

Changed handwashing habit: a concern for overconsumption of water during the COVID-19 pandemic in Bangladesh

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Abstract

People's handwashing with water and soap regularly was one of the most efficient ways to stop the transmission of infection during the COVID-19 pandemic. However, water overuse during handwashing may put enormous pressure on the already overstretched groundwater resources. Therefore, this study aimed to analyze how behavioral changes can affect water supply and also identified the most influential factors of water consumption during the COVID-19 pandemic. A standardized questionnaire (both paper-based and online) was developed to collect data from the participants living in Dhaka (Mirpur; Section 10 to 12) Bangladesh. The purposive sampling method was used to collect the data. After data processing, a total of 388 valid responses were considered for the analysis. This study found that during the COVID-19 pandemic, handwashing frequency was significantly higher ($M=2.57$) than participants' handwashing frequency ($M=1.54$; $P<0.05$) before the COVID-19 pandemic, handwashing duration during the pandemic ($M=2.39$) was also significantly increased compared with participants' handwashing frequency ($M=1.37$; $p<0.05$) before the pandemic period, participants' hand scrubbing duration during the COVID-19 pandemic ($M=2.22$) was also higher than participants' hand scrubbing duration ($M=1.38$; $p<0.05$) before the COVID-19 pandemic, participants' tendency of washing hands after returning home from outside ($M=2.85$) has increased during the COVID-19 pandemic compared with participants' tendency of washing hands after returning home from outside ($M=2.32$; $p<0.05$) before the COVID-19 pandemic. The COVID-19 pandemic significantly affected the practice of washing hands after sneezing during the pandemic ($M=2.38$) than before the pandemic ($M=1.47$; $p<0.05$). A significant positive association was also found between participants' water consumption level and behavioral changes. The results indicated an increase in the overall tendency to use more water. To ensure the urban water supply system is resilient in such pandemic situations, it is important to understand the aspects that are connected to water usage and using water with utmost sincerity.

Keywords: COVID-19, handwashing, water consumption behavior, water use, hand scrubbing, water overuse.

1. Introduction

Hand washing is a practical, efficient, and cost-effective method of preventing infectious diseases (Burton et al., 2011; Tao et al., 2013). During the COVID-19 pandemic, handwashing with water and soap was identified as one of the effective strategies to minimize the transmission of infection (UNICEF, 2024; World Health Organization, 2020). The likelihood of using water and soap to wash hands for at least 20 seconds five

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times a day prevents the transmission of infection (Feizizadeh et al., 2021). Increased water use because of high transmission, particularly keeping the tap on during the time of handwashing may put immense strain on already overstressed groundwater resources as well as the economic well-being of individuals (Sayeed et al., 2021).

Due to handwashing, water consumption during COVID-19 has increased dramatically because of fear of being affected (Biehl et al., 2021). A Brazilian study found that water consumption in the commercial, industrial, and public spaces has decreased while increasing in the residential area (Kalbusch et al., 2020). The rate of water consumption was also increased in residential areas during the pandemic in Bangladesh (Sayeed et al., 2021). Moreover, the perceptions of using water increased during the COVID-19 in South Africa (Goldin et al., 2022). Therefore, the water crisis would be a greatest challenges worldwide that people may face in the future decades (World Economic Forum, 2020). It is evident that the COVID-19 pandemic has an impact on urban water supplies (Feizizadeh et al., 2021), and excessive water consumption could be a risk in the future (Sayeed et al., 2021). In a developing country like Bangladesh, where resources are very limited, the increased water supply demand may put immense pressure on already-stretched groundwater supplies (Hedrick, 2018).

