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Association of Household Drinking Water Access with Gastrointestinal Morbidity: A Hospital-Based Cross-Sectional Observational Study

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Abstract

Background: In many urban and peri-urban settings, access to safe drinking water continues to be a major public health issue. Although infrastructure has improved, the association of multidimensional household water access and clinical gastrointestinal (GI) morbidity is incompletely described for hospital-based populations. We sought to examine the relationships of household drinking water access across dimensions with GI morbidity among patients and their caregivers in tertiary hospitals in Dhaka, Bangladesh. ***Methods:*** A hospital-based, analytical cross-sectional observational study was carried out from July to December 2025 in two tertiary-care centers. The sample of 150 patients were recruited by consecutive sampling. Data was obtained through face-to-face interviews with a structured questionnaire which included collection of socio-demographics, methods of access to household water (source, treatment, availability and perceived quality), GI morbidity in the past six months. Independent predictors of GI morbidity were determined by multivariable logistic regression. ***Results:*** The prevalence of household GI morbidity was 72.0%. Strong bivariate predictors of GI illness included, unimproved water source (90.5% vs. 58.6% for improved sources, p<0.001), no water treatment (94.4% vs. 59.4% for treated water, p<0.001), access <12 hours/day (78.3% vs 66.7%, p=0.035) and belief that there are problems with perceived quality of drinking water (85.3 % VS.43.8 %, P< 0.001). In multivariate analysis, not practicing household water treatment was the most significant independent risk factor (aOR=8.45; 95% CI: 2.68-26.68). Additional strong predictors were perceived water quality problems (aOR=6.03), use of unimproved water sources (aOR=2.91) and access <12 hours/day (aOR=1.72). ***Conclusion:*** This study exhibits a robust, independent relationship between unimproved household water access, and in particular lack of point-of-use treatment with GI morbidity. The results point to a dual approach for public health: widespread household water treatment should be promoted as an immediate measure; and also, parallel investment in reliable, higher-level source improved infrastructure that can address the burden of waterborne disease in other such urban settings.

Keywords: Drinking Water, Gastrointestinal Disease, Water Quality, Water Treatment, Household, Bangladesh.

INTRODUCTION

Gastrointestinal illnesses, especially diarrheal diseases, continue to be significant contributors to worldwide morbidity and mortality and disproportionately impact low- and middle-income countries [1]. Contaminated drinking water is a major source of enteral pathogen transmission and constitutes an estimated 485,000 diarrheal deaths per year [2]. Despite substantial advances in expanding access to water under the Millennium and Sustainable Development Goals, approximately 2 billion people globally continue to lack safe managed water services and are exposed repeatedly to pathogens transmitted through contaminated water [3]. The continued endurance of this public-health challenge points to an urgent need for deeper insight into the precise mechanisms by which household water availability influences gut health. The relative complexity of the relationship between water and health expresses itself

through a number of inter-linked facets of 'water security'. There is more to a better water source than being present, and reliability of supply, consistency in access, in-house treatment behaviours and perception of water safety are important determinant of health impact [4]. Intermittent water supply, which is prevalent in a number of resource-limited settings, has been especially linked to microbial contamination during distribution and storage resulting in the paradox that access to piped water does not automatically equate with safe consumption [5]. Moreover, research during the last decade has continued to draw attention to the fact that infrastructure alone is not enough and consistent household-level water treatment and safe storage are fundamental elements of effective prevention [6]. The gastrointestinal patient in the hospital is frequently the podcast of systemic water insecurity. Hospital-based observational studies provide an important but underused perspective to study the29elationn between water access patterns and disease burden [7]. Such research can generate granular, clinically applicable information on health outcomes while also collecting detailed data about household water practices that may be overlooked in community-level surveys. This is especially applicable in areas with rapidly changing water infrastructure but where disparity between accessibility and safety still exists. Although there is considerable evidence for the association between improved water and sanitation and diarrheal disease [6,7], knowledge gaps persist for how key household water access dimensions including source type, treatment regularity, duration of accessibility, or quality perception interact to influence gastrointestinal morbidity within clinical populations in situated settings [8]. The majority of previous studies have either concentrated on interventions that operate at a community level or single dimensions of water access in isolation, and thus may not have received an adequate appreciation for how the three interact (infrastructure, behavior, and perception) in the reality of household management [9]. The purpose of the present analysis is therefore to assess the relationship between multidimensional household drinking water access and gastrointestinal morbidity in a hospital-based observational study. In particular, we aim to (1) characterize the landscape of water access and treatment practices in individuals presenting with potential waterborne illness; (2) measure the burden of intestinal morbidity in this population; and (3) determine which domains of water access source safety, treatment practices, supply reliability and quality perception drive intestinal health outcomes. By studying these associations in a clinical setting, we hope to generate evidence that can help guide not only the care of individual patients but also public health policy, towards more integrated approaches for water quality interventions spanning from patient-scale care to population level. The results are especially important for clinicians treating GI disease and decision makers working to develop focused water safety interventions in comparable resource-limited areas.

