



Research Article

Sanitation and Hygiene Practice Among Rural and Tribal Households in Northern Bangladesh

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ABSTRACT

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The present study explores the sanitation and hygiene situation in Thakurgaon District, a rural area and tribal population, and inadequate access to modern healthcare facilities in Bangladesh. The general objectives of the study were to investigate satisfaction with hygiene practices in various demographic groups (education, age, and gender) and to assess the situation of sanitation facilities in rural areas under Thakurgaon district. This study is based on data from 267 rural dwellers and uses logistic regression to analyses factors (such as education, occupation, income, and family type) influencing sanitation and hygiene behavior practices. The results show that there is a significant difference in water supply comfort, safe drinking water, and hygiene practices. People with lower income and women with less than primary education reported being more satisfied with sanitation, whereas people living in joint family setups and households with four and more rooms were found to be more comfortable with hygiene and sanitation. These results underscore the fact that socio-economic status, in particular, education and income, has a significant impact upon sanitation behaviors. The results suggest there is a need for targeted effort on sanitation in rural areas, particularly targeted effort for sanitation among the disadvantaged people in those areas. Policymakers ought to focus on implementing a better hygiene-oriented education program, increasing access to safe water, and developing the sanitation infrastructure of the rural districts. Efforts should also concentrate on the culture of care needed to serve the needs of tribal and rural communities with culturally sensitive programs. Through public health policies adapted to the socio-economic conditions of these populations, it would make a great leap towards Sustainable Development Goal 6: water and sanitation for all.

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Introduction

Sanitation and hygiene are basic factors that determine public health, and they have a great impact on the overall health of people and the spread of communicable diseases (Hsan et al., 2019). Proper hygiene practices handwashing, use of clean water, and having proper sanitation facilities, are always needed to eliminate and lessen the impact of waterborne and communicable diseases in rural and marginalized areas (Ahmad et al., 2015). Poor sanitation still affects more

than 2 billion people around the world and this comes with a lot of health, social, and economic implications (Merid et al., 2023; Talukder et al., 2025). In South Asia, water, sanitation, and hygiene initiatives have made a huge difference but still, rural communities experience roadblocks due to inadequate infrastructure, cultural practices, and poverty (UNICEF, 2022; Ahmed et al., 2023). The issue is especially serious in the case of tribal and marginalized communities, where sanitation and hygiene practices are sometimes very hard to come

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by. Communities have to deal with barriers peculiar to their situation, such as low literacy, traditionalism, and being cut off from the rest of the world, which are all factors that negatively influence the adoption of better hygiene practices (Alam et al., 2024; Sharma et al., 2025).

The tribal populations in Thakurgaon face the steepest barriers to a proper sanitation system, safe drinking water, and health education (Ahamed et al., 2022), which in turn might lead them to suffer even more from hygiene-related illnesses (Ahmed et al., 2025; WASH 2025). The district's geographical and socio-cultural background, reliance on traditional health practices, and scant exposure to modern health interventions make it an appropriate and crucial area to assess sanitation and hygiene behaviors (Sharma et al., 2025). Knowledge of the type of hygiene practices and satisfaction level of this population gives insight into both the behavioral and infrastructural determinants of public health (Merid et al., 2023).

Existing literature Alam et al., (2024) found that ethnic households 42.3% enjoyed access to hygiene facilities that are not only improved but also at the same time, 60.6% of the ethnic population had just the basic drinking water services, and only 50% of the ethnic population could get a handwashing facility with water and soap. Begum et al., (2023) highlighted that household were 2.15 with no toilet space, and rural-household sharing the toilet almost 19.4%. During the floods one quarte of households in Bangladesh not use able of toilet after using the toilet minorities group had lower rate of handwashing practice (Hossain et al., 2022; Najnin et al., 2024). Tasnim, (2024) found that multiple issues were faced by the Santal group in Bangladesh, including fresh water, sanitation, inadequate sanitation infrastructure, and unsafe hygiene practices. Although the minority community in Bangladesh is struggling with socioeconomic challenges (Baral et al., 2022; Hsan et al., 2019), found the majority of people lived lower poverty line and have minimal access to education and hygiene. Talukder et al., (2023) indicated that indigenous practices not into morden health systems and their traditional systems created others pose health risks. Besides that, the investigation offers an assessment that cannot be more of a right time than now as it happens concurrently with the race to break the Sustainable Development Goal 6 which calls for 100% access to clean water and sanitation (WHO, 2023).

Recent research showing the village areas sanitation and hygiene issues in tribal communities in Bangladesh that influenced by access to water, sanitation and hygiene facilities including socioeconomic conditions. In

particular, the research results highlight that sanitation and hygiene practice considerable among the communities. Therefore, examining these issues at the local level is important for understanding the specific conditions and experiences of marginalized populations.

A limited number of studies exist on sanitation and hygiene among rural and indigenous societies in Bangladesh, specifically district-level evidence for Thakurgaon. There are a few researchers have paid attention to specific age differences and gender issues, hygiene satisfaction, and sanitation practices of sanitation in tribal communities. Moreover, in the villages of Thakurgaon, the novelty of this research lies in examining sanitation and hygiene facilities, education, age, gender, and other population groups for their hygiene satisfaction. The primary objective of this research is to analyze the satisfaction from practices of hygiene in education level, age, gender and various population groups with the aim of to analyze the level of sanitation facilities in the rural regions of Thakurgaon district. This study will entail domestic sanitation and hygiene amenities, availability of clean water, hand washing, disposal of waste, and social consciousness and attitude towards hygiene. Hopefully by pointing out both positive and negative aspects in sanitation and hygiene practices, the study will aim to facilitate sustainable community-based remedies of public health and advancement of the ability of the Sustainable Development Goals of clean water and sanitation towards all.