Numerous studies have explored the importance of handwashing in promoting public health, especially in preventing the spread of infectious diseases (Amuakwa-Mensah et al., 2021; Burton et al., 2011; Kalbusch et al., 2020), there remains a significant research gap understanding the relationship between handwashing practices and the overconsumption of water in developing countries, like Bangladesh. Water scarcity is an emerging concern due to population growth, climate change, and infrastructure challenges in Bangladesh (Hedrick, 2018). Therefore, the efficient use of water in daily hygiene practices, such as handwashing, is crucial. Although public health campaigns have successfully increased awareness the importance of regular handwashing, there is limited research on whether these practices are leading to excessive water use. This gap is particularly pronounced in rural and urban settings where water availability and access vary greatly (Akter et al., 2017). Existing studies have largely focused on the frequency and effectiveness of handwashing in reducing disease transmission but have not sufficiently addressed the potential trade-offs between promoting good hygiene and conserving water (Beale et al., 2020; Choi et al., 2021). Specifically, there is a lack of data on the amount of water typically used during handwashing, and how this varies across different demographic groups.

Unlike previous studies that have treated public health and water conservation as separate domains (Feizizadeh et al., 2021; Khatib et al., 2022; UNICEF, 2024), this research integrates these two critical aspects, providing a comprehensive understanding of how current handwashing habits impact water resources in Bangladesh. By investigating the behavioral patterns that influence water use during handwashing, this study offers novel insights into how habits can be modified to promote both effective hygiene and water conservation. It examines variables such as duration of handwashing and hand scrubbing, hand washing frequency, and the amount of using water which have not been thoroughly analyzed in the Bangladeshi context. This study could facilitate in decision making process to develop context-specific strategies that balance the need for rigorous hygiene practices with the imperative to conserve water. The strategies could include

innovations in handwashing techniques, the design of water-efficient handwashing stations, or public awareness campaigns tailored to the socio-economic and cultural realities of Bangladesh.

2. Materials and Methods

This study was conducted in Dhaka (Mirpur; Sections 10 to 12 selected as a case study), Bangladesh. The total population of Mirpur was 6,50,000 with an area of 6.5 square kilometers, and had 12,660 households. Each household with a holding number was considered a sample unit. The sample size was 388 households (confidence interval: 95% and standard error: 5%) (Yamane, 1967). The sample was selected using the purposive sampling technique.

Both paper-based and online questionnaire was used to collect data from each household. The online questionnaire was designed through Google Forms. Items regarding changing handwashing habits were asked each household participant, including 7 paired items (Table 1). The data relating to paired questions (before and during the COVID-19 pandemic) was continuous for handwashing frequency, handwashing duration, and hand scrubbing duration. In addition, data regarding the use of cleaners, handwashing after returning home and after sneezing and using a greater amount of water was dichotomous (Yes=1, No=0).

Table 1. Items used for measuring the changes in handwashing habits.

Items	Description	Reference
Handwashing frequency	Participants were asked about their handwashing frequency before and during the COVID-19 pandemic.	Ahmed and Yunus (2020)
Handwashing duration	Participants were asked about the duration of handwashing before and during the COVID-19 pandemic.	Ahmed and Yunus (2020)
Hand scrubbing duration	Participants were asked about the duration of hand scrubbing before and during the COVID-19 pandemic.	Sayeed et al. (2021)
Use of cleaners	Participants were asked about the use of cleaners before and during the COVID-19 pandemic.	Sayeed et al. (2021)
Handwashing after returning home	Participants were asked about their handwashing practices after returning home from outside before and during the COVID-19 pandemic.	Campos et al. (2021)
Handwashing after sneezing	Participants were asked about their handwashing practices after sneezing before and during the COVID-19 pandemic.	Swain (2021)
Using a greater amount of water	Participants were asked about their tendency to use a lot of water before and during the COVID-19 pandemic.	Ahmed and Yunus (2020)

Sociodemographic data were collected on age, gender, educational status, location of residence, marital status, and monthly income. Participants were classified into five age groups, such as 20 to 30, 31 to 40, 41 to 50, and more than 50 years. Gender was categorized into three categories: male, female, and diverse. However, there were no responses for the diverse category, and therefore, this category was removed from the dataset. Participants' marital status was classified into two categories: married and single; educational background into six categories: primary, secondary, higher secondary, bachelor, master, PhD degree; family income in Bangladeshi Taka (BDT) into five categories: >15000, 16000 to 30000, 31000 to 45000, 46000 to 60000 BDT, and 60000+.

