EFFECTIVENESS OF BRAC WASH PROGRAM IN INCREASING ACCESS TO WATER, SANITATION AND HYGIENE AMONG RESIDENTS OF COASTAL AREAS IN BANGLADESH

WATER, SANITATION AND HYGIENE (WASH) PROGRAMME

Effectiveness of BRAC WASH program in increasing access to Water, Sanitation and Hygiene among residents of coastal areas in Bangladesh

January 2022

WATER, SANITATION AND HYGIENE (WASH) PROGRAMME

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Published by:

Water Sanitation and Hygiene (WASH) Programme, BRAC
BRAC Centre, 75 Mohakhali, Dhaka 1212, Bangladesh
Website:http://www.brac.net/program/water-sanitation-hygiene/

Design & print by:
Progressive printers pvt. ltd.

ABOUT BRAC

The journey began in 1972 in the newly sovereign Bangladesh, and over the course of our evolution, we have been playing the role of recognising and tackling the many different realities of poverty. We have, therefore, developed support services in the areas of human rights and social empowerment, education and health, economic empowerment and enterprise development, livelihood training, environmental sustainability, and disaster preparedness across Asia and Africa.

VISION

A world free from all forms of exploitation and discrimination where everyone has the opportunity to realise their potential.

MISSION

Our mission is to empower people and communities in the situation of poverty, illiteracy, disease and social injustice. Our interventions aim to achieve large scale, positive changes through economic and social programmes that enable women and men to realise their potential.

VALUES

Integrity ■ Innovation ■ Inclusiveness ■ Effectiveness

TABLE OF CONTENT

Chapter 3

Chapter 4

Chapter 5

ACRONYMS

AOR	Adjusted odds ratio
CI	Confidence interval
HtRAs	Hard-to-reach areas
LMICs	Low- and middle-income countries
JMP	WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene
NGO	Non-governmental organization
ODK	Open data kit
OR	Odds ratio
PPS	Probability proportional to size sampling
PSM	Propensity score matching
PSF	Pond sand filter
UNICEF	The united nations international children's fund
WASH	Water, sanitation and hygiene
WHO	World health organization

ACKNOWLEDGMENTS

The impact study of BRAC WASH Programme's interventions at coastal areas titled "Effectiveness of BRAC WASH program in increasing access to Water, Sanitation and Hygiene among residents of coastal areas in Bangladesh" is conducted by International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B).

BRAC WASH Programme acknowledges the following person for their comments and insights in preparing and finalizing the report: Abu Said Md. Juel Miah, Team Lead - Research & Evidence, Advocacy for Social Change, BRAC; Abu Taleb Biswas. Senior Manager, BRAC WASH Programme and other members of BRAC WASH Progrmame. It also acknowledges the respective community people and Local Government Institute (LGI) members of BRAC WASH Programme's interventions areas for their contribution throughout the process.

EXECUTIVE SUMMARY

Background

Poor water, sanitation and hygiene (WASH) have detrimental effects on children's health, growth, and economic development of a country. Improving WASH access in hard-to-reach areas (HtRAs), including coastal areas, is challenging considering the geographical location and risk of frequent natural disasters. BRAC WASH program in HtRAs was an extension of the BRAC WASH program in Bangladesh and implemented from 2016 to 2020. Including other HtRAs of Bangladesh, the program was implemented in 48 sub-districts of 11 coastal districts. The program focused on an inclusive financing model to provide financial and technical support to the non-poor, poor, and ultra-poor population in improving WASH access through individual, community, and entrepreneur-level approaches. This study evaluated the impact of a WASH program implemented by BRAC (an international NGO based in Dhaka) in HtRAs of Bangladesh in improving 1) access to improved sanitation facilities and drinking water sources, 2) quality of hygiene and sanitation services: availability of handwashing stations, latrine cleanliness, privacy, security, and sanitation and hygiene behaviors, and 3) health of the household members, specifically diarrhea and acute upper respiratory tract infections.

