


Research Paper

Exploring behavioral determinants of handwashing with soap after defecation in an urban setting in Bangladesh: findings from a barrier analysis

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ABSTRACT

Social and behavior change (SBC) has long been recognized as a necessary step in the promotion of handwashing with soap (HWWS), and identifying the barriers and enablers of this behavior are key to increasing its adoption. Based on the health belief model (HBM), the theory of reasoned action (TRA) and other behavioral models, this barrier analysis study was conducted to identify the barriers and enablers of HWWS after defecation in an urban setting in Bangladesh. We conducted interviews with 45 adults who washed their hands with soap after defecation (doers) and compared them to 45 adults who did not (non-doers). The analysis showed that the main barriers of HWWS after defecation were related to perceived self-efficacy, difficulty to remember to buy soap, access to low-cost soap, low perceived severity of diarrhea, and not believing that HWWS would reduce diarrhea. Believing that it is Allah's will when one gets diarrhea was mentioned more frequently by the non-doers, while feeling clean and keeping free from illness were reported as benefits of HWWS significantly by the doers. The results suggest that an SBC strategy that addresses these key barriers and enablers would be more effective in promoting the adoption of HWWS.

Key words: barrier analysis, behavior change, behavioral determinants, handwashing, hygiene

HIGHLIGHTS

- This study has revealed critical differences in beliefs between doers and non-doers on HWWS from a behavioral perspective.
- Key barriers included access to soap and handwashing station and difficulty in remembering to hand wash.
- Self-efficacy and social norms are important determinants of HWWS behavior.
- Targeting the specific behavioral determinants is critical to increase the adoption of HWWS behavior.

INTRODUCTION

Handwashing with soap (HWWS) at critical times (e.g., after defecation) is known to be an effective strategy to prevent diarrheal and infectious diseases. Evidence from randomized controlled trials suggests that HWWS may decrease diarrhea, pneumonia and other respiratory infections, and parasitic infections (Curtis & Cairncross 2003; Freeman *et al.* 2014; Wolf *et al.* 2018). The recent pandemic, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) also supports the importance of HWWS to prevent the risk of infection. Among other non-clinical measures, HWWS was found to be one of the most effective approaches in preventing SARS-CoV-2 infection (Alzyood *et al.* 2020). While HWWS has long been considered as one of the most cost-effective approaches to reduce the burden of disease (Bartram & Cairncross 2010), it has been estimated that only 19% of the global population wash their hands with soap after defecation or management of children's excreta (Hirai *et al.* 2016) and Bangladesh is not an exception. Despite the increased risk of diarrheal disease morbidity and mortality among the Bangladeshi population, increasing HWWS has been a major challenge in the country (Parveen *et al.* 2018).

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Empirical evidence has identified a range of determinants that are associated with the practice of HWWS. These determinants include the availability of handwashing facilities, access to soap and water, social and cultural norms and supportive environment, motivations, knowledge on positive outcomes and risks, skills, and broader social and structural factors (White *et al.* 2020). Using a nationally representative sample, the 2014 Bangladesh National Hygiene Survey showed that 70% of urban households had a handwashing facility for use postdefecation with soap and water while poorer, urban households were less likely to have one (icddr 2014). Nevertheless, other factors such as the desire to feel clean have also been identified as behavioral determinants of HWWS. A systematic review on formative studies from 11 countries in Asia, Africa, and South America showed that emotional drivers (e.g., disgust, comfort, and the desire for social status) are often key determinants of handwashing behavior (Curtis *et al.* 2009). Little information is available on which behavioral determinants are important to consider in promoting HWWS in the Bangladeshi context. Most previous studies in Bangladesh focused on identifying the gap between handwashing knowledge and practices and proxy indicators such as access to a handwashing facility (Hulland *et al.* 2013), observing cleanliness of handwashing (Halder *et al.* 2010), and the association of household characteristics with HWWS (Luby *et al.* 2009). Therefore, this study aimed at studying a broader array of behavioral determinants and their association with behavioral adoption to inform behavior change communication strategies and to better design contextualized activities to promote HWWS after defecation in Bangladesh. This study also contributes to the development of a comprehensive social and behavioral change (SBC) strategy and culturally inclusive program activities.