Participants' sociodemographic characteristics were analyzed using descriptive statistics. A paired sample t-test was conducted to analyze the changes in water consumption patterns due to behavioral changes before and during the COVID-19 pandemic. A binary logistic model was used to determine the association between water consumption level (Yes=1, using a greater amount of water during the pandemic, No=0, otherwise) and participants' sociodemographic characteristics and behavioral changes during the COVID-19 pandemic. The data was analyzed using SPSS (version 27) and a p-value <0.05 was considered significant.

3. Results

Amongst all the 388 participants, the majority were found to be male (55.41%) and within the 20 to 30 years age group (29.12%) (Table 2). A greater percentage of the participants had an income ranging between 31,000 to 45,000 BDT per month (32.99%) and 27.58% of them reported that their income belongs within the range of 16000 to 30000 BDT (Table 2). Whereas only 10.31% of participants were earning less than 15,000 BDT per month (Table 2). A little over one-third of the participants (38.14%) obtained a Bachelor's degree, whereas less than 10% were found to have primary education (Table 2). Close to one-fourth of the respondents reported that have a Master' degree (22.68%). More than two-thirds (71.65%) of participants responded as married (Table 2).

Table 2. Sociodemographic characteristics of participants.

	No. of participants	Percentage
Age (Years)		
20-30	113	29.12
31-40	95	24.48
41-50	91	23.45
More than 50	89	22.94
Gender		
Male	215	55.41
Female	173	44.59
Household Income (BDT)		
>15000	40	10.31
16000-30000	107	27.58

	No. of participants	Percentage
31000-45000	128	32.99
46000-60000	67	17.27
60000+	45	11.60
Educational background		
Primary	28	7.22
Secondary	40	10.31
Higher secondary	83	21.39
Bachelors	148	38.14
Masters	88	22.68
Marital status		
Married	278	71.65
Single	110	28.35

Table 3. The relationship between sociodemographic characteristics and water consumption level during the COVID-19 pandemic.

Sociodemographic characteristics	Classification	Participants use a greater amount of water		Percentage	
		Yes	No	Yes	No
Age	20-30	97	16	28.7	32.0
	31-40	85	10	25.1	20.0
	41-50	83	8	24.6	16.0
	More than 50	73	16	21.6	32.0
Gender	Male	188	28	55.6	56.0
	Female	150	22	44.4	44.0
Household income (BDT)	<15000	27	13	8.0	26.0
	16000-30000	93	14	27.5	28.0
	31000-45000	117	12	34.6	24.0
	46000-60000	61	6	18.0	12.0
	60000+	40	5	11.8	10.0
Educational background	Primary	17	11	5.0	22.0
	Secondary	35	5	10.4	10.0
	Higher secondary	69	14	20.4	28.0
	Bachelors	136	13	40.2	26.0
	Masters	81	7	24.0	14.0
Marital status	Married	244	34	72.2	68.0
	Single	94	16	27.8	32.0

Participants were asked seven paired questions (before and during COVID-19 pandemic) relating to handwashing frequency (Pair 1), handwashing duration (Pair 2), hand scrubbing duration (Pair 3), participants tendency of using cleaners (Pair 4), handwashing after returning home from outside (Pair 5), handwashing after sneezing (Pair 6), and tendency of using more water (Pair 7). The results obtained from all pairs are reported in Table 4.

