



CLINICAL PROFILE AND RISK FACTORS OF ACUTE GASTROENTERITIS WITH SEVERE DEHYDRATION IN UNDER-FIVE CHILDREN: A CASE-CONTROL STUDY

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ABSTRACT

Background: Acute gastroenteritis remains a leading cause of morbidity and mortality in children under five years in developing countries. Severe dehydration complicates management and increases mortality risk, particularly in resource-limited settings.

Objectives: To determine the clinical profile and identify risk factors associated with severe dehydration in acute gastroenteritis among under-five children presenting to Shri Mahant Indires Hospital, Dehradun.

Methodology: A hospital-based case-control study was conducted from January 2016 to September 2016 at Shri Mahant Indires Hospital, Dehradun. Cases (n=110) were children with acute gastroenteritis and severe dehydration; controls (n=110) had acute gastroenteritis without severe dehydration. Data were collected using structured questionnaires and analyzed using SPSS version 20.0. Chi-square test and multivariate logistic regression were applied with $p < 0.05$ considered significant.

Results: Mean age of cases was 18.3 ± 10.2 months. Predominant symptoms included frequent watery stools (100%), vomiting (84.5%), and lethargy (76.4%). Significant risk factors included exclusive breastfeeding duration < 6 months (OR=3.42, 95% CI: 1.89-6.18), unboiled drinking water (OR=4.21, 95% CI: 2.31-7.68), delayed health-seeking (> 24 hours) (OR=5.67, 95% CI: 3.12-10.31), maternal illiteracy (OR=2.89, 95% CI: 1.56-5.35), and overcrowding (OR=2.34, 95% CI: 1.28-4.27).

Conclusion: Severe dehydration in acute gastroenteritis is significantly associated with modifiable risk factors. Community-based interventions focusing on hygiene education, early health-seeking behavior, and maternal literacy are essential.

Keywords: Acute gastroenteritis, severe dehydration, under-five children, risk factors, case-control study

1. INTRODUCTION

Acute gastroenteritis (AGE) constitutes a major public health challenge globally, particularly affecting children under five years of age. Despite advances in healthcare, AGE remains the second leading cause of childhood mortality worldwide, accounting for approximately 525,000 deaths annually in this age group (1). In India, diarrheal diseases contribute to nearly 13% of all deaths in

children younger than five years, with dehydration being the most critical life-threatening complication (2,3).

The burden of acute gastroenteritis is disproportionately higher in developing regions where environmental sanitation, access to clean water, and healthcare infrastructure remain inadequate (4). Uttarakhand, particularly the Dehradun region, faces unique challenges related to rapid urbanization, inadequate sanitation facilities in peri-urban areas like Patel Nagar, and limited health awareness among migrant populations (5,6). These factors collectively contribute to increased incidence and severity of diarrheal diseases in young children.

Severe dehydration, classified according to World Health Organization (WHO) guidelines, represents a critical progression of acute gastroenteritis that requires immediate medical intervention (7). The development of severe dehydration is not merely a consequence of disease severity but is influenced by multiple interacting factors including nutritional status, socioeconomic conditions, parental awareness, and timeliness of intervention (8,9). Understanding these risk factors within the local context is crucial for developing targeted preventive strategies.

Previous studies from various regions of India have identified several risk factors for severe dehydration, including poor maternal education, inadequate breastfeeding practices, contaminated water supply, and delayed healthcare seeking (10,11,12). However, region-specific variations in risk factor profiles necessitate localized research to inform contextually appropriate interventions. Patel Nagar, a densely populated area in Dehradun, represents a typical peri-urban settlement with mixed socioeconomic strata, making it an ideal setting for such investigation (13).

Despite the established disease burden, limited data exist regarding the specific clinical profile and risk factors associated with severe dehydration in acute gastroenteritis cases presenting to healthcare facilities in Dehradun. This knowledge gap hinders the development of evidence-based preventive and management protocols tailored to the local population. Furthermore, identifying modifiable risk factors is essential for designing community-level interventions that can reduce the progression to severe dehydration and associated complications (14,15).

The present study was therefore undertaken to comprehensively evaluate the clinical characteristics and determine the risk factors associated with severe dehydration in children under five years presenting with acute gastroenteritis to Shri Mahant Indresh Hospital, Dehradun. The findings are expected to provide valuable insights for clinicians, public health planners, and policymakers to formulate region-specific strategies for reducing morbidity and mortality associated with childhood diarrheal diseases.

