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A Cost-Illness Analysis of Economic Burden of Unimproved Water Use on Households: Empirical Evidence from Dhaka Urban Riparian Areas

Md. Abdul Khaleque^{1*}

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ABSTRACT

The rapid urbanization and increasing industrial establishment near Dhaka's rivers are creating environmental pressure on nearby communities. And people due to several factors are forced to use unimproved water from the nearby waterbodies. This study looks at how using unsafe water affects the health, health expenditure and poverty of 1,826 families living near the Turag River in Dhaka. It uses two main ways of measuring the impact: one that looks at the cost of getting sick and another that considers what people miss out on when they are ill. Quantitative methods like descriptive statistics, Ordinary Least Squares (OLS), Tobit, Logit, and Propensity Score Matching (PSM) were used to find out how the use of unimproved water is connected to illness, treatment costs, and household poverty. About 28.36% of the households surveyed used water from different waterbodies like river, canal, or pond water, for washing, bathing, or cooking at some time during the year. People were more likely to use this kind of water during the dry season compared to the monsoon season. Households that used the unimproved water had more people who were sick, about 1.4 compared to 1.0 among the non-user households. They also had more cases of stomach, skin, and diarrhea illnesses. These households spent an average of Tk.321 more each month, which adds up to about Tk.3,852 every year, on medical treatments. The censored (Tobit) regression results showed that the ordinary least squares estimates missed the true size of these effects, and Propensity Score Matching supported the initial differences between groups after adjusting for observable household traits, suggesting that the connections found are not just because of differences in observable characteristics. Poverty and how it changes over time are closely linked to people using unimproved water. The households that are poor for a long time suffers more than others. The study shows that even though there has been more development of pipes and tube wells, many families living near rivers still pays a higher indirect cost for using unimproved water. These costs make poverty worse and slow down Bangladesh's progress towards its goals for health and reducing poverty.

INTRODUCTION

Water is an important environmental resource used as input in the production process. Plants and animals are dependent on water. People have to use water for various purposes in their daily lives. They collect water from various sources and they try to use the safe water for drinking, bathing, and cooking purposes. Due to the scarcity of fresh and safe water, sometimes they may have to use unsecured water from different unimproved water like lakes/ canals/ rivers/ ponds, etc. Some of the people have to use the polluted water to perform their economic activities like agricultural cultivation, fishing, boating, etc. The open water bodies near the industrial settlement and growing industrial units suffer from water pollution generated through waste disposal by industrial units, communities, and individuals. Because property rights are poorly defined and existing environmental regulations are poorly enforced, common resources like open water bodies often become polluted. The use of unimproved water is unsafe, and unreliable. The use of such water, therefore, affects the people through illness, capital loss, and increased out of pocket expenditure.

In an agricultural economy, a significant portion of people have to interact with water bodies. If the water bodies are polluted, such contact will affect both the health of the incumbents and the production of the commodities. With the increasing dominance of the manufacturing sector in the urban economy, industrial growth is becoming closely linked to environmental concerns. It is therefore appropriate to ask what the marginal external costs of interacting with polluted waters are. Answering this question requires measuring the economic burden of using unimproved water. Literature shows that the use of unimproved water increases the risk of waterborne diseases. Health risks eventually translate into productivity risks. Poor health not only affects choices between work and leisure but also has an impact on individuals' income and well-being, and thus on poverty. However, the degree of the impact depends on the economic loss or economic cost of the disease, its dynamics, and coping mechanisms. Access to a safe, reliable, and affordable water supply is critical for good health (Hunter et.al., 2010).

According to World Bank (2018) estimates, Bangladesh experienced a high level of environmental pollution

¹ Associate Professor, Department of Development Studies, University of Dhaka, Bangladesh

* Corresponding author's e-mail: khaleque@du.ac.bd

causing the death of 8.43 million people. This was the highest of any South Asian country, with an average of 26.7 percent, compared to the global average of 16 percent. The economic impact of these deaths and disabilities was estimated to be \$1.4 billion for all urban areas in Bangladesh and \$310 million for Dhaka city, representing a loss of economic activity of 0.6-0.1% of GDP. Furthermore, the rapid growth of the readymade garments industry and the increase in the urban population from 40 million in 2006 to 55 million in 2015 exposed to environmental hazards, resulting in an estimated \$6.52 billion economic loss in 2015, 0.4-0.6% of GDP, and a productivity loss of around USD 90 million per year for RMG workers due to illness, as well as the associated treatment and time costs.

Bangladesh aims to eradicate extreme poverty and ensure good health and well-being by 2030, as stated in the Sustainable Development Goals. Poor health may create income constraints or intensify the economic hardship through low productivity, the low income earning, and high economic burden due to waterborne diseases. Good health and stable wealth are the source of happiness and good capital of earning. Therefore, it is very much pertinent to assess the cost of the use of unimproved water on, health, health expenditure, income, and the overall well-being of the household. This paper aims to study the relationships between (i) the use of unimproved water and illness/diseases; and (ii) the use of unimproved water, illness and out-of-pocket expenditure; and to examine the overall effect of the use unimproved water on poverty.

Theoretical discussion

A wide number of economic theories help us to understand the relationship between the unimproved water use and the household economic cost. Some theories and framework explain such relationships. The first one is household decision-making theories, second is health and epidemiological framework, poverty and capability framework, and institutional theory. The household decision-making theories describe the role of household as a producer, labor management entity, and exposed to unimproved water entity. In the Becker's theory of household production, household is presented as the economic agent which combines the factors of production like labor, physical capital, financial capital, and natural capital to produce commodities or services like health, cleanliness, and nutrition. The time allocation theory helps us to know how the household allocate finite time across various works, leisure, and water collection. The long distance from the main source of water represents a higher opportunity cost measured in foregone wages, schooling, or child-rearing time. As a rational response to health risk, the household may apply averting behavior while facing unreliable water and therefore may incur 'averting costs' like boiling costs, buying bottled water or filters, spending for water

treatment. The cost-of-illness framework decomposes the economic burden of water-related illness into direct costs like medical treatment, transport costs, and indirect costs like lost productivity, the foregone wages, and absenteeism. This framework help quantify the economic cost of the use of unimproved water. The exposure-pathway model explains how unimproved water sources become vectors for fecal-oral disease transmission which is the causal mechanism generating the downstream economic costs covering medical expenses, mortality risk, and productivity loss. The disease burden framework (DALYs) converts health outcomes attributable to unsafe water into Disability-Adjusted Life Years which can be monetized. The protection motivation theory explains household behavior of treating water or seeking alternatives based on the susceptibility to illness and perceived severity.

