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# Determination of Psychosocial Factors of Drinking Chlorinated Water to Design Behavior Change Interventions in Rohingya Camps in Bangladesh

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*Abstract.* The purpose of this study was to identify the psychosocial factors of chlorinated water uptake and to design effective behavior change techniques applying the risk, attitude, norm, ability, and self-regulation (RANAS) behavior change model. This cross-sectional study was conducted in two Rohingya refugee camps in Cox's Bazar, Bangladesh. In total, 596 respondents were recruited through systematic random sampling. A structured interviewer-administered questionnaire was used to assess the psychosocial factors according to the RANAS model. We used correlation analysis and multivariable linear regression models to predict the psychosocial factors of the consumption of chlorinated water. The respondents in this study had a medium to high habit of drinking chlorinated water. For the overall sample, participants' habits were predicted by income, perceived vulnerability, like of chlorinated water, feelings of being healthy, action planning skills, and coping planning skills. In Camp 14, income, vulnerability, and coping planning were strongly influential in predicting habit; in Camp 16, liking chlorinated water and action planning were the most influential factors. Behavior change techniques against each factor with proper communication channels have been proposed for the overall sample and specific to each camp. The psychosocial factors identified and the behavior change strategies proposed in this study may help to promote chlorinated water consumption among the camp population. This study also recommends follow-up research that considers more contextual factors, uses larger sample sizes, and examines the effectiveness of the intervention.

## INTRODUCTION

Treatment of water at the source or in the household is a common water, sanitation, and hygiene (WASH) intervention in emergency settings. This WASH intervention is mainly important in responses to emergencies, because untreated drinking water can increase the risk of infectious disease and, thus, the chances of an outbreak.[1–3] Chlorination is a widely used first-line method for treating drinking water in emergencies.[4] Its extensive use in such responses is a consequence of its ready availability, user friendliness, cost-effectiveness, and antibacterial and antiviral efficacy.[5] However, evidence about the effectiveness of chlorination interventions in emergencies is sparse.[4] Differences in living conditions, locations, culture, and type of emergency require a specific tailoring of chlorination programs, which are therefore challenging.[6,7]

The Rohingya refugee crisis is one of the largest complex humanitarian emergencies. In the Cox's Bazar district of Bangladesh, approximately 912,000 Rohingyas, also known as forcibly displaced Myanmar nationals), are currently residing in 34 camps. A large proportion of them, ≈723,000, fled to Bangladesh in August 2017.[8] The challenging environmental conditions they face, including high population density and uneven topography, produce a need for strong WASH facilities.[9] For such services, the Rohingya population depends entirely on support from United Nations agencies, the government of Bangladesh, and nongovernmental organizations (NGOs).[10] The use of heavily contaminated water sources for drinking poses a serious threat to public health among the Rohingya population.[11] Women and children are most likely to be affected with acute watery diarrhea (AWD), which is endemic to this region.[11] A recent study reported a significantly high prevalence of diarrheal diseases at the Rohingya refugee camps in Bangladesh, and children younger than 5 years of age are at high risk of AWD and cholera outbreaks.[11] Although the coverage of WASH responses has increased since the beginning of the influx, nearly half the households (48%) still face problems in accessing or collecting safe and chlorinated drinking water.[12] The interventions commonly implemented by the WASH agencies working in these camps includes distribution of chlorine tablets (water purification tablets) to households, bucket chlorination at the source during AWD outbreaks, and chlorinated piped water networks for the provision of safe drinking water.

Even when these infrastructure and environmental factors (e.g., ease of access and availability) are provided, effective implementation also depends on users' acceptance of chlorinated water, which in turn may depend on factors such as taste of water, mode of service delivery, frequency, and rumors and misconceptions.[4] The services provided by the WASH agencies require that some actions be taken at the personal or household levels; these include collection of chlorinated water from the source, chlorination with chlorine tablets at home, and safe storage. The consumer then decides which services to adopt, depending on their social, physical, and contextual factors.[13,14] These factors include cultural norms, the surrounding environment, socioeconomic factors, and demography. To understand and evaluate users' decisions about drinking chlorinated water, health psychology theory considers psychosocial factors describing individual's mind-sets.[15–17] These factors can provide insights into why users engage in specific health behaviors and, once identified, can be used to design behavior change interventions to foster drinking chlorinated water in the camps.[18–23] The situations in different camps may vary in their demographic, contextual, and psychosocial factors; the

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availability of services; and the design of WASH agencies' interventions. Therefore, identifying the factors that influence chlorinated water uptake will also help to decide whether to design separate behavior change strategies for each specific camp's population.

The risk, attitude, norm, ability, and self-regulation (RANAS) model is a useful tool for understanding behaviors and is designed specifically to be applied in development and emergency contexts; it has proved to be effective in formulating behavior change interventions for WASH-related behaviors.[18,20,23–26] In the context of drinking chlorinated water, behavior change campaigns based on the RANAS approach have improved safe water consumption among participants in Chad.[24] The RANAS model compiles a broad range of psychological factors from various models and assigns each to one of five categories.[17] Risk factors include peoples' understanding of their own vulnerability to contracting a disease, its severity, and their knowledge about it (e.g., risk of getting diarrhea if not drinking chlorinated water and its effect on health). Attitude factors comprise an individual's feelings and beliefs about the costs and benefits of a particular behavior (e.g., the perceived price, taste preferences, time and difficulties of water collection, benefits of chlorinated or nonchlorinated water). Norm factors represent an individual's understanding of a behavior commonly performed within a society, its popularity, approval or disapproval of it by others, and the individual's responsibility to perform it. Ability factors include the individual's perceived capacity to perform a behavior (treatment and uptake of chlorinated water), to maintain it, and to recover it after a crisis. The final component, self-regulation, includes coping planning, commitment, and remembering to perform the behavior.