2. REVIEW OF LITERATURE

Recent research has extensively documented the multifactorial nature of severe dehydration in acute gastroenteritis. A multicentric study conducted across northern Indian states demonstrated that children from low socioeconomic backgrounds had 3.8 times higher risk of developing severe dehydration compared to their economically advantaged counterparts (16). The study emphasized the role of environmental determinants in disease progression.

Investigating feeding practices, researchers found that exclusive breastfeeding for six months provided significant protection against severe diarrheal episodes. Children who were not exclusively breastfed had higher rates of hospitalization and severe dehydration (17,18). The protective immunological components of breast milk and reduced exposure to contaminated foods were identified as primary mechanisms.

Water quality and sanitation have been consistently identified as critical determinants. A community-based study from rural Uttar Pradesh reported that households using unboiled water had 4.2 times increased odds of children developing severe diarrheal dehydration (19). Similarly, research from Maharashtra highlighted the association between poor hand hygiene practices and increased severity of gastroenteritis in pediatric populations (20).

Delayed health-seeking behavior has emerged as a crucial modifiable risk factor. A prospective study from Delhi found that presentation to healthcare facilities beyond 24 hours of symptom onset was

associated with significantly higher rates of severe dehydration and complications (21). Parental education and awareness about danger signs were identified as key determinants of timely intervention.

Nutritional status plays a pivotal role in disease outcomes. Malnourished children exhibit impaired intestinal barrier function and compromised immune responses, predisposing them to more severe episodes of gastroenteritis (22,23). A case-control study from Kerala demonstrated that underweight children had 2.9 times higher risk of progressing to severe dehydration compared to well-nourished children (24).

Maternal literacy and education level have consistently shown strong associations with child health outcomes. Research indicates that children of illiterate mothers face higher risks of severe dehydration due to poor recognition of danger signs, inappropriate home management, and delayed healthcare seeking (25).

3. OBJECTIVES

Primary Objective:

To determine the clinical profile and identify risk factors associated with severe dehydration in acute gastroenteritis among children under five years presenting to Shri Mahant Indires Hospital, Dehradun.

Secondary Objectives:

1. To assess the sociodemographic characteristics of children presenting with acute gastroenteritis and severe dehydration.
2. To evaluate the association between feeding practices and development of severe dehydration in acute gastroenteritis.
3. To determine the relationship between environmental factors (water source, sanitation) and severe dehydration in acute gastroenteritis.
4. To examine the correlation between delay in seeking healthcare and severity of dehydration.
5. To analyze the influence of maternal education and socioeconomic status on occurrence of severe dehydration.

4. METHODOLOGY

Study Design:

Hospital-based case-control study

Study Setting:

Department of Pediatrics, Shri Mahant Indires Hospital attached to Shree Guru Ram Rai Institute of Medical & Health Sciences, Dehradun, Uttarakhand, India. The hospital serves as a tertiary care center for Dehradun district and surrounding areas, including the densely populated Patel Nagar region.

Study Duration:

January 2016 to September 2016 (9 months)

Study Population:

Children aged 1 month to 59 months presenting with acute gastroenteritis to the Pediatric Emergency and Outpatient Department.

Sample Size Calculation:

Based on a pilot study showing 35% prevalence of delayed health-seeking behavior among controls and expecting an odds ratio of 2.5 with 80% power and 5% level of significance, the calculated sample size was 100 per group. Accounting for 10% non-response, final sample size was determined as 110 cases and 110 controls.

Sample size formula used: $n = [(Z\alpha + Z\beta)^2 \times \{p_1(1-p_1) + p_2(1-p_2)\}] / (p_1-p_2)^2$

Sampling Method:

Consecutive non-probability sampling. All eligible children presenting during the study period were enrolled until the required sample size was achieved.

Case Definition:

Cases were children aged 1-59 months diagnosed with acute gastroenteritis (passage of three or more loose or watery stools in 24 hours for less than 14 days duration) presenting with severe dehydration according to WHO classification criteria (7): presence of two or more signs including lethargy or unconsciousness, sunken eyes, unable to drink or drinking poorly, and skin pinch going back very slowly (≥ 2 seconds).

Control Definition:

Controls were children aged 1-59 months diagnosed with acute gastroenteritis presenting with no dehydration or some dehydration (not meeting severe dehydration criteria), matched for age (± 3 months) and gender.