Evaluation methodology

icddr,b team evaluated BRAC WASH program in coastal areas using a post-interventional cross-sectional study design. We used a multi-stage sampling strategy to select the study households from both intervention and matched comparison areas. We matched the intervention and comparison groups at both union and household levels. Unions are the lowest rural administrative unit in Bangladesh. This study was conducted among 435 households from intervention and 435 households from comparison areas. Trained field staff from icddr,b conducted questionnaire surveys and spot-check of WASH facilities using structured questionnaire and observation check-list to assess the access to WASH facilities and the use of those by the household members. We used mixed-effect logistic regression modeling to assess the effect of the intervention.

Results

We assessed a total of 870 households. The majority of the respondents in our study were female with average age 38 years old (SD: 12). The households in the comparison areas were poorer according to the wealth quintile distribution than the ones from the intervention area. The respondents from the comparison households had fewer years of formal education compared to the respondents from the intervention households. Involvement of household members in a WASH program of any NGO was higher among intervention households compared to the comparison

households (77% vs 21%; OR: 12.0; 95% CI: 6.84, 21.1). Significantly more households in the intervention group compared to the comparison group received financial or technical support from an NGO including BRAC in constructing drinking water sources (40% vs. 16%; OR: 1.26; 95% CI: 1.1, 1.43), and latrines (28% vs. 6.4%; OR: 5.54; 95% CI: 3.06, 10.0.3).

In our study areas, 99% (n=858) households had access to improved drinking water sources within 30 minutes travel distance. The proportion of households with individual ownership of water sources was higher among the BRAC intervention households (34% vs. 11%) compared to the comparison households (adjusted odds ratio (AOR): 3.23; 95% CI: 1.8, 5.82). Households in the BRAC intervention areas reported storing drinking water for a shorter duration compared to the households in the comparison areas (mean: 18 hours vs. 34 hours).

Among all the study households, 49% (n=430) had access to a safely managed sanitation facility. BRAC intervention areas had more households with access to safely managed sanitation facility (58% vs 41%; AOR: 1.57; 95% CI: 1.00, 2.36), and an improved sanitation facility accessible to all age groups (82% vs 69%; AOR: 1.60; 95% CI: 1.01, 2.52) compared to the comparison group. Significantly more intervention households had their toilet facility within the courtyard boundary (62% vs 46%; AOR: 1.49; 95% CI: 1.03, 2.17) compared to comparison group households.

In the BRAC intervention areas, 49% (n=213) of the households had access to a handwashing facility with soap and water available for handwashing compared to only 30% in the comparison area (AOR: 1.48; 95% CI: 1.00, 2.19). Prortion of respondents who reported washing hands with soap before eating food (51% vs 43%) or preparing food (14% vs 6%) was higher in the BRAC intervention villages compared to the comparison villages. When the enumerators observed the hands of the respondents and under-5 children, 24% (n=212) of respondent's hands and 21% (n=61) of under-5 children's hands were observed clean.

The BRAC intervention areas had a higher proportion of households built water points above the usual flood line (48% vs 40%; AOR: 1.32; 95% CI: 0.6, 2.99) compared to those in comparison areas. A similarly higher proportion of households in the BRAC intervention areas built the sanitation facility above the usual flood line(68% vs 53%; AOR: 1.47; 95% CI: 0.93, 2.31).

Among all the study households, 1.38% (n=28) respondents reported diarrhea among any household members, and 2.13% (n=7) households reported diarrhea among under-5 children within a 14-day recall period. In intervention households, 0.4% reported diarrhea among any household members compared to 1.0% in the comparison households (AOR: 0.50, 95% CI: 0.14, 1.81). Regarding diarrhea incidence among under-5 children, in intervention households, 1.2% reported diarrhea among under-5 children compared to 3.1% in comparison households (AOR: 0.53; 95% CI: 0.04, 6.5). A similar trend of intervention effects was observed in terms of acute respiratory tract infection among all household members (4.6% vs 6.7%; AOR: 0.72; 95% CI: 0.05, 1.14) and under-5 children (8.4% vs 12%; AOR: 0.90; 95% CI: 0.40, 1.88).