To the best of our knowledge, no systematic assessment has been undertaken to determine psychosocial factors influencing chlorinated water uptake or behavior change interventions in a specific settlement or an entire population in the Rohingya camps in Cox's Bazar. In this assessment, the RANAS model, with its individual components, is used to identify the psychosocial factors that influence chlorinated water uptake by the people residing in two Rohingya camps. It also identifies the psychosocial factors distinctive to each camp. When these psychosocial factors are identified, the RANAS approach also outlines the behavior change techniques (BCTs) to be applied to the target beneficiaries.[27]

The main purpose of this study was to identify the psychosocial factors that influence the habit of drinking chlorinated water among the Rohingya population in two camps, and specific either to each camp if necessary, and for the population as a whole. Therefore, this study addresses the following research questions:

1. Which psychosocial factors influence the habit of drinking chlorinated water for the surveyed population in both Rohingya camps?
2. Which psychosocial factors influence the habit of drinking chlorinated water for the people specific to each camp?

## METHODS

**Study design.** The Rohingya refugees are located in 34 camps in two upazilas, or subdistricts, of Cox's Bazar district: Ukhiya and Teknaf. Consequently, our study area was in the Ukhiya Upazila, and our data were collected from the Rohingya population residing in multiple blocks of camps 14 and 16. The process started with a focus group discussion with WASH experts from various implementing partners working in different refugee camps. The Bangladesh Rural Advancement Committee (BRAC) and Dushthya Shashthya Kendra (DSK) are the national NGOs working as WASH camp focal agencies funded by United Nations Children's Fund (UNICEF). BRAC and DSK are working on behavior change interventions for the uptake of chlorinated water in camps 14 and 16.

**Survey instruments.** The data presented are the baseline data of a large pre-/post-design research project and therefore represent cross-sectional data. The data were collected by conducting face-to-face interviews at 596 households in total: 294 households in camp 14 and 302 households in camp 16. A sample size of 565 households was calculated for 14 predictors, assuming a medium effect of 20%, 80% power, a significance level of 5%, and a 20% expected dropout. Because of practical reasons, we wanted to collect 300 pieces of data from each camp. The total sample size was 596; this figure is less than 600 as a result of some missing data or errors. The total households in camps 14 and 16 are approximately 6,382 and 4,357 respectively. A systematic random sampling technique was used to select the households. We received a list of blocks from each camp. The data collectors were assigned according to the block numbers. In each block, we selected the households using the random route method in which every third household is selected. Our target group was both men and women 18 years and older. Persons with disabilities, children, and pregnant and lactating women were excluded from the study. All interviews were conducted using a structured interviewer-administered questionnaire based on the RANAS model.[17] The interviewers from BRAC and DSK are from the local host community. They are familiar with the Rohingya language. The interviewers also had prior experience in conducting qualitative and quantitative interviews. The research team went through a week of training to orient the interviewers regarding the study objectives, theoretical implications of the RANAS model, sampling procedures, the use of questionnaires in the local language, and the procedure for asking for consent. Simulation exercises and 2 days of fieldwork during training also tested the research instruments and validation. After the field exercise, modifications were made to the questionnaires as required.

The main questionnaire was designed in English and translated into Bengali by a team of local experts before the training took place. During training, the interviewers were familiarized with the questionnaire and tested it in the field in the Rohingya language. After the field test, a group of interviewers discussed any problematic terms used by the Rohingya community. The senior staff of BRAC and DSK supervised the interviewers from their respective organizations. The entire process was supervised by local experts, the members of the Hygiene Promotion Technical Working Group at the WASH Sector Cox's Bazar, WASH specialists from UNICEF, and international researchers.

The questionnaire had sections on demographics, method of water collection, water treatment practices, and the behavior and habits of drinking chlorinated water. Several items in the questionnaire (Supplemental Table 1) addressed

each psychosocial factor in the RANAS model. Responses to questions were collected on 5-point Likert scales, with 1 as the minimum and 5 as the maximum. To determine participants habits of drinking chlorinated water, we asked the question "How habitually do you drink chlorinated water?" Responses were collected on a 5-point Likert scale, with answers ranging from "not habitually at all" to "very habitually." To calculate health knowledge, we had two questions. Each question had six correct answers, with a wrong-answer option, and an I-don't-know option. Each correct answer received 1 point; the other answers received a score of zero. We summed the two health knowledge questions and found the highest score (12 points) and the lowest score (0 point). For coping planning and action planning in the self-regulation factor, a new variable was created with two categories: valid plan coded as 1 point and no plan/invalid plan coded as 0 point. Responses were considered either one of the categories.

**Data analysis.** The data collected were analyzed with IBM's SPSS Statistics software package (version 26.0; IBM Corp., Armonk, NY). Descriptive statistics were used to analyze the sociodemographic variables. Independent *t*- and $\chi^2$ tests were used to find the difference between the two camps. Pearson's correlation was used to find the association between the dependent variable (habit of drinking chlorinated water) and a range of independent variables (e.g., psychosocial factors, demographic variables) for the entire sample. The psychosocial factors that correlated significantly with the dependent variable, with an effect size more than 0.2,[28] were then entered into the regression analysis considering all assumptions to meet the criteria. A multivariable linear regression model was used to determine the significant predictor variable for the habit of drinking chlorinated water among the entire surveyed population. Another multivariable linear regression model was used to determine the predictor variables for habit separately for the respondent groups in each camp to answer research question 2. An additional multivariable linear regression model was used to identify significant demographic and contextual factors for habit. Data were distributed normally based on standardized residual plotting.