Methodology

Study Area

Thakurgaon district has been located to be about 26.0333° N latitude, and 88.4667° E longitude, with its total area of 1,809.48 square kilometers. Baliyadangi Upazila is located in the west of the district and has international border with India. Negkmarad (also known Nekmarad locally) is an upazila, a union in the southern region of the district. The areas of study chosen are Baliyadangi, Nakmarad and Ranishankoil which are the representative of the rural tribal setting of Thakurgaon. The selected villages are made up of small scattered homesteads with agricultural fields, ponds and patches of forests. Baliyadangi is mainly agricultural with most households having paddy fields and seasonal crops based on tube wells and ponds as the primary source of water. Nakhangaon is more dispersed in the pattern of settlement, having communal water sources and common sanitation facilities, as a response to the local adaptation to weak infrastructure. Ranishankoil is an amalgamation of agricultural land with minimal forests and tribalistic communities with the carrying of a traditional hygiene and sanitation system and the use of

its available water supply. These regions are a perfectly living in geography, social-economic level, and cultural traditions intertwine and influence the decision-making of tribal people regarding the use of water, hygiene habits, and sanitation standards. Tribal families usually live-in joint family set-ups, and their everyday water

gathering, cleanliness, and sanitation procedures are disseminated by traditional knowledge, the environmental conditions in the region and socio-economic limitations. A graphical representation of the study area is provided in Map 1.

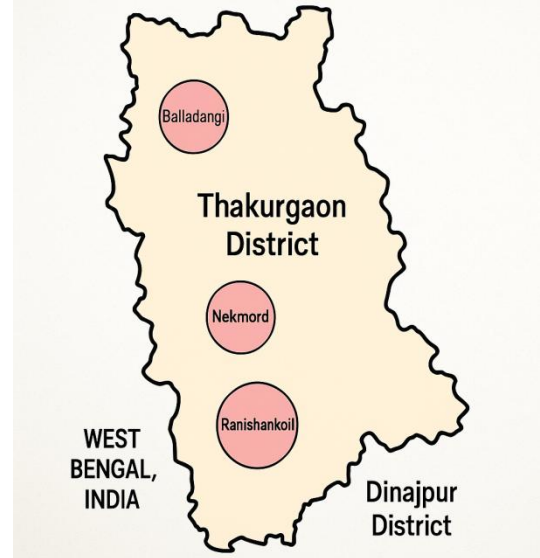


Fig. 1: Map of Study Areas

Sample Size

To select the participants for this research, the random sampling technique was used. A total of 266 respondents were randomly selected from the study area, and the identification of tribal communities was included in the sampling method. The appropriate size of the sample for this study was selected by applying the process suggested by Daniel (1999) as calculated below in equation: n

$$n = \frac{Y \times X}{X + Y - 1}$$

Where, n = sample size; Y = population size existed in the study areas that was 15000

X = $(Z_{\alpha/2})^2 \cdot P \cdot (1 - p) / e^2$, here $Z_{\alpha/2}$ was the critical value of the normal distribution that is 1.645, e is the margin of error that was 5% level or 0.05, p was the sample proportion that was found with a pilot survey that 50% people living in the study areas were unaware of hygienic, safe drinking water, and sanitation. Then, by putting these values in the proposed formula we have

$$n = \frac{15000 \times 270.6025}{270.6025 + 15000} = 265.82 = 266$$

So, the desired sample size for this study would be 266 samples. The random sampling technique was followed.

Data Collection

This research utilizes primary data, specifically examining hygienic practices among tribal populations in rural areas. A field survey will be undertaken using primary data during the period of September-October, 2025. The information was collected through face-to-face interviews, during which postgraduate enumerators were trained to gather the data under strict supervision. Data were collected using the structured questionnaires, the main instrument of data collection. A pilot survey was conducted on a small sample of the students to check the questions' clarity and reliability prior to the final data collection. Additional wording and logic improvements were made in response to comments received from the pilot. The survey covered three parts of questions: first, identification; then secondly demographic sections & thirdly, sanitation-related questions. The interviews were carried out in Bengali to better understand the participants. Confidentiality and anonymity of the participants were guaranteed, and written consent was obtained prior to participation. After getting the participants' verbal consent, the interviews started. A 266 valid respondents were used for final analysis. The selection criteria required participants to face hygiene issues, be members of tribal communities in the

selected areas, and be willing to allow data enumerators to describe their issues. Respondents who were not facing the issues of hygiene and sanitation issues, were unable to answer the questions, or were not permanent residents of the study areas were excluded. We interviewed only one respondent from each selected household. Relevant books, journals, research papers, documents, and research reports were used to collect secondary data. All statistical work was done using STATA statistical software. The descriptive statistics included the description of the characteristics of respondents, and Chi-square tests were used to measure the relationship between demographic features and sanitation, hygiene, and water practices. The determinants of contentment with these practices were determined by a logit regression model.

Model of logit

The logit model is used to determine the possible variables likely to affect a binary (dichotomous) outcome by determining the likelihood of a particular event happening. It discusses the relationship between explanatory variables and the likelihood of the outcome to be predicted in determination of how a variance in such explanatory variables influences odds ratio. The odds or the log-odds depict the proportional change between the independent and the dependent variable thus showing a relationship between them. The dependent variables included water supply, safe

drinking water, hygiene practices, and shared sanitation facilities items that assessed respondents' level of comfort and satisfaction with the various WASH conditions. The perceptions were gathered using the structured questionnaire items. There was no Likert scale scoring applied. Logistic regression analysis involved converting the responses into a binary variable: yes (1) or no (0) if respondents indicated they were comfortable/satisfied or not, respectively. These binary variables were used as dependent variables in the logit regression models. Due to this binary characteristic of the dependent variables, the logistic regression is used. Let P is the likelihood that a patient is content with the practice. (1-P) are the likelihoods of dissatisfaction. The logit model of this observation can be then stated as

$$\left(\frac{P_i}{1-P_i} \right) = \frac{1 + \exp(Z_i)}{1 + \exp(-Z_i)} \dots\dots (1)$$

