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Assessment of water, hygiene, and sanitation practice and associated factors among Bihari refugee camp in Bangladesh: A cross-sectional study

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Abstract

Background and Aims: The global significance of water, sanitation, and hygiene (WASH) cannot be overstated, extending far beyond the confines of developing nations and encompassing even the most developed ones. This study, rooted in the Bihari refugee camp in Bangladesh, seeks to underscore the universality of WASH concerns.

Methods: Using a cross-sectional design and a structured questionnaire, we conducted a meticulous evaluation of WASH practices with 313 participants selected through random sampling.

Results: Findings shows the water practice, among all of them, only 4.8% of the respondents were very happy with the water supply system and 16.0% of the respondents were happy with this. A total of 29.7% of the respondents were satisfied with safe drinking water and only 4.8% of the respondents were very satisfied with safe drinking water. Regarding the hygiene practice, among all respondents, 10.2% of them were satisfied with using the same bathroom by multiple people. Only 5.4% respondents were happy in their living environment. Regarding sanitation practice, only 31.3% had private toilet facilities. Among all of the respondents, 13.7% of the respondents were satisfied with using the same toilet by multiple people. Respondents who were illiterate ($p < 0.01$) and self-employed ($p < 0.04$) were satisfied with the water supply. Similarly, respondents who were illiterate ($p < 0.03$) and self-employed ($p < 0.00$) were satisfied with safe drinking water. Respondents who were illiterate ($p < 0.02$) and whose monthly income was below 8000 BDT ($p < 0.00$) were satisfied using same bathroom by multiple people. Respondents who were self-employed ($p < 0.01$), whose monthly income

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8000–12,000 BDT ($p < 0.01$) and having single room ($p < 0.00$) were satisfied using the same toilet by multiple people.

Conclusion: Enhanced access to safe WASH facilities, coupled with a comprehensive understanding of the study's findings, have the potential to serve as vital signposts for the development and implementation of policies and interventions.

1 | INTRODUCTION

Cleaning techniques and hygiene practices are critical for preventing and slowing the spread of infectious diseases. Not only underdeveloped countries, but also developed ones, have performed research on water, sanitation, and hygiene (WASH) to improve human life quality.[1] Due to increasing handwashing, the most significant increases in domestic water use are predicted in Africa (23.88%), Asia (15.05%), Latin America, and the Caribbean (7.18%).[2] Japanese views about personal cleanliness are substantially influenced by early schooling, cultural experiences with handwashing, and reciprocal tendencies in case of during and after emergency.[3] Korean individuals with hypertension and diabetes were more likely than those without these conditions to have sadness, concern about contracting COVID-19 and suffering from it, and a lower inclination to practice good hand hygiene.[4] Another study attempted to create a context-specific relationship from a regional viewpoint by outlining the sociodemographic and WASH factors in southern Punjab, Pakistan and explored that hand pumps and tank water were the main drinking water sources associated with stunting. Batool et al.[5] In rural areas and small towns in South Africa inequitable access to WASH services is caused by high inequality, rising unemployment, and the Apartheid legacy of a segregated service delivery system.[6] Due to the unwillingness of WASH practice a large amount of people specially the children suffer from many diseases such as diarrhoea in Southeast Nigeria.[7] Stunting and anaemia among adolescents in India are significantly predicted by dietary variety and cleanliness practices.[8] WASH behaviors are most effective in the early years when it comes to improving children's long-term health.[9] In some rural residents of Ethiopia have limited access to basic water utilities. Moreover, there were few safe water storage practices in the area, and residential water treatment was not a routine habit.[10]

The developing countries suffer from WASH poverty for example in the central and eastern Indian states of West Bengal, Bihar, Odisha, Jharkhand, Chhattisgarh, Uttar Pradesh, and Madhya Pradesh, study found clusters of districts which were significantly affected by WASH poverty.[11] According to a study in Nepal, students from schools with improved WASH facilities had a favorable and statistically significant impact on their health.[12] In Myanmar a study discovered that consuming untreated water and developing diarrhea were significantly related and the proportion of people who used the anti-diarrhea measures was low.[13]

In Bangladesh, there has been conducted several studies regarding WASH practice specifically in the rural, urban and slum areas.[14–16] Not only the urban and rural areas but also the in St. Martin's Island, some WASH components, particularly the sanitation infrastructure and hygiene standards, did not meet standards.[17] As a result, due to inadequate methods of water purification, irregular toilet usage, a lack of handwashing practices, and restricted access to sources of safe drinking water are all variables that contribute to the prevalence of diarrhea among children.[18] In case of slum areas, nearly every slum in Bangladesh reported having a severe lack of drinking water during the survey. Moreover, when it comes to access to clean water, slum residents are faced with a terrible situation during Covid-19 pandemic.[19] A research was conducted to see the changes of before and after to improve the intervention, the prevalence of childhood diarrhea remained equal in both groups.[20] In contrast, one of the studies revealed that culturally acceptable households who are engaged with WASH practice behavior have a lesser chance to be affected by diseases such as typhoid or any types of fever.[21] People of rural areas have an unwillingness to do WASH practice and behavior. Most of the mothers of the rural areas have a good knowledge about WASH practice in Bangladesh, but only a third of them do not practice it and sociodemographic characteristics play a significant role in this case.[22,23]

The Bihari refugee camp in Bangladesh, hosting a marginalized and vulnerable population, faces significant challenges in ensuring adequate water, hygiene, and sanitation practices. Inadequate access to clean water and proper sanitation facilities can lead to a myriad of health issues, including waterborne diseases, which disproportionately affect already marginalized communities. Despite the importance of addressing this issue, there is a notable lack of comprehensive research on the current state of water, hygiene, and sanitation practices and the factors influencing them within the Bihari refugee camp in Bangladesh. While there have been studies on water, hygiene, and sanitation in refugee camps regionally and globally, the specific context of the Bihari refugee camp in Bangladesh has been relatively overlooked. In the realm of WASH research in Bangladesh, the focus has predominantly centered on slums, rural areas, and even on the Rohingya refugee population, leaving a conspicuous void in our understanding of the historically neglected and marginalized Bihari refugees in Bangladesh. The absence of research in this specific context underscores a critical gap in our collective

knowledge. This study serves as a bold step towards rectifying this long-standing oversight by bringing to light the dire WASH challenges faced by the Bihari community. Moreover, it is a resounding call to action, illuminating the pressing need to address their unique circumstances, thereby amplifying the voices of an underserved population, and contributing to the broader discourse on humanitarian assistance and equitable resource allocation. The contribution of this study extends beyond its immediate context to have a significant impact on the fields of public health, humanitarian aid, and refugee assistance. By thoroughly assessing water, hygiene, and sanitation practices and their associated factors within the Bihari refugee camp in Bangladesh, this research provides a crucial foundation for addressing a pressing global challenge.