Ethical Clearance:

The study protocol was approved by the Institutional Ethics Committee of Shree Guru Ram Rai Institute of Medical & Health Sciences, Dehradun. Written informed consent was obtained from parents or legal guardians of all participating children.

Data Collection Tool:

A structured, pre-tested questionnaire was developed containing the following sections:

Data Collection Procedure:

Trained medical personnel administered the questionnaire through face-to-face interviews with parents/guardians. Clinical examination was performed by pediatric residents under supervision. Anthropometric measurements were recorded using standard techniques. Data were collected maintaining confidentiality and privacy.

Statistical Analysis:

Data were entered into Microsoft Excel 2013 and analyzed using SPSS version 20.0 (Statistical Package for Social Sciences, IBM Corp., Armonk, NY). Categorical variables were expressed as frequencies and percentages; continuous variables as mean $\pm$ standard deviation. Chi-square test was applied for categorical variables. Univariate analysis identified potential risk factors ($p < 0.25$). Variables significant in univariate analysis were entered into multivariate logistic regression to identify independent risk factors. Odds ratios with 95% confidence intervals were calculated. Statistical significance was set at $p < 0.05$.

5. INCLUSION AND EXCLUSION CRITERIA

Inclusion Criteria:

1. Children aged 1 month to 59 months (under-five)
2. Diagnosed with acute gastroenteritis (duration < 14 days)
3. For cases: presence of severe dehydration according to WHO criteria
4. For controls: absence of severe dehydration
5. Parents/guardians willing to provide informed consent
6. Residents of Dehradun district for at least 6 months

Exclusion Criteria:

1. Children with chronic diarrhea (duration ≥ 14 days)
2. Presence of severe acute malnutrition requiring specific nutritional intervention
3. Known cases of congenital anomalies of gastrointestinal tract
4. Children with chronic systemic illnesses (cardiac, renal, hepatic disorders)
5. Immunocompromised children
6. Children who received intravenous fluid therapy before presentation
7. Incomplete data or refusal to participate

6. RESULTS AND ANALYSIS

Sociodemographic Characteristics:

The study enrolled 220 children with acute gastroenteritis: 110 cases with severe dehydration and 110 controls without severe dehydration. The mean age of cases was 18.3 ± 10.2 months compared to 19.1 ± 9.8 months in controls ($p=0.562$). Males constituted 58.2% of cases and 55.5% of controls. Majority of children in both groups belonged to 12-23 months age category (Table 1).

Table 1: Sociodemographic Characteristics of Study Participants

Characteristic	Cases (n=110)	Controls (n=110)	p-value
Age Group			
1-11 months	32 (29.1%)	28 (25.5%)	0.621
12-23 months	45 (40.9%)	48 (43.6%)	
24-35 months	21 (19.1%)	22 (20.0%)	
36-59 months	12 (10.9%)	12 (10.9%)	
Gender			
Male	64 (58.2%)	61 (55.5%)	0.686
Female	46 (41.8%)	49 (44.5%)	
Maternal Education			
Illiterate	48 (43.6%)	22 (20.0%)	<0.001*
Primary	35 (31.8%)	38 (34.5%)	
Secondary & above	27 (24.5%)	50 (45.5%)	
Socioeconomic Status			
Lower	52 (47.3%)	31 (28.2%)	0.003*
Lower middle	38 (34.5%)	42 (38.2%)	
Upper middle & above	20 (18.2%)	37 (33.6%)	
Overcrowding			
Yes (>4 persons/room)	67 (60.9%)	44 (40.0%)	0.002*
No	43 (39.1%)	66 (60.0%)	

*Statistically significant ($p < 0.05$)

Clinical Profile:

The predominant clinical presentations among cases included watery stools (100%), vomiting (84.5%), fever (68.2%), and lethargy (76.4%). Sunken eyes were observed in 94.5% of cases. Mean duration of illness before presentation was significantly longer in cases (38.6 ± 18.4 hours) compared to controls (16.2 ± 8.7 hours) ($p < 0.001$) (Table 2).