Since the Equation (1) is non-linear, the linearized form can be taken as using log forms. So, by using log forms the logit model would be like below:

$$L_i = \ln \left(\frac{P_i}{1-P_i} \right) = Z_i$$

$$= \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_{11} X_{11} + \varepsilon_i \dots\dots, (2)$$

Table 1. Measurement of dependent and independent variables

	Variables	Vectors	Description
Dependent	How comfortable are you with the water supply?	Y1	Dummy variable: 1 for comfortable/satisfied and 0 for not comfortable/otherwise
	How comfortable are you with safe drinking water?	Y2	Dummy variable: 1 for comfortable/satisfied and 0 for not comfortable/otherwise
	How comfortable are you with the hygiene?	Y3	Dummy variable: 1 for comfortable/satisfied and 0 for not comfortable/otherwise
	How satisfied are you that multiple people are using the same toilet?	Y4	Dummy variable: 1 for comfortable/satisfied and 0 for not comfortable/otherwise
Independent	Gender	X1	1 for Male and 0 for Female
	Age	X2	Measured in years
	Education	X3	Measured in years of schooling
	Credit access	X4	1 for credit access 0 for otherwise
	Monthly income	X5	Measured in BDT.
	Household size	X6	Measured in Number
	Type of family	X7	Measured as dummy where 1 for nuclear and 0 for joint family
	Occupation	X8	Measured as homemaker, public, sector worker, self-employed, student, teacher, unemployed and others
	Numbers of Tubewell	X9	Measured in 1 for there is and if not 0
	Numbers of rooms	X10	Measured in 1, 2, 3, 4, and others
	Land size	X11	Measured in hector

Source: Authors' own computation

Where, $P_i/(1-P_i)$ model shows the ratio of the possibility of a person being satisfied or comfortable with different practices including water use, hygiene, and sanitation and being not satisfied with different practices. Where β_s are unknown parameters that will be estimated in this equation, and X_s are the independent variables that will be used to determine the potential factors in determining the respondents' practices. The term represents the chance variation of the total system. Moreover, the Chi-square test was used to identify the association between the demographic features and three types of practices (water, hygiene and sanitation). The data were sorted by the education level of the respondents, occupation, monthly income, family type, and rooms of the family. The Chi-square was used to assess correlations between categorical variables with respect to sanitation, hygiene

and water practices that were coded using a polytomous Price. The Chi-square value is positive and this means that there exists a higher level of satisfaction with respect to the respective variable.

However, while this study measured perceived satisfaction with WASH conditions, the use of more objective indicators would improve future assessments. The current study was not comprehensive in measuring important indicators such as toilet technology type, availability of handwashing stations with soap and distance to water sources. Future research should include measures of both subjective perceptions and objective WASH service monitoring indicators to develop a more comprehensive understanding of households' experience with WASH.

Table 2. Socio-demographic and Household Characteristics of the Respondents

Variables	Category	n (%)
Age (years)		
	20–≤40	138 (51.69)
	>40–≤60	101 (37.45)
	>60	28 (10.86)
Gender		
	Male	214 (80.15)
	Female	53 (19.85)
Education Status		
	No education	181 (67.79)
	Only read & write	2 (0.75)
	Primary	60 (22.47)
	SSC	17 (6.37)
	HSC	5 (1.87)
	Bachelor	2 (0.75)
Household Size (persons)		
	0–≤3	84 (31.46)
	>3–≤6	162 (60.68)
	>6	21 (7.86)
Monthly Income (BDT)		
	0–≤4000	26 (9.74)
	>4000–≤8000	139 (52.06)
	>8000–≤12000	62 (23.22)
	>12000–≤16000	30 (11.23)
	>16000–≤20000	6 (2.25)
	>20000	4 (1.50)
Land Size		
	0–≤0.02023	196 (41.20)
	>0.02023–≤0.04046	54 (32.21)
	>0.04046–≤0.076874	16 (20.22)
	>0.076874	1 (6.37)
Number of Rooms in House		
	0–≤1	165 (61.80)
	>1–≤3	101 (37.83)
	>3	1 (0.37)
Tubewell Ownership		
	0–≤1	266 (99.63)
	>1	1 (0.37)
Using Same Toilet		
	No	244 (91.39)
	Yes	23 (8.61)
Using Same Room		
	No	191 (71.54)
	Yes	76 (28.46)
Using Same Tubewell		
	No	257 (96.25)

	Yes	10 (3.75)
Credit Account	No	117 (43.82)
	Yes	150 (56.18)

Source: Authors' own calculation from field survey, 2025

Results

Table 2 shows the socio-demographic and household characteristics of the respondents, which clearly depicts the socio-economic status and living conditions of the study population. The age distribution indicates that, the majority of the respondents are relatively young (51.69% age group 20–40 years), followed by 37.45% of age group 40–60 years and only 10.86% are over 60 years. This means that the majority of the respondents are aged between 18 and 64. The sample size is largely male, comprising 80.15% male and 19.85% female respondents, which could be due to the gender roles or the availability of the respondents during the survey. There is a significant lack of education, with 67.79% of the people having no formal education and very few having secondary or tertiary education. This indicates lack of educational opportunities and may affect awareness and practices in health, hygiene, sanitation.

Household composition shows relatively high family sizes with 60.68% of households having more than 3 members, thus suggesting co-residence and intra-household resource stress. The constraints of the economy are also evident in income distribution with more than half of the respondents earning between BDT 4000–8000, and only a small percentage (1.50%) earning more than BDT 20,000. The overall trend is that many households are in a low to lower middle income

bracket. Only a small proportion of respondents own substantial tracts of land, with 41.20% of respondents owning very small tracts. This means that access to productive assets is limited and there is reduced economic security. The situation is exacerbated by housing conditions with 61.80 % of households living in single room houses and a large percentage sharing living space and potentially curtailing freedom of movement. There seems to be good availability of water sources where 99.63% have at least one tubewell, but there is a problem of sharing of facilities. Most of the respondents say they do not share toilet (91.39%), however a significant amount of respondents say they share a room (28.46%) which could have an impact on hygiene and comfort. Likewise, 96.25 percent do not share tubewells, indicating relatively good access to water sources as compared to sanitation facilities. Lastly, financial inclusion seems to be at a moderate level, with 56.18% of the respondents having a credit account, suggesting some degree of access to financial services in a country where the overall economic conditions are less favourable. In general, the results indicate that the study population has low levels of education, insufficient income and land resources and moderately high crowding levels, which are expected to affect WASH behaviors in the study area.