**Ethics approval.** The study was conducted within the scope of UNICEF's official mandate in the Rohingya camp and under the hygiene promotion intervention project titled Integration of Risks, Attitudes, Norms, Abilities, and Self-Regulation (RANAS) Methodology for Behavior Change in Hygiene Promotion Approaches in the WASH Rohingya Response: Analysis, Testing and Evaluation. The project obtained ethical approval from the institutional review board of the Institute of Health Economics, University of Dhaka, which is approved by Federalwide Assurance (no. FWA00026031).

**Field procedures.** The study was conducted within the scope of UNICEF's official mandate in the camp and followed the ethical principles of the American Psychological Association and the Declaration of Helsinki. Before the survey was implemented, verbal permission was obtained from both the local authority in the camps and community leaders. Verbal consent was gathered prior to the interview, but after an explanation of the study background. Participation in this survey was voluntary, and data were kept anonymous.

## RESULTS

A total of 596 Rohingya people were interviewed from the two camps in this assessment.

**Demographics.** The mean age of the respondents was $34.9 \pm 12.19$ years (SD) (range, 18–75 years). The mean age was older in camp 16 than in camp 14 ($F = 4.95$, $P = 0.001$). The average household size was $5.6 \pm 2.35$ people. The average household sizes for camps 14 and 16 were $5.8 \pm 2.37$ people and $5.34 \pm 2.31$ people, respectively. The majority of the respondents among the surveyed population were women ($n = 521$, 87.4%); in both camps, a significant proportion of women attended the interview (camp 14, 84.0%; camp 16, 90.7%). Respondents were also asked about their educational level. Most of the respondents were illiterate ($n = 469$, 78.7%), with a small minority having received primary education ($n = 68$, 11.44%) (Table 1). When we examined the respondent groups by camp, the proportion of people who were illiterate was greater in camp 14, whereas the number of people with a primary education was greater in camp 16 ($P < 0.001$). The average monthly family income was $2,427 \pm 3,393$ Bangladeshi Taka (BDT), with a range of 0 to 40,000 BDT (1 USD $\approx$85.10 BDT). The population in camp 14 had a significantly greater income level than that of camp 16 ($P < 0.001$) (Table 1).

**Source of water and water treatment practices.** Several items in the questionnaire addressed water treatment techniques and chlorinated water consumption. The majority of respondents reported they collect water from a tap or tap stand ($n = 379$, 63.6%; 55.8% for camp 14 and 71.2% for camp 16), followed by a well or tube well ($n = 242$, 40.6%; 54.4% for camp 14 and 27.2% for camp 16). They also mentioned other sources such as rivers, rainwater, and multiple sources. The majority of the respondents (60.2%) reported they collect chlorinated water from the source (bucket chlorination done by volunteers on a roster basis; $n = 359$) (Table 2). The figures were quite similar in both surveyed locations (60.9% in camp 14 and 59.6% in camp 16). Nearly half the respondents (49.3%) also reported they use chlorine tablets to treat the collected water ($n = 294$). Thirty-four percent of respondents ($n = 100$) from camp 14 used chlorine tablets, whereas, in camp 16, this value was 64.2% ($n = 194$). A small proportion of participants mentioned they do not use anything to treat their water ($n = 40$, 6.7%) (Table 2). The frequency of drinking chlorinated water for the whole sample was $4.56 \pm 0.99$) measured on a 6-point Likert scale, with values ranging from 1 point (never) to 6 points (several times a day), which means they drank chlorinated water almost every day. The frequency of drinking chlorinated water was greater among the population in camp 14 than the population in camp 16 ($P < 0.001$). We also asked about the alternatives they used if chlorination was not available. Most replied they drank water without chlorination ($n = 297$, 49.8%), and a large proportion of them were from camp 16 (Table 2).

**Psychosocial factors for drinking chlorinated water.** For the complete sample, the mean score for habit was $2.94 \pm 1.16$ points (SD); the habit for drinking chlorinated water was rather low (Table 3). The score was significantly greater in camp 14 ($3.31 \pm 1.07$ points) than in camp 16 ($2.58 \pm 1.14$ points; $P < 0.001$). Habit was assessed using a 5-point Likert scale, with 1 point meaning "not habitually at all" to 5 points meaning "very habitually." All the psychosocial factors were also measured using a 5-point Likert scale.

TABLE 1
Characteristics of respondents according to their age, gender, and levels of education and income