The vicious cycle of poverty or poverty trap theory suggests that unimproved water access and poverty reinforce each other: poor households cannot afford improved water infrastructure, incur high illness and time costs from unimproved sources, which further limits income and asset accumulation – a self-perpetuating trap. The Sen's Capability Approach frames water access not just as a commodity as a determinant of a person's capability to achieve valued function like health, education, and work. Therefore, the economic costs are understood as capability deprivation, not just monetary loss. The human capital theory links water-related illness and time loss to reduced human capital accumulation – school absenteeism among children, reduced cognitive development from chronic illness/malnutrition, and reduced worker productivity. This theory connects the short-term costs to long-term economic outcomes. Since water is often considered as a quasi-public good, the market failure theory suggests that the lack of access to improved water reflects a market failure to provide adequate infrastructure, which shifts costs into households as private, informal coping expenditures.

LITERATURE REVIEW

Water is behind most natural hazards. As per the UN's 2012 World Water Development Report, about 90% of them is related to water. These hazards bring illness and water-borne disease. People's wellbeing is closely related to the environment, and the level of pollution damaging health. The higher medical and non-medical costs, lost income or productivity, and reduced leisure time constitutes of direct and indirect costs of using unimproved water. These effects show up both in individual measures (how often people fall ill, what treatment costs them) and in broader outcomes (prolonged poverty, diminished quality of life). The use unimproved water has a deleterious effect on human health and welfare. In developing countries, about 80% of illnesses were attributed to unsafe drinking water and waterborne diseases (Abedin et.al., 2019).

Table 1: Summary of Previous Studies on the Economic and Health Impacts of Water and Sanitation

Author	Objective and Methodology	Key findings
Hubbard et.al. (2020)	- Quantify the impact of diarrheal and respiratory diseases at the household level - a cross-sectional household survey covering 12,500 households. - Multivariate logistic regression	- Illness of member(s) of the household in the 7 days before the interview is 1.07 times higher among households who are using unimproved drinking water compared to their counterpart. - Illness propensity is 1.22 times higher among households that have no improved sanitation and it is 1.18 times higher among households that have to use shared toilets.
Fink et.al. (2011)	- Examine the relationship between child health and access to water and sanitation - General logistic model	- The use of improved water and sanitation reduces diarrhea and stunting among u5 children compared to their counterfactual group. - diarrhea and stunting among u5 children are low whose mothers have an over secondary level of education.
Ali et.al. 2021	- Measure the economic impacts and risk of illness of using unsafe water sources - Primary data set consisted of 210 peri-urban and urban households - Use regression model	A peri-urban/urban household study in Pakistan applying the cost-of-illness method alongside irrigation-efficiency techniques found average illness costs of \$10.79 in peri-urban areas, with social status, income, and family size positively associated with cost of illness, while education and awareness were negatively associated with it
Das et.al. 2025	- Examine the economic cost of contaminated water to households focusing on waterborne diseases - Use bivariate Probit model	Households relying on piped water actually reported more illness than those using non-piped sources, with an average household cost of about \$0.57
Lal 2014	Estimate the economic costs of the current inadequate water supply and sanitation in South Tarawa using cost savings and avoidance (CSA) method	Regional-scale COI work in Kiribati estimated the total annual economic burden of poor water and sanitation on South Tarawa at roughly A\$3.7–7.3 million, equivalent to A\$553–1,083 per household or 2–4% of national GDP
Akaelu et.al. 2026	Assess the hidden health-economic costs of the failure of water and energy infrastructure.	In the U.S. context, national-scale COI estimates put annual healthcare costs from waterborne disease above US\$3.3 billion, illustrating that the framework scales from micro (household) to macro (national) applications
Zozmann et.al. 2022	- A diary-based study in Pune, India - Assess the implications of water procurement time for household water demand	The author assigned monetary values to water-procurement time based on wage rates and tested whether time costs reduced consumed water quantities, finding effects were more pronounced for households with higher opportunity costs of time — a clean micro-level test of the opportunity-cost mechanism
Sukharomana 1998	- Estimate the benefits of water quality improvement - Use methods: contingent valuation (CV) and averting expenditures (AE) methods	Study showed that an average household averting expenditures of \$6.00–8.20/month for nitrate and broader contamination reduction, notably lower than the \$9.50–9.72/month willingness-to-pay estimated via contingent valuation.

WHO (2017) stated that people living near rivers tend to suffer more from skin and waterborne diseases. The use of unsafe water is the leading global causes of death – diarrhoea alone kills roughly 8.42 million people worldwide. Communities settled along rivers and khals are especially vulnerable, facing chronic illness, high medical costs, reduced productivity, and persistent poverty. Pandey (2006) noted that about 2.6 billion people - 40% of the world's population – lack basic sanitation, and over a billion still rely on unsafe drinking water, contributing to child deaths from diarrhoea and other water-related diseases and leaving many others weakened

by illness. Cheung *et al.* (1990) found that swimmers at Hong Kong beaches reported significantly higher rates of gastrointestinal, ear, eye, skin, respiratory, and fever-related symptoms than non-swimmers. Rodríguez-Tapia et.al. (2017) linked river pollution directly to disease, since contaminated water affects health through drinking, food, washing, and bathing. In Hazaribagh, formerly a tannery hub in Bangladesh, pollution-related health costs constitute of about 21.5% of annual income, with high rates of jaundice, skin disease, and diarrhoea; men and infants are hit hardest, and land productivity losses reach around 40%.

Halder and Islam (2015) found that skin diseases, diarrhoea, gastric ulcers, fever, and dysentery are widespread among people living in riparian areas. Illness among non-earning family members can also drag down the productivity of those who do earn (Angrist and Evans, 1996; Corman *et al.*, 2003), and Mitchell and Bates (2011) showed that employers bear substantial costs from this health-related loss of productivity. This connects to what several scholars call the “health-poverty trap”: Sala-i-Martin (2005) argued that poverty causes poor health, which in turn deepens poverty – a cycle that can’t be resolved by tackling either side alone. Kawuwa *et al.* (2026) found that poverty affects healthcare utilization. Khullar and Chokshi (2018) likewise described poor health as driving a self-reinforcing loop of poverty. Yang and Liu (2018) extended this to an environment-health-poverty trap, showing empirically that pollution worsens both income and health inequality. Bonds *et al.* (2010) tied

the trap to the ecology of infectious disease, suggesting it can be broken by improving health outcomes. Banerjee and Duflo (2012), in *Poor Economics*, also revisit this health-poverty trap repeatedly.

Framework

The economic cost of using unimproved water measured through health risks, financial risks, and social risks is complicated to model. In the first step, we modeled the association between the use of non-improved water and health risks (in terms of illness and diseases of the household members). The illness variable is based on the number of ill household members within one month during the survey period. The number of diseases facing the household members is constructed in a similar manner. Both the number of ill people and the number of diseases faced by the household members are mostly zero-inflated variables.