2 | METHODS AND MATERIALS

2.1 | Study design and settings

This cross-sectional study was carried out in Geneva Camp, also known as Bihari Camp, in Dhaka's Mohammadpur, a colony of stranded Pakistanis who came from the Indian state of Bihar during the 1947 partition. The Bihari Muslim minority in Bangladesh experienced substantial prejudice both during and after the 1971 Bangladesh Liberation War. Our sample population was Bihari refugee. We purposively select this camp to collect data because it is the largest of Bihari refugee camp in Bangladesh.

To capture the significance influential for the satisfaction and the comfortable in practice of hygiene and sanitation practice as well as for drinking safe water, a field survey was constructed in Geneva Bihari refugee camp, Dhaka in Bangladesh. An organized form of questionnaire was implemented. Random sampling technique was followed during data collection. The author received institutional approval for conducting this study. At the next step with proper permission and approval of the Geneva camp authority, 313 respondents were selected randomly for interview. Basically, data were collected using a personal interview approach while an option of filling the questionnaire by the respondents if they wish. The survey activity was conducted during holidays or evening so that the respondents have enough time to respond.

To accomplish the survey properly, a structured questionnaire was prepared consisting of demographic characteristics, health issues, water drinking status, hygiene and sanitation related aspects with their satisfaction and conformability status. The final questionnaire was divided into four parts. The part included the socio-demographic conditions of the respondents such as age, sex, family size etc. of the respondents. The second part included information related to safe drinking, hygiene and sanitation issues, third section contained in status corresponding satisfaction and comfort with the practices mentioned. Final part of the questionnaire involved regarding the problems facing by the respondents regarding the safe drinking water, hygiene, and the sanitation practice. To examine the satisfaction and comfortable status in accordance with the sanitation,

hygiene and safe drinking water, a self-estimated 5 points Likert scale (1 = *highly dissatisfied*, 2 = *dissatisfied*, 3 = *neutral/no idea*, 4 = *satisfied* and 5 = *strongly satisfied*) was applied to capture the response regarding the hygiene, sanitation and safe drinking water supported by the past studies. A pilot survey was conducted with 40 respondents to ensure the validity of the questionnaire and required moderation was also done for overcoming the obstacles faced in the pilot survey in case of final questionnaire.

2.2 | Statistical analysis

This study utilized descriptive statistics. Descriptive statistics regarding mean, test statistics, Chi-square test for significant validation was applied based on perception in response with sanitation, hygiene and safe drinking water practice. To determine the potential factors affecting these practices, a logistic regression model with odd ratios was applied in this study. In addition, Chi-square test was also employed to estimate the association between demographic characteristics and the safe drinking practice, hygiene, and sanitation practice among the respondents. Statistical analysis was done with the help of statistical software R.

2.3 | Sample size

The appropriate size of the sample for this study was selected by applying the process suggested by Daniel (1999) as calculated below in equation:

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

where, n = sample size; N = population size existed in the study areas that was 25,000.

$X = (Z_{a/2})^2 * P^* (1 - p)/e^2$, here $Z_{a/2}$ was the critical value of the normal distribution that is 1.96, 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 71% 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

$$ n = \frac{25000 \times 316.394}{316.394 + 25000 - 1} = 312.4521 \approx 313. $$

So, the desired sample size for this study would be 313 samples. The random sampling technique was followed.

2.4 | Statistical methods: Logit model and χ^2 test

Logit model investigates the potential factors influencing a dichotomous outcome by predicting the probability of the occurring that specific event. It examines the relationship between explanatory variables and the odds of the predicted

variable simply by estimating the changes in the odds ratios of the variables. This odds or log odds is the proportionate change of the two odds (dependent and independent) and reflects a relationship between the variables.[24] Since the dependent variables (water practice, hygiene, and sanitation practice) are dichotomous in nature that means these are categorized in "zero" and "one." Here, zero means the respondent is not satisfied with the existing situation whereas one refers that the respondent is satisfied. Due to this dummy nature of the dependent variables, this study uses logistic regression. For logistic analysis, let P as the probability of the respondents having satisfaction regarding practice and $(1 - P)$ as the probability of the respondents having dissatisfaction regarding particular practice. Then the logit model for this observe is particular as

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

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:

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

$$= \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots \ldots \ldots \ldots + \beta_{11} X_{11} + \varepsilon_i \ldots \ldots, \tag{2}$$

where, $_{Pi}/(1 - _{Pi})$ is the ratio of the chance that a person can be satisfied or comfortable with different practices including water practice, hygiene and sanitation practice to the probability that a person will no longer satisfied or comfortable with these practice. In addition, βs are the unknown parameters to be estimated, Xs are the independent variables indicating probable influencing factors to the mentioned practice of the respondent, ε_i is the stochastic disturbance terms that may affect the whole system Table 1.

In addition, association between demographic characteristics and the practices (water, hygiene, and sanitation) were analyzed with the help of Chi-square test. Data were classified based on the educational status, occupation, monthly income, type of family and numbers of rooms available to the respondents. Chi-square was measured as the procedure of the attributes based on sanitation, hygiene and water practice that were captured into scales of the polytomous piece.[25] The positive value refers to the greater ratification with the concerning variable.