Table 3. Logit analysis for affecting factors between demographic variables and water practice

Variables	Water supply comfort OR (95% CI)	p-value	Safe drinking water OR (95% CI)	p-value
Education				
Illiterate	1.31 (0.89–1.92)	0.175	1.27 (0.62–2.60)	0.509
Under Primary	1.63 (1.05–2.53)**	0.032	1.32 (1.01–1.73)**	0.039
Primary pass	1.02 (1.00–1.04)	0.120	1.01 (1.00–1.03)	0.116
Under High School	1.18 (0.98–1.43)*	0.080	1.24 (0.98–1.58)*	0.070
High School Pass & Others	1.00 (0.91–1.10)	0.978	0.64 (0.39–1.07)*	0.080
Occupation				
Agriculture/Home workers	1.00 (0.92–1.10)	0.927	1.52 (0.88–2.61)	0.132
Others	1.34 (1.03–1.73)**	0.027	1.49 (1.08–2.05)**	0.016
Monthly Income (BDT)				
Below 10,000 BDT	1.99 (0.80–4.94)	0.138	5.61 (1.08–29.06)**	0.040
10,000–20,000 BDT	1.62 (1.04–2.53)**	0.030	1.17 (1.02–1.35)**	0.029
Above 20,000 BDT	1.02 (0.99–1.05)	0.118	1.14 (0.45–2.84)	0.783
Family Type				
Nuclear	1.98 (0.79–4.95)	0.146	1.03 (0.50–2.12)	0.931
Joint	0.63 (0.42–0.95)**	0.025	0.74 (0.57–0.95)**	0.020
Number of rooms				
1 room	1.83 (0.48–6.98)	0.374	0.83 (0.58–1.18)	0.292
2 rooms	1.91 (1.08–3.37)**	0.027	1.37 (1.06–1.77)**	0.016
3 rooms	1.44 (0.94–2.21)*	0.090	1.19 (1.04–1.36)**	0.013

Others	0.64 (0.40–1.00)*	0.051	1.23 (0.87–1.75)	0.249
LR Chi2	27.92	00.00	26.88	00.00
Pseudo R2	0.507		0.450	

Asterisk stand *** for 1%, ** for 5% and * for 10% level of significance.

Source: Authors' own calculation from field survey, 2025

Logistic regression results are shown in Table 3 for the effects that demographic factors have on respondents' perception of comfort with water supply and safe drinking water. The logistic regression results indicate which factors were associated with their satisfaction with the comfort they experienced with the water supply and their perception of safe drinking water. Results are presented in odds ratios (ORs) with 95% confidence intervals (CIs), with an OR > 1 representing higher odds of satisfaction (as compared with the reference category) and an OR < 1 representing lower odds. The findings suggest that the socioeconomic factors such as education, occupation, income, family status and housing conditions were significant factors affecting perceptions on water-related services. In the field of education, those with under-primary education are more likely to be satisfied with the water supply and safe drinking water than the reference group. Specifically, they had 1.63 times higher odds of being comfortable with water supply (OR = 1.63, 95% CI: 1.05–2.53, $p = 0.032$) and 1.32 times higher odds of being satisfied with safe drinking water (OR = 1.32, 95% CI: 1.01–1.73, $p = 0.039$). This indicates that people with less education may have lower expectations about the quality of service or they may have come to expect the water they have in their homes. Respondents with more education, however, did not report any significant improvement in satisfaction, suggesting that an awareness and expectations of water quality may shape perceived water quality.

Water-related satisfaction was also found to be significantly related to occupational status. Those who reported being classified as other occupations were more likely to report having comfort with water supply (OR = 1.34, 95% CI: 1.03–1.73, $p = 0.027$) and safe drinking water (OR = 1.49, 95% CI: 1.08–2.05, $p = 0.016$) than those who reported being classified as agriculture or household workers. The study indicates that occupational diversity might help to enhance access to resources, economic opportunities, and their knowledge of better WASH services. Another important determinant was income level. Moderate improvement in household economy (between 10,000 and 20,000 BDT per capita) was associated with significantly higher odds of satisfaction with water supply (OR = 1.62, 95% CI: 1.04–2.53, $p = 0.030$) and safe drinking water (OR = 1.17, 95% CI: 1.02–1.35, $p = 0.029$), suggesting that a moderate economic improvement is linked to improved access and perception of water services. Interestingly, people with income less than BDT 10,000 had

significantly higher odds of being satisfied with the drinking water's safety (OR = 5.61, 95% CI: 1.08–29.06, $p = 0.040$). This should be interpreted with caution, however, due to the large confidence interval; this may be indicative of differences in expectations of low-income households or of limited observations.

Water satisfaction was also related to family structure. Those in joint families were significantly less happy about their water supply (OR = 0.63; 95% CI: 0.42–0.95, $p = 0.025$) and their safe drinking water (OR = 0.74; 95% CI: 0.57–0.95, $p = 0.020$) compared to other family arrangements. This shows that bigger households can put strain on water resources and can be less satisfied with the water. The number of rooms in the house was positively correlated with water satisfaction. Households with two rooms had significantly higher odds of being comfortable with water supply (OR = 1.91, 95% CI: 1.08–3.37, $p = 0.027$) and safe drinking water (OR = 1.37, 95% CI: 1.06–1.77, $p = 0.016$). Households with three rooms also had higher likelihood of being satisfied with safe drinking water (OR = 1.19, 95% CI: 1.04–1.36, $p = 0.013$), indicating that conditions of households may be associated with their socioeconomic status and access to WASH facilities.