| Characteristic | Whole sample ($N = 596$) | | Camp 14 ($n = 294$) | | Camp 16 ($n = 302$) | | Camp-wise comparison |
|---|---|---|---|---|---|---|---|
| | *n* | % | *n* | % | *n* | % | |
| Age y; mean ± SD | 34.9 ± 12.3 | | 33.3 ± 11.5 | | 36.6 ± 12.9 | | $t(594) = -3.42$, $P = 0.001$ |
| Gender | | | | | | | |
| Male | 75 | 12.6 | 47 | 16.0 | 28 | 9.3 | $\chi^2$ (1) = 6.11, $P < 0.013$ |
| Female | 521 | 87.4 | 247 | 84.0 | 274 | 90.7 | |
| Educational level | | | | | | | |
| None or don't know | 469 | 78.7 | 247 | 84.4 | 222 | 73.5 | $\chi^2$ (5) = 24.34, $P < 0.001$ |
| Can read but not write | 23 | 3.9 | 14 | 4.8 | 911 | 3.0 | |
| Can read and write | 25 | 4.2 | 14 | 5.4 | 52 | 3.6 | |
| Primary | 68 | 11.4 | 16 | 5.4 | 7 | 17.2 | |
| Secondary | 10 | 1.7 | 3 | 1.0 | 1 | 2.3 | |
| College and higher | 1 | 0.2 | 0 | 0 | 1 | 0.3 | |
| Income, mean ± SD | 2,426.9 ± 3,093.4 | | 3,042.5 ± 2,702.9 | | 1,827.5 ± 3,327.7 | | $t(594) = -4.89$, $P < 0.001$ |

The respondents in this survey perceived neither low nor high risk of becoming sick if they drank chlorinated water (vulnerability, mean ± SD, 2.19 ± 1.23 points), and they thought the impact would be very severe if they became sick by drinking unchlorinated water (severity, 4.37 ± 0.85 points). The respondents did not report a great deal of knowledge regarding becoming sick by drinking unchlorinated water (7.18 ± 1.98 points, out of 12 points). Respondents found it very beneficial to drink chlorinated water (4.14 ± 0.49 points). This survey found a very positive attitude toward drinking chlorinated water (4.14 ± 0.49 points), although many respondents reported they did not like the taste of chlorinated water (3.96 ± 0.84 points). They also felt very comfortable drinking chlorinated water (4.06 ± 0.83 points), and felt quite healthy (2.71 ± 1.03 points) and proud (2.71 ± 1.24 points) of drinking chlorinated water. Respondents found it very important to drink chlorinated water (4.03 ± 0.61 points), and thought it made them respected in their society (3.10 ± 1.18 points) (personal importance factors). The respondents expressed a medium level of confidence in drinking chlorinated water regularly (confidence performance, 3.74 ± 0.78 points). They also showed a medium level of confidence in continuing the behavior (3.65 ± 0.86 points) and recovering even after a crisis (3.56 ± 0.91 points). The respondents reported that they rarely fail to execute the behavior (action control factor, 3.38 ± 0.89 points). Among the respondents, 31% had valid plans to drink chlorinated water (action planning), and 25% had valid plans to continue drinking chlorinated water even when problems arise (coping planning). The respondents remembered (3.39 ± 0.86 points) and also committed to drinking chlorinated water (3.01 ± 1.31 points) (Table 3).

The correlation analysis identified 13 variables to enter into the regression analysis that correlated statistically with the habit of drinking chlorinated water and that had effect sizes more than 0.2, which is a medium effect size[28] (Supplemental Table 2). The results in the regression analysis for the entire sample (adjusted $R^2 = 0.33$, $F[14, 598] = 22.09$, $P < 0.001$) show that vulnerability, liking or disliking chlorinated water, feeling healthy, action planning, and coping planning were the most significant influential factors for habit. In the risk factor block of the RANAS model, vulnerability was a significant predictor for the habit of drinking chlorinated water ($\beta = 0.20$). The stronger the habit of drinking chlorinated water, the less respondents felt the risk of becoming sick by drinking it. Among attitude factors, liking or disliking chlorinated water was also a significant predictor for habit for the whole sample ($\beta = 0.13$). The more they liked to drink chlorinated water, the more they habitually drank it. Another attitude factor, feeling healthy, was an influential psychosocial determinant for the whole sample ($\beta = -0.17$). Respondents were more likely to drink chlorinated water if they felt less healthy. Among self-regulation factors, action planning was also a significant predictor variable for the whole sample ($\beta = 0.29$). The more they reported to have a detailed plan about how, when, and where to drink chlorinated water, the

TABLE 2
Method of water treatment, sources of water, and frequency of uptake chlorinated water

| Variable | Whole sample ($N = 596$) | | Camp 14 ($n = 294$) | | Camp 16 ($n = 302$) | | Camp-wise comparison |
|---|---|---|---|---|---|---|---|
| | *n* | % | *n* | % | *n* | % | |
| Method* | | | | | | | |
| Bucket chlorination at source | 359 | 60.2 | 179 | 60.9 | 180 | 59.6 | $\chi^2$ (1) = 0.10, $P < 0.749$ |
| Chlorine tablets | 294 | 49.3 | 100 | 34.0 | 194 | 64.2 | $\chi^2$ (1) = 54.45, $P < 0.001$ |
| Nothing | 40 | 6.7 | 36 | 12.2 | 4 | 1.3 | $\chi^2$ (1) = 28.38, $P < 0.001$ |
| Other | 40 | 6.7 | 10 | 3.4 | 30 | 9.9 | – |
| Source of water† | | | | | | | |
| Tube well | 242 | 40.6 | 160 | 54.4 | 82 | 27.2 | $\chi^2$ (1) = 45.93, $P < 0.001$ |
| Tap/tap stand | 379 | 63.6 | 164 | 55.8 | 215 | 71.2 | $\chi^2$ (1) = 15.28, $P < 0.001$ |
| Other | 17 | 2.9 | 11 | 3.7 | 6 | 2.0 | – |
| Frequency, mean ± SD | 4.56 ± 0.99 | | 4.74 ± 1.04 | | 4.37 ± 0.91 | | $t(594) = -4.63$, $P < 0.001$ |

* Did you do anything to make your drinking water safer to drink?
† Multiple responses are possible.
‡ In the past week, how often did you drink chlorinated water?

