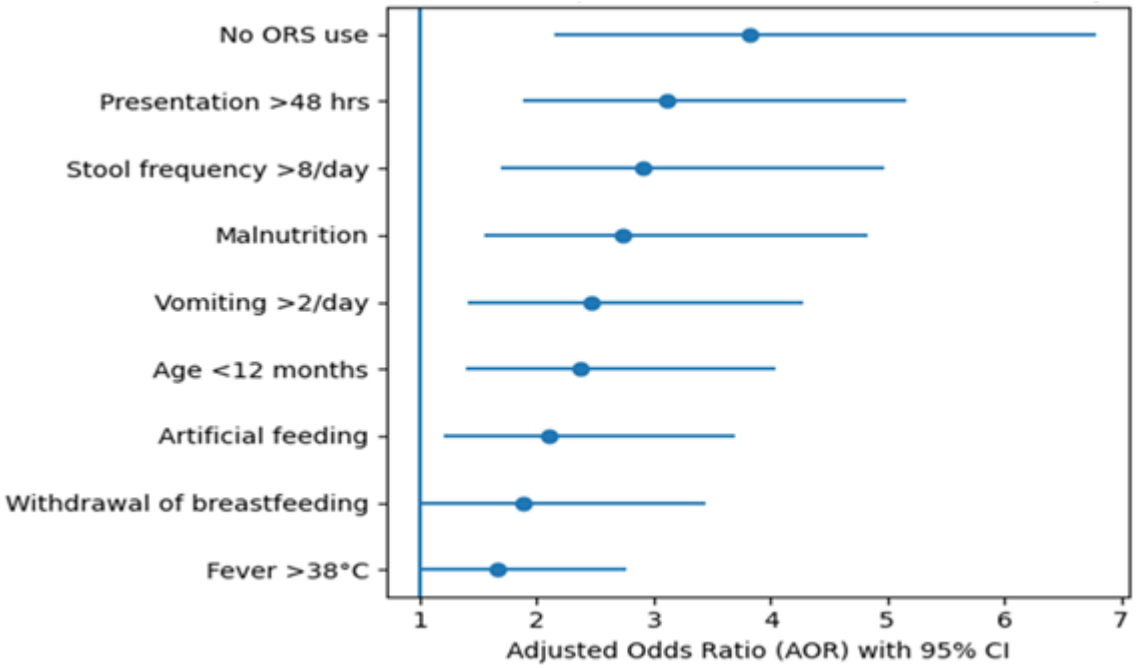

Figure 1. Adjusted Odds Ratios for Risk Factors of Severe Dehydration

4. Discussion

In the current investigation, a high percent (128/420), 30.5 percent of children attending in emergency departments with acute diarrhea were found to have severe dehydration. This is similar to the prevalence in Bangladesh (2835) and Kenya (32) in hospital-based pediatric cohort (13,14). Nevertheless, it is still higher than the estimates in the community level, which implies late presentation to the tertiary emergency departments.

Severe dehydration was strongly relevant with age since 59.4% of severe cases occurred among infants compared with 35.6% among non-severe (AOR = 2.38, 95% CI: 1.40 -4.05, p = 0.001). In line with this, Ahmed et al. reported a 2.6-fold risk among the infants (15,16), and Alam et al. showed the infancy as the most strong predictive demographic (13). This association can be attributed to the vulnerability of infants physiologically, which is increased extracellular fluid turnover and low compensatory capacity of the kidney (15).

The prevalence of moderate-to-severe malnutrition among children with severe dehydration was 40.6% and in the non-severe group, it stood at 19.9 (AOR = 2.74, p <0.001). Similar findings were indicated in East African researches in which malnutrition aggravated dehydration severity by almost three times (14). Malnutrition inhibits the mucosal immunity and extends the duration of diarrhea increasing fluid losses (17).

The high stool frequency (>8 stools/day) was noted in 68.8% of severe and 39.7%, and non-severe (AOR = 2.91, p <0.001). This result is consistent with Thiam et al., who found that a stool frequency greater than 7/day increased the likelihood of dehydration among emergency samples by two times (9). Higher stool volume quickens the intravascular depletion of the volume.

The incidence in vomiting more than once a day was much higher in the severe group (73.4%), compared to that in the non-severe group (41.8%) (AOR = 2.46, p = 0.002). Associations with the same were observed in Indian and Nigerian studies (18,19) of pediatric emergency cases, where the effect of oral rehydration was hampered by the persistence of vomiting.

Lack of ORS at home or low fluid intake at home was the best predictor in this study. It is important to note that 76.6 per cent of children with severe dehydration had not received ORS as compared to 35.6 per cent in children with no severe dehydration (AOR = 3.82, 95% CI: 2.15-6.78, p <0.001). The results are in line with the evidence in the world that shows that early administration of ORS can help to reduce severe dehydration more than 60 percent (20,21). The

large number of non-ORS use points to the lack of understanding and primary care training among caregivers.

In diarrheal episodes, 35.9 per cent of the severe cases reported withdrawal of breastfeeding compared to 18.5 per cent of the non-severe cases (AOR = 1.88, p = 0.041). It is advisable to continue breastfeeding in the case of diarrhea owing to the immunologic protection and fluid replacement that breast milk has (22). Similar protective effects have been reported in several trials sponsored by WHO (12).

Fever greater than 38 o C was also found to be independent of severe dehydration (65.6% vs. 45.2; AOR = 1.67, p = 0.046). Fever enhances insensible fluid loss and can indicate invasive infection, which leads to a more rapid loss of water (15). Whereas rural residence and poverty were found to have a significant effect in bivariate analysis (p = 0.006), they were not found to have independent significance in multivariate analysis, indicating that their effect may be mediated through malnutrition, delayed presentation, and insufficient use of ORS.

In general, this research confirms that clinical severity indicators (high stool frequency, vomiting, fever) and modifiable home-care variables (absence of ORS, artificial feeding, breast feeding withdrawal) also play an important role in the case of severe dehydration in the emergency department. The significance of caregiver education programs and community-based interventions is highly emphasized by the strength of the association of the modifiable variables and especially ORS non-use (AOR = 3.82).

5. Conclusion

In emergency care facilities, severe dehydration in children with acute diarrhea is still widespread. Among the independent risk factors, there are young age, low maternal education, late presentation, the lack of ORS use, and vomiting. The interventions aiming at minimizing emergency complications should be based on caregiver education and initial rehydration measures.

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