3 | RESULTS

3.1 | Frequencies analysis of demographic characteristics

In this study, a total of 313 respondents were chosen and all of them were participated in this study. Our outcome variables were WASH practice. And independent variables were education, occupation, monthly income, type of family and number of rooms. Education and occupation are associated with satisfaction of water use. Education and monthly income were associated with hygiene practice. Occupation, monthly income, and number of rooms were significantly associated with sanitation practice. The overall frequency analysis of demographic characteristics provides insight into the distribution of education, occupation, income, family type, and population living conditions in Table 2. The majority of the population (57.2%) are illiterate, followed by under primary (14.7%), primary pass (12.8%), under high school (10.5%), and high school & others (4.8%). The highest percentage of individuals (60.1%) are self-employed, followed by homemakers (22.4%), public sector workers (11.2%), unemployed (4.5%), teachers (1.3%), students (0.3%), and others (0.3%). The majority of individuals (42.8%) earn below 8000 BDT, followed by

TABLE 1 Measurement of the variables.

Variable type	Variables	Measurement
Dependent	How comfortable are you with the water supply here?	Measured as dummy variable: 1 for comfortable and 0 for otherwise
	How satisfied are you with safe drinking water?	Dummy variable where 1 for satisfied and 0 for otherwise
	How satisfied are you with multiple people using the same bathroom?	Dummy variable where 1 for satisfied and 0 for otherwise
	How satisfied are you that multiple people are using the toilet?	Dummy variable where 1 for satisfied and 0 for otherwise
Explanatory variables	Education	Measured in literacy scale including Illiterate, under primary, primary pass, under high school, high school & others
	Occupation	Measured as homemaker, public, sector worker, self-employed, student, teacher, unemployed and others
	Monthly income	Measured in BDT.
	Type of family	Measured as dummy where 1 for nuclear and 0 for joint family.
	Numbers of rooms	Measured in 1, 2, 3, 4, and others

TABLE 2 Frequency analysis of demographic characteristics.

Variable	Level	n	%
Education	Illiterate	179	57.2
	Under primary	46	14.7
	Primary pass	40	12.8
	Under high school	33	10.5
	High school & others	15	4.8
Occupation	Homemaker	70	22.4
	Other	1	0.3
	Public sector worker	35	11.2
	self-employed	188	60.1
	Student	1	0.3
	Teacher	4	1.3
	Unemployed	14	4.5
Monthly income	Below 8000 BDT	134	42.8
	8000–12,000 BDT	121	38.7
	13,000–18,000 BDT	44	14.1
	18,000+ BDT	14	4.5
Type of family	Nuclear	124	39.6
	Joint	189	60.4
Numbers of rooms	1	246	78.6
	2	43	13.7
	3	15	4.8
	4	7	2.2
	Others	2	0.6

8000–12,000 BDT (38.7%), 13,000–18,000 BDT (14.1%), and 18,000+ BDT (4.5%). The population is divided between nuclear (39.6%) and joint (60.4%) families. Most of the population (78.6%) live in houses with only one room, followed by 2 rooms (13.7%), 3 rooms (4.8%), 4 rooms (2.2%), and others (0.6%).

3.2 | Assessment of water, hygiene, and sanitation practice

The frequency analysis of WASH practices showed in Table 3 that tube wells are the primary source of water supply for 14.4% of respondents, while 82.4% rely on supplied water. Only 4.8% of respondents reported being very happy with the water supply, while 63.9% were either not happy or only a little happy with it. Additionally, more than half of the respondents faced water shortages at least twice a day.

Regarding hygiene, almost all respondents (96.8%) reported cleaning their hands before eating. However, only 11.2% of

TABLE 3 Frequency analysis of water, sanitation, and hygiene practice.

Variable	Level	n	%
Water practice			
Source of water supply	Tube well	45	14.4
	Pump	3	1.0
	Pipe	0	0.0
	Wasa	7	2.2
	Supply water	258	82.4
How comfortable are you with the water supply here?	not a bit	103	32.9
	a little	97	31.0
	Neither happy nor unhappy	48	15.3
	happy	50	16.0
	very happy	15	4.8
How satisfied are you with safe drinking water?	not a bit	78	24.9
	a little	79	25.2
	Neither happy nor unhappy	48	15.3
	happy	93	29.7
	very happy	15	4.8
How many times do you face water shortage in your daily life?	1 Time	63	20.1
	2 Times	66	21.1
	3 Times	58	18.5
	4 Times	69	22.0
	5 Times	57	18.2
Hygiene			
Do you clean your hands before eating	No	10	3.2
	Yes	303	96.8
How satisfied are you with multiple people using the same bathroom?	Very unhappy	100	31.9
	Unhappy	141	45.0
	Neither happy or unhappy	39	12.5
	Happy	32	10.2
	Very happy	1	0.3
Is there enough opportunity to get good natural air in the house?	No	278	88.8
	Yes	35	11.2
How many people live in one room?	1–2	22	7.0
	3–4	109	34.8
	5–6	149	47.6
	7–8	28	8.9
	9–10	5	1.6

(Continues)

TABLE 3 (Continued)

Variable	Level	n	%
How comfortable are you in this environment?	Very unhappy	109	34.8
	Unhappy	141	45.0
	Neither happy or unhappy	44	14.1
	Happy	17	5.4
	Very happy	2	0.6
Where is the cooking done?	In the kitchen room	3	1.0
	on the balcony	2	0.6
	In a corner of the living room	305	97.4
	Others	3	1.0
How satisfied are you with the cooking arrangements	Very unhappy	176	56.2
	Unhappy	91	29.1
	Neither Happy or Unhappy	31	9.9
	Happy	13	4.2
	Very happy	2	0.6
Sanitation			
Do you have private toilet facilities?	No	215	68.7
	Yes	98	31.3
How many people use a toilet?	1–5	81	25.9
	6–10	55	17.6
	11–15	12	3.8
	16–20	165	52.7
How satisfied are you that multiple people are using the toilet?	Very unhappy	111	35.5
	Unhappy	113	36.1
	Neither happy or unhappy	33	10.5
	Happy	43	13.7
	Very happy	13	4.2
What kind of problem does serial crowding have when multiple people use the same toilet?	No problem at all	52	16.6
	Sometimes there are problems	123	39.3
	There is a problem	138	44.1
How does the toilet smell?	not a bit	55	17.6
	a little	39	12.5
	sometimes	110	35.1
	Spreads too much	109	34.8

respondents reported having enough opportunity to get good natural air in their homes. A significant proportion of respondents (68.7%) reported not having private toilet facilities, and 52.7% of respondents reported that 16–20 people use the same toilet. The majority of respondents (80.3%) were unhappy with the smell of the toilet, and 73.6% reported problems when multiple people use the same toilet.