The overall logistic regression models were statistically significant with the water supply comfort model having LR χ^2 (27.92, $p < 0.001$) and Pseudo R^2 (0.507) values, and the safe drinking water model having LR χ^2 (26.88, $p < 0.001$) and Pseudo R^2 (0.450) values. The values support the interpretation that the variables selected in the framework of the socioeconomic and the household are able to account for a significant amount of variance among the respondents' perception of water supply and safe drinking water. The findings indicate that satisfaction with WASH services is more than just a function of physical availability of water, but also relates to socioeconomic factors and the expectations held by each household member in terms of service quality. The increased satisfaction of a few disadvantaged groups in some surveys should be approached with caution. Such patterns may reflect differences in expectations, adaptations to their current living conditions, due to cultural norms or due to international differences in perceived service quality. Nonetheless, the current cross-sectional design cannot ascertain the reasons for these differences. In light of the above, satisfaction outcomes may be seen as measures of perceptions of WASH conditions rather than reflections direct measures of the objective quality of service.

Table 4. Logistic analysis for affecting factors between demographic variables and hygiene and sanitation practice

Variables	Hygiene comfort OR (95% CI)	p-value	Shared toilet satisfaction OR (95% CI)	p-value
Education				
Illiterate	1.01 (0.72–1.42)	0.950	1.79 (0.30–10.81)	0.527
Under Primary	2.46 (1.14–5.32)**	0.023	1.19 (1.14–1.24)***	<0.001
Primary pass	1.04 (1.00–1.09)**	0.046	1.02 (0.92–1.13)	0.704
Under High School	1.42 (0.33–6.18)	0.639	1.91 (1.33–2.74)***	<0.001
High School Pass & Others	0.45 (0.22–0.94)**	0.034	2.04 (1.01–4.13)**	0.048
Occupation				
Agriculture/Home workers	1.09 (0.95–1.25)	0.245	1.49 (0.79–2.83)	0.220
Others	1.92 (0.95–3.87)*	0.069	1.13 (1.09–1.16)***	<0.001
Monthly Income (BDT)				
Below 10,000 BDT	3.74 (1.02–13.73)**	0.046	1.08 (1.01–1.16)**	0.030
10,000–20,000 BDT	2.50 (1.27–4.89)***	0.008	1.04 (1.01–1.08)**	0.015
Above 20,000 BDT	0.98 (0.80–1.20)	0.831	1.18 (1.09–1.27)***	<0.001
Family Type				
Nuclear	1.27 (0.44–3.67)	0.656	1.01 (0.89–1.15)	0.860
Joint	1.07 (0.99–1.16)*	0.084	1.27 (1.05–1.55)**	0.017
Number of rooms				
1 room	1.25 (0.97–1.63)*	0.087	1.14 (0.99–1.30)*	0.066
2 rooms	1.05 (1.00–1.09)**	0.033	1.34 (1.24–1.46)***	<0.001
3 rooms	1.00 (1.00–1.00)*	0.069	1.26 (1.00–1.59)*	0.055
Others	1.02 (0.97–1.07)	0.447	1.04 (0.96–1.13)	0.330
LR Chi2	31.91	00.001	30.73	00.001
Pseudo R2	0.447		0.397	

Asterisk stand *** for 1%, ** for 5% and * for 10% level of significance.

Source: Authors' own calculation from field survey, 2025

A logistic regression was used to determine whether demographic factors were associated with comfort with hygiene and satisfaction with the use of shared toilets and is presented in Table 4.

The logistic regression results show the factors that were associated with respondents' comfort in hygiene practices and satisfaction with shared toilet facilities. Results are reported as odds ratios (ORs) with 95% confidence interval (CIs) with an OR > 1 representing a higher likelihood of reporting satisfaction and an OR < 1 representing a lower likelihood than the reference group. The model outcomes show that certain socioeconomic factors such as education, occupation, income, family structure and housing conditions had significant effects on hygiene perceptions and satisfaction with sanitation. In terms of education, respondents with under-primary education had significantly higher odds of reporting being comfortable with hygiene practices (OR = 2.46, 95% CI: 1.14–5.32, $p = 0.023$). This means that people with less education are about 2.46 times more comfortable with their hygiene condition. The same applies to those who had received under-primary education who were

significantly more likely to be satisfied with shared toilet facilities (OR = 1.19, 95% CI: 1.14–1.24, $p < 0.001$). The discovery provides some indication that people with low education levels may have different expectations of hygiene and sanitation services or that they may have adapted to the current environment. Respondents with primary education also had slightly higher odds of being satisfied with hygiene (OR = 1.04, 95% CI: 1.00–1.09, $p = 0.046$), suggesting minor improvement in hygiene satisfaction. However, those who attained higher educational level (HS and above) had significantly lower odds of hygiene comfort (OR = 0.45, 95% CI: 0.22–0.94, $p = 0.034$), indicating that higher school education may enhance awareness of hygiene standards and help to critically assess sanitation conditions. Higher education was the opposite in the case of satisfaction with shared toilets, with high school pass and above respondents having higher odds of satisfaction (OR = 2.04, 95% CI: 1.01–4.13, $p = 0.048$). Perceptions of occupation also were affected by occupation. The odds of hygiene comfort were higher among those classified as other occupations, although the association was not