METHODOLOGY

Study site and context

This barrier analysis (BA) study was conducted in Gazipur City Corporation (GCC) which was formed in 2013, merging then Tongi and Gazipur Municipalities, along with large semi-urban and rural areas. In 2017, an initiative entitled ‘Development of Integrated Wastewater Management System for Gazipur City Corporation (GCC)’ was started under the guidance of the Greater Dhaka Watershed Restoration (GDWR) Work-Stream of the Bangladesh Water Multi-Stakeholder Partnership (MSP), supported by the 2030 Water Resources Group (2030WRG) under the World Bank. SNV Netherlands Development Organisation is providing advisory technical assistance to the city council as part of its WASH SDG Program. The aim of this program is to enhance the capacity of the city authority so it can provide citywide, safely managed hygiene, and sanitation. A baseline population-based study found that 54.7% of the households have a handwashing station within 10 m of the toilet with access to water, while 40% of them did not have soap. The study also found that around 39% of the study population shared a toilet in different forms. However, the majority of people who had a handwashing station with soap did not have a water source that provided clean water for handwashing. In order to address this, the city authority agreed to implement an SBC intervention to influence household demand for – and adoption of – improved hygiene and sanitation services. As part of designing the SBC strategy, this BA study aimed to identify important beliefs and other important responses regarding the behavioral determinants of HWWS in order to create contextualized messages and activities.

Study tool

As part of the *Designing for Behavior Change* (DBC) approach, BA is a formative research tool that was developed in 1990 by Davis, based on an earlier doer/non-doer analysis tool, and popularized by Kittle and Davis. BA is similar in some respects to the RANAS formative research tool (Mosler 2012), but requires less time and less statistical knowledge to implement by field practitioners. Cross-sectional surveys, key informant interviews, and focus groups have often been used to explore different beliefs and possible drivers of HWWS. However, commonly held beliefs about a behavior and other characteristics of adopters are not necessarily linked with adoption of a behavior and can lead an implementer astray when planning what to change through an intervention (Kalam *et al.* 2021). BA is meant to make up for that shortcoming by identifying beliefs and other responses associated with behavioral determinants that are correlated with adoption of a behavior. BA draws mostly from the health belief model (HBM), the perceived behavioral control (PBC), and the theory of reasoned action (TRA) model (Kittle 2017), and has been used mostly to study health, nutrition, and WASH behaviors (e.g., HWWS). The beliefs and other responses regarding behavioral determinants assessed during BA are identified so that more effective behavior change communication messages, strategies, and supporting activities can be developed, with a focus on the most actionable findings.

Questionnaire development

This study adapted the standardized BA questionnaire from the DBC training manual ([The TOPS Program 2016](#)) for exploring key beliefs and other responses regarding the behavioral determinants of handwashing behavior. As recommended by the BA developers, the research design began with defining the behavior, the details of when and how the behavior needs to be practiced, and – using information from the earlier baseline study – the priority groups for the behavior (see [Box 1](#)).

The BA questionnaire is divided into two parts. The first part includes a set of screening questions to identify the participant as either a ‘doer’ (a person who claims to wash their hands after the last time they defecated using soap and water, and has soap that has been used at a handwashing station) or a ‘non-doer’ (a person who does not regularly practice HWWS after defecation, or does not have soap [used or unused] at the handwashing station). In the screening section of the questionnaire, both self-reported handwashing behavior and the observed presence of used soap at the handwashing facility were used. The second part of the questionnaire consists of open- and closed-ended questions relating to each of the 12 determinants assessed with BA (described in [Box 1](#)). While not part of the traditional BA approach, along with the determinant on access, structured observations were done to record the presence of a handwashing facility within 10 feet of a latrine or toilet, the presence of a permanent handwashing facility in the home, and the presence of covered bucket of water used only for handwashing purposes. The questionnaire (available in Supplementary Material, file 1) was developed in English and then was translated into Bengali and back-translated into English to check for accuracy.