METHODS

This was a hospital-based analytical cross-sectional observational study carried out during the 6-month period (July to December, 2025) in the Department of Medicine of two tertiary-care centers in Dhaka, Bangladesh: Holy Family Red Crescent Medical College Hospital and AMZ Hospital Ltd., Badda. We enrolled 150 adults (aged ≥18 years) or primary caregivers of pediatric patients by consecutive sampling. Qualified subjects had been in charge of the household water control for at least six months and lived at the same address during that time. Patients who were critically ill, had cognitive deficits or did not sign an informed consent form were excluded. Data were collected through face-to-face interviews in private clinical settings using a structured questionnaire based on modules developed by the WHO/UNICEF Joint Monitoring Programme. The study was approved by the committee of ethical review at the study hospital. Data analysis was performed using SPSS version 26.0. Descriptive statistics were used to summarize sociodemographic characteristics and water access variables. Associations between household water access variables and GI morbidity were first tested using bivariate analyses, including Chi-square or Fisher's exact tests, depending on the data distribution. Variables with a p-value of <0.10 in the bivariate analysis, along with demographic confounders, were included in the multivariable logistic regression model. The adjusted odds ratios (aOR) with 95% confidence intervals (CI) were calculated to identify independent predictors of GI morbidity. A p-value of <0.05 was considered statistically significant.

Inclusion Criteria:

- Adults aged ≥18 years or primary caregivers of pediatric patients.
- Responsible for household water control for a minimum of 6 months.
- Living at the same address during the study period.

Exclusion Criteria:

- Critically ill individuals or those with cognitive impairments.
- Individuals who refused to provide informed consent.

RESULTS

Table 1: Demographic Characteristics of Study Participants (n=150)

Characteristic	Category	Frequency (n)	Percentage (%)
Age (Years)	18-35	75	50.0%
	36-50	54	36.0%
	>50	21	14.0%
Gender	Male	68	45.3%
	Female	82	54.7%
Education	≤Primary	75	50.0%
	Secondary	51	34.0%
	Higher	24	16.0%
Household Size	≤4	63	42.0%
	≥5	87	58.0%

The number of the subjects studied was 150. The sample was slightly female-dominated (54.7%) and half of the respondents were younger than 35 years old. Educational status was low, 50% had primary education or less. The majority of households (58%) were ≥ 5 in number, reflecting larger household sizes.