Conclusion

Our study findings suggest that financial support alone may help with access to water and sanitation facilities. Although the study has limitations, these findings indicate that the intervention had a positive impact on access to WASH facilities among residents of coastal communities in Bangladesh.

CHAPTER

1

INTRODUCTION

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Lower respiratory tract infections and diarrheal diseases are the second and third leading causes of under-5 child death globally [1]. Poor water, sanitation and hygiene (WASH) facilities are the major contributing factors to diarrhea and respiratory tract infections [2-6]. In 2015, 30% of the global population lacked basic sanitation services, and 892 million people practiced open defecation [7]. Basic drinking water sources were inaccessible to 844 million people, and in the least developed countries, only one-fourth of the population had access to handwashing stations with soap and water [7]. Lack of access to improved WASH facilities is prevalent in low- and middle-income countries (LMICs) compared to high-income countries [8], and rural communities are less likely to have access to improved WASH facilities compared to urban areas [7], People living in disaster-prone hard-to-reach areas are especially susceptible to illness due to inadequate WASH facilities [9]. Access to improved WASH facilities can prevent diarrhea and respiratory tract infections among high-risk populations [8, 10-12].

Over the last few decades, Bangladesh has made significant progress in increasing access to improved WASH facilities at the community level [13]. In 2019 in Bangladesh, 85% of households had access to an improved sanitation facility, 64.4% had improved sanitation facility not shared with others, 99% had access to improved drinking water sources, 98% had the improved drinking water sources within 30 minutes travel time including queuing, and 75% households had access to a handwashing facility on household premises with soap and water [14]. This scenario is not uniform throughout Bangladesh; in hard-to-reach coastal areas, the access to improved WASH facilities is far below the national average [15]. In coastal areas, the main challenges of improved WASH access are the lack of climate-resilient WASH facilities, disaster-prone geographical locations of the target communities, climate change, lack of WASH-related projects in the climate change trust fund of the Government of Bangladesh, lack of knowledge among policy makers regarding the impact of climate change in WASH access, and lack of budget allocation for WASH improvement in these areas [16]. These difficulties serve as barriers for implementing WASH improvements.

Furthermore, the sustainability of WASH interventions is affected by financial, institutional, environmental, technical, and social factors [17]. High levels of expenditure from government and non-governmental organizations in building WASH facilities may not result in sustained improved WASH access at community and household levels due to a lack of operational and capital maintenance expenditure [18]. In resource-constrained settings without any financial support, motivating households and communities to adopt improved WASH facilities is challenging. To overcome these difficulties and expand water and sanitation, inclusive financing model comprised of microfinance and grant support for the ultra-poor has been used. Microfinance is a range of financial and non-

financial services to the low-income population of a community to encourage small businesses or increase savings, with the expectation that recipients will improve their social and economic status through business ventures that will also enable them to repay the loans [19]. Microfinance was introduced in Bangladesh in the 1970s and included providing the poor with primarily agriculture-based small loans and flexible payment schemes without required collateral [20, 21]. One example of a successful micro-finance program in Bangladesh is BRAC's social enterprise model. This model enables community members to become entrepreneurs addressing social challenges while generating more significant impact through reinvestment in the community [22].

Evaluation of BRAC's previous micro-finance program revealed a positive impact on access to improved water sources and sanitation facilities among the beneficiaries [23]. Micro-finance reduces government costs and enables recovery of financial loss through privatization of water and sanitation services, allowing civil society to be involved in market-building [19, 24, 25]. Microfinance for sanitation can significantly increase the use of improved sanitation and generate community awareness in households, resulting in a better quality of life [26, 27].