Sampling

Adult men and women were the Priority Group for this BA study and were selected through random sampling from both slum and non-slum areas. The BA approach recommends a sample size of 45 doers and 45 non-doers in order to detect statistically significant odds ratios of 3.0 or higher at a confidence level of 90% ([Kittle 2017](#)). For this study behavior, 45 doers and 45 non-doers were selected from different areas of GCC in order to make the results more applicable to both contexts.

Box 1 | Key definitions based on barrier analysis approach

Key terms	Definition
Study behavior	Handwashing with soap after defecation
Target group	Women and men
Details of the behavior	Women and men wash their hands with soap every time after defecation
<i>Behavioral determinants</i>	
Perceived self-efficacy	An individual's belief that he/she can wash their hands with soap every time after defecation given his/her current knowledge and skills
Perceived social norms	The perception that people important to an individual think that he/she should wash their hands with soap every time after defecation
Perceive positive consequences	The positive things a person thinks will happen as a result of handwashing with soap every time after defecation
Perceived negative consequences	The negative things a person thinks will happen as a result of handwashing with soap every time after defecation
Access	The availability of the needed products or services (e.g., soap, water, handwashing facilities) required for handwashing with soap every time after defecation. This includes real and perceived barriers related to the cost, distance, and cultural acceptability of these products and services
Cues to action/reminders	The presence of reminders that help a person remember to wash their hands with soap every time after defecation
Perceived susceptibility	A person's perception of how vulnerable or at risk they are of getting diarrhea
Perceived severity	The extent to which a person believes that getting diarrhea would be very serious
Perceived action efficacy	The extent to which a person believes that by practicing handwashing with soap every time after defecation they will be able to avoid getting diarrhea
Perceived divine will	The extent to which a person believes that it is Allah's, God's, or the gods' will for him/her to get diarrhea
Policy	The presence of laws and regulations that may affect whether people wash their hands with soap every time after defecation
Culture	The extent to which cultural rules or taboos that may affect whether people wash their hands with soap every time after defecation

Data collection, management, and analysis

Data were collected through individual interviews with responses recorded on paper questionnaires by two teams with one female and one male in each team. The data collection team and the lead author coded the open-ended responses thematically, using both an inductive and deductive coding process. At the end of this process, the team quantified the responses in each category for doers and non-doers separately. These categories and the number of responses registered for each were then entered into a standardized BA tabulation spreadsheet that revealed which response were significant (at the $p < 0.05$ level) and should be addressed by the behavior change strategy. For each question and category of responses, the BA tabulation calculates the percentage of responses for both doers and non-doers; the odds ratio, the standard error, and its confidence interval; the estimated relative risk (ERR) (Zhang & Yu 1998); and p -values. This allows the user to identify those differences between doers and non-doers that are statistically significant (at $p < 0.05$) and to see the strength of those associations between each response and the behavior (based on the ERR).

Ethical considerations

We performed all procedures in studies in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the senior management of GCC in consultation with higher leadership. The respondents were informed of the study objectives prior to taking part in the interviews, and all respondents were asked to give their written consent before they were interviewed. All respondents had the right to withdraw from the interview at any moment without jeopardizing their access to any services. No identifying data such as name, date of birth, or address was collected from the respondents.

RESULTS

Respondents' demographic profile

The characteristics of the study respondents are shown in Figure 1. The majority of the respondents were male (71 and 58% of doers and non-doers, respectively), and most of them belonged to the 18–25 years of age group (29 and 29%, respectively). In terms of educational attainment, the majority of the respondents had completed education until 10th grade (36 and 49% of doers and non-doers, respectively), while the dominant profession was service jobs followed by small business.

