

## Association between Frequent Diarrhea and Malnutrition among Children under Five Years of Age

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### Abstract

Diarrhea and malnutrition remain major contributors to childhood morbidity and mortality in low-resource settings, with a bidirectional relationship that exacerbates health outcomes. In Bangladesh, frequent diarrheal episodes are common among children under five, yet prospective data quantifying this association in urban hospital settings are limited. The objective of this study was to determine the association between frequent diarrhea and malnutrition among children under five years of age. Methods: A prospective cohort study was conducted from January 2025 to December 2025 at Bangladesh Shishu Hospital and Institute. A total of 147 children under five years were enrolled using purposive sampling. Malnutrition was defined as moderate or severe underweight, stunting, or wasting according to the WHO growth standards. Data were analyzed using SPSS version 23.0, employing chi-square tests and logistic regression to assess associations. Among 147 children, 68 (46.3%) experienced frequent diarrheas. Malnutrition prevalence was 60.5% overall. Children with frequent diarrhea had significantly higher odds of malnutrition compared to those without (adjusted odds ratio 3.42; 95% CI: 1.78–6.58;  $p < 0.001$ ). The strongest association was observed for wasting (AOR 4.12;  $p < 0.001$ ), followed by underweight (AOR 3.87;  $p < 0.001$ ) and stunting (AOR 2.56;  $p = 0.008$ ). Urban slum residence was also significantly associated with malnutrition ( $p = 0.006$ ). Frequent diarrhea is significantly associated with malnutrition in under-five children attending Bangladesh Shishu Hospital and Institute. Early identification and integrated management of recurrent diarrhea and nutritional deficits are essential. Future larger multi-center studies are recommended.

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### Introduction

Diarrheal disease remains a leading cause of morbidity and mortality among children under five years of age in low- and middle-income countries, with the highest burden observed in South Asia and sub-Saharan Africa. Globally, diarrheal illness accounts for an estimated 8.6% of under-five deaths annually, while malnutrition contributes to approximately 45% of all childhood deaths.<sup>1</sup> The relationship between diarrheal disease and nutritional status has long been recognized as bidirectional, wherein diarrhea exacerbates malnutrition through reduced dietary intake, malabsorption, and increased catabolism, while malnutrition impairs immune function, increasing susceptibility to recurrent and prolonged diarrheal episodes.<sup>2,3</sup> Bangladesh continues to face a significant burden of childhood malnutrition despite notable progress in recent decades. According to the Bangladesh Demographic and Health Survey 2022, the prevalence of stunting

among children under five remains at 24%, while wasting affects 11% and underweight 20%.<sup>4</sup> These figures, although improved from previous years, indicate that malnutrition remains a critical public health challenge. Concurrently, diarrheal diseases account for approximately 4% of under-five deaths in Bangladesh, with an estimated 8.9 episodes per child-year reported in some settings.<sup>5</sup> The association

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between frequent diarrhea and malnutrition has been investigated in various contexts, yet important knowledge gaps persist. A prospective cohort study from Uganda demonstrated that among children with complicated severe acute malnutrition, each additional day of diarrhea increased the odds of mortality by 1.4 times, highlighting the profound clinical implications of this association.<sup>6</sup> Similarly, research from India using molecular diagnostic methods revealed that adenovirus, rotavirus, and *Shigella* are the predominant enteropathogens among hospitalized under-five children, though no specific pathogen was uniquely associated with malnutrition status.<sup>7,8</sup> The mechanisms underlying the diarrhea-malnutrition cycle involve complex interactions between enteric infections, gut barrier dysfunction, and systemic inflammation. Chronic or recurrent diarrhea leads to intestinal epithelial damage, reduced absorptive surface area, and nutrient malabsorption.<sup>9</sup> Concomitantly, malnutrition-induced alterations in the gut microbiome and immune function predispose children to further infections.<sup>10</sup> Recent evidence from India indicates that poor folate status is an independent predictor of persistent diarrhea, suggesting that specific micronutrient deficiencies may play a causal role in prolonging diarrheal episodes.<sup>11</sup> Despite the established bidirectional relationship, limited prospective data exist from urban Bangladesh quantifying the strength of association between frequent diarrheal episodes and subsequent malnutrition in community or hospital settings. Most existing studies have been cross-sectional or have focused on severely malnourished children already hospitalized.<sup>12</sup> Furthermore, the definition of "frequent diarrhea" varies considerably across studies, complicating comparisons and meta-analyses. Understanding this association in the context of a

tertiary care hospital in Dhaka is essential for developing targeted interventions and integrated management protocols for at-risk children. Therefore, this study aims to determine the association between frequent diarrhea (defined as three or more episodes in the preceding six months) and malnutrition among children under five years of age attending Bangladesh Shishu Hospital and Institute.