TABLE 3
Descriptive analysis of psychosocial factors ($N = 596$)

| Variables | Whole sample ($N = 596$), mean (SD) | Camp 14 ($n = 294$), mean (SD) | Camp 16 ($n = 302$), mean (SD) |
|---|---|---|---|
| Habit | 2.94 (1.16) | 3.31(1.07) | 2.58 (1.14) |
| Risk factors | | | |
| Vulnerability 1 (drinking chlorinated water) | 2.19 (1.23) | 2.21 (0.89) | 2.17 (1.49) |
| Vulnerability 2 (not drinking chlorinated water) | 4.21 (0.77) | 3.82 (0.78) | 4.59 (0.54) |
| Severity | 4.37 (0.85) | 3.90 (0.84) | 4.83 (0.56) |
| Health knowledge | 7.18 (1.98) | 7.08 (2.47) | 7.27 (1.34) |
| Attitude factors | | | |
| Beliefs about costs and benefits 1 (time-consuming) | 2.33 (1.14) | 2.23 (1.27) | 2.43 (0.98) |
| Beliefs about costs and benefits 3 (beneficial) | 4.14 (0.49) | 4.09 (0.53) | 4.20 (0.45) |
| Feeling 1 (like/dislike chlorinated water) | 4.04 (0.86) | 3.96 (0.95) | 4.11 (0.76) |
| Feeling 2 (like/dislike the taste of unchlorinated water) | 3.20 (1.38) | 3.02 (1.32) | 3.38 (1.41) |
| Feeling 3 (like/dislike the taste of chlorinated water) | 3.96 (0.84) | 4.01 (0.85) | 3.92 (0.83) |
| Feeling 4 (comfortable/uncomfortable) | 4.06 (0.83) | 3.98 (0.83) | 4.13 (0.82) |
| Feeling 5 (anxious) | 1.40 (0.69) | 1.39 (0.77) | 1.40 (0.61) |
| Feeling 6 (disgusted) | 4.53 (0.83) | 4.46 (0.98) | 4.60 (0.64) |
| Feeling 7 (proud) | 2.71 (1.24) | 2.71 (1.32) | 2.71 (1.15) |
| Feeling 8 (healthy) | 2.71 (1.03) | 2.51 (0.90) | 2.91 (1.11) |
| Norm factors | | | |
| Others' behavior 1 (people in the community) | 3.98 (0.79) | 3.98 (0.83) | 3.97 (0.76) |
| Others' behavior 2 (relatives in the community) | 3.78 (0.97) | 3.75 (0.98) | 3.81 (0.97) |
| Others' (dis)approval | 3.84 (0.77) | 3.75 (0.78) | 3.94 (0.75) |
| Personal importance 1 (important/unimportant) | 4.03 (0.61) | 4.00 (0.52) | 4.06 (0.69) |
| Personal importance 2 (respected person) | 3.10 (1.18) | 3.05 (1.28) | 3.14 (1.07) |
| Ability factors | | | |
| Confidence in performance | 3.74 (0.78) | 3.58 (0.83) | 3.90 (0.71) |
| Confidence in continuation | 3.65 (0.86) | 3.58 (0.81) | 3.72 (0.89) |
| Confidence in recovering | 3.56 (0.91) | 3.34 (0.88) | 3.78 (0.89) |
| Self-regulation factors | | | |
| Action planning* | 31 | 35 | 26 |
| Action control | 3.38 (0.89) | 3.37 (1.12) | 3.39 (0.60) |
| Coping planning* | 25 | 30 | 20 |
| Remembering | 3.39 (0.86) | 3.34 (1.06) | 3.42 (0.62) |
| Commitment | 3.01 (1.31) | 2.74 (1.38) | 3.26 (1.19) |

* Percentages with valid plans.

more likely participants were to drink it habitually. The last significant predictor is coping planning, under the self-regulation factors ($\beta = 0.61$). Even when any crisis occurs or a problem arises, the more respondents reported having solutions to possible arising problems, the more strongly they retained the habit of executing the behavior (Table 4).

The regression analysis for each specific camp also revealed the potential predictors of habit of drinking chlorinated water. In camp 14 (adjusted $R^2 = 0.28$, F[14, 279] = 8.94, $P < 0.001$), vulnerability ($\beta = 0.25$), confidence in recovering ($\beta = 0.33$), and coping planning ($\beta = 0.56$) were the significant predictors of habit. In camp 16 (adjusted $R^2 = 0.51$, F[14, 287] = 23.27, $P < 0.001$), liking to drink chlorinated water ($\beta = 0.33$) and action planning ($\beta = 1.07$) were the only significant predictors (Table 4).

The results of regression analysis with demographic variables (adjusted $R^2 = 0.09$, F[2, 37] = 3.00, $P = 0.06$) shows that income was a significant predictor of habit of drinking chlorinated water ($\beta = 6.01$). Gender ($\beta = 0.53$), educational level ($\beta = 0.27$), and income ($\beta = 7.92$) were the significant predictors of habit in camp 14 (adjusted $R^2 = 0.10$, F[4, 289] = 8.82, $P < 0.001$), whereas only age ($\beta = -0.01$) and educational level were related to the habit of drinking water among the population in camp 16 (adjusted $R^2 = 0.02$, F[4, 297] = 2.32, $P = 0.057$). We conducted a separate regression analysis for the water treatment method (adjusted $R^2 = 0.09$, F[2, 37] = 3.00, $P = 0.062$) and water sources (adjusted $R^2 = -0.07$, F[2, 14] = 0.48, $P = 0.631$). Bucket chlorination at the source was the only significant predictor of habit ($\beta = 0.92$) for the whole sample, which was also true for the population at camp 16 ($\beta = 1.25$) (adjusted $R^2 = 0.26$, F[2, 27] = 6.21, $P = 0.006$) (Table 5).