Determinant specific results

The results are presented based on the highest, statistically significant differences in responses and beliefs between doers and non-doers of HWWS after defecation. All quantification of associations mentioned below are based on the ERR. The detailed results are included in Supplementary Material, file 2. These beliefs and determinants are discussed below.

Self-efficacy and perceived access

When responding to the open-ended question on *what makes (or would make) the behavior easier* (see Table 1), respondents mentioned access issues. Doers were 22.9 times more likely to mention availability of soap ($p < 0.001$) than doers. Non-doers were 26

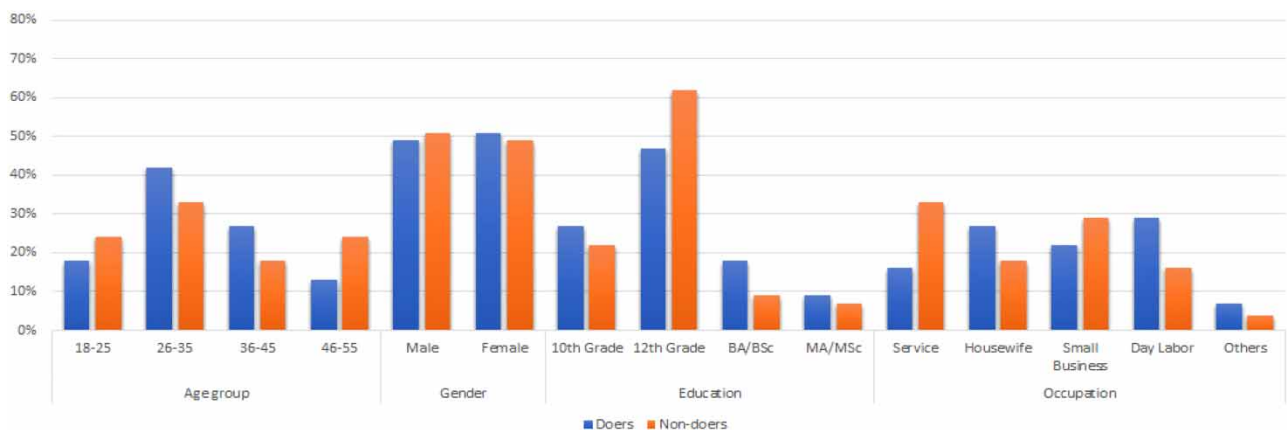


Figure 1 | Demographic characteristics of the respondents

Table 1 | Perceived self-efficacy and access

Determinant/responses	Total Doers = 45 Total Non-doers = 45		Diff.	Odds ratio	Confidence interval	ERR	p-value
	Doers n (%)	Non-doers n (%)					
Self-efficacy: What makes you easier to wash your hands with soap after defecation?							
Availability of soap	44 (98%)	22 (49%)	49%	46.00	5.82–22.91	22.91	<0.001
Availability of water	43 (96%)	9 (20%)	76%	86.00	17.45–423.79	25.16	<0.001
Low price of soap	1 (2%)	25 (56%)	–53%	0.02	0.00–0.14	0.04	<0.001
Self-efficacy: What makes you difficult to wash your hands with soap after defecation?							
When I am outside of home	29 (64%)	3 (7%)	58%	25.38	6.77–95.07	5.00	<0.001
Inability to buy soap	1 (2%)	9 (20%)	–18%	0.09	0.01–0.75	0.14	0.008
Difficult to remember	4 (9%)	15 (33%)	–24%	0.20	0.06–0.65	0.29	0.004

times more likely to mention lower price of soap ($p < 0.001$). When responding to the open-ended question on *what makes (or would make) the behavior difficult*, non-doers were 7.1 times more likely to mention (than doers) an inability to buy soap ($p = 0.008$), an access issue. Doers were 25.2 times more likely to mention availability of water as something that makes the behavior easier. However, when asked directly (using a closed-ended question) how difficult it was to get water for HW, the responses of doers and non-doers were not statistically different (with 11% of doers and 7% of non-doers saying that it was difficult or very difficult). Also, based on household observations, doers were found to be 2.9 times more likely to have a permanent HW facility in the home ($p < 0.001$) and 2.1 times more likely to have a HW facility within 10 feet of a latrine or toilet ($p = 0.01$) than non-doers, and non-doers were 2.4 times more likely to not have a covered bucket for HW purposes ($p = 0.01$) than doers.