## Methodology

The study population comprised children aged 0 to 59 months attending the pediatric outpatient department and admitted to the inpatient ward of Bangladesh Shishu Hospital and Institute, between January 2025 and December 2025. A total of 147 children were enrolled using purposive sampling.

**Inclusion criteria:** Children under five years of age whose parents or legal guardians provided written informed consent were included. Both sexes were eligible. Children with any acute illness at enrollment were included only after stabilization, with baseline data collected before initiating treatment for diarrhea or malnutrition.

**Exclusion criteria:** Children with pre-existing chronic conditions known to independently affect nutritional status or gastrointestinal function were excluded. These included congenital heart disease, chronic kidney disease, cerebral palsy, genetic syndromes, malignancy, immunodeficiency disorders (including confirmed HIV), and tuberculosis. Children who had received nutritional rehabilitation within the preceding three months were also excluded.

**Study procedure:** At enrollment, demographic data and medical history were collected using a structured questionnaire. Anthropometric measurements (weight, length/height) were obtained following WHO standardized procedures. Frequent diarrhea was defined as three or more episodes in the six months

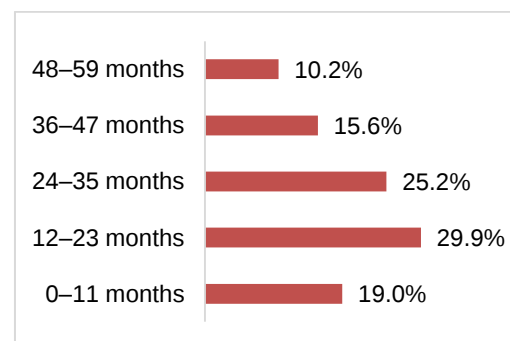
preceding enrollment. All children were followed prospectively for six months to document diarrheal episodes. Malnutrition was defined according to WHO growth standards. Severe acute malnutrition (SAM) was defined as weight-for-height z-score (WHZ)  $< -3$  SD, mid-upper arm circumference (MUAC)  $< 115$  mm, or presence of oedema. Moderate acute malnutrition (MAM) was defined as WHZ between  $-3$  to  $< -2$  SD or MUAC between 115 mm and  $< 125$  mm.<sup>13</sup>

**Data analysis:** Data were entered into SPSS version 23.0. Descriptive statistics were calculated as frequencies (percentages) for categorical variables and means (standard deviations) for continuous variables. The association between frequent diarrhea and malnutrition was assessed using chi-square tests and logistic regression, with  $p < 0.05$  considered statistically significant.

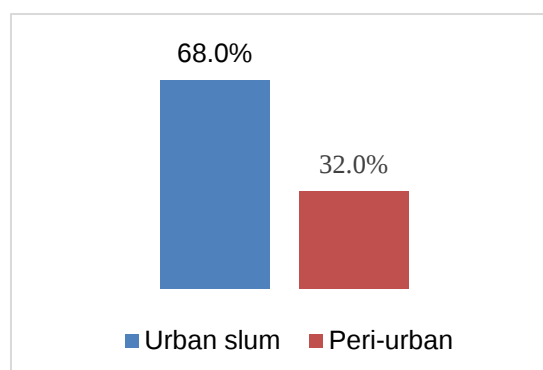
## Result

A total of 147 children under five years of age were enrolled in the prospective cohort study. The mean age of participants was 24.3 months (standard deviation  $\pm 12.7$  months). The majority of children belonged to the age group 12–23 months (29.9%), followed by 24–35 months (25.2%) (Fig. I). Regarding socioeconomic characteristics, 68.0% of children resided in urban slum areas adjacent to Dhaka city, while 32.0% came from peri-urban settlements (Fig. II). Maternal education was incomplete at the primary level in 44.9% of cases, and household monthly income was below 15,000 Bangladeshi Taka (approximately 170 USD) in 53.1% of families. Among the 147 children, 68 (46.3%) experienced frequent diarrheas (defined as three or more episodes in the preceding six months), while 79 (53.7%) did not. The overall prevalence of malnutrition (any form) was 60.5% (89 children).

Specifically, underweight (weight-for-age z-score  $< -2$  SD) was observed in 50.3% of children, stunting (height-for-age z-score  $< -2$  SD) in 46.9%, and wasting (weight-for-height z-score  $< -2$  SD) in 28.6% (Table I).