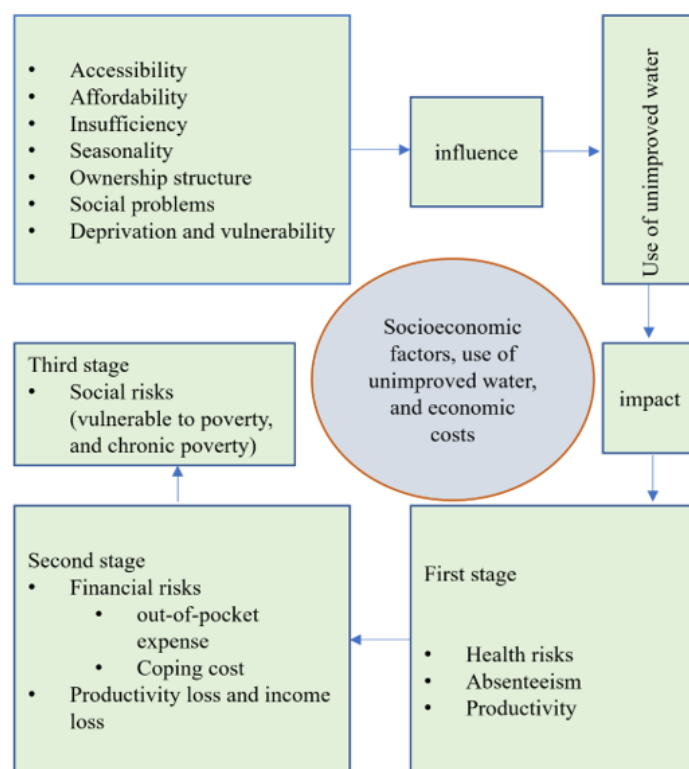


Figure 1: Conceptual framework of the study

In the second stage, the health risks are translated into financial risks, out-of-pocket expenditure and coping costs. In the third stage, the households seem susceptible to social risks (vulnerability to poverty).

MATERIALS AND METHODS

Study Areas, Sampling and Samples

The study focused on areas physically or economically connected to nearby rivers, lakes, or khals. Households were the sampling unit; collectively, the households in the Turag riparian areas form the study population. A

systematic random sampling approach was used, with sample size was determined based on the nature of the samples, their degree of homogeneity, and the intended level of analysis. Samples were drawn from three zones: the upstream area, marked by growing industrial activity; the midstream area, with scattered households in low-lying land; and the downstream area. Overall, the survey spans roughly 49 kilometers by road.

The following formula, most commonly used in cluster-sampled surveys, has been used to determine the sample size.

$$n = \frac{Z * r * (1 - r) * deff}{(RME * r)^2 * pb * AvgSize * RR}$$

where n = sample size, Z = Z statistic for a level of confidence, r = expected prevalence or proportion, $r(1-r)$ is the variance of a binomial proportion. It's maximized when $r = 0.5$, meaning the more uncertainty requires the larger sample. The term $deff$ is the design effect. It inflates the sample size to account for cluster sampling. Because people within the same cluster (village, neighborhood) tend to be more similar to each other than to people in other clusters, a clustered sample yields less statistical information per unit than a true simple random sample. $deff > 1$ (commonly 1.5–2) compensates for this loss of precision. In the expression $(RME \times r)^2$, RME is the relative margin of error. The term pb represent the proportion of the target subgroup within the general population. $AvgSize$ is the average household size. Combined with pb , this converts the required number of eligible individuals into the required number of households. RR (response/participation rate) is the anticipated response rate. Dividing by RR inflates the sample to compensate for expected non-response, refusals, or absent households, ensuring the achieved sample still meets the target after dropouts.

The sample size was calculated assuming that around 50% of households near the open waterbodies used open water, with a design effect of 1.5 and a relative margin of error of about 1% at 95% confidence. The target sample was estimated at roughly 8% of the total population, with an average household size of 4.2. Based on these parameters – along with drinking water sources and the proportion of riverside households – the target sample size was set at 1,826 households. The data was collected from the respondents who gave consent for the interview and the study followed the ethical guidelines of the Central University Research Ethics Committee (CUREC) of the University of Oxford.

Specification of regression models

Households using unimproved water may be affected by various kinds of health risks like illness of the members, higher treatment expenditure to reduce the risks, and so on. For performing the cross-sectional causal relationship among a set of explanatory variables with the explained variable, we used several specifications of the regression models. The causal relationship is being modeled using the following regression models:

$$\begin{aligned} illmem_i &= \alpha_0 + \alpha_1 OSW_i + \beta_k HHC_{ki} + u_i & (1) \\ numdiseases_i &= \lambda_0 + \lambda_1 OSW_i + \theta_k HHC_{ki} + v_i & (2) \\ \log(treatcost)_i &= \gamma_0 + \gamma_1 OSW_i + \gamma_2 illmem_i + \phi_k HHC_{ki} + \epsilon_i & (3) \end{aligned}$$

To examine how the number of ill household members relates to household characteristics, and how treatment costs relate to the use of unimproved water along with other household characteristics, ordinary least squares was used. To handle the censored outcome, the censored regression analysis was also used. The model treated the use of unimproved water as the key explanatory variable,

alongside a range of other household- and regional characteristics. The coefficient on this variable captures the mean difference in outcomes between the users or non-users of unimproved water.

The Propensity Score Matching (PSM) Model

The study used propensity score matching (PSM) to compare average socioeconomic indicators — such as expenditure, number of ill members, number of diseases, and poverty levels — between households using unimproved water and households not using. Since the study followed a non-experimental design, PSM was applied to balance the distribution of characteristics between the participating (treatment) and control households, which helped correct for expected exposure bias. Households were matched based on known shared characteristics, ensuring the comparison groups were as similar as possible aside from their water source. This balancing and matching made it possible to estimate differences in mean outcomes between the groups and test whether those differences were statistically significant.

RESULTS AND DISCUSSIONS

The description of the socioeconomic characteristics of the surveyed households shows that 6.52 percent households have brick/cement-based roof and nearly 93% of the dwellings have tin/iron-roof. Nearly, tin/iron is the major wall material of 58% of the dwelling and 37.35% has brick/cement wall, and few walls are made of earth/mud (3.4%). The key floor materials are brick (60.19%) and earth/mud (35.49%). Grid supply of electricity is the key source of lighting power and few use kerosene while as cooking fuel, most of houses use wood/fuel sticks as cooking fuel (75.6%) and around 44.4 percent households have gas connection. Households use multiple sources of fuel for lighting and cooking. Nearly three-fourth (75%) of the households collect drinking water from tube-wells – mostly from motorized tube-well (73.82%) and a few (2.03%) from deep tube-wells. About 70% of the households can collect their drinking water within five minutes and around 83 percent households (cumulative) can collect it within 10 minutes. Adult women are the main collector of water (97.1%) and adult men of about 30% households also collect water from main source. Of only 2.4% households, men are the only collector of water whereas women are the only collector of water of 68.7% of the households. Both men and women are the collector of water of 29% households. For making the water payment, around 40.14% pay mostly at the place where water is fetched from or delivered to, around 58% at the utility office like WASA office or bank, and one-fourth to tariff collector. One-third pay with their house rent. Almost all of them (99%) of the households make their payment on monthly basis. The average monthly water cost is around BDT 195, and the median is BDT 100.