When asked specifically about access (see Table 2), non-doers were 8.9 times more likely to say that it was ‘very difficult’ to get soap to wash hands ($p = 0.002$), and 5.1 times more likely to say that it was ‘somewhat difficult’ ($p < 0.001$). Conversely,

Table 2 | Perceived access, reasons behind difficulty in access to water and soap, and proxy measures

Determinant/responses	Total Doers = 45 Total Non-doers = 45		Diff.	Odds ratio	Confidence interval	ERR	p-value
	Doers n (%)	Non-doers n (%)					
Access: How difficult it is to get soap to wash your hands with soap after defecation?							
Very Difficult	1	11 (24%)	–22%	0.07	0.01–0.57	0.11	0.002
Somewhat Difficult	5 (11%)	24 (53%)	–42%	0.11	0.04–0.33	0.20	<0.001
Not Difficult	40 (89%)	10 (22%)	67%	28.00	8.73–89.81	9.69	<0.001
Access: What makes it difficult to get soap to wash your hands with soap after defecation?							
Financial crisis in family (chronic poverty)	1 (2%)	20 (44%)	–42%	0.03	0.00–0.22	0.05	<0.001
Unavailability of soap at nearby stores	1 (2%)	17 (38%)	–36%	0.04	0.00–0.30	0.07	<0.001
Handwashing facility within 10 feet?							
Yes	19 (42%)	8 (18%)	24%	3.38	1.29–8.88	2.06	0.01
No	26 (58%)	37 (82%)	–24%	0.30	0.11–0.78	0.49	0.01
Presence of handwashing permanent facility							
Yes	21 (47%)	5 (11%)	36%	7.00	2.33–21.00	2.87	<0.001
No	24 (53%)	40 (89%)	–36%	0.14	0.05–0.43	0.35	<0.001
Presence of covered bucket to preserve water for handwashing purpose							
Yes, but without cover	26 (58%)	35 (78%)	–20%	0.39	0.16–0.98	0.56	0.035
No bucket	10 (22%)	2 (4%)	18%	6.14	1.26	2.41	0.013

doers were 9.7 times more likely to say that it was ‘not difficult’ to get soap ($p < 0.001$). When asked what makes it difficult to get soap, non-doers were 18.7 times more likely to mention a financial crisis in their family ($p < 0.001$), and 15.1 times more likely to mention unavailability of soap at nearby markets ($p < 0.001$) than non-doers.

Cues for action

When responding to the closed-ended question on whether it was *easy to remember* to do the behavior (see Table 3), doers were 8.5 times more likely to say that it was ‘not difficult at all’ to remember ($p < 0.001$) than non-doers. Non-doers were 15.2 times more likely to say that it was ‘very difficult’ ($p < 0.001$) and 3.4 times more likely to say that it was ‘somewhat difficult’ to remember ($p < 0.000$) than doers.

Perceived social norms

When asked if most people the respondent knew *approved* (or would approve) of their washing their hands with soap after defecation (see Table 3), doers were 12.9 times more likely to say yes ($p < 0.001$) than non-doers. When asked who the people are (or would be) that approve (or would approve), doers were 7.7 times more likely to say household members ($p < 0.001$), 3.2 times more likely to say teachers ($p < 0.001$), and 3.9 times more likely to say NGO agents ($p < 0.001$).