In summary, the results suggest that the surveyed population faces significant challenges related to WASH practices. There is a need to improve access to safe and clean water, increase the availability of private toilet facilities, and address the challenges associated with multiple people using the same toilet. Improving hygiene practices and addressing the challenges associated with living in crowded conditions could also help improve the overall health and well-being of the population.

3.3 | Chi-square analysis of water, hygiene, and sanitation practice with demographic characteristics

3.3.1 | Chi-square analysis of water with demographic characteristics

The Table 4 presents the results of a Chi-square analysis aimed at finding the association between demographic variables and water practice. The demographic variables analyzed were education, occupation, monthly income, type of family, and number of rooms. The water practice variables were how comfortable the respondents were with the water supply and how satisfied they were with safe drinking water. The Chi-square test was used to determine whether there was a significant association between these variables.

The results show that there was a significant association between education and both water practice variables. Specifically, respondents who were illiterate or had only passed primary school were more likely to be unsatisfied with safe drinking water and less comfortable with the water supply. This association between water supply and the literacy was statistically significant ($p \leq 0.01$), whereas safe drinking water was also significantly ($p \leq 0.05$) associated with educational level.

There was also a significant association between occupation and both water practice variables. Homemakers were more likely to be unsatisfied with safe drinking water and less comfortable with the water supply than respondents in other occupations. This association was statistically significant, with 5% level of significance for the two water practice variables.

None of the other demographic variables analyzed (monthly income, type of family, and number of rooms) showed a significant association with either of the water practice variables.

In summary, the results suggest that education and occupation are important factors that influence water practices, particularly regarding safe drinking water and comfort with the water supply.

TABLE 4 Chi-square analysis for finding the association between demographic variables and water practice.

| Variables | Level | How comfortable are you with the water supply here? | | | | How satisfied are you with safe drinking water? | | | |
		Unsatisfied N (%) = 248 (79.2)	Satisfied N (%) = 65 (20.8)	Total N (%) = 313	p-value	Unsatisfied N (%) = 205 (65.5)	Satisfied N (%) = 108 (34.5)	Total N (%) = 313	p-value
Education	Illiterate	148 (59.7)	31 (47.7)	179 (57.2)	**0.007**	115 (56.1)	64 (59.3)	179 (57.2)	**0.032**
	Under primary	41 (16.5)	5 (7.7)	46 (14.7)		39 (19.0)	7 (6.5)	46 (14.7)	
	Primary pass	24 (9.7)	16 (24.6)	40 (12.8)		22 (10.7)	18 (16.7)	40 (12.8)	
	Under high school	24 (9.7)	9 (13.8)	33 (10.5)		19 (9.3)	14 (13.0)	33 (10.5)	
	High school & others	11 (4.4)	4 (6.2)	15 (4.8)		10 (4.9)	5 (4.6)	15 (4.8)	
Occupation	Homemaker	61 (24.6)	9 (13.8)	70 (22.4)	**0.036**	59 (28.8)	11 (10.2)	70 (22.4)	**0.004**
	Other	1 (0.4)	0 (0.0)	1 (0.3)		1 (0.5)	0 (0.0)	1 (0.3)	
	Public sector worker	33 (13.3)	2 (3.1)	35 (11.2)		25 (12.2)	10 (9.3)	35 (11.2)	
	self-employed	138 (55.6)	50 (76.9)	188 (60.1)		107 (52.2)	81 (75.0)	188 (60.1)	
	Student	1 (0.4)	0 (0.0)	1 (0.3)		1 (0.5)	0 (0.0)	1 (0.3)	
	Teacher	4 (1.6)	0 (0.0)	4 (1.3)		3 (1.5)	1 (0.9)	4 (1.3)	
	Unemployed	10 (4.0)	4 (6.2)	14 (4.5)		9 (4.4)	5 (4.6)	14 (4.5)	
Monthly income	Below 8000 BDT	114 (46.0)	20 (30.8)	134 (42.8)	0.164	91 (44.4)	43 (39.8)	134 (42.8)	0.863
	8000–12,000 BDT	91 (36.7)	30 (46.2)	121 (38.7)		76 (37.1)	45 (41.7)	121 (38.7)	
	13,000–18,000 BDT	32 (12.9)	12 (18.5)	44 (14.1)		29 (14.1)	15 (13.9)	44 (14.1)	
	18,000+ BDT	11 (4.4)	3 (4.6)	14 (4.5)		9 (4.4)	5 (4.6)	14 (4.5)	
Type of family	Nuclear	104 (41.9)	20 (30.8)	124 (39.6)	0.135	77 (37.6)	47 (43.5)	124 (39.6)	0.367
	Joint	144 (58.1)	45 (69.2)	189 (60.4)		128 (62.4)	61 (56.5)	189 (60.4)	
Numbers of rooms	1	199 (80.2)	47 (72.3)	246 (78.6)	0.210	160 (78.0)	86 (79.6)	246 (78.6)	0.758
	2	30 (12.1)	13 (20.0)	43 (13.7)		27 (13.2)	16 (14.8)	43 (13.7)	
	3	13 (5.2)	2 (3.1)	15 (4.8)		12 (5.9)	3 (2.8)	15 (4.8)	
	4	4 (1.6)	3 (4.6)	7 (2.2)		5 (2.4)	2 (1.9)	7 (2.2)	
	Others	2 (0.8)	0 (0.0)	2 (0.6)		1 (0.5)	1 (0.9)	2 (0.6)	

Respondents who were less educated or worked as homemakers were more likely to be unsatisfied with safe drinking water and less comfortable with the water supply.

3.3.2 | Chi-square analysis of hygiene and sanitation practice with demographic characteristics

Table 5 represents the association between hygiene and sanitation and demographic characteristics. From the Chi-square analysis, it appears that there is a statistically significant association between education, occupation, monthly income, and the number of rooms in the house with both hygiene and sanitation practices. Specifically:

Education

There is a statistically significant ($p \leq 0.05$) association between education and hygiene but this study finds no significant association between education and sanitation practices. Those who are illiterate or have only completed primary school are less satisfied with both hygiene and sanitation practices compared to those who have completed high school or beyond.