Significant psychosocial, demographic, and contextual predictors from a previous regression analysis from the whole sample were added to a final multivariable linear regression model. The regression analysis (adjusted $R^2 = 0.32$, F[7, 588] = 41.38, $P < 0.001$) reveals that income ($\beta = 3.94$), vulnerability ($\beta = 0.26$), liking chlorinated water ($\beta = 0.20$), and coping planning ($\beta = 0.59$) were the most significant predictors of habit. In camp 14 (adjusted $R^2 = 0.25$, F[7, 286] = 15.09, $P < 0.001$), income ($\beta = 7.62$), vulnerability ($\beta = 0.25$) and coping planning ($\beta = 1.05$) were the most significant predictors of habit. In camp 16 (adjusted $R^2 = 0.50$, F[7, 294] = 44.76, $P < 0.001$), liking chlorinated water ($\beta = 0.39$) and action planning ($\beta = 1.22$) were the most significant predictors of habit (Table 6).

## DISCUSSION

The results in the regression analysis revealed the relevant psychosocial factors of the reported habitual level of drinking chlorinated water for the overall surveyed sample and the subsamples in each camp. The main significant psychosocial factors were vulnerability, liking or disliking chlorinated water, feeling healthy, action planning, and coping planning. Among them, only vulnerability, confidence in

TABLE 4
Results of linear regression analysis on the effect of psychosocial factors on the habit of drinking chlorinated water ($N = 596$)

| Factors | Whole sample | | Camp 14 | | Camp 16 | |
|---|---|---|---|---|---|---|
| | Coefficient | SE | Coefficient | SE | Coefficient | SE |
| Risk factor | | | | | | |
| Vulnerability 1 | 0.20*** | 0.04 | 0.25*** | 0.07 | 0.13 | 0.07 |
| Attitude factors | | | | | | |
| Feeling 1 (like/dislike chlorinated water) | 0.13* | 0.06 | 0.08 | 0.08 | 0.33** | 0.09 |
| Feeling 3 (like/dislike the taste of chlorinated water) | 0.10 | 0.70 | 0.08 | 0.10 | −0.08 | 0.09 |
| Feeling 4 (comfortable/uncomfortable) | −0.11 | 0.08 | −0.01 | 0.11 | −0.03 | 0.09 |
| Feeling 7 (proud) | −0.04 | 0.04 | −0.02 | 0.05 | 0.05 | 0.06 |
| Feeling 8 (healthy) | −0.17*** | 0.04 | 0.00 | 0.07 | −0.07 | 0.06 |
| Norm factors | | | | | | |
| Others' behavior 1 (people in the community) | 0.29 | 0.12 | 0.13 | 0.15 | −0.08 | 0.19 |
| Others' behavior 2 (relatives in the community) | −0.03 | 0.10 | 0.00 | 0.13 | 0.22 | 0.18 |
| Ability factors | | | | | | |
| Confidence in performance | −0.11 | 0.08 | −0.04 | 0.10 | 0.10 | 0.11 |
| Confidence in continuation | 0.07 | 0.08 | 0.01 | 0.12 | −0.16 | 0.11 |
| Confidence in recovering | 0.12 | 0.06 | 0.33*** | 0.09 | 0.08 | 0.08 |
| Self-regulation factors | | | | | | |
| Action planning | 0.29* | 0.14 | −0.35 | 0.18 | 1.07*** | 0.19 |
| Coping planning | 0.61*** | 0.16 | 0.56** | 0.20 | −0.02 | 0.29 |
| Commitment | −0.00 | 0.04 | 0.13 | 0.05 | 0.04 | 0.08 |
| Adjusted $R^2$ value | 0.33*** | | 0.28*** | | 0.51*** | |
| F value | 22.09 | | 8.94 | | 23.27 | |

* $P < 0.05$; ** $P \leq 0.01$; *** $P < 0.001$.

recovering, and coping planning were the significant predictors in camp 14, whereas liking or disliking chlorinated water and action planning were the significant predictors for drinking chlorinated water in camp 16. This discrepancy might be a result of the data quality or because of different influencing factors in camp 14, which was documented with low variance in the regression model. However, the significant psychosocial factors identified in this study helped to list several behaviors change techniques, which are described in detail later in this section. All the BCTs could be achieved through various activities incorporated into WASH interventions implemented by the WASH agencies working in the camps.