1.2 Objectives and research questions

The effectiveness of the BRAC WASH program in hard-to-reach areas at the population level in coastal areas could provide evidence for the potential of these interventions to improve WASH in this high-risk geographical region. Thus, we investigated the effectiveness of the BRAC WASH program in coastal areas on improving access to and use of improved sanitation facilities and drinking water sources at the population level, thereby reducing diarrheal and acute upper respiratory tract infections. We assessed the impact of the BRAC WASH program in coastal areas on 1) access to improved sanitation facilities and drinking water sources, 2) quality of hygiene and sanitation conditions: availability of handwashing stations, latrine cleanliness, satisfaction, privacy, security, and sanitation and hygiene behaviors, and 3) health of the household members, specifically diarrhea and acute upper respiratory tract infections.

1.3 Scope of the study

- Conducted a standard questionnaire survey to collect data on the household's socio-economic status, water, sanitation and hygiene practices, and quality of WASH facilities (satisfaction, privacy, security), caregiver-reported data on diarrhea (14-day recall), and symptoms of recent acute respiratory tract infections (14-day recall) among all household members to assess the health impact of the intervention on household members health.
- Conducted a spot-check of water, sanitation and hygiene facilities to assess the access and quality and inspection of the children's and their primary caregiver's hands for cleanliness.
- Analyzed collected data and provided recommendations for future interventions to improve WASH situation, hygiene awareness, and practices in similar settings.

1.4 Structure of the report

This is a brief report of BRAC WASH program in HtRAs evaluation study. This report comprised of a brief background of WASH in Bangladesh and HtRAs, brief implementation method of BRAC WASH program in HtRAs, detailed methodology of the post-intervention evaluation study, results of the study, and a brief discussion of the results, including conclusion and recommendations.

CHAPTER

2

METHODOLOGY

CHAPTER 2

METHODOLOGY

2.1 Intervention settings

The BRAC WASH program in hard-to-reach areas (HtRAs), including coastal areas, was an expansion of the BRAC WASH program in Bangladesh, which has been ongoing since 2006 [28]. This expansion was implemented from 2016 to 2020 [29]. HtRAs in Bangladesh is defined based on their remote geographical location and inaccessibility to traditional development activities [30]. Six indicators are used to characterize the HtRAs: groundwater table, improved drinking water coverage, sanitation coverage, natural disaster hotspots, level of poverty, and child mortality rate [30]. People residing in HtRAs are trapped in the vicious cycle of poverty [30]. Coastal areas of Bangladesh are one of the HtRAs. The people living in those coastal areas mainly depend on agriculture, aquaculture, fishing, and seasonal employment for their livelihoods [31]. Compared to other non-coastal populations, coastal populations are more prone to natural disasters, such as flash floods, water logging, water surge, and saline water intrusion due to cyclones in the Bay of Bengal and rising water levels resulting from climate change [32]. Deep hand tubewells are the main drinking water source, and sanitation infrastructures are highly susceptible to natural disasters [30]. Coastal populations are more vulnerable to displacement due to frequent natural disasters and damage to their livelihoods [33].

In three coastal divisions, Khulna, Barishal, and Chittagong, 213 unions fall under the category of HtRs areas [30]. The BRAC WASH program was implemented in 48 sub-districts of 11 coastal districts [15, 29].

2.2 Intervention design

The BRAC WASH program in HtRs intervention was mainly focused on an inclusive financing model for WASH interventions in the form of financial and technical support. The non-poor and poor beneficiaries received financial support through the social enterprise model, and ultra-poor beneficiaries, people who lived at less than half the $1.25-a-day poverty line, and those who eat below 4/5 of their energy requirements despite spending at least 4/5 of their income on food [34], received grant support from the program. The technical support was intervention-specific and based on the type of intervention; each beneficiary received relevant technical support from the program, such as training and health education. In the targeted communities, the intervention was delivered at the household level, community level, and individual level. The intervention was demand-driven to ensure the sustainability of the program's effect in the targeted community.