Occupation

There is a statistically significant ($p \leq 0.05$) association between occupation and sanitation practices. Homemakers are less satisfied with sanitation practices compared to those who are self-employed, public-sector workers, teachers, or unemployed.

TABLE 5 Chi-square analysis for finding the association between demographic variables and hygiene and sanitation practice.

Variable	Level	Hygiene How satisfied are you with multiple people using the same bathroom?				Sanitation How satisfied are you that multiple people are using the toilet?			
		Unsatisfied N (%) = 280 (89.5)	Satisfied N (%) = 33 (10.5)	Total N (%) = 313	p-value	Unsatisfied N (%) = 257 (82.1)	Satisfied N (%) = 56 (17.9)	Total N (%) = 313	p-value
Education	Illiterate	169 (60.4)	10 (30.3)	179 (57.2)	**0.021**	154 (59.9)	25 (44.6)	179 (57.2)	0.239
	Under primary	38 (13.6)	8 (24.2)	46 (14.7)		37 (14.4)	9 (16.1)	46 (14.7)	
	Primary pass	32 (11.4)	8 (24.2)	40 (12.8)		29 (11.3)	11 (19.6)	40 (12.8)	
	Under high school	28 (10.0)	5 (15.2)	33 (10.5)		26 (10.1)	7 (12.5)	33 (10.5)	
	High school & others	13 (4.6)	2 (6.1)	15 (4.8)		11 (4.3)	4 (7.1)	15 (4.8)	
Occupation	Homemaker	61 (21.8)	9 (27.3)	70 (22.4)	0.479	50 (19.5)	20 (35.7)	70 (22.4)	**0.007**
	Other	1 (0.4)	0 (0.0)	1 (0.3)		0 (0.0)	1 (1.8)	1 (0.3)	
	Public sector worker	34 (12.1)	1 (3.0)	35 (11.2)		34 (13.2)	1 (1.8)	35 (11.2)	
	self-employed	165 (58.9)	23 (69.7)	188 (60.1)		155 (60.3)	33 (58.9)	188 (60.1)	
	Student	1 (0.4)	0 (0.0)	1 (0.3)		1 (0.4)	0 (0.0)	1 (0.3)	
	Teacher	4 (1.4)	0 (0.0)	4 (1.3)		4 (1.6)	0 (0.0)	4 (1.3)	
	Unemployed	14 (5.0)	0 (0.0)	14 (4.5)		13 (5.1)	1 (1.8)	14 (4.5)	
Monthly income	Below 8000 BDT	121 (43.2)	13 (39.4)	134 (42.8)	**0.001**	113 (44.0)	21 (37.5)	134 (42.8)	**0.013**
	8000–12,000 BDT	109 (38.9)	12 (36.4)	121 (38.7)		99 (38.5)	22 (39.3)	121 (38.7)	
	13,000–18,000 BDT	42 (15.0)	2 (6.1)	44 (14.1)		38 (14.8)	6 (10.7)	44 (14.1)	
	18,000+ BDT	8 (2.9)	6 (18.2)	14 (4.5)		7 (2.7)	7 (12.5)	14 (4.5)	
Type of family	Nuclear	109 (38.9)	15 (45.5)	124 (39.6)	0.591	95 (37.0)	29 (51.8)	124 (39.6)	0.057
	Joint	171 (61.1)	18 (54.5)	189 (60.4)		162 (63.0)	27 (48.2)	189 (60.4)	
Numbers of rooms	1	226 (80.7)	20 (60.6)	246 (78.6)	0.054	213 (82.9)	33 (58.9)	246 (78.6)	0.001
	2	35 (12.5)	8 (24.2)	43 (13.7)		30 (11.7)	13 (23.2)	43 (13.7)	
	3	12 (4.3)	3 (9.1)	15 (4.8)		8 (3.1)	7 (12.5)	15 (4.8)	
	4	6 (2.1)	1 (3.0)	7 (2.2)		6 (2.3)	1 (1.8)	7 (2.2)	
	Others	1 (0.4)	1 (3.0)	2 (0.6)		0 (0.0)	2 (3.6)	2 (0.6)	

Monthly income

There is a statistically significant ($p \leq 0.01$) association between monthly income and both hygiene and sanitation practices. Those with lower monthly incomes (below 8000 BDT) are less satisfied with both hygiene and sanitation practices compared to those with higher monthly incomes.

Number of rooms

There is a statistically significant association between the number of rooms in the house and both hygiene ($p \leq 0.05$) and sanitation practices ($p \leq 0.01$). Those with fewer rooms in the house are less satisfied with both hygiene hand sanitation practices compared to those with more rooms.

There is no statistically significant association between type of family (nuclear or joint) and hygiene but has a significant relation between sanitation practices types of family ($p \leq 0.05$). However, there is a significant ($p \leq 0.05$) association between the type of family and sanitation practices. Those living in joint families are less satisfied with sanitation practices compared to those living in nuclear families, although this result did not reach statistical significance at the conventional level of 5% level.

It is important to note that while these associations are statistically significant, they do not necessarily imply causation. Other factors may be at play that influence both the demographic variables and hygiene and sanitation practices. Further research is needed to determine the nature of these relationships.

3.4 | Logistic regression analysis of water, hygiene, and sanitation with demographic characteristics

3.4.1 | Logistic regression analysis of demographic characteristics and water

The Table 6 shows the results of a logistic regression analysis that aimed to determine the potential factors between demographic variables and water practice. The variables included in the analysis were education, occupation, monthly income, type of family, and number of rooms.

For the variable education, those who had under primary education had significantly lower odds (odds ratio [OR] = 0.29, $p = 0.006$) of being satisfied with safe drinking water compared to those who were illiterate. Those with primary pass education had higher odds (OR = 2.40, $p \leq 0.05$) of being comfortable with the water supply.

For the occupation variable, those who were self-employed had significantly higher odds (OR = 4.33, $p \leq 0.01$) of being satisfied with safe drinking water compared to homemakers. The odds for other occupation categories were not significant.

TABLE 6 Logistic regression analysis for determining potential factors between demographic variables and water practice.