The results from Pair 1 indicate that participants' handwashing frequency during the COVID-19 pandemic was significantly higher ($M=2.57$) than before ($M=1.54$; $P<0.05$). Participants' handwashing duration during the COVID-19 pandemic ($M=2.39$) was also significantly increased in comparison to pre-COVID-19 periods ($M=1.37$; $p<0.05$) (Pair 2 results). Participants' hand scrubbing duration during the COVID-19 pandemic ($M=2.22$) had risen than earlier times ($M=1.38$; $p<0.05$) (pair 3 results). Participants intended use of cleaners or soaps ($M=2.92$) during the COVID-19 pandemic was increased compared to earlier times ($M=2.82$; $p<0.05$) (Pair 4 results). Pair 5 outcome unveils that participants' tendency to wash hands after returning home from outside ($M=2.85$) was increased during the COVID-19 pandemic compared to their pre-COVID-19 periods' propensity ($M=2.32$; $p<0.05$). The COVID-19 pandemic significantly affected participants' practice of washing hands after sneezing during the pandemic ($M=2.38$) than before ($M=1.47$; $p<0.05$) (pair 6 results). As per the results of pair 7, during the COVID-19 pandemic, participants' tendency to use more water for washing hands ($M=2.83$; $p<0.05$) was increased significantly than before the pandemic ($M=1.84$; $p<0.05$).

Table 4. Measuring behavioral changes to water consumption before and during the COVID-19 pandemic using a Paired sample test.

		Mean	Paired difference		P -value
			Mean	Standard deviation	
Pair 1	Handwashing frequency before the COVID-19 pandemic.	1.54	-1.02	.69	.000
	Handwashing frequency during the COVID-19 pandemic.	2.57			
Pair 2	Handwashing duration before the COVID-19 pandemic.	1.37	-1.02	.75	.000
	Handwashing duration during the COVID-19 pandemic.	2.39			
Pair 3	Hand scrubbing duration before the COVID-19 pandemic.	1.38	-.84	.71	.000
	Hand scrubbing duration during the COVID-19 pandemic.	2.22			
Pair 4	Use of cleaners before the COVID-19 pandemic.	2.81	-.10	.41	.000
	Use of cleaners during the COVID-19 pandemic.	2.92			
Pair 5	Handwashing after returning home before the pandemic.	2.32.	-.52	.75	.000

		Mean	Paired difference		P-value
			Mean	Standard deviation	
Pair 6	Handwashing after returning home during the pandemic.	2.85			
	Handwashing after sneezing before the pandemic.	1.47	-.91	.86	.000
	Handwashing after sneezing during the pandemic.	2.38			
Pair 7	Using a greater amount of water before the pandemic	1.84	-.68	.80	.000
	Using a greater amount of water during the pandemic	2.53			

The general univariate model found that among participants' socio-demographic characteristics, education level and income had a significant positive association with water consumption ($p < 0.05$) during the COVID-19 pandemic (Table 5). No associations were found between participants' water consumption levels with their age and gender. It was also found that participants' behavioral changes (e.g., handwashing frequency, handwashing duration, hand scrubbing duration, participants' tendency to use cleaners, handwashing after returning home from outside, handwashing after sneezing, and tendency to use more water) had also positive association with water consumption level during the COVID-19 pandemic (all $p < 0.05$) (Table 5).

Table 5: Measuring the association between participants' sociodemographic characteristics, behavioral changes, and water consumption using a binary logistics model.

	Coefficient	Standard error	Odd ratio	95% confidence level		P- value
				Lower limit	Upper limit	
Age (Reference category: more than 50 years)						
20-30 years	.28	.38	.75	.35	1.60	.462
31-40 years	.62	.43	.53	.22	1.25	.151
41-50 years	.82	.46	.44	.17	1.08	.075
Gender (Reference category: Female)						
Male	.015	.30	1.01	.55	1.84	.960
Marital status (Reference category: Single)						
Married	.20	.32	.81	.43	1.55	.540
Educational background (Reference category: Masters)						
				2.53	22.09	.000