significant (OR = 1.92, 95% CI: 0.95–3.87, $p = 0.069$). This occupational group, however, had a strong positive association with shared toilet satisfaction (OR = 1.13, 95% CI: 1.09–1.16, $p < 0.001$). This suggests that the diversity and the variety of occupations might be linked to better sanitation facility awareness, financial means, or adaptation strategies. Income was found to be a significant factor affecting the satisfaction with hygiene and sanitation. Respondents with monthly income below 10,000 BDT had significantly higher odds of reporting hygiene comfort (OR = 3.74, 95% CI: 1.02–13.73, $p = 0.046$) and shared toilet satisfaction (OR = 1.08, 95% CI: 1.01–1.16, $p = 0.030$). Similarly, households earning between 10,000 and 20,000 BDT had significantly higher odds of hygiene comfort (OR = 2.50, 95% CI: 1.27–4.89, $p = 0.008$) and shared toilet satisfaction (OR = 1.04, 95% CI: 1.01–1.08, $p = 0.015$). These results indicate that economic capacity could contribute to access to sanitation resources and to satisfaction with sanitation facilities. Interestingly, for hygiene comfort, there was no significant association with the increase in income, whereas there was a significant relationship with increased odds of satisfaction with shared toilet (OR = 1.18, 95% CI: 1.09–1.27, $p < 0.001$), suggesting that in some cases, improving economic conditions could have positive impacts on sanitation facility acceptance or availability.

There was a significant relationship between family structure and shared satisfactions with sanitation. The odds were slightly higher for respondents who lived in joint families (OR = 1.07, 95% CI: 0.99–1.16, $p = 0.084$) but not significant at the 5% level. Joint families were

however more likely to be satisfied with shared toilets (OR = 1.27, 95% CI: 1.05–1.55, $p = 0.017$). This could mean people in nuclear families are more used to sharing household facilities and thus have a more positive attitude to shared sanitation. The number of rooms was also related to hygiene and sanitation perceptions. Households with two rooms had significantly higher odds of hygiene comfort (OR = 1.05, 95% CI: 1.00–1.09, $p = 0.033$) and shared toilet satisfaction (OR = 1.34, 95% CI: 1.24–1.46, $p < 0.001$). The association was marginally significant for households with three rooms and satisfaction with sharing the toilet (OR = 1.26, 95% CI: 1.00–1.59, $p = 0.055$). These results suggest that better housing can provide a decrease in crowding and may improve hygiene experiences and satisfaction with sanitation. The logistic regression models were overall statistically significant—suggesting that the selected socioeconomic and household factors were important factors that determined hygiene comfort and shared toilet satisfaction. The hygiene comfort model showed LR $\chi^2 = 31.91$ ($p < 0.001$) with a Pseudo R^2 value of 0.447, while the shared toilet satisfaction model showed LR $\chi^2 = 30.73$ ($p < 0.001$) with a Pseudo R^2 value of 0.397. These results show that the models accounted for around 44.7% and 39.7% of the variance of hygiene comfort and satisfaction with shared toilet use, respectively. In general, the results indicate that sanitation perception is influenced by factors other than access to sanitation facilities such as socioeconomic status, educational awareness, household structure and living conditions.

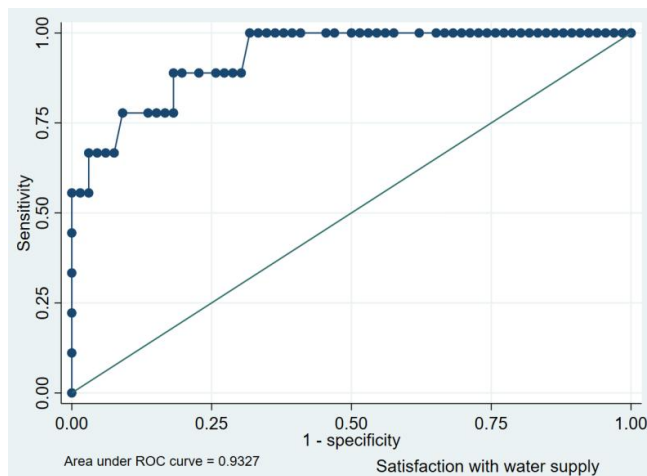


Fig 2. Satisfaction with the water supply

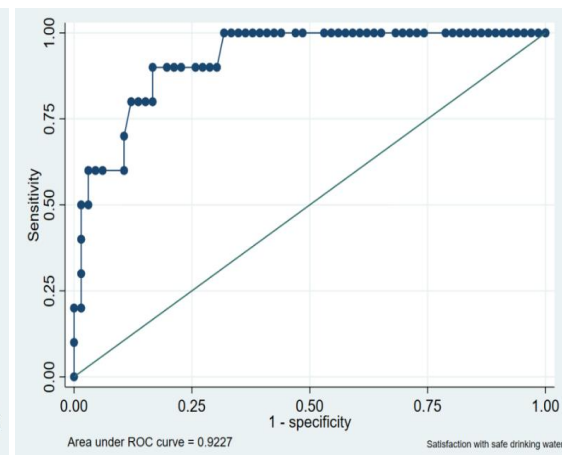


Fig 3. Satisfaction with the safe drinking water

The sensitivity analysis is illustrated using ROC (Receiver Operating Characteristic) curves in Figures 2 and 3 and examines the ability of logistic regression models to predict satisfaction with water supply and safe drinking water. Receiver operating characteristic curve analysis

was conducted to assess the model discrimination of the logistic regression models. Model for satisfaction with water supply showed an excellent discrimination ability (AUC value 0.9327). This shows that the model is very likely able to guess respondents who were satisfied

and dissatisfied with water supply even at lower probability thresholds. The discriminatory performance of the model for satisfaction with safe drinking water was also excellent (AUC value = 0.9227). The results demonstrate that the chosen explanatory variables are effective predictors of differences in respondents' perceptions of water services. The ROC curve is very far from the diagonal reference line, indicating that the model has high sensitivity (true positive rate) and good specificity (true negative rate). Likewise, regarding satisfaction with safe drinking water (Figure 3), the model shows an AUC of 0.9227, which is also considered as an excellent predictive model. The model achieves an accuracy of approximately 92% when applied to real-world data, showing reliable and

consistent performance. Furthermore, the curve is near the top left corner, which further validates a good balance of sensitivity and specificity in the model. Overall, both models have high discrimination power; thus, they are effective in detecting the difference between satisfied and not satisfied persons. The relatively high AUC values (above 0.90) indicate that the chosen explanatory variables, including education, income, occupation, and household characteristics, are good indicators of satisfaction with water. The results in this study support the validity of the models employed, as well as the validity of the regression results, and thus the confidence that can be placed in the results of the present study.