The average water expenditure is around 1.24 percent of total monthly household expenditure whereas the median

water expenditure is around 1 percent of the median total monthly household expenditure.

Although only 2.35 percent households use river/ lake/ canal/ pond/ khal water for drinking purpose, the percentage of households who uses water from those sources for any purpose is not mere. We find that around 28 percent households are exposed to this kind of unimproved water for various purposes within a year: during monsoon and dry seasons. Households do contact with unimproved water and the exposure rate varies by seasonality. The survey shows that during monsoon 11.61 percent households washed their clothes and dishes using unimproved of water and 13.31 percent households has members who take their bath in river/

lake/pond. On the other hand, during dry season, the incidence of exposing to unimproved water for washing clothes and dishes increases to 23.82 percent and the propensity to take bath in unimproved water increases to 27.05 percent: almost double compared to the monsoon season. The study lucidly reveals that households do contact with unimproved water mostly due to washing clothes, taking bath, and cleaning cooking utensils. The differential housing characteristics of the households implies that the surveyed households live mostly in poor houses compared to a random urban household. They also collect water from unimproved source of water. The differences, therefore, imply that the current sample households are socially marginalized.

Table 2: Characteristics of the samples

Variable	Description	The user of Unimproved Water		Percent/ Value
		No (N=1308)	Yes (N=518)	
Years of residence	Less than 1 year	9.94	3.67	8.16
	1-4 years	15.90	11.39	14.62
	5-10 years	13.69	11.20	12.98
	More than 10 years	60.47	73.75	64.24
Wall materials	Brick/cement	41.97	25.68	37.35
	Tin/iron	52.75	70.66	57.83
Roof materials	Brick/cement	7.49	4.05	6.52
	Tin/iron	92.05	93.44	92.44
Floor materials	Brick/cement	67.58	41.51	60.19
	Earth/mud	29.36	50.97	35.49
	Wood/bamboo	2.14	7.14	3.56
Lighting fuel**	Grid supply electricity	97.09	84.94	93.65
	Kerosene	2.91	5.21	3.56
Cooking fuel**	Natural gas	52.37	24.32	44.41
	Wood/fuel sticks	69.88	90.15	75.63
	Straw/shrubs/grass	33.26	38.61	34.78
	Animal dung	5.89	4.63	5.53
Major concerns	Dirty river water	67.58	86.68	73.00
	Rubbish	42.43	34.75	40.25
	Water logging	13.69	17.37	14.73
	Sanitation	12.31	31.47	17.74
Drinking Water source	Piped at dwelling/yard/public tap	21.71	27.03	23.22
	Motorized tube-well	77.98	71.62	76.18
	River/canal/Lake/pond	0.08	8.11	2.35
Use of unimproved water for	Cooking	0.00	7.72	2.19
	Washing (clothes & utensils)	0.00	85.33	24.21
	Bathing	0.00	96.91	27.49
Can collect water within 5 minutes		75.46	55.60	69.82
Average monthly cost of water (BDT)		299	290	296
Median monthly cost of water (BDT)		100	150	120
Average monthly expenditure (BDT)		18449	16031	17763

Source: Authors' estimation based on Household Survey Data (2018)

The key concern is that around 2.35 percent household still now dependent on river/canal/lake/pond water for drinking purpose mostly during crisis of fresh water. Few households collect drinking water from other sources like vended water. Around 58 percent respondents reported dirty river water as the key environmental issues in the survey areas. The scarcity of fresh water increases during dry season, mostly due to the interruption of electricity. The water scarcity forces them to use unimproved water. Other factors can also play the important role like poverty and vulnerability of the households. The use of unimproved water is high among extreme poor and female led households compared to non-extreme poor and male-led households. The exposure to unimproved water is high among the chronically struggling households.

Although only 2.47% of households use unimproved water for drinking purposes, the percentage of households who use water from those sources for any purpose is not mere. We find that around 28 percent of households use the unimproved water in a year. Households exposed to unimproved water and the exposure rate varies by seasonality. The survey shows that during monsoon 11.61% of households washed their clothes and dishes using unimproved water and 13.31% of households have members who take their baths in unimproved water. On the other hand, during dry season, the incidence of exposure to unimproved water for washing clothes and dishes increases to 23.82% and the propensity to take a bath in unimproved water increases to 27.05%: almost double compared to the monsoon season (Table 3).

Table 3: Distribution of the use of unimproved water by seasonality

Season	Purpose	Percent
Dry	Cooking water	2.14
	Washing (clothes & utensils)	23.82
	Bathing	27.05
Monsoon	Cooking water	0.99
	Washing (clothes & utensils)	11.61
	Bathing	13.31
Exposure to unimproved water in any season		28.36
User of unimproved water for drinking purposes		2.47

Source: Authors' estimation based on Household Survey Data (2018)

Table 4: Water cost, payment place, and payment mode

	Value
Average monthly cost of water (BDT)	195
Median monthly cost of water (BDT)	120
Place of water payment	
At the service delivery point (%)	40.14
Bank Branch/WASA Office (%)	58
Tariff Collector (%)	25.5
Average monthly expenditure (BDT)	15702

Source: Authors' estimation based on Household Survey Data (2018)

The attributes include the poverty status of the households under both lower and upper poverty lines, poverty dynamics, sex of household head, education of household head, water accessibility, and affordability. Under the upper poverty line, 27.4% of non-poor households have exposure to unimproved water and 32.4% of poor households have such exposure. On the other hand, under the lower poverty line, the incidence of exposure to unimproved water is about 27.8% among the non-poor and 37.1% among the poor. Although there is a propensity to be exposed to unimproved water among both poor and non-poor households, the incidence of exposure to unimproved water is found high among the poor, particularly, among extremely poor households. The differences in the incidence of exposure to unimproved

water due to the status of household poverty under both upper and lower poverty lines are found statistically significant at a 1% level of significance (Table 5).

The incidence of exposure to unimproved water is high among struggling households (36.6%) compared to movers (18.5%) and better-off groups (30.3%). However, it is the highest – about 39.6% - among the households who have been living below the poverty for a long time. We observe a visible difference in the incidence of exposure to unimproved water by the dynamic states of poverty. Compared to always better-off groups, the incidence of exposure to unimproved water is about 9.33% higher among the chronically poor or long-term struggling households and this difference is found statistically significant as the value of the test

statistics lies in the rejection regions. We find a similar significant difference in the incidence of exposure to unimproved water between households whose conditions

have improved compared to their previous condition and households who are always better off (Table 5).