	Coefficient	Standard error	Odd ratio	95% confidence level		P- value
				Lower limit	Upper limit	
Primary	2.01	.55	7.48			
Secondary	.50	.61	1.65	.49	5.56	.417
Higher secondary	.85	.49	2.34	.89	6.14	.082
Bachelors	.10	.48	1.10	.42	2.88	.837
Household income in BDT (Reference category: 60000+)	1.34	.58	3.85	1.23	12.05	.021
<15000	.187	.55	1.20	.40	3.56	.737
16000-30000	.19	.56	.82	.27	2.47	.725
31000-45000	.24	.63	.78	.22	2.75	.708
46000-60000						
Handwashing frequency	.82	.20	.44	.29	.66	.000
Handwashing duration	.37	.17	.68	.48	.97	.035
Hand scrubbing duration	.25	.18	.77	.53	1.10	.045
Use of cleaners (Reference category: No)						
Yes	1.14	.42	.31	.13	.73	.007
Handwashing after returning home (Reference category: No)						
Yes	2.19	.57	.11	.03	.34	.000
Handwashing after sneezing (Reference category: No)						
Yes	.99	.33	.36	.19	.70	.003

4. Discussion

This study analyzed participants' behavioral changes before and during the COVID-19 pandemic and examined the association between their sociodemographic characteristics, behavioral changes, and water consumption levels. The major findings are 1) participants' handwashing frequency, handwashing duration, and hand scrubbing duration have increased during the COVID-19 pandemic; 2) participants' tendency to use cleaners, handwashing after returning home from outside, handwashing after sneezing, and tendency to use more water has also increased; 3) A significant positive association was also found between participants' water consumption level and behavioral changes including handwashing frequency, handwashing duration, hand scrubbing duration, participants tendency of using cleaners, handwashing after returning home from outside, handwashing after sneezing, and tendency of using more water.

The study findings correspond with similar results from diverse contextual imprints. In particular, the current study found that participants' handwashing frequency and duration were higher during the COVID-19 pandemic in comparison to earlier periods. Previous studies conducted in a similar context found that handwashing frequency had significantly increased during the pandemic and almost 90% of people regularly washed their hands during the pandemic (Haque et al., 2020). Health professionals, health institutions, public health professionals, and related researchers across the world recommended that washing hands regularly may reduce the risk of coronavirus infection. And evidence reveals that such a recommendation has emerged to be effective. For instance, a study conducted in the United Kingdom found that handwashing with moderate frequency has been linked to a lower overall risk of coronavirus infection (Beale et al., 2020). Swain (2021), referring to their research findings from Africa, reported that there was a notable rise in the frequency of handwashing with soap during the COVID-19 pandemic. Consistent with the findings of Feizizadeh et al. (2021), this study also observed that there was a positive association between handwashing duration and water consumption level during the COVID-19 pandemic. Fear relating to coronavirus's spreading propensity increased the possibility of washing hands five times a day for at least 20 seconds with soap and water (Feizizadeh et al., 2021). Ahmed and Yunus (2020) reported that the range of handwashing time was raised from 38.84% to 57.74% during the pandemic in Iraq. According to the Centers for Disease Control and Prevention (2020), one of the best strategies to stop the spread of germs involves scrubbing hands for at least 20 seconds. Furthermore, UNICEF (2024) recommended that 20 seconds of hand washing with plain soap might help lower the number of alive germs on hands. The current study findings also come up with the suggestion that handwashing practice regularly may be an important intervention in avoiding the transmission of the COVID-19 pandemic.

Compared to pre-COVID-19 pandemic times, hand scrubbing duration and participants' intended use of cleaners increased during the pandemic. One previous study reported that when hands are rinsed, the virus fragments that have been enveloped by the soap molecules get washed away as the soap molecules damage the lipid membrane that encases the genetic material, which makes up the virus (Ijaz et al., 2021). Sayeed et al. (2021) their study found that the rate of participants' hand scrubbing duration was 17.9 seconds during the COVID-19 pandemic compared to 4.4 seconds pre-pandemic times. In South Korea, the number of people who primarily used liquid hand soaps increased from 23.5 to 41.3% during the COVID-19 period (Choi et al., 2021). Also, in Iraq, a study found that the rate of using liquid soap increased during the COVID-19 pandemic (Ahmed & Yunus, 2020). Thus, referring to Centers for Disease Control and Prevention (2020) and Tuyet-Hanh et al. (2020), it can be asserted that using soap for handwashing might very well remove bacteria, oil, and other particles from the skin, including viruses that cause illness.