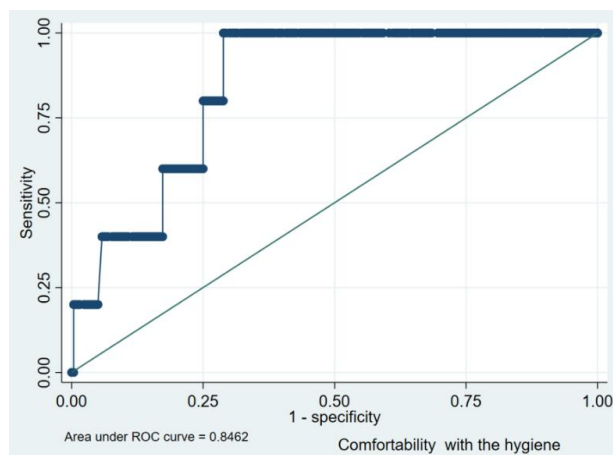


Fig 4. Satisfaction with the hygiene

ROC curves are shown for the predictive performance of the logistic regression models for hygiene comfort and satisfaction with shared use of the toilet in Figures 4 and 5, respectively.

ROC curve analysis demonstrated that the hygiene comfort model had a good discriminatory performance for discrimination with an area under the ROC curve (AUC) value of 0.8462 (Figure 4). It suggests that the model was able to make a good discrimination among respondents who were comfortable and uncomfortable about hygiene practices. The shared toilet satisfaction model showed good discrimination by AUC value (0.9212) suggesting that the model was able to differentiate between the attitudes of respondents who were either satisfied or dissatisfied with shared sanitation facilities (Figure 5). The ROC curve is in the upper left corner, indicating good sensitivity and specificity, and suggesting that the model is highly effective at separating satisfied and dissatisfied respondents with respect to shared sanitation. The two models are compared and it is clear that the shared toilet satisfaction model outperforms the hygiene

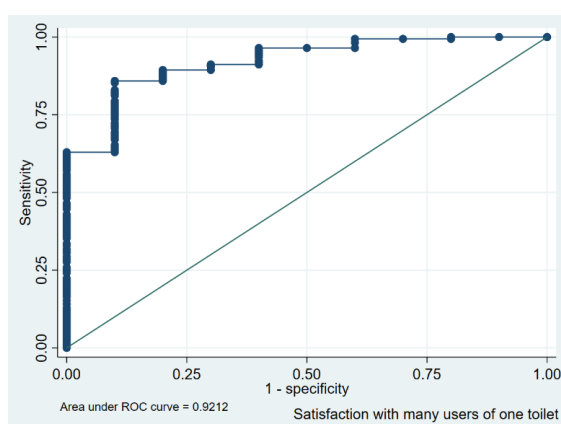


Fig 5. Satisfact. with multiple users of the same toilet

comfort model, suggesting that the variables included in the shared toilet satisfaction model better predict the attitudes toward shared sanitation than the variables included in the hygiene comfort model. This discrepancy could be due to the fact that the overall hygiene behavior may be affected by other, more complex and unobserved factors like personal habits, awareness, and cultural practices, not fully captured in the model. In general, the findings strengthen the robustness of the analytical framework of this study as both models showed satisfactory to excellent predictive ability, with high reliability for predicting satisfaction with shared sanitation.

Discussion

This study aims to give a detailed picture of water, sanitation, and hygiene (WASH) conditions in tribal communities of rural Thakurgaon and the importance of socio-demographic and household factors in influencing access and perception. Overall, the results indicate that although general access to water sources is relatively good, access to sanitation and hygiene practices is not consistent, and there is clear variation by level of

education, income and household structure. Perhaps most impressively, the link between education and satisfaction with life is observed. Teachers have less knowledge regarding water supply and hygiene practices as compared to the others. A similar observation has been made in other rural areas, where individuals with lower education levels exhibit less knowledge about the importance of hygiene practices and health risks (Najnin et al., 2023; Hsan et al., 2019). Respondents with more educational attainment, on the other hand, tend to be less satisfied with the service; this might be because they are more aware and more critical of the quality of the service. This indicates caution should be taken in interpreting satisfaction reports, as it could be attributed to expectations rather than improvements in WASH conditions (Sifullah et al., 2024). The result of the research highlighted the more extensive WASH problem in the remote areas of Bangladesh. Where people have access to developed water sources and sanitation and hygiene services. This comparison is highly valuable reason of a water source does not indicate the households have access to pure, managed WASH services. Recent research from the rural area of Bangladesh has explored how facilities for water and sanitation do not have appropriate uses with social norms such as education and socioeconomic factors being involved for this paretics. The current study shows that the use of water sources improves and develops WASH conditions. The results highlight that access, quality, use, and satisfaction need to be considered together (Fisher et al., 2011). This is also influenced by economic conditions. Most of the respondents are among the low and lower middle-income groups, a situation supported by the low level of land ownership, small houses and shared facilities. This observation has been noted in rural and marginalized populations where poverty hinders access to improved sanitation and safe water (Alam et al., 2024; Ahmed et al., 2023). There was a general tendency for higher income to be linked with better access and higher comfort (Sifullah et al., 2025), however, that some lower income groups report relatively high satisfaction does suggest a level of adaptation to life in a constrained environment (Sifullah et al., 2024). This is a reflection of the difference between objective reality and subjective perception. In South Asia, a parallel socioeconomic dimension has been reported in indigenous and other marginalized populations, where geographical isolation, poverty level, poor access to infrastructure and dependence on open and ground sources of drinking water would affect both WASH access as well as household practices (Balasubramanya et al., 2022). Thus, the results from rural Thakurgaon may extrapolate to the broader South Asia region where inequalities in WASH availability exist

not just urban–rural divides, but also along socioeconomic and social hierarchies. The current study contributes to this literature by examining whether perceptions of WASH conditions are associated with socioeconomic status and household structure in a rural tribal population.