Perceived severity and perceived divine will

When asking the respondents how serious it would be if he or she got diarrhea in the coming months (see Table 4), doers were found to be 2.7 times more likely to say that it would be ‘very serious’ ($p = 0.001$) and non-doers were found to be 5.9 times more likely to say that it would be ‘not serious at all’ ($p < 0.001$). When asked if the respondent believed that it was Allah’s, God’s, or the gods’ will that people get diarrhea, non-doers were 3.7 times more likely to believe that it is Allah’s, God’s, or the gods’ will ($p = 0.002$).

Perceived positive and negative consequences of the behavior

Overall, in response to an open-ended question about the *advantages* of performing this behavior (see Table 5), doers were 3.3 times more likely to say ‘feeling clean’ ($p = 0.045$) and 2.6 times more likely to say being ‘free from illness’ were advantages of the behavior. When asked about the *disadvantages* of performing this behavior, non-doers were 2.8 times more likely to mention ‘increasing costs’.

Table 3 | Cues for action and social norms

Determinant/responses	Total Doers = 45		Total Non-doers = 45		Diff.	Odds ratio	Confidence interval	ERR	p-value
	Doers n (%)	Non-doers n (%)							
Cues for action: How difficult to remember to wash your hands with soap after defecation?									
Very Difficult	1 (2%)	17 (38%)	-36%	0.04		0.00–0.30	0.07	<0.001	
Somewhat Difficult	8 (18%)	25 (56%)	-38%	0.17		0.07–0.45	0.29	<0.001	
Not Difficult at all	36 (80%)	3 (7%)	73%	64.75		14.08–222.69	8.51	<0.001	
Social norms: Do most of the people you know approve you to wash your hands with soap after defecation?									
Yes	44 (100%)	30 (67%)	31%	22.0		2.76–175.53	12.85	<0.001	
Possibly	1 (2%)	12 (27%)	-24%	0.06		0.01–0.50	0.10	0.001	
Social norms: Who are the people that approve you to wash your hands with soap after defecation?									
Household members (husband, wife, mother, son, daughter, father)	43 (96%)	28 (62%)	33%	13.05		2.80–60.92	7.66	<0.001	
Teachers	34 (76%)	16 (36%)	40%	5.60		2.25–13.97	3.17	<0.001	
NGO agents	27 (60%)	5 (11%)	49%	12.00		3.98–36.21	3.86	<0.001	

Table 4 | Perceived severity, perceived divine will, and perceived risk

Determinant/responses	Total Doers = 45 Total Non-doers = 45		Diff.	Odds ratio	Confidence interval	ERR	p-value
	Doers n (%)	Non-doers n (%)					
Perceived severity: How serious it would be if you get diarrhea in the coming months?							
Very serious	18 (40%)	4 (9%)	31%	6.83	2.08–22.40	2.73	0.001
Not serious at all	4 (9%)	23 (51%)	–42%	0.09	0.03–0.30	0.17	<0.001
Divine will: Do you think that God is responsible to get diarrhea?							
Yes	4 (9%)	16 (36%)	–27%	0.18	0.05–0.58	0.27	0.002
Perceived risk: How likely to get diarrhea in coming months?							
Somewhat Likely	25 (56%)	38 (84%)	–28%	0.23	0.08–0.62	0.43	0.003
Not Likely	13 (29%)	1 (2%)	28%	17.88	2.22–143–70	3.15	<0.001

Table 5 | Perceived positive and negative consequences of the behavior

Determinant/responses	Total Doers = 45 Total Non-doers = 45		Diff.	Odds ratio	Confidence interval	ERR	p-value
	Doers n (%)	Non-doers n (%)					
Positive consequences: What are the positive consequences of washing hands with soap after defecation?							
Feeling clean	43 (96%)	37 (82%)	13%	4.65	0.93–23.27	3.26	0.045
Free from illness	12 (27%)	2 (4%)	22%	7.82	1.64–37.36	2.64	0.004
Negative consequences: What are the negative consequences of washing hands with soap after defecation?							
Increasing cost	3 (7%)	10 (22%)	–16%	0.25	0.06–0.98	0.35	0.034
Don't know	27 (76%)	25 (40%)	36%	4.64	0.52–2.77	1.13	<0.001

Perceived action efficacy

Non-doers were 2.5 times more likely to say that it was ‘not likely’ that they would get diarrhea ($p = 0.004$) if they did not wash hands, and doers were 2.3 times more likely to say that was ‘somewhat likely’ ($p = 0.005$) (Table 6).