The present study reported that participants' tendency to wash hands after returning home and handwashing after sneezing has increased during the COVID-19 pandemic in comparison to the pre-pandemic period. Sayeed (et. al., 2021) found 77.9% of people practiced regular handwashing after returning home from outside during the pandemic. It also reports that 37.1% of people regularly washed their hands after sneezing and 31.2%

of people sometimes washed their hands after sneezing during the COVID-19 pandemic (Sayeed et al., 2021). A Brazilian study also found that during the pandemic, 99% of people washed their hands as soon as they arrived home compared with the before pandemic (64.1%) (Campos et al., 2021). To prevent the COVID-19 and other afflictions from spreading, hand washing regularly is essential, especially after coughing or sneezing (Swain, 2021).

The discussions above echoed time and again that study participants' behavioral changes - before and during the COVID-19 pandemic on changed hand washing habits and water consumption are largely analogous to findings of similar studies across the globe. Hence, it crafts the scope to assert that urbanite water consumption has increased during the COVID-19 period which was triggered by frequencies, patterns, and intensities of hand-washing habits in the study area (Xun et al., 2021). Although there are many studies on the effect of handwashing practices on water consumption during the COVID-19 pandemic, there hasn't been much research done in Bangladesh on this issue. To the best of our knowledge, the present study first attempts to quantitatively assess the behavioral changes in handwashing practices and water consumption in Bangladesh, offering data-driven recommendations that could influence policy and public health guidelines. Along with using the paired sample t-test to compare the difference between the two periods' water usage, this study also used both binary logistics regression models to assess the influencing factors of water consumption during COVID-19. The study itself is not without limitations. Major limitations have been that the study used self-reported data that could have recall biases; as the data used are cross-sectional, no causal inference can be made; and finally, this study may limit the generalization of findings to other developing cities. Future research would consider measuring the behavioral changes during and before the COVID-19 pandemic in another geographical context.

The current study crafts scopes to understand the importance of hygiene education and behavioral change initiatives induced by a pandemic and how it might increase water demand and supply. To cope with such a public health concern, the study findings might be considered as insights for the water supply authority of the study area as well as a city, specifically, what strategies the authority needs to focus on immediately to meet such increased requirements. This could entail constructing or maintaining water supply infrastructure, setting up handwashing stations in public areas, or giving families resources to increase their access to water. To assure long-term water availability for hygiene and other basic requirements, this study's insights can be effective foundations relating to investment in water infrastructure. In particular, these might be funding urbanites' awareness building on the promotion of appropriate water usage practices, water recycling, and reuse technology, and engaging in water conservation activities. There might be a renewed emphasis on sustainable water management techniques.

5. Conclusions

A significant positive behavioral change in people has been observed during the COVID-19 pandemic. People were more frequently washed their hands with a long duration during the COVID-19 pandemic compared with before the pandemic. Hand scrubbing duration and the tendency to use cleaners also increased during the pandemic. People were more concerned about handwashing after returning home from outside. The rates

of handwashing after sneezing and the tendency to use more water escalated during the pandemic. In addition, peoples' education and income level were positively associated with water consumption. The elements of behavioral changes (e.g., handwashing frequency and duration, hand scrubbing duration, the tendency to use cleaners, handwashing after returning home from outside, handwashing after sneezing, and the tendency to use more water) were also positively associated with water consumption. The study findings inform academicians, practitioners, researchers, and policymakers about the relationship between handwashing practice and water consumption. The study findings may be helpful for policymakers to design interventions to reduce the overuse of water and to estimate the actual demand for water during any pandemic.

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