Household structure and living arrangements are also important. The size of households and the presence of joint family systems is seen to be negatively associated with satisfaction of water-related practices as it increases the stress on common water resources. Meanwhile, those who live in these settings might get desensitised to sharing facilities, resulting in greater acceptance of shared sanitation. The same is seen in the studies of tribal population in which the social norms and the way they live together affect sanitation behavior and perception (Tasnim, 2024; Talukder et al., 2023). This two-way effect indicates that physical limitation and social adjustment must be taken into account when assessing WASH outcomes. It is noted that between access to water and hygiene behaviors, there is a clear difference (Sifullah et al., 2025). While almost all households have access to tubewells, hygiene practices do not show the similar level of improvement. This reflects earlier research which concluded that infrastructure alone is not enough to change hygiene behavior, as this can be influenced by habits, culture and awareness (WHO, 2023; UNICEF, 2022). The relatively weaker predictive value of hygiene-related models in this study further validates the complexity of behavioral factors which cannot be fully captured by using socio-economic variables. Results are enhanced by the sensitivity analysis, especially for water-related outcomes, which have good predictive capability. The situation is different for hygiene-related outcomes that are more predictable and seem to be the result of other unobserved factors. This difference has also been emphasized in the earlier studies which found that sanitation and hygiene practices are found to be more behaviorally driven and less directly related to the measurable characteristics of the households.

The results may also be interpreted in the context of the WHO and UNICEF joint monitoring framework that calls for WASH to be measured by service levels as opposed to household access. The joint monitoring uses standardized service ladders to track household drinking water, sanitation and hygiene and reports on disparities between rural-urban populations, socioeconomic groups and other population sub-groups (Steele et al., 2018). The current results align with this perspective because the study shows comparatively good access to water sources might be accompanied by poorer sanitation and hygiene status. Therefore, the results support the need to assess different elements of

WASH separately and not rely on access to water alone as a measure for overall WASH.

The results emphasize the need to separate perceptions of satisfaction with WASH services or provision from actual level of service. Satisfaction is a good indicator of community perceptions, but not necessarily objective realities. Future evaluations would benefit from combining perception-based measures with standard WASH indicators including sanitation type, handwashing infrastructure and soap availability, and water source access. The overall results also highlight the need to do more than build infrastructure to improve WASH conditions in rural tribal communities. A holistic approach combining economic development, education, behavioral change and tackling the constraints at the household level is necessary to effectively improve access and sustain change in hygiene and sanitation. Comparison with evidence from rural Bangladesh, indigenous and marginalized populations in South Asia and the WHO and UNICEF joint monitoring framework shows that WASH inequalities are multi-dimensional. Thus, the results from Thakurgaon complement previous evidence by revealing the relevance of socioeconomic conditions, household composition and subjective satisfaction in addition to physical access to WASH facilities. The effectiveness of improvement in infrastructural development is more accompanied with education-behavioral change and household level support to achieve sustainable changes on hygiene and sanitation practices.

Conclusion

This study was conducted to explore the water, sanitation and hygiene (WASH) practices in rural and tribal communities of Thakurgaon district, Bangladesh and the socio-demographic determinants of satisfaction with water, sanitation and hygiene. The results show that there is a fairly high proportion of access to tubewell water sources but there is a significant variation in satisfaction with safe drinking water, hygiene and sanitation facilities between education, income, occupation, family type and housing characteristics. The logistic regression analysis indicates that both education (lower compared to higher) and income (moderate compared to high) are statistically significant factors influencing how comfortable people feel using water and hygiene. The analysis also reveals that the persons' level of comfort in using water and hygiene practices is influenced by their perceived housing conditions (poor compared to good), and by their occupation (unskilled compared to skilled). Their satisfaction with limited facilities, however, may also be due to lower expectations of the facilities and services

that are offered and not necessarily that the facilities and services are inadequate. The results of the ROC analysis are acceptable to excellent, thus providing confidence in these results. Overall, the study reveals that there are not only infrastructural WASH problems in rural tribal communities, but also social, economic and behavioral ones. Hence policy interventions need to integrate and integrate improved sanitation infrastructure, safe access to water, awareness and culturally sensitive hygiene education programs. Low income, less educated and Joint family households should be given special consideration. Inclusive actions can play a significant role in SDG 6 in marginalized rural areas.

However, the study has some limitations. The study design was cross-sectional, so it cannot infer a causal relationship. In addition, objective happiness and practice measures may suffer from reporting or recall bias, as self-reported responses may be affected by individual perception or expectation. Moreover, since this study was conducted on a few selected tribal communities residing only in the Thakurgaon district of Bangladesh, these findings may not be generalizable to all tribal communities or other places. Test data for drinking-water quality were also not available in this study, so whether measurement of accessibility to water sources meant that the water was safe to drink could not be inferred. Longitudinal designs, objective water-quality assessments, and standardized WASH indicators should be used in future studies to provide a more comprehensive assessment of the impact of WASH and prepare them for comparison with national and international benchmarks. In addition, there are some limitations to this study. First, gender distribution of respondents was unequal with 80.15% of males and 19.85% of females. While one person was chosen from each household, the comparatively higher participation by males could have been because of availability and willingness to participate in the household during the survey period. Women also often take part in household water collection as well as sanitation management and hygiene-related tasks, which could affect their ability to interpret gender-specific perceptions and practices. Acknowledging the need for greater gender parity in representation, gender sensitive sampling methods should be included in future studies.

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