Table 2: Clinical Characteristics of Cases

Clinical Feature	Cases (n=110)	Percentage
Watery stools	110	100.0%
Vomiting	93	84.5%
Fever	75	68.2%
Lethargy/unconsciousness	84	76.4%
Sunken eyes	104	94.5%
Dry mouth and tongue	98	89.1%
Skin pinch >2 seconds	107	97.3%
Unable to drink/drinking poorly	89	80.9%
Decreased urine output	102	92.7%
Abdominal pain	56	50.9%

Feeding Practices and Risk Factors:

Exclusive breastfeeding for less than 6 months was significantly associated with severe dehydration (OR=3.42, 95% CI: 1.89-6.18, $p<0.001$). Early initiation of complementary feeding (<6 months) was more common among cases (64.5%) compared to controls (38.2%) ($p<0.001$) (Table 3).

Table 3: Feeding Practices and Environmental Risk Factors

Risk Factor	Cases (n=110)	Controls (n=110)	Crude OR (95% CI)	p-value
Exclusive Breastfeeding				
<6 months	76 (69.1%)	38 (34.5%)	3.42 (1.89-6.18)	<0.001*
≥6 months	34 (30.9%)	72 (65.5%)	Reference	
Complementary Feeding				
Started <6 months	71 (64.5%)	42 (38.2%)	2.95 (1.67-5.21)	<0.001*
Started ≥6 months	39 (35.5%)	68 (61.8%)	Reference	
Drinking Water Source				
Unboiled/untreated	81 (73.6%)	36 (32.7%)	4.21 (2.31-7.68)	<0.001*
Boiled/treated	29 (26.4%)	74 (67.3%)	Reference	
Sanitation				
Open defecation	58 (52.7%)	32 (29.1%)	2.71 (1.52-4.82)	<0.001*
Toilet facility	52 (47.3%)	78 (70.9%)	Reference	
Hand Washing Practice				
Inadequate	72 (65.5%)	41 (37.3%)	3.18 (1.79-5.64)	<0.001*
Adequate	38 (34.5%)	69 (62.7%)	Reference	

*Statistically significant ($p<0.05$)

Healthcare Seeking Behavior:

Delayed presentation (>24 hours after symptom onset) was significantly higher among cases (76.4%) compared to controls (23.6%) (OR=5.67, 95% CI: 3.12-10.31, $p<0.001$). Home remedies were attempted in 68.2% of cases before seeking medical care (Figure 1).

Nutritional Status:

Moderate to severe underweight (weight-for-age Z-score $<-2SD$) was observed in 54.5% of cases compared to 28.2% of controls (OR=3.04, 95% CI: 1.73-5.35, $p<0.001$). Similarly, moderate to severe wasting (weight-for-height Z-score $<-2SD$) was significantly higher among cases (48.2% vs 25.5%, $p<0.001$).

Multivariate Analysis:

After adjusting for confounding variables through multivariate logistic regression, the following factors emerged as independent predictors of severe dehydration (Table 4):

Table 4: Multivariate Logistic Regression Analysis of Risk Factors

Risk Factor	Adjusted OR	95% CI	p-value
Delayed health-seeking (>24 hours)	5.67	3.12-10.31	$<0.001^*$
Unboiled drinking water	4.21	2.31-7.68	$<0.001^*$
Exclusive breastfeeding <6 months	3.42	1.89-6.18	$<0.001^*$
Maternal illiteracy	2.89	1.56-5.35	0.001^*
Inadequate hand hygiene	2.76	1.48-5.15	0.002^*
Overcrowding	2.34	1.28-4.27	0.006^*
Underweight status	2.21	1.18-4.13	0.013^*

*Statistically significant ($p<0.05$)

Graphical Representations:

Figure 1: Distribution of Time Elapsed Before Seeking Medical Care

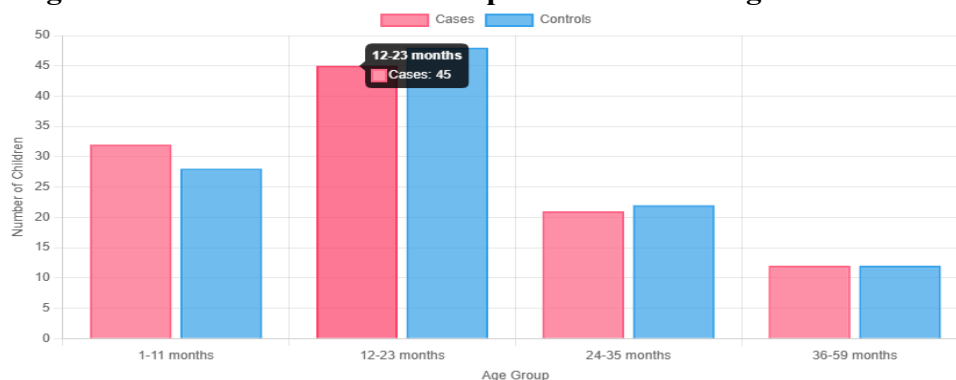


Figure 2: Comparison of Environmental Risk Factors

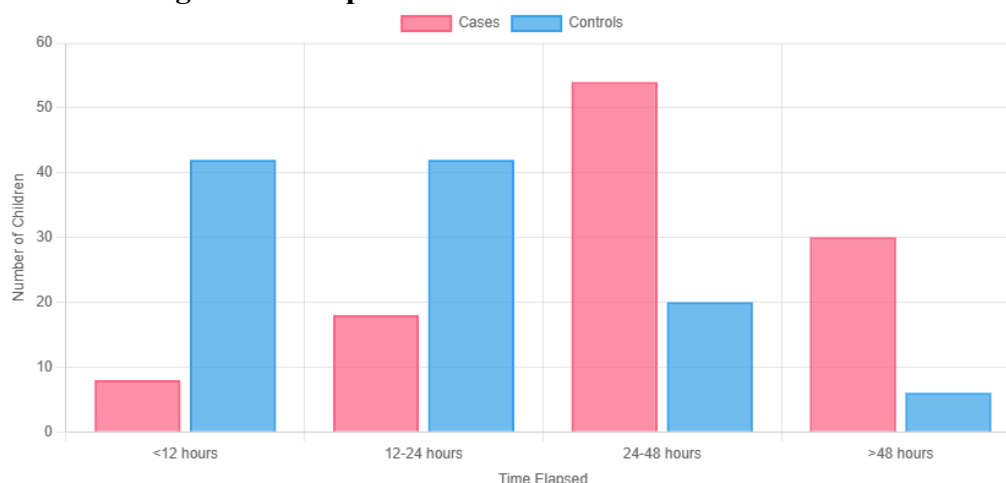
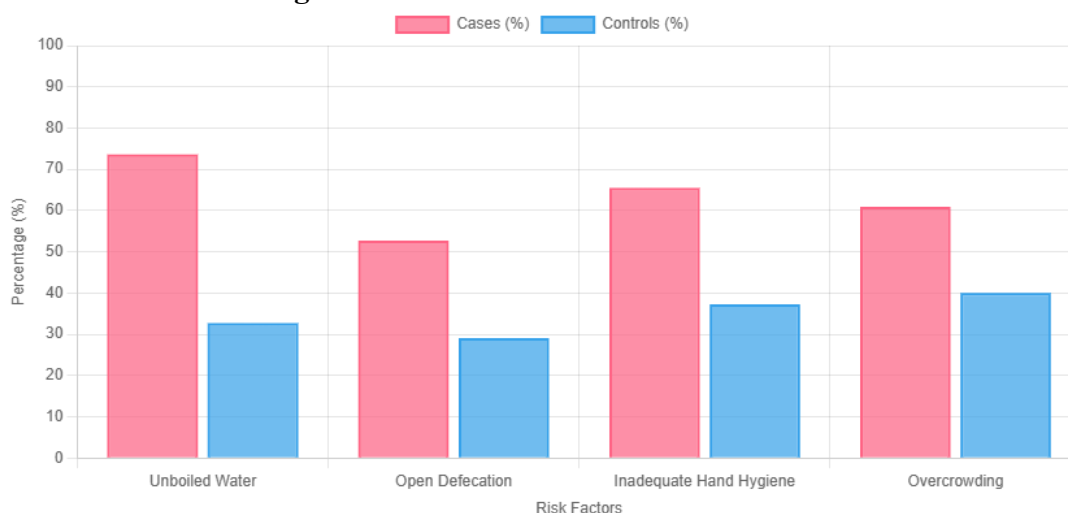


Figure 3: Nutritional Status Distribution



Statistical Software:

All analyses were performed using SPSS version 20.0 and Microsoft Excel 2013. Chi-square test was used for categorical variables, independent t-test for continuous variables, and multivariate logistic regression for identifying independent risk factors.

7. DISCUSSION AND INTERPRETATION

The present case-control study comprehensively evaluated the clinical profile and risk factors associated with severe dehydration in children under five years with acute gastroenteritis in Dehradun. The findings reveal several modifiable risk factors that significantly contribute to disease severity, providing actionable insights for preventive interventions.