Table 5: The use of unimproved water by socioeconomic characteristics

Characteristics	Percent	SE/SD	Difference	t-stat/ z-value
Gender				
Female	29.75	3.65	1.51	0.40
Male	28.24	1.10		
Education				
Illiterate	34.08	47.43	26.14	3.79
I-V	30.08	45.92	22.14	3.36
VI-VIII	24.34	43.01	16.40	2.68
IX-X	21.1	40.89	13.16	2.30
XI-XII	13.98	34.86	6.04	1.14
Higher education	7.94	27.25	Base	
Poverty Status				
Non-poor (under UPL)	27.40	1.16	5.24	1.93
Poor (under UPL)	32.64	2.56		
Non-poor (under LPL)	27.83	1.08	9.31	2.06
Poor (under LPL)	37.14	4.74		
Poverty dynamics				
Strugglers	36.60	48.99	9.33	2.67
Movers	18.49	38.85	11.78	5.15
Fallers	39.55	49.01	9.28	2.37
Always better off	30.27	45.98	Base	
Accessibility of water (Minutes)				
<= 5	22.59	41.83	Base	
5-10	31.66	56.58	9.07	3.43
10-15	56.74	49.72	34.15	8.23
15-30	60.66	49.26	38.07	6.15
>=30	54.55	52.22	31.96	2.32
Affordability				
Unconstrained	26.38	1.12	12.85	4.43
Constrained	39.22	2.91		

Source: Authors' estimation based on Household Survey Data (2018)

The incidence of using unimproved water by the characteristics of the household head is presented in Table 5. The results show that there are no significant differences in the incidence of using unimproved water by the sex of the household head. However, the using pattern varies by the level of education of the household head – compared to members of households led by highly educated persons, there is a high incidence of such interactions.

People using the unsafe water for various purposes may face harmful health shocks and could end up with higher chances of getting sick. We found that 44.3% of households where the members did not use unimproved water sources had no sick people in them, while 27.2% of households where the members using unimproved

water had no sick people. So, 72.8% of the households that used unimproved water had people who were sick. The results also showed that among the households not using unimproved water, 28.6% had one sick person, 17.1% had two sick people, and 9.9% had more than two sick members. For the user households, 33.59% had one sick person, 23.17% had two sick people, and 16.02% had more than two sick members. On average, families that used unimproved water had more sick people in their homes, with about 1.35 people getting ill each household, compared to 0.97 people per household in families that didn't use unimproved water. Many families who used unsafe water got sick a lot, and the difference in sickness rates was 0.38, which is a big difference and significant at the 1% level (Table 6).

Table 6: Number of ill members in the households due to the use of unimproved water

Description	The user of unimproved water		Weighted average
	No (1308)	Yes (518)	N=1826
Number of ill members			
0	44.3	27.2	39.4
1	28.8	33.6	30.1
2	17.1	23.2	18.8
>2	9.9	16.0	11.6
Average	1.0	1.4	1.1
Types of disease			
Dysentery/diarrhea	7.8	16.2	10.2
Cholera	0.8	0.6	0.7
Typhoid	5.7	7.3	6.1
Jaundice	7.5	12.4	8.9
Skin diseases	8.2	18.3	11.1
Gastric/ulcers	25.1	35.9	28.2
Mosquito-borne	6.8	10.4	7.8
Respiratory disease	4.1	7.7	5.2
Other	24.4	27.2	25.2
Out-of-pocket expenditure			
Average (BDT)	582	261	491

Source: Authors' estimation based on Household Survey Data (2018)

The average number of ill people among users and non-users of unimproved water were 1.54 and 1.13 in the upstream area. In the middle stream, the averages were 0.81 and 0.68 respectively. In the downstream area, the averages were 1.75 and 1.66 respectively. In the upstream and downstream areas, the average number of sick people among both those who use and those who don't use unimproved water is higher than in the middle stream. It was found that in all areas, more people who were sick among the household using unimproved water compared to those who weren't using such water. The average differences were 0.41, 0.13, and 0.09 in the upstream, middle stream, and downstream areas respectively, and these differences were significant in the upstream area but not in the other areas. The disease was common in the people living in the households studied in those areas. The data showed that in households where people used unimproved water, many had health issues like diarrhea (16.2%), typhoid (7.3%), jaundice (12.4%), skin diseases (18.3%), gastric ulcers (35.9%), mosquito-borne illnesses (10.4%), and respiratory diseases (7.7%).

Many people who didn't use unimproved water also got sick often. Among those groups, the most common diseases were diarrhea affecting 7.8%, typhoid at 5.7%, jaundice at 7.5%, skin diseases at 8.2%, gastric or ulcer problems at 6.8%, mosquito-borne illnesses at 6.8%, and respiratory diseases at 4.1%. The findings showed that stomach ulcers were the most common illness among both men and women in the households. Skin disease and diarrhea were the second and third most common

diseases, after excluding other categories, among the members of the households. When comparing the occurrence of diseases between users and non-users of unimproved water, it was found that the user people had a higher rate of different diseases, with the exception of cholera (Table 6).

The use of unsafe water led to health problems, causing more sickness and illnesses within the family. These effects could make it harder for families to pay for healthcare costs because they may need to spend money on treatment and buying medicine and medical services to get better from illnesses and diseases. On average, households that used unimproved water spent about BDT 582 each month on health expenses. In contrast, households not using unimproved water spent an average of BDT 261 per month on health costs. Households that used unimproved water spent BDT 321 extra on treatment costs compared to a similar group of households. Every year, they had to spend an extra BDT 3852 to ensure the health of all the people in their household (Table 6).

The pairwise correlation analysis has been done to understand the potential relationship of the use of unimproved water with some socioeconomic variables like characteristics of household head (age, education, sex, occupation, etc.), water source related variables like (ownership of main water source, required time to collect water from main source, etc.), and social problem faced during water collection. The results are presented in Table 7.

Table 7: The pairwise correlation coefficients between the use of unimproved water and various socioeconomic covariates

Variables	Pairwise Correlation Coefficient
5-10 minutes	0.03
10-15 minutes	0.1821*
15-30 minutes	0.1332*
Above 30 minutes	0.05
Water cost above 120	0.1031*
Own water point	-0.1264*
Shared water point	0.03
Faced social problem during water collection	0.2392*
Gender of household head (female=0)	-0.01
Age of household head	-0.01
Education of household head	-0.1588*
Agri. Worker	0.04
Boatman/fisherman	0.0818*
Farmer/landlord	0.0474*
Downstream	0.1479*
Upstream	0.1031*

Source: Authors' estimation based on Household Survey Data (2018)

Note: The asterisk (*) implies that the pairwise correlation coefficient is statistically significant at 5% level of significance.