Perceived vulnerability connected significantly to the habit of drinking chlorinated water among the population we surveyed. In contrast, studies have reported that people feel less vulnerable to threats of using unsafe water while they are currently treating the water.[24,29] Low perceived vulnerability was also observed in a study in Chad.[25] Respondents in our study also did not see themselves at higher or lower risk if they drank chlorinated water, but the perceived severity of contracting a disease was high. Two knowledge-based questions revealed that respondents had moderate levels of knowledge regarding causes of diarrheal diseases and preventive measures related to safe drinking water. A study in Chad also reported a moderate level of knowledge related to

TABLE 5
Results of linear regression analysis on the effect of demographic and contextual factors on the habit of drinking chlorinated water ($N = 596$)

| Factors | Whole sample | | Camp 14 | | Camp 16 | |
|---|---|---|---|---|---|---|
| | Coefficient | SE | Coefficient | SE | Coefficient | SE |
| Regression analysis for demographics | | | | | | |
| Age | −0.00 | 0.00 | 0.00 | 0.01 | −0.01* | 0.01 |
| Gender | 0.08 | 0.15 | 0.53** | 0.18 | −0.15 | 0.23 |
| Educational level | −0.08 | 0.04 | 0.27*** | 0.07 | −0.13* | 0.05 |
| Income | 6.01*** | 0.00 | 7.92*** | 0.00 | 7.29 | 0.00 |
| Adjusted $R^2$ value | 0.02** | | 0.10 | | 0.02 | |
| F value | 4.69 | | 8.82*** | | 2.32 | |
| Regression analysis for method of water treatment | | | | | | |
| Bucket chlorination at source | 0.92* | 0.35 | 0.22 | 0.74 | 1.25** | 0.36 |
| Chlorine tablets | −0.04 | 0.39 | 1.22 | 0.74 | −0.16 | 0.39 |
| Nothing | – | – | – | – | – | – |
| Other | – | – | – | – | – | – |
| Adjusted $R^2$ value | 0.09 | | 0.07 | | 0.26 | |
| F value | 3.00 | | 1.36 | | 6.21 | |
| Regression analysis for sources of water | | | | | | |
| Tube well | 0.61 | 0.86 | −1.25 | 1.74 | – | – |
| Tap/tap stand | 0.08 | 0.89 | 0.08 | 1.01 | – | – |
| Other | – | – | – | – | – | – |
| Adjusted $R^2$ value | −0.07 | | −0.17 | | – | |
| F value | 0.48 | | 0.27 | | – | |

* $P < 0.05$; ** $P \leq 0.01$; *** $P < 0.001$.

TABLE 6
Final linear regression analysis on the effect of psychosocial, demographic, and contextual factors on the habit of drinking chlorinated water ($N = 596$)

| Factors | Whole sample | | Camp 14 | | Camp 16 | |
|---|---|---|---|---|---|---|
| | Coefficient | SE | Coefficient | SE | Coefficient | SE |
| Income | 3.94** | 0.00 | 7.62*** | 0.00 | −2.68 | 0.00 |
| Bucket chlorination at source | −0.08 | 0.09 | −0.20 | 0.12 | −0.04 | 0.10 |
| Vulnerability 1 | 0.26*** | 0.04 | 0.25*** | 0.06 | 0.15* | 0.06 |
| Feeling 1 (like/dislike chlorinated water) | 0.20*** | 0.05 | 0.16* | 0.06 | 0.39*** | 0.07 |
| Feeling 8 (healthy) | −0.13** | 0.04 | −0.03 | 0.06 | −0.06 | 0.05 |
| Action planning | 0.33* | 0.14 | −0.19 | 0.17 | 1.22*** | 0.19 |
| Coping planning | 0.59*** | 0.16 | 1.05*** | 0.18 | −0.08 | 0.29 |
| Adjusted $R^2$ value | 0.32*** | | 0.25*** | | 0.50*** | |
| F value | 41.38 | | 15.09 | | 44.76 | |

* $P < 0.05$; ** $P \leq 0.01$; *** $P < 0.001$.

diarrheal diseases among their respondents.[25] To design BCTs against vulnerability, a risk factor of the RANAS model, the activities proposed here are to present facts about getting diarrhea by drinking unchlorinated water; and causes of sickness and prevention through community consultation, storytelling, group meetings, and so on to sensitize the population in the selected Rohingya refugee camps (BCT 3).[30] Both camps should profit from this proposed activity.

Two attitudinal factors influenced the habit of chlorinated water consumption in this study. Although liking chlorinated water had a very low level of significance for the overall sample, it was higher among the population in camp 16. A possible explanation could be that a large proportion of people in camp 14 do not use chlorine, and a large proportion of people in camp 16 use water that is chlorinated at the source. Our study also revealed that chlorination at the source is a significant predictor of habit for the overall sample, and this is also specific to camp 16. Data from a previous assessment in camp 14 also suggested that people were drinking water directly from the tube wells, or the availability of chlorine is limited.[31] The taste of treated water was rated higher than that of untreated water in a similar study.[25] This could establish the relationship between liking chlorinated water and the drinking habit of chlorinated water. A study in Chad found that only 30% of their study population used chlorine products as a method of water treatment.[25] There is a large proportion of the Rohingya population in the camps that had an increasing demand for a safe water supply. Moreover, the long wait times, odd hours of availability, uneven surfaces, and security hazards for women make it difficult to collect water treated with chlorine.[32] As a result, many of them are still using water from contaminated sources such as rivers, ponds, and shallow tube wells, leading to water-borne diseases in the camps.[9] Another attitudinal factor, feeling healthy, was significant for the whole sample. The habit of drinking chlorinated water by improving attitude could be strengthened by sharing good feelings about taste and positive experiences of others, and explaining the possible consequences of adopting such behavior (BCT 8).

One of the ability factors was related significantly to the habit of drinking chlorinated water: confidence in recovering (in camp 14). To improve their perceived ability, respondents should be encouraged to cope with relapses and not to consider it as a matter of shame or failure. The mode of communication to convey these messages is by regular household visits. This intervention could be specifically targeted at camp 14, although the overall population can benefit from this intervention.