The intervention contained both hardware and behavior change components. At the household level, the WASH interventions were construction or installation of deep tube-wells, tube-well platforms, water tanks, water pumps, water filters, water treatment units/ plants, pond sand filters, water reservoirs for rain water harvesting, dual pit latrines, and other water and sanitation products, and repair or upgrade of latrines. At the community level, some targeted communities received pipe water systems. At the individual level, entrepreneurs, such as water vendors and sanitation workers, received water and sanitation products and training from the program to initiate or expand their businesses. The program also included a behavior change intervention. The hygiene promotion intervention included awareness generation related to hand hygiene and hygiene education sessions with the beneficiaries. Spreading awareness of climate change issues was the main focus of this program in coastal areas. Thus, the program promoted climate-resilient WASH interventions, such as rain water harvesting, desalination, WASH-related climate change awareness, and disaster preparedness initiatives (Table 1).

Table 1 Intervention components of BRAC WASH program in hard-to-reach areas of Bangladesh

Sl.		Target Group	Support Activities
Individual/Entrepreneurial Intervention			
1	Developing Water Treatment Plant	1. All Male and Female above 18 years of age 2. Non-ultra-poor group	Financial and Technical Support
2	Developing Water Transport Vendor	1. All Male and Female above 18 years of age 2. Non-ultra-poor group	Financial and Technical Support
3	Developing Local Sanitation Entrepreneurs	1. All Male and Female above 18 years of age 2. Non-ultra-poor group	Financial and Technical Support
Water Options at household level			
1	Installation of Deep tube wells	1. All Male and Female above 18 years of age 2. Non-ultra-poor group	Financial and Technical Support
2	Installation of Rain Water Harvesting System	1. All Male and Female above 18 years of age 2. Non-ultra-poor group	Financial and Technical Support
3	Provide Free water	Ultra poor group	Water jar and safe water
Sanitation Options at the household level			
1	Installation of Latrine (double pit offset and septic tank)	1. All Male and Female above 18 years of age 2. Non-ultra-poor group	Financial and Technical Support
2	Installation of Latrine through grants (double pit offset)	1. All Male and Female above 18 years of age 2. Non-ultra-poor group	Grants and Technical Support

Before initiating the program activities in the target areas, BRAC used its existing network to identify eligible communities, entrepreneurs, and households. They conducted sensitization meetings at the community level with stakeholders and shared the program objectives and relevant activities. Then, each eligible beneficiary was approached to assess their WASH-related demand, and BRAC field workers proposed the relevant interventions from the program. Based on individual agreements between the beneficiaries and the program workers about the best-suited intervention, each beneficiary received intervention-specific financial and technical support from the program. At the community level, a village WASH Committee (VWC) was formed in each village to monitor and implement the community-level WASH intervention. The VWC was comprised of local leaders, teachers, and elite community members. The committee was responsible for conducting bi-monthly meetings and discussing the progress and difficulties of the ongoing interventions. During those meetings, a representative from BRAC was present to monitor VWC's activity and responsiveness and also shared technical support as needed. VWCs were also responsible for using the generated revenue to maintain community WASH infrastructure and develop new infrastructure to meet the community need.

2.3 Evaluation study design

We used a post-intervention cross-sectional study for the evaluation of the effectiveness of the BRAC WASH intervention. We adopted a post-implementation-only evaluation design because no baseline study was carried out before the intervention. Our study areas were comprised of a subset of intervention unions and geographically matched comparison unions from the same sub-district of two southern coastal divisions, Khulna and Barishal. In Bangladesh, unions are the smallest rural administrative units [35].