To see how the use of unimproved water was connected to getting sick, spending money on healthcare, and being poor. We did this by checking the pair-wise correlation among these factors, and the results are shown in Table 7. The table showed the correlation coefficient value, the p-value for testing if there is no correlation between the variables, and whether the test results were significant or not. Because outliers can change how correlations are measured, the analysis was carried out in two ways: (i) without removing the outliers, and (ii) after removing the outliers. The outlier was identified by using the 99th percentile value of each variable. We treated any value higher than this 99th percentile as an outlier. In

situations where we needed to control the correlation, we limited the number of outliers considered. The pairwise correlation showed that using unimproved water was linked in a positive way to the chosen outcome variables. The Pearson correlation coefficient between how people interact with unimproved water and how much they spend on treatment was 0.0667, and the p-value for this relationship was 0.004. The Pearson correlation coefficient showed a relationship between interacting with unimproved water and the number of sick people in the household, with a value of 0.1505, and this connection was statistically significant.

Table 8: Correlation analysis among unimproved water user, different variables related to health risks, and some other related variables

Pairwise correlation	Correlation Coefficient	P-value
Use of unimproved water and treatment expenditure	0.0667	0.004
Use of unimproved water and the number of ill people	0.1505	0.000
Use of unimproved water and poverty	0.0481	0.399
Treatment expenditure and number of ill members	0.1186	0.000
Controlling the extreme values (99th percentile value)		
Use of unimproved water and treatment expenditure	0.108	0.000
Use of unimproved water and the number of ill people	0.1471	0.000
Use of unimproved water and poverty	0.0456	0.053
Treatment expenditure and number of ill members	0.1347	0.000

Source: Authors' estimation based on Household Survey Data (2018)

The sick members and the cost of their treatment should be related in a positive way, and this was shown by the

Pearson correlation coefficient. The estimated correlation coefficient between ill members and treatment costs was

0.1186. In the scenarios where outliers were controlled, we found that the estimated correlation between the use of unimproved water and treatment expenditure was 0.108, which was lower than the 0.0667 found in the previous case. Similarly, the correlation between the use of unimproved water and the number of sick people was

found to be 0.1471, which was previously 0.1505. So, after taking care of the unusual case related to treatment costs, we found that the correlation coefficients for the previously mentioned relationships were lower, with the exception of the correlation between users of unimproved water and treatment spending.

Table 9: Number of ill members in the households due to the contact with unimproved water in various areas of Turag Riparian during the study period

Description	User of unimproved water		User of unimproved water Upstream		User of unimproved water Middle Stream		User of unimproved water Downstream	
	No	Yes	No	Yes	No	Yes	No	Yes
Number of ill members								
0	44.3	27.2	38.9	20.3	53.6	44.5	22.0	15.6
1	28.8	33.6	27.9	31.9	29.5	36.8	27.5	31.8
2	17.1	23.2	19.8	28.2	13.1	13.7	26.3	28.3
More than 2	9.9	16.0	13.4	19.6	3.8	4.9	24.3	24.3
Average	1.0	1.4	1.1	1.5	0.7	0.8	1.7	1.8
Mean Difference	0.4		0.4		0.1		0.1	
Test statistics (t-stat)	6.5		3.5		1.9		0.7	

Source: Authors' estimation based on Household Survey Data (2018)

In the upstream areas, among the households whose members had no interaction with unimproved water, around 38.87 percent had no ill-members whereas among exposing groups, around 20.25 percent had no ill-members. In the upstream areas, among the users of unimproved water, 60.12 percent households had 1-2

ill members and among the non-users of unimproved water, 47.71 percent had 1-2 ill members.

Based on the OLS and Tobit methods the effects of the use of unimproved water on number of ill members of the study have been presented in Table 10.

Table 10: Effects of using unimproved water on some health and economic indicators

Explanatory variables	Ill members		Number of diseases		Out-of-pocket expense	
	OLS	Tobit	OLS	Tobit	OLS	Tobit
Use of unimproved water	0.361a	0.610a	0.448a	0.703a	0.771a	4.667a
	(0.059)	(0.093)	(0.058)	(0.092)	(0.127)	(0.817)
Sex: male=1	-0.057	-0.076	-0.138	-0.168	-0.078	-0.275
	(0.095)	(0.152)	(0.095)	(0.15)	(0.203)	(1.335)
Age	0.004c	0.008b	0.004c	0.008b	-0.003	-0.014
	(0.002)	(0.003)	(0.002)	(0.003)	(0.005)	(0.031)
Education	-0.004	-0.01	0.001	-0.003	-0.011	-0.064
	(0.006)	(0.01)	(0.006)	(0.01)	(0.013)	(0.088)
Household size	0.153a	0.21a	0.104a	0.152a	-0.026	-0.346
	(0.019)	(0.03)	(0.019)	(0.031)	(0.042)	(0.291)
Ill members					0.377a	2.19a
					(0.05)	(0.33)
Constant	0.272c	-0.59a	0.448a	-0.380c	0.722b	-12.57a
	(0.141)	(0.228)	(0.14)	(0.226)	(0.301)	(2.157)
Sigma		1.675a		1.658a		10.522a
		(0.039)		(0.039)		(0.569)
N	1,825	1,825	1,825	1,825	1,825	1,825
F	24.832		20.832		19.194	

Source: Authors' estimation based on Household Survey Data (2018)

Note: a, b, and c stand for the significance of the variables at 1%, 5%, and 10% level

The study found that the use of unimproved water led to sickness among the household members. The results also showed that in households where people used unimproved water, the average number of sick people was about 0.36 more than in households who did not use unimproved water. The coefficient for the household size variable was positive, meaning that having more people in a household led to more ill people in that household. This outcome worked well because having one more person in the home means each person gets less of the available resources on average. The other factors related to the household head's gender and their years of education were also negative, which means there was a reverse connection between the number of sick people in the household and those factors. However, the OLS results might be biased because the dependent variable had a tendency to be zero. So, a model that has been censored would be better suited for this purpose. The TOBIT model was used to address this issue, and the results are shown in the last column of Table 10 for each of the variables. The TOBIT coefficients were not the same as the OLS coefficients, which showed that the OLS estimates were biased, and the bias was in the downward direction. The TOBIT model showed that the intensity of illness among household members who used unimproved water increased by 0.61, compared to those who did not use unimproved water, when all other factors stayed the same. In the TOBIT model, the coefficient for the variable unimproved water contact was 0.25 points greater than in the OLS model. The impact of adding more people to a household on the number of sick members in that household became stronger in the TOBIT model. In the TOBIT model, the age variable became more important compared to other factors.