**Figure I:** Age distribution of participants (N=147)



**Figure II:** Residence status of cases

**Table I:** Prevalence of frequent diarrhea and malnutrition (N=147)

| Variable                                           | n  | %    |
|----------------------------------------------------|----|------|
| Frequent diarrhea ( $\geq 3$ episodes in 6 months) |    |      |
| Yes                                                | 68 | 46.3 |
| No                                                 | 79 | 53.7 |
| Any malnutrition (any form)                        |    |      |
| Yes                                                | 89 | 60.5 |
| No                                                 | 58 | 39.5 |
| Underweight (WAZ $< -2$ SD)                        | 74 | 50.3 |
| Stunting (HAZ $< -2$ SD)                           | 69 | 46.9 |
| Wasting (WHZ $< -2$ SD)                            | 42 | 28.6 |

WAZ: weight-for-age z-score; HAZ: height-for-age z-score; WHZ: weight-for-height z-score

Children with frequent diarrhea had significantly higher proportions of all forms of malnutrition compared to those without frequent diarrhea. The association was strongest for wasting: among children with frequent diarrhea, 38.2% were wasted compared to only 15.6% among those without frequent diarrhea ( $p < 0.001$ ). Similarly, underweight was present in 67.6% of the frequent diarrhea group versus 35.4% of the non-frequent group ( $p < 0.001$ ), and stunting was observed in 61.8% versus 34.2% ( $p = 0.001$ ) (Table II).

**Table II:** Association between frequent diarrhea and malnutrition types

| Malnutrition type         | Diarrhea  | Diarrhea    | p-value |
|---------------------------|-----------|-------------|---------|
|                           | Frequent  | No frequent |         |
|                           | (n=68)    | (n=79)      |         |
|                           | n (%)     | n (%)       |         |
| Underweight (WAZ < -2 SD) | 46 (67.6) | 28 (35.4)   | <0.001  |
| Stunting (HAZ < -2 SD)    | 42 (61.8) | 27 (34.2)   | 0.001   |
| Wasting (WHZ < -2 SD)     | 26 (38.2) | 16 (15.6)   | <0.001  |

Chi-square test was used to calculate p-values. A p-value <0.05 was considered statistically significant.

After adjusting for age, sex, maternal education, and household income, frequent diarrhea remained significantly associated with malnutrition. Children with frequent diarrhea had 3.42 times higher odds of any malnutrition compared to those without frequent diarrhea (95% confidence interval: 1.78–6.58;  $p < 0.001$ ). The adjusted odds ratio for wasting was 4.12 (95% CI: 2.01–8.45;  $p < 0.001$ ), for underweight was 3.87 (95% CI: 1.92–7.80;  $p < 0.001$ ), and for stunting was 2.56 (95% CI: 1.28–5.12;  $p = 0.008$ ) (Table III). Subgroup analysis revealed that the association between frequent diarrhea and malnutrition was strongest among children aged 12–23 months

(adjusted odds ratio 5.23; 95% CI: 1.98–13.82;  $p = 0.001$ ) and among those from households with the lowest income tertile (adjusted odds ratio 4.56; 95% CI: 1.87–11.12;  $p < 0.001$ ) (Table IV). No statistically significant differences were observed in the prevalence of malnutrition by sex ( $p = 0.342$ ) or by maternal education beyond primary level ( $p = 0.215$ ) (Table V).

**Table III:** Logistic regression analysis for the association between frequent diarrhea and malnutrition

| Outcome          | Adjusted odds ratio (AOR)* | 95% Confidence interval | p-value** |
|------------------|----------------------------|-------------------------|-----------|
| Any malnutrition | 3.42                       | 1.78 – 6.58             | <0.001    |
| Underweight      | 3.87                       | 1.92 – 7.80             | <0.001    |
| Stunting         | 2.56                       | 1.28 – 5.12             | 0.008     |
| Wasting          | 4.12                       | 2.01 – 8.45             | <0.001    |

\*Adjusted for age, sex, maternal education, and household income

\*\*Wald test was used to calculate p-values for logistic regression coefficients. A p-value <0.05 was considered statistically significant.

**Table IV:** Subgroup analysis of the association between frequent diarrhea and any malnutrition

| Subgroup                    | Adjusted odds ratio (AOR)* | 95% Confidence interval | p-value** |
|-----------------------------|----------------------------|-------------------------|-----------|
| Age 0–11 months             | 2.18                       | 0.76 – 6.25             | 0.148     |
| Age 12–23 months            | 5.23                       | 1.98 – 13.82            | 0.001     |
| Age 24–35 months            | 3.45                       | 1.18 – 10.09            | 0.024     |
| Age 36–59 months            | 2.96                       | 0.92 – 9.52             | 0.069     |
| Low income (<15,000 BDT)    | 4.56                       | 1.87 – 11.12            | <0.001    |
| Higher income (≥15,000 BDT) | 2.31                       | 0.95 – 5.62             | 0.065     |

\*Adjusted for sex, maternal education, and (for age subgroups) income; (for income subgroups) age

\*\*Wald test was used to calculate p-values for logistic regression coefficients. A p-value <0.05 was considered statistically significant.