2.4 Selection of study households

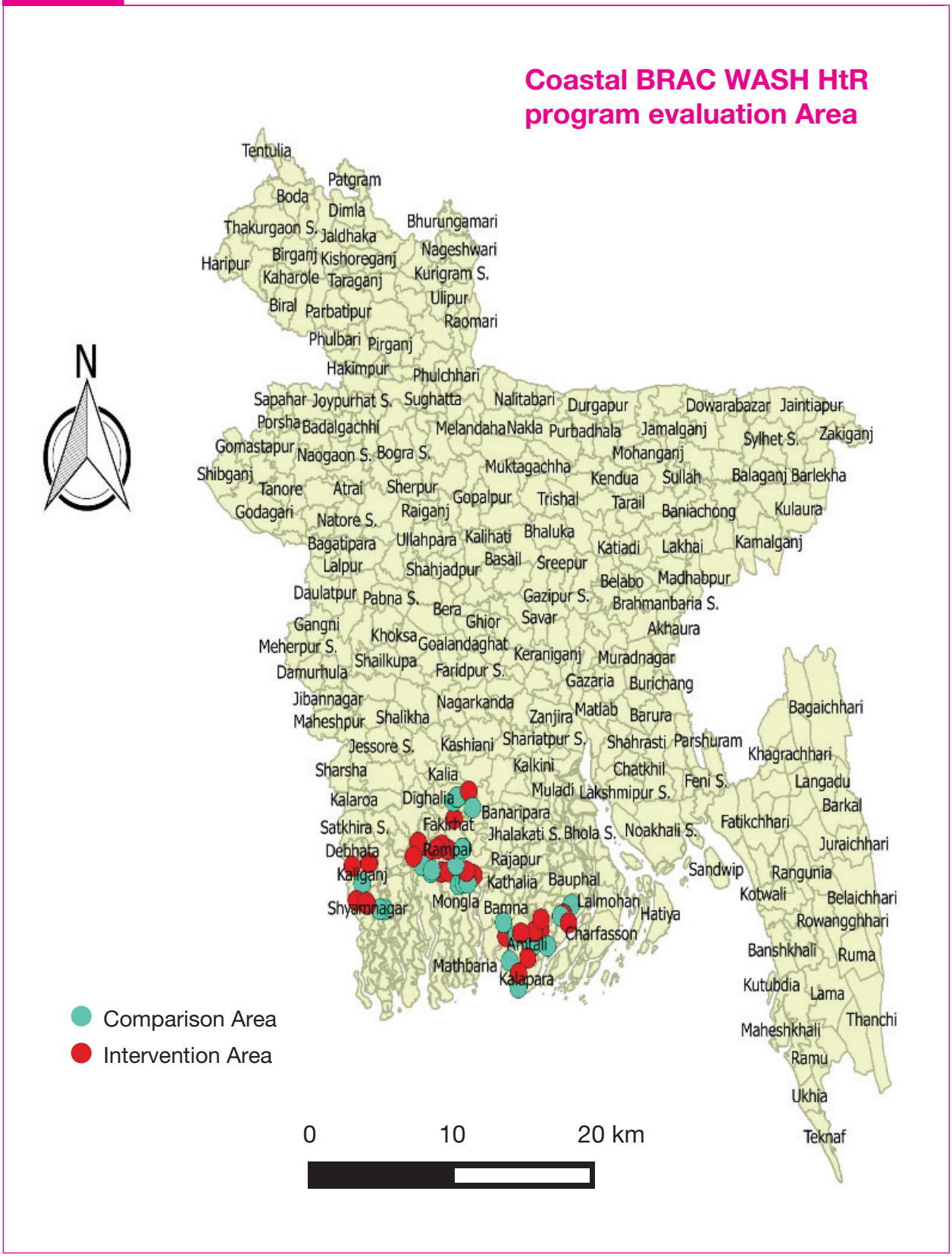
All the households living in the selected comparison villages for at least one year without any plan to migrate within the subsequent two months were eligible for the evaluation. In the intervention villages, all the BRAC WASH program beneficiaries were eligible to be included in this study. The evaluation team approached the female household members who were the main earning member, wife of the main earning member, or mother of the main earning member of that household. Female household members could provide more detailed information about WASH facilities, and they were more likely to be available than their male counterparts. Households with any member who had COVID-19 signs and/or symptoms within the preceding 10 days of data collection were excluded to reduce the risk of disease transmission.