Variables	How comfortable are you with the water supply here?			How satisfied are you with safe drinking water?		
	OR[a]	95% CI[a]	p-value	OR[a]	95% CI[a]	p-value
Education						
Illiterate	–	–		–	–	
Under primary	0.47	0.15, 1.23	0.2	0.29	0.11, 0.67	0.006
Primary pass	2.40	1.07, 5.32	0.031	1.34	0.62, 2.84	0.5
Under high school	1.47	0.54, 3.71	0.4	1.18	0.50, 2.75	0.7
High school & others	2.39	0.53, 9.34	0.2	1.31	0.35, 4.54	0.7
Occupation						
Homemaker	–	–		–	–	
Other	0.00		>0.9	0.00		>0.9
Public sector worker	0.37	0.05, 1.66	0.2	2.12	0.74, 6.06	0.2
self-employed	2.22	0.98, 5.55	0.069	4.33	2.08, 9.66	<0.001
Student	0.00		>0.9	0.00		>0.9
Teacher	0.00		>0.9	2.30	0.10, 25.3	0.5
Unemployed	2.61	0.56, 10.9	0.2	2.69	0.69, 9.88	0.14
Monthly income						
Below 8000 BDT	–	–		–	–	
8000–12,000 BDT	1.73	0.87, 3.51	0.12	1.05	0.59, 1.89	0.9
13,000–18,000 BDT	1.48	0.59, 3.60	0.4	0.84	0.37, 1.84	0.7
18,000+ BDT	0.67	0.10, 3.59	0.7	0.62	0.12, 2.77	0.5
Type of family						
Nuclear	–	–		–	–	
Joint	1.39	0.73, 2.70	0.3	0.71	0.42, 1.22	0.2
Numbers of rooms						
1	–	–		–	–	
2	1.54	0.65, 3.49	0.3	1.26	0.58, 2.72	0.6
3	0.56	0.08, 2.55	0.5	0.55	0.11, 2.12	0.4
4	3.52	0.53, 21.7	0.2	1.25	0.15, 7.41	0.8
Others	0.00		>0.9	2.01	0.06, 68.2	0.7

[a]OR = odds ratio, CI = confidence interval.

For monthly income, there were no significant differences in odds between income categories.

For type of family and number of rooms, there were no significant differences in odds between categories.

Overall, the results suggest that education and occupation may be factors that influence people's perception of water supply and safe drinking water in this context.

3.4.2 | Logistic regression analysis of demographic characteristics and hygiene and sanitation practice

The Table 7 provides the OR with 95% confidence intervals (CI) and p-values for the association between education level, occupation, monthly income, type of family, number of rooms, and satisfaction with hygiene and sanitation variables.

TABLE 7 Logistic regression analysis for determining potential factors between demographic variables and hygiene and sanitation practice.

Variables	Hygiene How satisfied are you with multiple people using the same bathroom?			Sanitation How satisfied are you that multiple people are using the toilet?		
	OR[a]	95% CI[a]	p-value	OR[a]	95% CI[a]	p-value
Education						
Illiterate	–	–		–	–	
Under primary	4.50	1.55, 13.0	0.005	2.13	0.82, 5.28	0.11
Primary pass	3.70	1.19, 11.2	0.020	1.95	0.76, 4.83	0.2
Under high school	3.29	0.80, 12.0	0.080	2.05	0.61, 6.19	0.2
High school & others	1.75	0.19, 10.3	0.6	1.88	0.34, 8.64	0.4
Occupation						
Homemaker	–	–		–	–	
Other	0.00		>0.9	16,564,443	0.00, NA	>0.9
Public sector worker	0.31	0.02, 2.08	0.3	0.10	0.01, 0.55	0.031
self-employed	0.90	0.34, 2.49	0.8	0.51	0.24, 1.11	0.087
Student	0.00		>0.9	0.00		>0.9
Teacher	0.00		>0.9	0.00		>0.9
Unemployed	0.00	0.00, 665,335,831,610	>0.9	0.27	0.01, 1.76	0.2
Monthly income						
Below 8000 BDT	–	–		–	–	
8000–12,000 BDT	0.96	0.37, 2.47	>0.9	1.51	0.70, 3.30	0.3
13,000–18,000 BDT	0.38	0.05, 1.64	0.2	1.11	0.33, 3.32	0.9
18,000+ BDT	4.57	0.79, 28.4	0.091	1.70	0.27, 9.74	0.6
Type of family						
Nuclear	–	–		–	–	
Joint	0.54	0.22, 1.33	0.2	0.29	0.13, 0.61	0.001
Numbers of rooms						
1	–	–		–	–	
2	2.45	0.79, 7.13	0.11	3.89	1.58, 9.62	0.003
3	2.83	0.40, 15.0	0.2	8.56	2.23, 34.0	0.002
4	1.00	0.04, 9.82	>0.9	1.38	0.06, 11.0	0.8
Others	3.03	0.07, 125	0.5	150,919,830	0.00, NA	>0.9

[a]OR = odds ratio, CI = confidence interval.

For the variable "satisfaction with multiple people using the same bathroom," the following significant associations were found:

Education: Compared to illiterate individuals, those who passed primary school (OR = 3.70, 95% CI: 1.19–11.2, $p \leq 0.05$) were more likely to be satisfied with multiple people using the same bathroom.

Type of family: Those living in joint families (OR = 0.54, 95% CI: 0.22–1.33, $p \leq 0.05$) were less likely to be satisfied with multiple people using the same bathroom compared to those living in nuclear families.

Number of rooms: Those living in houses with two (OR = 2.45, 95% CI: 0.79–7.13, $p > 0.10$) and three rooms (OR = 2.83, 95% CI: 0.40–15.0, $p > 0.1$) were more likely to be satisfied with multiple people using the same bathroom compared to those living in houses with one room.

For the variable "satisfaction that multiple people are using the toilet," the following significant associations were found:

Occupation: Public sector workers (OR = 0.10, 95% CI: 0.01–0.55, $p \leq 0.05$) were less likely to be satisfied that multiple people are using the toilet compared to homemakers.

Type of family: Those living in joint families (OR = 0.29, 95% CI: 0.13–0.61, $p \leq 0.01$) were less likely to be satisfied that multiple people are using the toilet compared to those living in nuclear families.

Number of rooms: Those living in houses with two (OR = 3.89, 95% CI: 1.58–9.62, $p \leq 0.01$) and three rooms (OR = 8.56, 95% CI: 2.23–34.0, $p \leq 0.01$) were more likely to be satisfied that multiple people are using the toilet compared to those living in houses with one room.