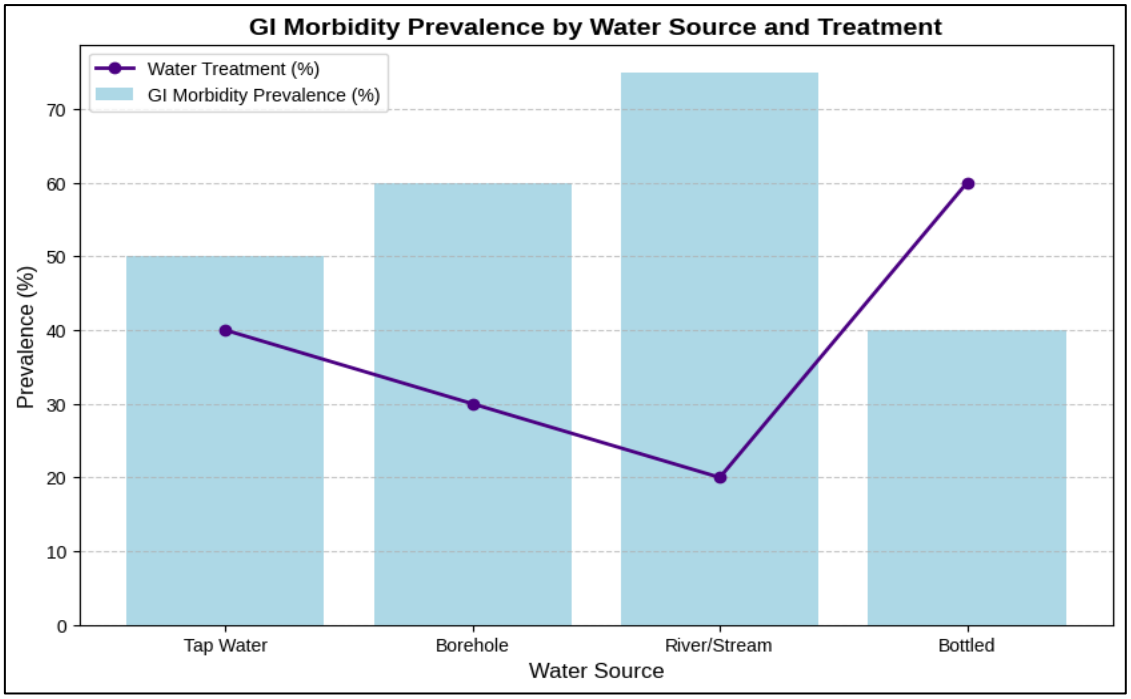

Figure 1: Prevalence of GI Morbidity by Water Source and Treatment Status

Figure 1: GI diseases by type of water source unimproved sources (borehole, river/stream) have higher percentage of illness (80-90%) while improved sources (tap, bottled) have lower rates (<60%).

Table 2: Household Drinking Water Access Characteristics

Water Characteristic	Category	Frequency (n)	Percentage (%)
Primary Source	Improved	87	58.0%
	Unimproved	63	42.0%
Water Treatment	Treated	96	64.0%
	Untreated	54	36.0%
Daily Access	≥12 hours	81	54.0%
	<12 hours	69	46.0%
Quality Issues	Reported	102	68.0%
	Not Reported	48	32.0%

The profile of access to water is depicted in Table 2. Of these households, 58% used improved sources (tap or bottled water) while 42% depended on unimproved sources such as boreholes or rivers. Sixty four percent of the households treated their water, while 36% drank untreated water. Almost half (46%) of them had water access for less than 12 hours a day, while 68% faced problems related to quality of the water (taste, smell or color).