Overall, income was the only demographic factor that was related significantly to the habit of drinking chlorinated water. This was also true for the population in camp 14. That population has a significantly greater income than the population in camp 16, which contributed to their more frequent higher practice. Gender and education were also significant predictors of habit when the regression model was conducted individually. It is also evident that people with a low educational profile did not perform water treatment behavior[25] and other WASH-related practices.[33]

Information on the user acceptability of chlorine in emergencies is scarce. Many emergency responders have presumed that the taste and odor of chlorine are unacceptable to affected populations, but these populations will accept chlorination if they realize the risks of drinking unsafe water in emergencies.[4] More information is needed to identify the factors relevant to user acceptance of chlorine and the perceptions of risk by populations in emergencies. Based on the RANAS model, our research explored the different psychosocial factors of drinking chlorinated water in the Rohingya refugee camps in Cox's Bazar, Bangladesh, and designed effective BCTs that affects each factor.

To mitigate the risk of AWD, several United Nations agencies such as UNICEF, and other national and international NGOs are focusing on improving WASH service provision, raising awareness, and disseminating prevention messages in the camps through regular hygiene promotion activities.[34] The hygiene promotion activities of the WASH actors in the camps also aim to move away from didactic messaging, focus on behavior change components, and design interventions based on clear evidence and need. Nevertheless, it is also evident that there is still a gap in the WASH sector in using evidence-based interventions, community engagement, and complaint and feedback mechanisms.[32] Therefore, the psychosocial factors revealed in this study and the BCTs it proposes based on the RANAS methodology provide evidence-based guidance to design effective WASH interventions for promoting household water treatment and the uptake of chlorinated water in the Rohingya refugee camps.

**Recommendations for practice.** The factors that were identified by the linear regression model were used to develop RANAS-based behavior change activities. These significant factors indicated which interventions to combine

in a program to promote the uptake of chlorinated water. BCTs are the elements of an intervention plan that influence or redirect the processes that control behavior. According to the guideline on the RANAS approach to systematic behavior change, each BCT affects a specific psychosocial factor.[14] Activities can be arranged so that BCTs are combined with one another to increase their impact.[14] According to the model, we chose the BCTs against the significant psychosocial factors from the catalog of BCTs provided in the RANAS guideline.[14] The proposed BCTs are designed for the whole sample, but they can be tailored for specific locations. For the whole population, BCTs were designed to address vulnerability (risk factor), like or dislike of chlorinated water (attitude factor), feeling healthy (attitude factor), action planning (self-regulation factor), and coping planning (self-regulation factor). In camp 14, the BCTs can be tailored to address vulnerability, confidence in recovering, and coping planning, as they were the strongest influential predictors for the habit of drinking chlorinated water. Similarly, in camp 16, the BCTs could be specific to address liking or disliking chlorinated water, and action planning factors (Supplemental Table 3). Those BCTs will help to promote personal awareness about the effectiveness of drinking chlorinated water in preventing water-borne diseases, encourage healthy behavior through sharing positive experiences, raise the ability to perform the behavior with confidence even after a crisis, and plan to perform the behavior regularly and cope with barriers.

**Limitations and the way forward.** The results shown in this study are revealed from the self-reported behavior of respondents. Assessing areas related to subjective fields of health, knowledge, liking, satisfaction, and other similar areas present a risk of bias related to a social desirability effect.[35] Moreover, self-reports of health behavior are also known to be biased by various processes.[18,36–38] Although collecting data through structured observation in this study might have given a clearer understanding of the problem, it is very difficult and time-consuming to do. The length of the questionnaire was another challenge. Some respondents found it difficult to answer so many questions in one sitting beside of their regular household work. However, after a few interviews, the interviewers became familiar with all the questions and were able to save time. The language used for the interviews in this study was the only verbal language spoken by the Rohingya population. Therefore, translation of the questionnaire verbally during the interview was another challenge, even though the interviewers were from the local community and were familiar with the language. The explanation given by the interviewers in the local language and the responses of the respondents could have influenced the original theme of the questionnaires. We countered this issue with follow-up training with all the interviewers to formulate a common understanding of the language of the questionnaires. Another challenge was the capacity of the interviewers to understand the concept of the model we applied. More simulation training and close monitoring at the field level would have countered this challenge. The current study was a cross-sectional study; therefore, it was not possible to show any causal relationships between the variables. This is the only study conducted thus far to determine the psychosocial factors and then, by design, BCTs in this context. Therefore, it was difficult to compare our results and conclude with new hypotheses. Further research could consider more contextual factors with in-depth statistical analysis to determine the relationship with behavioral factors and a larger sample.

## CONCLUSION

Various psychosocial factors have been identified from the domains of the RANAS systematic approach to behavior change used to design effective BCTs for targeted populations. This research also allows evidence-based decision making to support the behavior change interventions of the WASH actors. Income, vulnerability, feeling healthy, and coping planning have been identified as the most influential psychosocial factors of behavior changes regarding chlorinated water among the Rohingya population in camps in Bangladesh. This study recommends specific BCTs against each factor, which was revealed statistically by regression models. To apply the BCTs targeting the whole sample or a specific camp, the main modes of communication include frequent community consultation, hygiene sessions, household visits, demonstrations, and role-play to promote chlorinated water uptake because these may induce behavior change among the respondents in these camps. The psychosocial factors identified with high importance in this study for the habit of chlorinated water uptake can help design customized intervention strategies for the whole population in the study areas, but significant factors for specific locations should also be considered. Further research considering larger samples and contextual factors might provide more insights with which to design more effective behavior change interventions. The effectiveness of such interventions also needs to be addressed in the future.

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