The results showed that among the users of unimproved water, the average number of diseases was 0.45 more than those who did not use it. The coefficient for the household size variable was again positive, meaning that having more people in a household leads to a higher number of diseases occurring in that household. The other factors in the Tobit model, like the gender of the household head and the years of education of the household head, had negative coefficients. The TOBIT model showed that the number of diseases in households where members used unimproved water increased by 0.703, compared to households where members did not use unimproved water, assuming all other factors stayed the same. In the TOBIT model, the coefficient for the variable unimproved water contact was 0.25 points greater than in the OLS model. The impact of adding one more household member on the number of diseases in the household became stronger in the TOBIT model. Both the OLS and Tobit models showed that the coefficient of the unimproved water use variable was positive meaning that people who used unimproved

water sources had higher treatment costs compared to those who did not use such water, assuming other factors remain the same. The results were statistically significant at the 1 percent level in both models. If the number of sick family members in a household increased by one, while other factors stay the same, the log of monthly treatment spending goes up by 0.377 in the OLS model and by 2.189 in the Tobit model. The OLS estimates gave a lower result, but the Tobit model showed that among the users of unimproved water, there was a bigger impact on the number of sick people in the household and the number of diseases that the household members experienced. The results showed that when people used water that wasn't properly treated or cleaned, it led to more sickness and health problems for the people living in the household.

The earlier results clearly showed that the use of unimproved water led to sickness and health problems for people. These effects could make it more likely that people who used unsafe water sources end up in poverty. In this situation, there is a cycle between the environment, health, and poverty. First, pollution can make it harder to get clean water. Then, not having enough safe water can make it harder for people to escape poverty. Also, being poor can make it even harder to get the water they need. The answer wasn't simple because the two things were connected in both ways: (i) lack of safe water can come from being poor, and (ii) not having enough water can make poverty worse. The findings from the analysis on how the use of unimproved water affects household poverty in the Turag riparian areas, considering various factors, have been shown using a logistic regression model and were listed in Table 10. It was clear that not having enough water made it more likely for people to be poor. The results showed that households using unimproved water had a 1.005 times higher chance of the probability of being poor. The results also showed that when the standard deviation of water insecurity goes up, the likelihood of poverty increases by about 0.26, assuming all other factors stay the same. These results showed that the successful effort to reduce water insecurity would also help lower poverty levels.

Robustness of the results

The comparison between the users and non-users of unimproved water may be questioned because the differences between the groups in some key factors might be caused by other differences in the households themselves. This could make the results seem unrealistic and not trustworthy. So, it made sense to see if the results from the non-matched case were backed up by the matched comparison. The similar results from both methods will make the findings more trustworthy, show that the results are strong and dependable, and make the

Table 11: Effects of unimproved water contact of members of the households on lost working days, illness during two weeks in Turag Riparian areas in 2018 (Results were based on Propensity Score Matching Model)

Variables	Results without controlling PSCORE		
	Observed	Bias	Bias corrected CI
Average number of sick people			
Sick people	0.40	-0.011	0.27 - 0.60
Sick female	0.15	0.11	0.03 - 0.25
Sick male	0.25	-0.03	0.19 - 0.34
	Results with controlling PSCORE		
Sick people			
Sick female	0.39	-0.004	0.25 - 0.57
Sick male	0.18	-0.004	0.13 - 0.30
Sick people	0.21	-0.003	0.16 - 0.38

Source: Authors' estimation based on Household Survey Data (2018)

Note: The results were significant at 1 percent level.

estimates more reliable.

The results were (i) without PSCORE and (ii) with PSCORE. Three different values for each outcome were given: the average effect seen, the estimated bias, and the confidence interval adjusted for bias. The results looked at three main things: (i) how many family members were sick, and (ii) how much money was spent on treatments. The first outcome variables were also broken down by the gender of the people living in the household. When comparing households that used unimproved water to a similar group, the average number of sick people in the household was 0.4 higher when PSCORE was not taken into account, and 0.39 higher when PSCORE was considered (Table 11). Looking more closely at the average number of sick members by gender, it was found that the average for males was higher than for females. This could be the reason why male members of the households used more unimproved water than the female members.

Discussion

This study aimed to measure how much money the riparian households in Dhaka lose because of the use of unimproved water, and it looked at this problem through different ways of understanding costs and how poverty affects decisions. Three results stand out. Even though most households have access to piped water and motorized tube-wells, 28.36% of households still use unimproved water from different sources. This shows that people choose unimproved water not because there are no other options, but because the available alternatives are too expensive, too far away, not always reliable during certain seasons, or take too much time to collect. This matches the idea from Becker's household production theory, which looks at how families decide how to spend their time and what choices they make to avoid risks. Second, the difference in health and spending between people who use unimproved water and those who don't is real, not just a result of how the data is analyzed. This gap stays the same when using different methods like

OLS, Tobit, and matched (PSM) models. Also, when we take into account that some illness and spending data is missing or censored, the gap actually gets bigger. Third, the burden isn't spread out evenly — it mostly hits the very poor, those who are always struggling, and families who take longer to get help, which makes the cycle of poverty worse. This supports the idea that water poverty keeps people trapped in poverty, instead of just being a one-time health problem.

The estimated extra cost for treatment, which is about Tk.321 each month or roughly Tk.3,852 a year, is not very large on its own. However, compared to the average monthly household spending of about Tk.15,700 to 17,800, this cost is quite significant. It also falls within the range of costs found in similar studies about the cost of illness at the household level in South Asia. For example, Ali *et al.* (2021) found that the average cost of illness was about USD 10.79 for households in peri-urban areas of Pakistan that used unsafe water. In contrast, Das *et al.* (2025) reported much lower average costs, around USD 0.57, for households in Eastern India. This shows how much the cost of illness can vary depending on local health issues, how people seek treatment, and the cost of medical care in different areas. The increased risk of illness seen here—meaning 0.36 to 0.61 more sick people in each home, depending on how it's measured—is similar to what Hubbard *et al.* (2020) found. They studied households in Zambia that didn't have better water and sanitation and saw a higher chance of illness, about 1.07 to 1.22 times more. This also matches the global report by Wolf *et al.* (2023), which says unsafe water, poor sanitation, and bad hygiene cause around 1.4 million deaths and 74 million years of lost healthy life each year. Gordon and others from 2023 point out that even after more than ten years since the Sustainable Development Goals were introduced, the problem of safely managed water services is still not enough to reach the 2030 aim, especially in cities like Dhaka where people live near rivers and in lower- and middle-income areas.