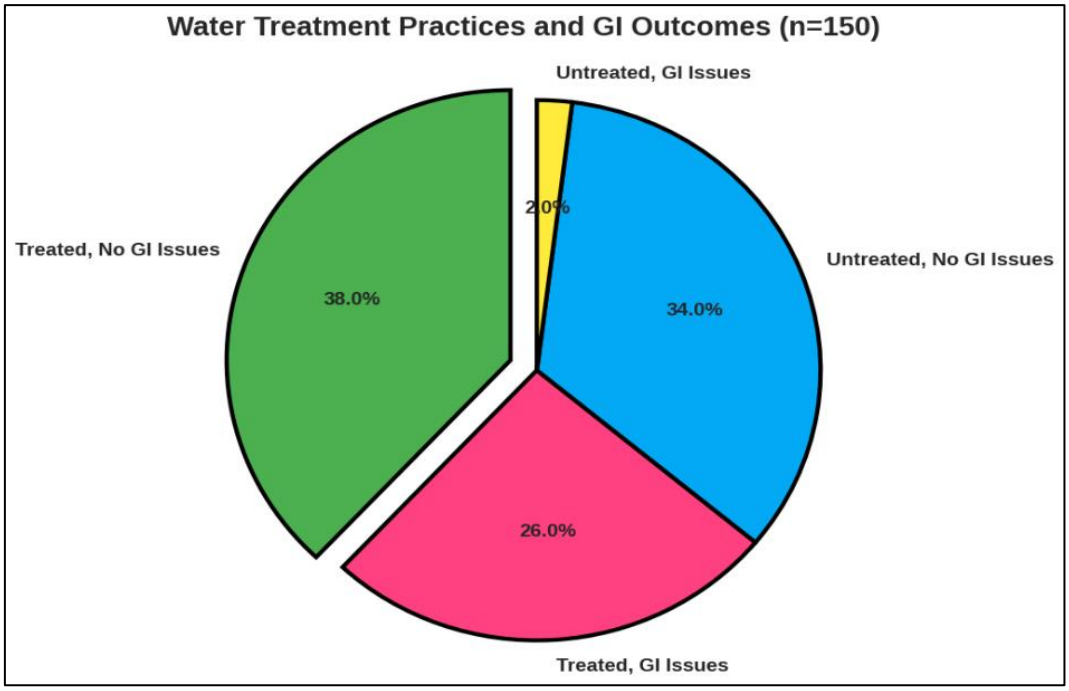

Figure 2: Water Treatment Practices vs. GI Illness Outcomes

Figure 2: The contribution to reduction of GI illness by water treatment only 2% from untreated households did not have any GI illness while still, 34% among those with untreated water still reported having some form of a GI related problem. Treatment lowers but does not remove the risk.

Table 3: Prevalence of Gastrointestinal Morbidity (Past 6 Months)

Gastrointestinal Health Indicator	Frequency (n)	Percentage (%)
Households with GI Issues	108	72.0%
- Diarrhea	87	80.6% of affected
- Abdominal Pain	75	69.4% of affected
- Vomiting	48	44.4% of affected
Healthcare Utilization		
- Sought Medical Treatment	63	58.3% of affected
- Multiple Visits	39	36.1% of affected
Perceived Link to Water		
- Yes, water causes GI problems	117	78.0% of total

The proportion of GI morbidities was considerable (Table 3). A total of 72.0% households reported a GI symptom during these last six months; diarrhea was the most Precent (80.6%) followed by abdominal pain (69.4%). A majority (58.3%) sought medical care, and 36% experienced multiple visits. Seventy-eight percent also thought that were so GI health was concerned, their water was the culprit.

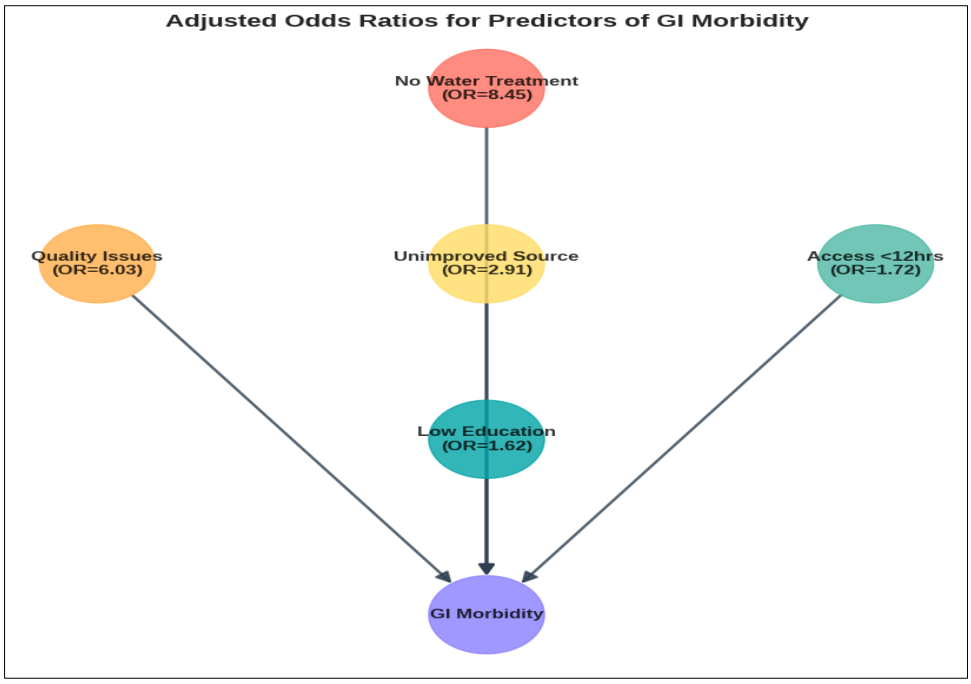

Figure 3: Adjusted Odds Ratios for Predictors of GI Morbidity

Figure 3: Independent predictors from multivariable analyses lack of treatment is the strongest driver (aOR = 8.45) followed by a history of water quality issues (aOR = 6.03), unimproved sources (aOR = 2.91), limited access to multiple sources (aOR = 1.72) and low education (aOR = 1.62).