We used a multi-stage sampling strategy to select the study households. The number of clusters we selected from each division, Khulna and Barishal, was proportional to the number of intervention unions engaged in BRAC WASH programs in each division. We matched the intervention and comparison groups at both union and household levels. At the union level, we matched the union's physiographic characteristic, coastal location. For each comparison union, we selected an intervention union in the same sub-district or nearby sub-district. At the household level, we used the propensity score matching (PSM) method to match comparison households with the intervention ones.

We identified intervention and comparison unions from a list provided by BRAC, which was developed from a list of hard-to-reach areas created by the government of Bangladesh [15]. From that list, we excluded urban areas (pourasava). We used probability proportional to size sampling (PPS) at the union level to select the comparison unions from each division, and we selected the intervention unions from the same or nearby sub-districts by matching total population size, literacy rate, access to improved sanitation, use of tubewell for drinking water, and access to electricity using data from the 2011 census [36]. From the randomly selected intervention villages from each union, 15 households were selected at random from the list of BRAC WASH beneficiaries.

In the comparison villages, the nearest household to the center was the starting point for finding the eligible households. A household was considered eligible if they lived in that area for at least one year and were planning to stay there for at least the next two months starting from the screening period. From each comparison village, the field workers listed at least 60 households and collected information. Then, we selected 15 comparison households from that list by using propensity score matching (PSM) methods with the intervention households. We used socio-demographic co-variates that affect the availability and accessibility of WASH infrastructure at the household level, such as socio-economic status (household income, housing materials, and assets, and educational status of the main earning member) and household size.

Figure 1 Schematic presentation of study areas of BRAC WASH program in HtRAs evaluation



2.5 Data collection

A team of university-graduate enumerators received 10 days of training on the data collection tools through interactive discussion sessions, role play, and field testing in non-intervention sites. The enumerators used two iteratively revised data collection instruments: (i) Standard questionnaire survey and (ii) Spot-check. For the survey, we adopted icddr,b's standard WASH assessment module, which was developed based on the WHO/UNICEF Joint Monitoring Programme (JMP) indicators. Using the structured questionnaire survey tool, the enumerators collected data on the household's socioeconomic status, WASH practices, and quality of WASH facilities (cleanliness, satisfaction, privacy, security). Self-reported data on diarrhea (14-day recall) and symptoms of recent acute respiratory tract infections (14-day recall) among all the household members were also collected to assess the health impacts of the intervention among the study population. The enumerators conducted the interviews in the location preferred by the respondents. The enumerators conducted a spot-check of WASH facilities among all the households that participated in the questionnaire survey to assess the access and quality. They recorded the location, type, building material, accessibility status, cleanliness, and signs of use of the WASH facilities during the spot-check. In addition, hands of children less than 10 years old and of the respondent were inspected for cleanliness as the proxy indicator for hand hygiene practices. The enumerators conducted the survey in Bangla and used ODK software on tablet computers to record the collected data. The duration of each interview and spot-check was 40 to 60 minutes.

Picture 1 Enumerators interviewing the respondents and conducting spot-check of the WASH facilities

2.6 Outcomes

The primary outcomes of this evaluation were the proportion of households with access to improved sanitation facilities, improved drinking water sources, and a handwashing facility with soap and water. The secondary outcomes were the prevalence of diarrhea and acute upper respiratory tract infections among all household members within the preceding 14-day recall period.