The pattern seen here shows that during the dry season, people are exposed to unimproved water about twice as much as during the monsoon season, which matches recent findings from rural and coastal areas of Bangladesh. Broyles and their team in 2023 used a long-term study of households in Matlab and discovered that water shortages aren't just a yearly problem; they change a lot through the seasons, with the worst times usually happening before the monsoon season. This directly affects the ways people change their behavior and the costs they face, as explained in the theory: when the reliability of better water sources drops during certain times of the year, families start using less safe water for things like washing, bathing, and cleaning tools instead of spending more time or money on better options. This puts them at risk of getting sick from germs in the water, even if they still have access to cleaner water for drinking. Only 2.47% of the sample used unimproved water for drinking, while 28.36% used it for other purposes. This shows that efforts to protect drinking water have been more successful than those aimed at reducing skin contact and accidental exposure during household tasks. This difference is important because skin diseases, stomach illnesses, and other health issues that are not related to diarrhea are the main health problems listed in Table 6. The results also show what was discussed earlier about the health-poverty trap. Sala-i-Martin (2005) and Khullar and Chokshi (2018) both talk about a cycle where poverty leads to bad health and poor health makes poverty worse; Yang and Liu (2018) take this idea further by showing how the environment, health, and poverty are all connected. The current results support this idea: being poor, whether according to higher or lower poverty measures, and how poverty changes over time—like being poor all the time versus only sometimes—are both linked to not having access to safe water. The analysis shows that not having reliable water access makes it more likely for someone to be poor. Because the cross-sectional design can't fully tell which way the cause and effect go, the best explanation is that the relationship works both ways. Households may move toward using unimproved water partly because poverty limits their ability to afford better options (this is about cost and avoiding the problem). At the same time, the sickness and medical costs that result can lower their income and resources, making it harder for them to escape that situation (this is called a capability-deprivation channel, as Sen would put it). Ahile et.al. (2026) found the variation of water security within and between income groups. The Propensity Score Matching results show that male members of a household tend to have a higher average sickness effect compared to female members. Also, since women are responsible for almost all water collection, which is 97.1% of the time, this suggests that the negative impact of not having safe water is not spread equally within households, but also affects men and women differently.

Several limitations qualify these conclusions. The data is taken at one point in time, so the results from the

regression and matching methods show connections rather than clear cause-and-effect relationships; there may still be some unknown factors affecting both water choice and health, like a person's natural tendency to get sick or their ability to handle problems without being measured, even after trying to balance the groups. People report their illness and treatment costs based on their memory of past events, which may lead to errors in remembering or sharing information, especially for less serious or symptoms that come and go. The study also doesn't include actual water-quality tests, so touching contaminated water is used as a stand-in for being exposed to germs, instead of using real lab results to show the risk. Finally, since the sample comes from riparian communities along one river system, the results accurately describe this group but should be carefully applied to other similar, untouched water areas in Bangladesh.

Even though there are some limits, the results stay similar whether we use OLS, Tobit, or matched-sample methods. Also, these results match what other studies in South Asia and around the world have found about the cost of illness. This gives us more confidence in our main point: using unimproved water isn't just a simple or personal way to deal with water shortages. Instead, it actually harms household health and money, making poverty worse. This affects water policies in the areas around Dhaka that are near rivers and urban spaces, which will be discussed more later.

CONCLUSION

This study aimed to find out the cost of using unimproved water on households in the Turag river areas of Dhaka, and to show how that cost starts with getting sick from bad water, then leads to spending money on treatment, and finally results in poverty. The evidence matches up at every step of that process. Even though there has been more development of pipes and tube wells, 28.36% of the households surveyed still used water that wasn't safe for washing, bathing, or cooking at some time during the year, and this problem almost doubled during the dry season. Households that used unclean water had more people who were sick, a higher chance of getting stomach, skin, and diarrhea illnesses, and spent an extra Tk.321 each month, which is around Tk.3,852 every year, on medical treatment compared to similar households. These differences stayed the same, and in many cases got even bigger, after we accounted for censorship using the Tobit model and after we adjusted for selection based on observable traits using Propensity Score Matching. This suggests that the burden is a real part of using unimproved water and not just something that happens because of who chooses to use it.

The bigger picture shows that if we look at these results through the lens of poverty trapping and losing ability to improve, it makes sense: poverty makes it more likely someone will use unsafe water, and using unsafe water keeps them poor. So, solutions that only focus on providing water through better infrastructure might not

be enough. To close the gap, action needs to be taken on at least three different areas. First, we should focus on extending safe water through pipes and tube wells to specific areas where people living near rivers are most at risk, especially those in the upper and lower parts of the river, and also to very poor and long struggling families. Instead of just expanding water access city-wide in the same way everywhere, we need to target these high-risk groups more carefully and make sure the cost is manageable for them. Second, planning for water management that responds to the seasons is important because people rely more on unimproved water sources during the dry season when electricity-powered water supply becomes unreliable. Providing stored, off-grid, or low-energy water options during this time could lead to much better health improvements. Third, efforts to change behaviors and promote hygiene were focused on non-drinking water use at home, such as washing, bathing, and cleaning tools in open water sources, because these activities, not drinking water use, make up most of the poor water exposure in this group.

Future studies based on this research could improve by using panel or long-term data to better understand which comes first—poverty or the use of unsafe water. They could also connect people's reported illnesses with actual water quality tests in labs. Additionally, the cost-of-illness and opportunity-cost analysis done here could be expanded into a full cost-benefit study of specific projects and programs aimed at improving water access and changing behaviors in Dhaka's river areas. Until these interventions help close the gap in affordability and reliability, the evidence shows that many households living along the rivers in Dhaka will keep paying the private costs of using unsafe water. These costs include getting sick, spending money on treatment, and losing income. This burden hits hardest those who are least able to handle it, and it directly prevents Bangladesh from meeting its goals for health, well-being, and ending poverty.

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APPENDIX

Table 12: The effects of the use of open-source water and a set of exogenous variables on poverty in Turag Riparian areas during 2018 (Results were based on Logit model)

Explanatory variable	Coefficient	P-value	Marginal Effect	eβ	eβstdX
Use unimproved water (yes=1, 0 otherwise)	0.005***	0.001	0.005	1.005	1.2659
Gender of household head	-0.090	0.209	-0.090	0.914	0.975
Age of household head	0.003	0.005	0.003	1.003	1.0431
Education of household head: years of schooling	-0.438***	0.024	-0.438	0.645	0.1335
Household size	-0.211***	0.047	-0.211	0.810	0.7444
Downstream	1.641***	0.170	1.641	2.005	2.005
Upstream	1.033***	0.156	1.033	1.558	1.5582
Constant	0.648**	0.328			
Number of observations	1,825				
Pseudo R2	0.353				

Note: The figures in parentheses show standard errors. * Indicates significance at 10 percent level, ** indicates significance at 5 percent level, and *** indicates significance at 1 percent level.