Table 4: Association Between Water Access Characteristics and GI Morbidity

Water Characteristic	Category	HH with GI Morbidity (n=108)	HH without GI Morbidity (n=42)	Prevalence Ratio (PR)	p-value*
Water Source	Improved	51 (58.6%)	36 (41.4%)	1.0 (Ref)	<0.001
	Unimproved	57 (90.5%)	6 (9.5%)	1.54 (1.27-1.88)	
Water Treatment	Yes	57 (59.4%)	39 (40.6%)	1.0 (Ref)	<0.001
	No	51 (94.4%)	3 (5.6%)	1.59 (1.36-1.86)	
Access Duration	≥12 hours	54 (66.7%)	27 (33.3%)	1.0 (Ref)	0.035
	<12 hours	54 (78.3%)	15 (21.7%)	1.17 (1.01-1.37)	
Quality Perception	No Issues	21 (43.8%)	27 (56.2%)	1.0 (Ref)	<0.001
	Issues	87 (85.3%)	15 (14.7%)	1.95 (1.48-2.57)	

Bivariate associations between access to water and GI morbidity are presented in Table 4. The prevalence of GI illness was 1.54 times higher in households using unimproved water (90.5% vs. 58.6%, p<0.001). Prevalence of GI illness was 94.4% in the non-treated households versus 59.4% (PR=1.59, P<0.001) in the treated households. Water access (<12 hours/day) and water quality issues were also associated with increased GI morbidity (p = 0.035 and p <0.001, respectively).

Independent Risk Factors

Table 5: Multivariable Logistic Regression: Predictors of GI Morbidity

Predictor Variable	Adjusted Odds Ratio (aOR)	95% Confidence Interval	p-value
Unimproved Water Source	2.91	1.45 - 5.86	0.003
No Water Treatment	8.45	2.68 - 26.68	<0.001
Access <12 hours/day	1.72	1.02 - 2.90	0.043
Reported Quality Issues	6.03	2.85 - 12.76	<0.001
Education (≤Primary)	1.62	1.08 - 2.42	0.020

In multivariable logistic regression (Table 5) drinking untreated water was the most powerful independent risk factor for GI illness (aOR=8.45, 95% CI: 2.68-26.68). Drinking from unimproved water source was associated with more than three-fold increased odds (aOR=2.91, 95% CI: 1.45-5.86). Issues regarding perceived water quality (aOR=6.03) and restricted daily access (aOR=1.72) were also significant.

Through school (≤primary) was associated with 62% higher likelihood of GI morbidity.

Table 6: Water-Related Challenges Among Households with GI Morbidity (n=108)

Reported Challenge	Frequency	Percentage
Interruption in Supply	87	80.6%
Contaminated/Dirty Water	75	69.4%
Insufficient Quantity	66	61.1%
High Cost	39	36.1%
Distance to Collect (>100m)	24	22.2%

Water-related problems associated with the GI illness were water cuts (80.6%), suspected contamination of household drinking water (69.4%) and inadequate quantity of water for any activity (61.1%) from among 108 GI-households(table-6). These concerns emphasize wider water insecurity that impacts on poor gastrointestinal health in households.