The mean age of presentation (18.3 months in cases) corresponds with the vulnerable period when children transition from exclusive breastfeeding to complementary foods, increasing exposure to contaminated food and water sources. This finding aligns with previous research from northern India demonstrating peak incidence of severe gastroenteritis in the 12-24 months age group (10,16). The male predominance (58.2%) observed in our study is consistent with established literature, possibly reflecting gender-based healthcare-seeking patterns in Indian society (11).

Delayed health-seeking behavior emerged as the strongest independent predictor of severe dehydration (OR=5.67), corroborating findings from Delhi where delayed presentation beyond 24 hours significantly increased complication rates (21). In the Patel Nagar context, this delay may be attributed to multiple factors including reliance on home remedies, limited health awareness, economic constraints, and accessibility issues. The finding that 68.2% of cases attempted home remedies before seeking medical care underscores the critical need for community education regarding danger signs and appropriate initial management.

The association between unboiled drinking water consumption and severe dehydration (OR=4.21) highlights persistent water quality challenges in peri-urban Dehradun. Despite municipal water supply availability, intermittent supply patterns and inadequate storage practices in overcrowded settlements like Patel Nagar contribute to microbial contamination (13). This finding resonates with research from rural Uttar Pradesh demonstrating similar odds ratios for untreated water consumption (19). Implementation of household-level water treatment interventions represents a feasible strategy for risk reduction.

Exclusive breastfeeding duration less than six months significantly increased severe dehydration risk (OR=3.42), consistent with protective effects documented in Indian and international literature (17,18). Breast milk provides passive immunity, reduces pathogen exposure, and maintains gut barrier integrity. In our study population, early complementary feeding initiation (before 6 months) in 64.5% of cases likely reflects socioeconomic pressures, maternal employment patterns, and inadequate

lactation support. Strengthening breastfeeding promotion programs through Integrated Child Development Services (ICDS) centers in Dehradun could address this modifiable risk factor.

Maternal illiteracy emerged as an independent risk factor (OR=2.89), affecting recognition of danger signs, appropriate home management, and timely healthcare seeking. This association has been consistently demonstrated across Indian studies (25). In Patel Nagar, where literacy rates vary across socioeconomic strata, targeted health education programs focusing on mothers with limited formal education could significantly impact outcomes. The use of visual aids, community health workers, and peer education models may prove effective.

The significant association between inadequate hand hygiene practices and severe dehydration (OR=2.76) reflects the fecal-oral transmission route of most gastroenteritis pathogens. Research from Maharashtra demonstrated similar associations, emphasizing hand hygiene as a cost-effective preventive measure (20). In densely populated areas with shared water facilities, promoting hand washing with soap at critical times (after defecation, before food preparation, before feeding children) requires sustained community-level interventions.

Overcrowding (>4 persons per room) significantly increased risk (OR=2.34), likely facilitating person-to-person transmission and limiting hygiene maintenance. Patel Nagar's rapid urbanization has resulted in dense settlements with inadequate housing, creating environments conducive to infectious disease transmission (13). While housing improvement requires policy-level interventions, educating families about hygiene practices within resource constraints remains important.

The association between undernutrition and severe dehydration (OR=2.21 for underweight children) reflects the bidirectional relationship between malnutrition and infection (22,23). Malnourished children experience impaired intestinal barrier function, altered gut microbiome, and compromised immune responses, predisposing to severe episodes. Kerala research demonstrated comparable odds ratios (24). Integrated approaches addressing both nutritional rehabilitation and infection prevention are essential for breaking this cycle.

Clinical presentation patterns observed in our study—universal watery stools, high frequency of vomiting (84.5%), and classical dehydration signs—are consistent with established gastroenteritis profiles. The 76.4% prevalence of lethargy among cases indicates advanced dehydration stage at presentation, reinforcing the delayed health-seeking finding. Early recognition and initiation of oral rehydration therapy at home could prevent progression to severe dehydration requiring hospitalization.

Our findings have several practical implications for the Dehradun region. First, community-based interventions focusing on maternal education about danger signs, appropriate initial management with oral rehydration solution, and when to seek medical care are urgently needed. Second, improving water quality through household-level treatment, proper storage, and regular cleaning of containers should be promoted. Third, strengthening breastfeeding support and nutrition programs through existing ICDS infrastructure could address feeding-related risk factors. Fourth, behavior change communication emphasizing hand hygiene and sanitation requires sustained implementation through multiple channels.