4 | DISCUSSION

The study revealed the practice level of WASH of Bihari Refugees and associated factors. Education ($p \leq 0.01$) and occupation ($p \leq 0.05$) are associated factors of water supply. Education ($p \leq 0.05$) and occupation (0.004) are associated with satisfaction of drinking water. Education ($p \leq 0.05$) and monthly income ($p \leq 0.01$) are associated with hygiene practice. Educated respondents with high monthly income are not satisfied with hygiene practice. Occupation ($p \leq 0.01$), monthly income ($p \leq 0.05$) and number of rooms ($p \leq 0.01$) are associated with sanitation practice.

The study has some limitations. The study is cross-sectional in design, which means that it only captures a snapshot of the situation at one point in time and cannot establish causality or determine changes in behavior over time and study only focuses on one refugee camp in Bangladesh and may not be representative of all refugee camps in the country or in other parts of the world. The study relies on self-reported data from the refugees, which may be subject to social desirability bias or recall bias.

The assessment of water, hygiene, and sanitation practice suggests that the surveyed population faces significant challenges related to WASH practices. There are many similar findings of various studies about challenges related to WASH practices. A study

conducted in refugee camps in Bangladesh found that access to safe water, sanitation facilities, and hygiene promotion programs was inadequate, leading to a high prevalence of waterborne diseases and poor hygiene practices among the population.[24] Another study in a rural community in Nigeria reported that lack of access to clean water and sanitation facilities led to poor hygiene practices, contributing to the high prevalence of diarrheal diseases among children.[26]

Inadequate practices in the domains of WASH can yield adverse consequences for both public health and the environment. Numerous regions across the globe suffer from inadequate access to a dependable and uncontaminated supply of potable water (Orimoloye et al., 2015). Consequently, individuals are compelled to rely on compromised water sources, thereby increasing the likelihood of contracting waterborne illnesses. Insufficient or absent sanitation facilities, encompassing poor toilet infrastructure, can result in the practice of open defecation, inappropriate waste disposal, and the pollution of water sources. Certain cultural habits and beliefs may impede the adoption of enhanced WASH practices.[27] For example, cultural norms and beliefs regarding sanitation or the utilization of certain water sources can discourage communities from embracing and implementing healthy practices. Lack of adequate understanding on the significance of appropriate hygiene and sanitation might lead to the adoption of substandard practices.[28] There exists a potential lack of awareness among individuals regarding the potential hazards linked to inadequate hygiene practices, or a potential lack of knowledge regarding the methods and practices necessary to uphold optimal hygiene standards. Low-income communities may encounter challenges in terms of financial accessibility and sustainability when it comes to procuring and upkeeping adequate WASH infrastructure. These circumstances may lead to the presence of below-standard facilities, limited availability of clean water, and poor provision of hygiene products.[29]

A study in urban slums in India found that inadequate water supply and poor sanitation facilities were major contributors to poor health outcomes, with high rates of diarrhoea and other waterborne diseases.[27] In rural Cambodia a study was conducted which found that lack of access to safe water and sanitation facilities led to poor hygiene practices and contributed to high rates of waterborne diseases and other health problems.[29]

These studies highlight the challenges faced by populations in different contexts related to WASH practices, and emphasize the need for effective interventions to improve access to clean water, sanitation facilities, and hygiene promotion programs. There is a need to improve access to safe and clean water, increase the availability of private toilet facilities, and address the challenges associated with multiple people using the same toilet. Improving hygiene practices and addressing the challenges associated with living in crowded conditions could also help improve the overall health and well-being of the population.

The Chi-square analysis of water, hygiene, and sanitation practice with demographic characteristics found that education and occupation are important factors that influence water practices, particularly regarding safe drinking water and comfort with the water

supply. Respondents who were less educated or worked as home-makers were more likely to be unsatisfied with safe drinking water and less comfortable with the water supply. The analysis also found a statistically significant association between education, occupation, monthly income, and the number of rooms in the house with both hygiene and sanitation practices. Specifically, those who are illiterate or have only completed primary school, homemakers, those with lower monthly incomes, and those with fewer rooms in the house are less satisfied with both hygiene and sanitation practices compared to their counterparts. In Kenya, the sanitation coverage stood at 47.6%, with a majority of individuals use shared sanitary facilities.[30] Atuyambe et al., conducted a study in Eastern Uganda and reported that gender was significantly associated with WASH practice.[31] Males did 1.583 times more good practice of WASH.[31] In Mongolia, a study was conducted by Enkhbat et al., and reported that handwashing practice among pupils for both key occasions was found to be 50.1%. The results indicate a significant association between the female gender (AOR = 0.56, 95% CI = 0.45, 0.70), number of siblings (AOR = 0.72, 95% CI = 0.61, 0.80), and the presence of handwashing facilities at school (AOR = 1.15, 95% CI = 0.86, 1.42).[32] According to the data, a mere 34% of students engage in the practice of handwashing with soap while at school. The primary factors contributing to the omission of handwashing include the unavailability of soap, accounting for 23.9% of cases, the absence of a sink facility, which constituted 14.5% of instances, and the substitution of hand sanitizer, which accounted for 19.7% of occurrences.[32] In the Nigerian context, a significant majority of respondents, specifically 386 individuals (representing 96.5% of the sample), engage in the practice of handwashing mostly after consuming meals.[33] Additionally, a substantial proportion of partici-pants, 318 individuals (equivalent to 79.5% of the sample), reported engaging in handwashing before eating. Furthermore, a considerable number of respondents, 284 individuals (representing 71.0% of the sample), indicated that they engage in handwashing after coming into contact with children's feces. Furthermore, the data revealed that a significant majority of houses, specifically 357 (89.2%), lacked a drainage system. Additionally, 313 (78.3%) of the houses were found to possess a waste storage facility, while 325 (81.3%) had access to a rubbish dumpsite. Notably, a substantial proportion of houses, 358 (89.5%), did not exhibit any stench of excreta in their vicinity (Inah et al., 2020).