DISCUSSION

This BA study on HWWS after defecation revealed important differences in responses and beliefs between doers and non-doers regarding ten different (but sometimes linked) behavioral determinants of HWWS in this urban setting of Bangladesh. The sheer number of important determinants for this behavior may help to explain why HWWS has been a difficult behavior

Table 6 | Perceived action efficacy, culture, and policy

Determinant/responses	Total Doers = 45 Total Non-doers = 45		Diff.	Odds ratio	Confidence interval	ERR	p-value
	Doers n (%)	Non-doers n (%)					
Action Efficacy: How likely are you to get diarrhea if you wash your hand with soap after defecation?							
Somewhat Likely	32 (71%)	19 (42%)	29%	3.37	1.40–8.08	2.25	0.005
Not Likely	9 (20%)	22 (49%)	–29%	0.26	0.10–0.67	0.39	0.004

to scale in many countries. Even if one or two determinants or barriers are addressed, there are a multitude of important determinants and barriers that may make it difficult for a person to adopt the behavior.

A study like this that examines associations with behavioral adoption cannot *definitively* identify the true drivers of the behavior, but can provide clues as to the possible drivers of a behavior and the interventions that may be effective in promoting adoption. The factors most highly associated with HWWS in this population – based on responses to questions on the 12 determinants studied – were around beliefs and responses regarding self-efficacy and access. Randomized controlled trials and population-based research have shown that integrating handwashing facility into WASH programs may increase HWWS (Ram *et al.* 2017) and access to soap and water is a vital component in assuring HWWS in many contexts (Hoque 2003; Jumaa 2005). In terms of access to water, our baseline study found that almost 86% of the households had a permanent water facility, but access to soap was found to be a major barrier in this population. Doers were much more likely to say that they could do the behavior with their current knowledge, skills, and resources than non-doers. Key enablers included availability of soap (especially low-priced soap) and money (presumably for purchasing soap), and key barriers included unavailability of soap in local markets and difficulty in remembering to buy soap for handwashing. When asked the open-ended question, ‘what makes it easier?’, doers were more likely to mention that having water made it easier (than non-doers), but when asked specifically ‘how difficult is it to get water that you need to wash your hands every time after defecation?’, there were no significant differences between doers and non-doers. Non-doers were more likely to say that getting soap was very difficult when asked the similar closed-ended question, so soap availability appears to be a more important barrier than water access in this population. Findings from the observation on handwashing facilities show that having a permanent HW facility in the home that is less than 10 feet from a latrine or toilet, and having a covered bucket of water for HW purposes are important, as well. In this urban context, poorer people are living in the slum setting where access to a handwashing station with soap has been found to be a major barrier in this and other studies (Hoque 2003). Also, it is widely accepted that access to a handwashing facility is an important determinant of HWWS in lower-income settings globally (Zangana *et al.* 2020) and having a handwashing facility is a critical determinant of HWWS in critical times including after defecation (White *et al.* 2020). These findings are similar to our study.

Cues for action – specifically, being able to remember to do the behavior – is another important behavioral determinant of HWWS in this population. Results of our study showed that non-doers were more likely to say that it is very difficult to remember to perform the behavior and represents a barrier for them. This result is aligned with other previous WASH studies of Bangladesh (Rahman *et al.* 2017; Parveen *et al.* 2018).