DISCUSSION

The present hospital-based observational study provides compelling evidence of a significant association between inadequate household drinking water access and gastrointestinal morbidity within the study population. The results demonstrate an unacceptably high burden of GI illness (72% household level) over a 6-month period, highlighting the ongoing issue of water-borne disease in similar low resource settings [10]. This prevalence is in accordance with (though seemingly higher than) those reported in community-based surveys from Westernized settings and might be consistent with a selection bias related to the hospital setting, which may select for a more health-affected population [11]. The large, positive associations found, in particular with no HHWT, drinking untreated source water and few access hours provide important directions for public health targeting. Findings The most important discovery of this analysis is the strong protective effect of household water treatment. The adjusted OR of untreated water (8.45) allows this to be classified as the single most powerful modifiable risk factor for GI morbidity. This is well-supported by the extensive body of evidence from around the world that shows point-of-use interventions like boiling, chlorination, filtration are all very effective at reducing incidence of diarrheal disease [6,12]. Our data adds depth to this understanding in that although treatment is important, it is not determinative; of households treating their water, 38 % still experienced GI symptoms. This may indicate that treatment practices are not always adhered to, recontamination post-treatment is taking place during storage, or other modes of transmission such as poor food hygiene and environmental contamination account for a significant part of the total disease burden [13]. The fact that relatively few (2%) of households drank untreated water but did not experience a GI illness suggests the almost complete risk associated with drinking untreated water in this setting. The research also confirms the necessity of high quality water source. After adjusting for treatment practices, households reliant on unimproved sources (boreholes and rivers) were almost three times as likely to report a GI illness than those using improved sources. This is in line with the widely reported contamination hazards of raw ground and surface fresh water sources by faucal pathogens [14]. It underscores the fact that whereas household treatment is the redoubt of last defense, upstream investments in water supply infrastructure to ensure access to piped or otherwise safe water constitute a core public health concern [15]. Of note is the striking association between perceived problems with water quality and GI morbidity (aOR=6.03). Therefore, perceived unsafe water quality may be based on true contamination, lead to protection behaviour or simply promote understanding of risk: A relationship that deserves more indirect qualitative investigation [16]. The magnitude of lack of access to water, in particular getting less than 12 hours per day supply of water remained an independent risk factor (aOR=1.72). Intermittent supply is a well-established driver of water insecurity, as it may require households to store water for long durations, thus increasing the likelihood of recontamination [5]. It can additionally force dependence on a second source which may also be unsafe if only for the reason that an ordinary supply is unavailable. This result suggests that access reliability is as important as source quality, which can be an overlooked parameter in water access indicators [4]. The retained independence of low educational level as a predictor (aOR=1.62) despite adjusting for water variables suggests that the aspects associated with human health vulnerability have multiple dimensions. Education may be an indicator for social economic status, health literacy and the capacity to understand and maintain hygiene practices to prevent infection [17]. This highlights the importance of holistic, multi-sectoral interventions that would combine water sanitation and hygiene (WASH) with overall education and poverty alleviation. Our results concerning the high rate of problem water reports for example, suspensions/ interruptions, perceived contamination and inadequate amount, create a distinct profile of chronic water insecurities. This corresponds to household experiences of “water distress” in other low-resource settings, in which adaptive strategies used to cope with intermittent supplies can lead to health risks [18]. In conclusion, addressing the challenges of waterborne illness in low-resources settings demands a comprehensive approach that includes investments in enhanced water

infrastructure, household-level best practices for treatment and education to diminish health risks associated with poor access to safe water.

Limitations of The Study

This study was based on participants' self-reports of GI symptoms during the previous 6 months, which may be subject to recall bias. Time intervals; however, are more difficult for the patient to remember, therefore questioning might be inexact resulting in unreliable data.

CONCLUSION

This study provides evidence for an important, independent association between modifiable components of household water insecurity on diarrheal morbidity among a clinic population. The empirical evidence shows the lack of residential point-of-use water treatment to be the leading modifiable risk factor, working within a syndemic of correlative vulnerabilities that are characterized by unimproved water sources, intermittent supply and lower SES based on education. This pattern suggests that GI health impacts are not just a matter of water-supply infrastructure but are modulated in the last mile by safety-related practices and the dependent daily reliability of access.

RECOMMENDATION

The data require a staged approach to intervention. First, public health interventions should focus on scaling up the adoption of efficacious and sustainable point-of-use water treatment primarily through targeted education, social marketing, and subsidized access to proven technologies (e.g., chlorine tablets, ceramic filters). Simultaneously, long-term infrastructure development should work to eliminate intermittent supply and retire unimproved sources in order governments that treatment is an essential and insufficient–fix for systemic water insecurity. Prospective research, including in longitudinal cohort designs with environmental sampling, is necessary to determine causality and understand the behavioral and socio-economic determinants of adherence to household water treatment use.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee.

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