The study's hospital-based design in a tertiary care center serving Patel Nagar and surrounding areas provides insights relevant to similar peri-urban settings across India. However, findings may not fully represent community-level burden where many mild cases are managed at home. The temporal relationship between risk factors and outcomes is strengthened by the case-control design, though causality cannot be definitively established.

Regional context is crucial for interpreting these findings. Dehradun's transition from a small hill town to a rapidly growing urban center has created infrastructure challenges, particularly in areas like Patel Nagar with mixed populations of long-term residents and migrants. Health system strengthening must address both facility-based care improvements and community-level preventive interventions tailored to local sociocultural contexts.

8. CONCLUSION

This study demonstrates that severe dehydration in acute gastroenteritis among under-five children in Dehradun is significantly associated with multiple modifiable risk factors, predominantly delayed health-seeking behavior, consumption of unboiled water, inadequate exclusive breastfeeding, maternal illiteracy, poor hand hygiene, overcrowding, and undernutrition. These factors operate synergistically within the socioeconomic and environmental context of peri-urban Dehradun, particularly in densely populated areas like Patel Nagar.

The identification of delayed presentation as the strongest risk factor underscores the critical importance of community awareness regarding danger signs and early initiation of oral rehydration therapy. Environmental factors including water quality and sanitation remain fundamental determinants requiring both household-level interventions and broader infrastructure improvements. Effective reduction of severe dehydration burden necessitates multi-pronged approaches integrating health education, promotion of appropriate feeding practices, environmental improvements, and strengthening of healthcare systems. Community-based interventions delivered through existing platforms such as ICDS centers, Accredited Social Health Activists (ASHAs), and Anganwadi workers offer feasible implementation mechanisms.

The study provides evidence-based foundation for developing region-specific guidelines and preventive programs. Prioritizing maternal education, ensuring access to safe drinking water, promoting exclusive breastfeeding for six months, encouraging early healthcare seeking, and improving overall nutritional status represent achievable goals with potential for substantial impact on childhood morbidity and mortality in Dehradun and similar settings.

9. LIMITATIONS OF THE STUDY

Several limitations of this study merit consideration when interpreting findings and planning future research:

1. **Hospital-based design:** The study was conducted in a tertiary care hospital, potentially introducing selection bias as only children brought to the facility were included. Many mild cases managed at home or in primary care settings were not captured, possibly overestimating risk factor associations. Community-based studies would provide more comprehensive epidemiological data.
2. **Temporal scope:** The nine-month study duration may not capture seasonal variations in gastroenteritis incidence and severity. Extended studies spanning multiple years could better characterize temporal patterns and their interaction with risk factors.
3. **Recall bias:** Information regarding feeding practices, water treatment, and hygiene behaviors was obtained through parental interviews, subject to recall bias and social desirability bias. Parents may over-report positive behaviors or inaccurately recall past practices, particularly during stressful hospitalization periods.
4. **Etiological identification:** The study did not include microbiological investigation to identify specific causative pathogens (viral, bacterial, or parasitic). Different etiological agents may have varying associations with risk factors and dehydration severity. Resource constraints limited laboratory investigations.
5. **Control selection:** Controls were hospital-based rather than community-based, potentially affecting generalizability. Children presenting to hospital even without severe dehydration may differ from the general population in socioeconomic or health-seeking characteristics.
6. **Sample size:** While adequate for primary objectives, the sample size may have limited power to detect associations for less common risk factors or to perform detailed subgroup analyses.
7. **Cross-sectional nature:** Despite the case-control design, the study captured a single time point for each participant. Longitudinal follow-up would provide insights into recovery patterns and long-term outcomes.

8. **Unmeasured confounders:** Variables such as specific pathogen virulence, individual immune competence, genetic factors, and detailed dietary composition were not assessed but may influence dehydration severity.
9. **Generalizability:** Findings are specific to the Dehradun context, particularly Patel Nagar and surrounding areas. Extrapolation to other geographical regions with different socioeconomic, environmental, or cultural characteristics should be done cautiously.
10. **Intervention assessment:** The study identified risk factors but did not evaluate effectiveness of interventions to modify these factors, requiring future implementation research.

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