Perceived social norms were found to be a powerful determinant of HWWS in this study. In addition to doers being much more likely to say that ‘most people approve’, they were more likely to mention key groups who they believe approve: household members, NGO agents, and teachers. These groups should be reached with messaging and used as key influencers of the behavior in this context. Other studies have found that perceived social norms and self-efficacy can be powerful factors in adoption of WASH behaviors (Parveen *et al.* 2018) and determinants associated with the HBM are often found to be driving adoption of HW behavior (Zeigheimat *et al.* 2016). Perceived severity of diarrhea was very important, with non-doers being much more likely to say that diarrhea is ‘not serious at all’. Using testimonials of people who have had diarrhea and caregivers who have lost children to diarrhea may be effective in changing this erroneous perception.

Perceived divine will is a determinant that is usually studied with BA but has not been systematically studied in many other studies of determinants of HW, despite the fact that the HBM has been used for many years to suggest various influences on health care, including religion (Kirn 1991). This determinant was also found to be an important driver in this study: Non-doers were much more likely to believe that it was Allah’s, God’s, or the gods’ will when one gets diarrhea. Reminding people who adhere to Islam of key verses that promote handwashing in the Quran and texts from other holy books may be useful for other religions in Bangladesh to address this determinant.

Aligned with another study in Bangladesh (Parveen *et al.* 2018), the current study found several positive consequences of HWWS after defecation as important enablers of the behavior. Doers of this behavior were much more likely to say that HWWS after defecation enables them to ‘feel clean’ and keeps them ‘free from illness’.

This study has a number of limitations. First, given that this study was only done in a limited urban area with a limited sample size, the results should not be generalized to the rest of the country. Since 67 individual comparisons were made between doers and non-doers response during data analysis, we chose to focus on findings where $p < 0.01$ rather than $p < 0.05$ to reduce the chance of identifying spurious findings as important ones. This, of course, does not entirely reduce this risk, so the findings presented here should be considered less than definitive especially for any individual finding.

Second, by design, the BA approach does not consider respondents' socio-economic information which may lead to some confounding or interaction of variables. Finally, as another means to make the tool easy to use, the questions on some determinants that are assessed are closed-ended and may lead to some bias that may be avoidable through use of more open-ended questions. However, applying these changes to the BA methodology could make it harder to use with less personnel, time, statistical skill, and funding for formative research.

RECOMMENDATIONS

An effective behavior change strategy for HWWS after defecation is required to address multiple beliefs and behavioral determinants, reducing barriers and leveraging enablers identified in this study. For example, an intervention to improve access to low-cost soap could be educating the population (and doing demonstrations) on how to use soapy water as a means to substantially reduce the cost of handwashing, as has been done in other projects in Bangladesh. To increase cues for action, reminder stickers could be put in key places in the home (e.g., in sight when using the latrine or toilet) and designated handwashing stations could be encouraged. To increase perceived positive social norms, people – especially those found to be important influencers of this behavior (e.g., teachers, NGO agents) – can be videoed modeling and giving testimonials in each neighborhood on why and how they do the behavior and distributed over social media and other means. To increase the perception that diseases linked with not HWWS are serious (to address perceived severity), country-wide data on deaths from diarrhea and other WASH-related diseases could be disseminated, and testimonials by people who have lost or almost lost family members due to WASH-related diseases could be used. To address perceived divine will, religious leaders could be assisted in creating sermon outlines using verses from the Quran or other sacred texts that promote HWWS, and assisted in creating radio spots on this. Essay contests could be used to encourage people to name positive consequences of the behavior. To increase perceived action efficacy, information on the effectiveness of HWWS in decreasing diarrhea, pneumonia, cholera, COVID-19, and other diseases could be disseminated using social and traditional media.

CONCLUSION

A host of important behavioral determinants were found to be associated with HWWS after defecation in this population. A broad set of activities and messages – based on key beliefs and responses associated with these determinants – will most likely be needed to significantly scale HWWS in this and other populations. Based on the HBM, PBC, and TRA, the BA formative research tool is an important and easy-to-use tool for rapidly identifying beliefs and behavioral determinants of key WASH and other sector behaviors.

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DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

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