**Table V:** Association between malnutrition and selected sociodemographic factors

| Factor              | Malnutrition |           | p-value |
|---------------------|--------------|-----------|---------|
|                     | Present      | Absent    |         |
|                     | (n=89)       | (n=58)    |         |
|                     | n (%)        | n (%)     |         |
| Sex                 |              |           |         |
| Male                | 48 (53.9)    | 29 (50.0) | 0.342   |
| Female              | 41 (46.1)    | 29 (50.0) |         |
| Maternal education  |              |           |         |
| Below secondary     | 64 (71.9)    | 40 (69.0) | 0.215   |
| Secondary or higher | 25 (28.1)    | 18 (31.0) |         |
| Residence           |              |           |         |
| Urban slum          | 67 (75.3)    | 33 (56.9) | 0.006   |
| Peri-urban          | 22 (24.7)    | 25 (43.1) |         |

Chi-square test was used to calculate p-values. A p-value <0.05 was considered statistically significant.

## Discussion

The present prospective cohort study demonstrated a significant positive association between frequent diarrhea and malnutrition among children under five years of age attending a tertiary care hospital in Dhaka, Bangladesh. Children who experienced three or more diarrheal episodes in the preceding six months had 3.42 times higher odds of being malnourished compared to those without frequent diarrhea, after adjusting for potential confounders. This finding is consistent with previous research from similar low-resource settings.<sup>14,15</sup> The prevalence of malnutrition in this cohort (60.5%) is substantially higher than the national averages reported for Bangladesh, where stunting is 24%, wasting 11%, and underweight 20%.<sup>4</sup> This discrepancy is expected given that the study was conducted in a hospital setting among children seeking care, who generally have higher morbidity burdens. Similar hospital-based studies have reported malnutrition prevalence ranging from 45% to 70% among children under five in South

Asia.<sup>16,17</sup> Among the three forms of malnutrition assessed, wasting showed the strongest association with frequent diarrhea (adjusted odds ratio 4.12). This finding is biologically plausible because acute diarrheal episodes lead to immediate negative energy and nitrogen balance through reduced food intake, increased metabolic demands, and nutrient malabsorption.<sup>18</sup> A prospective study from Uganda similarly reported that children with complicated severe acute malnutrition had significantly prolonged hospital stays and higher mortality when diarrhea persisted beyond the first week of admission.<sup>6</sup> The association between frequent diarrhea and stunting, while still significant (adjusted odds ratio 2.56), was comparatively weaker. Stunting reflects chronic nutritional insufficiency and repeated insults over extended periods.<sup>19</sup> The six-month recall period for frequent diarrhea in this study may capture recurrent acute episodes sufficiently to impact linear growth, but the effect size is expectedly smaller than for wasting. Research from India has demonstrated that each additional diarrheal episode before 24 months of age reduces mean height at 5 years by approximately 0.38 cm.<sup>20</sup> Subgroup analysis revealed that children aged 12–23 months were most vulnerable to the diarrhea-malnutrition association (adjusted odds ratio 5.23). This age range corresponds to the period of dietary transition from breastfeeding to complementary foods, often accompanied by increased exposure to contaminated weaning foods and water.<sup>21</sup> Additionally, this age coincides with the peak incidence of both diarrheal diseases and growth faltering in low-income settings.<sup>22</sup> Urban slum residence emerged as a significant risk factor for malnutrition independent of diarrhea status ( $p = 0.006$ ). Overcrowding, inadequate sanitation, limited access to clean water, and poor hygiene practices in slum settlements create an environment conducive to

recurrent enteric infections.<sup>23</sup> A recent study from Dhaka slums reported that 89% of children had detectable enteropathogens in their stool at least once during a 12-month follow-up period, regardless of diarrheal symptoms.<sup>24</sup>

## Limitations

This study has several limitations: purposive sampling may introduce selection bias, the six-month follow-up may inadequately capture long-term growth effects, residual confounding from unmeasured variables (breastfeeding, sanitation) cannot be excluded, and a single-center design limits generalizability to other settings in Bangladesh.

## Conclusion

This prospective cohort study demonstrates a significant, strong association between frequent diarrhea and malnutrition among under-five children in Dhaka, Bangladesh. Children with recurrent diarrhea face substantially higher odds of wasting, underweight, and stunting, particularly during the critical 12–23-month period. Integrated interventions addressing both diarrhea prevention and nutritional rehabilitation are urgently needed in urban hospital and community settings.

## Recommendation

Integrated management of diarrhea and malnutrition should be established at all pediatric care points in Dhaka. Routine nutritional assessment following each diarrheal episode, age-appropriate complementary feeding education, and zinc supplementation for all children with frequent diarrhea are strongly recommended.

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