Water, hygiene, and sanitation practices are critical in refugee camps as they are key factors in maintaining the health and well-being of refugees. Access to clean and safe drinking water is essential to prevent the spread of waterborne diseases such as cholera, typhoid, and diarrhoea. Proper water management and sanitation systems help to prevent the spread of disease, improve overall health, and ensure adequate hydration. Hygiene practices, such as regular handwashing, are essential to prevent the spread of disease. In a crowded environment like a refugee camp, where disease can easily spread, it is important to promote and encourage good hygiene practices. Proper sanitation facilities, including toilets and waste disposal systems, are crucial in preventing the spread of disease.

Inadequate sanitation facilities can lead to the contamination of water sources and the spread of diseases. Access to appropriate sanitation facilities can help to maintain the dignity and privacy of refugees. It can also reduce the risk of gender-based violence. Access to safe and adequate water, hygiene, and sanitation facilities can have a positive impact on the mental health of refugees. It can reduce stress and anxiety and promote a sense of well-being.[34–36]

The Bangladesh government, in collaboration with various international organizations, should take several steps to improve water, hygiene, and sanitation practices among the Bihari refugee camps. Here are some of the steps taken:

- Provision of clean water: The government, with the support of UNICEF and other aid organizations, has installed hand pumps and tube wells in the camps to provide clean water for drinking and other purposes.
- Construction of latrines: The government has constructed latrines in the camps to improve sanitation and hygiene. They have also launched awareness campaigns to educate refugees on the importance of using the latrines.
- Solid waste management: The government has established waste management systems in the camps to reduce environmental pollution and prevent the spread of diseases.
- Hygiene promotion: The government has conducted hygiene promotion campaigns in the camps, focusing on handwashing, menstrual hygiene, and personal hygiene.
- Capacity building: The government has provided training to refugee community leaders on water, hygiene, and sanitation practices. This helps them to spread awareness among their community members.
- Rehabilitation and Resettlement: The government has taken steps to rehabilitate and resettle the Bihari refugees. They have provided housing, education, and employment opportunities to help them lead a better life.
- Overall, the government's efforts have significantly improved water, hygiene, and sanitation practices among the Bihari refugee camps in Bangladesh. However, more needs to be done to ensure a sustainable and long-term solution to their problems.

5 | CONCLUSION AND POLICY IMPLICATIONS

In a world that often perceives WASH issues as predominantly affecting developing countries, this study serves as a poignant reminder that the challenges within this realm transcend geographical and socioeconomic boundaries. The evaluation of WASH practices among Bihari refugees in Bangladesh sheds light on a broader, universal concern—the fundamental human right to access clean water, proper sanitation, and hygienic conditions, which should be upheld regardless of one's refugee status or location. The findings reveal a stark reality: the vast majority of respondents express dissatisfaction with their WASH conditions, indicating an urgent need

for intervention and improvement. These statistics not only reflect the immediate plight of the Bihari refugee community but also echo the struggles of numerous marginalized and displaced populations worldwide. Moreover, the study identifies specific socioeconomic factors influencing WASH satisfaction, emphasizing the complex interplay between individual circumstances and broader systemic issues. It underscores the importance of tailored and holistic approaches to address the multifaceted challenges faced by refugee communities, seeking to empower them to take control of their living conditions and futures.

The assessment of water, hygiene, and sanitation practices among Bihari refugees in Bangladesh provides broader policy recommendations and implications for refugee management and humanitarian efforts. Firstly, the study underscores the critical importance of addressing the basic needs of refugees, including access to clean water and proper sanitation facilities, as a fundamental right. It highlights the necessity for governments, humanitarian organizations, and international bodies to work collaboratively to ensure adequate infrastructure and resources are in place to meet these needs.

Additionally, the findings emphasize the significance of culturally sensitive educational programs and community engagement initiatives aimed at improving hygiene and sanitation practices within refugee camps. These programs can help empower refugees to take ownership of their living conditions and promote healthier behaviors. Moreover, the study underscores the need for long-term solutions, including potential resettlement or integration programs, to improve the overall well-being and prospects of the refugee population. Such initiatives can alleviate the strain on host countries and facilitate the self-reliance and self-sufficiency of refugees. Furthermore, this study's implications extend to a broader context of refugee management, emphasizing the critical importance of basic needs provision, education, and long-term solutions in ensuring the welfare and dignity of displaced populations.

AUTHOR CONTRIBUTIONS

Md. Khaled Sifullah: formal analysis; investigation; methodology; validation; visualization; writing—original draft. **Md. Salman Sohel**: data curation; formal analysis; investigation; methodology; resources; supervision; writing—original draft; writing—review & editing. **Safayet Jamil**: data curation; investigation; software; visualization; writing—original draft. **Md. Mahdi Hasan**: investigation; resources; validation; visualization; writing—original draft. **Jeba Anika**: data curation; investigation; software; validation; writing—original draft. **Husain Rakib Swadhin**: formal analysis; methodology; software; writing—original draft. **Neeru Chaudhary**: formal analysis; supervision; validation; visualization. **Md. Naimur Rahman**: conceptualization; formal analysis; methodology; project administration; supervision; writing—original draft; writing—review & editing. **Mohima Shaiara**: data curation; validation; visualization; writing—original draft. **Md Tariqul Islam**: data curation; formal analysis; investigation; resources; writing—original draft. **Babor Ahmad**: methodology; resources; validation; visualization; writing—original draft. **Mishal Islam Shomapto**: investigation; visualization; writing—original draft. **Md Fouad Hossain Sarker**: conceptualization; investigation; methodology; visualization; writing—original draft; writing—review & editing. **S. M. Sohag**: data curation; formal analysis; software; visualization; writing—original draft.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

All data generated or analyzed during this study are included in this article and can be requested from the corresponding author. All authors have read and approved the final version of the manuscript [CORRESPONDING AUTHOR or MANUSCRIPT GUARANTOR] had full access to all of the data in this study and takes complete responsibility for the integrity of the data and the accuracy of the data analysis."

ETHIC STATEMENT

The study was approved by Institutional Ethical Review Board, Faculty of Humanities and Social Science, Daffodil International University, Dhaka 1212, Bangladesh, (Protocol No. Ethics/khaled2/2022). The respondent's identity was maintained anonymous. Before each interview, participants were asked for permission, and they had the option to withdraw at any moment.

TRANSPARENCY STATEMENT

The lead author Md. Naimur Rahman affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.