We used the Joint Monitoring Programme (JMP) guidelines for defining improved WASH facilities. The improved drinking water sources were those that had the potential to deliver safe water by nature of their design and construction, such as piped water, boreholes or tubewells, protected dug wells, protected springs, rainwater, and packaged or delivered water. The limited drinking water sources were those improved drinking water sources from which the water collection time exceeded 30 minutes roundtrip including queuing [37]. If the time was less than 30 minutes, those improved sources were defined as basic drinking water sources [37]. Improved sanitation facilities were those designed to hygienically separate feces from human contact, such as flush or pour-flush latrines connected to piped sewer systems, septic tanks or pit latrines, pit latrines with slabs (including ventilated pit latrines), and composting toilets. The improved sanitation facilities not shared with other households were defined as basic sanitation facilities [38]. If the basic sanitation facilities were designed to safely dispose the excreta in situ, or the households removed and treated the excreta offsite, they were categorized as safely managed sanitation facilities [38]. The basic handwashing facilities were those with soap and water at home [39].

2.7 Statistical analysis

We calculated sample size using access to improved sanitation as the primary outcome. We set the significance level to 0.05 and the power to 0.80. In the comparison areas, we assumed that 52% of the households would have access to improved latrines. With a minimum detectable difference of 15% increase in access to improved sanitation in the intervention areas compared to the comparison areas, considering 15 households per village cluster, 29 village clusters per arm, and a design effect of 2.54, we needed 435 households per arm, and our total sample size was 870 households.

We used Stata Statistical Software: Release 13 (StataCorp LP, College Station, TX) for data analysis. For descriptive analyses, we calculated proportions for binary and categorical variables and means and standard deviations for continuous variables, which are summarized in descriptive tables. To assess the effect of the intervention on WASH facilities, reported practices, and reported health outcomes (e.g. diarrhea and respiratory infections), we compared the intervention group with the comparison group. For binary outcome variables, odds ratios (ORs) and associated 95% confidence intervals were calculated using mixed-effect logistic regression models adjusting for clustering at the village level. A multilevel mixed-effects linear regression model was used for the continuous outcomes. To quantify the impact of the program, we used intention-to-treat analyses without regard for program adherence. For determining the intervention effect, we adjusted for potential covariates such as socio-economic conditions and involvement of the study households with other WASH programs and other NGOs.

2.8 Ethical considerations

The icddr,b institutional review board has approved this study. We collected informed written consent from each respondent after explaining the objectives and process of the survey, the risks and benefits of participating in this study, and their rights to withdraw their consent at any syage of the study. We maintained the confidentiality and anonymity of the respondents and responses.

2.9 Limitations of the study

This study has several limitations, and some of those are

- Lack of baseline data for the intervention and comparison groups which limited to assess the actual impact of the program
- Non-random selection of comparison group. Although propensity score matching was used to select the comparison group, there was limited time and resources for doing household listing to make the propensity score as effective as we expected.
- Actual behavior change could not be interpreted due to the lack of data on observed behaviors
- This study has limited power to detect differences in health outcomes between intervention and comparison groups

CHAPTER

3

RESULTS

CHAPTER 3

RESULTS

3.1 Study sample and socio-demographic characteristics

As part of this evaluation, we assessed 870 households (435 intervention and 435 comparison) from 58 village clusters (29 intervention and 29 comparison). All the study samples were from 44 unions of 16 sub-districts of five districts in two coastal divisions. Among the households approached for this study, 109 households were excluded (66 intervention and 43 comparison) for reasons like migration, absence refusal, and presence of COVID-19 symptoms within 10 days preceding the data collection day. For all the excluded households, an alternate eligible household was enrolled for the study (Figure 2).

The majority of the respondents were the wife of the main earning member of the family with an average age of 38 years (SD: 12). Thirty-four percent (n=293) of the households had a child aged less than five years old. More respondents and main earning members of the intervention group had more than five years of formal education. A higher proportion of households from the comparison villages were in the poorest category of the wealth index (Table 2).

Figure 2 Study sample selection flow chart

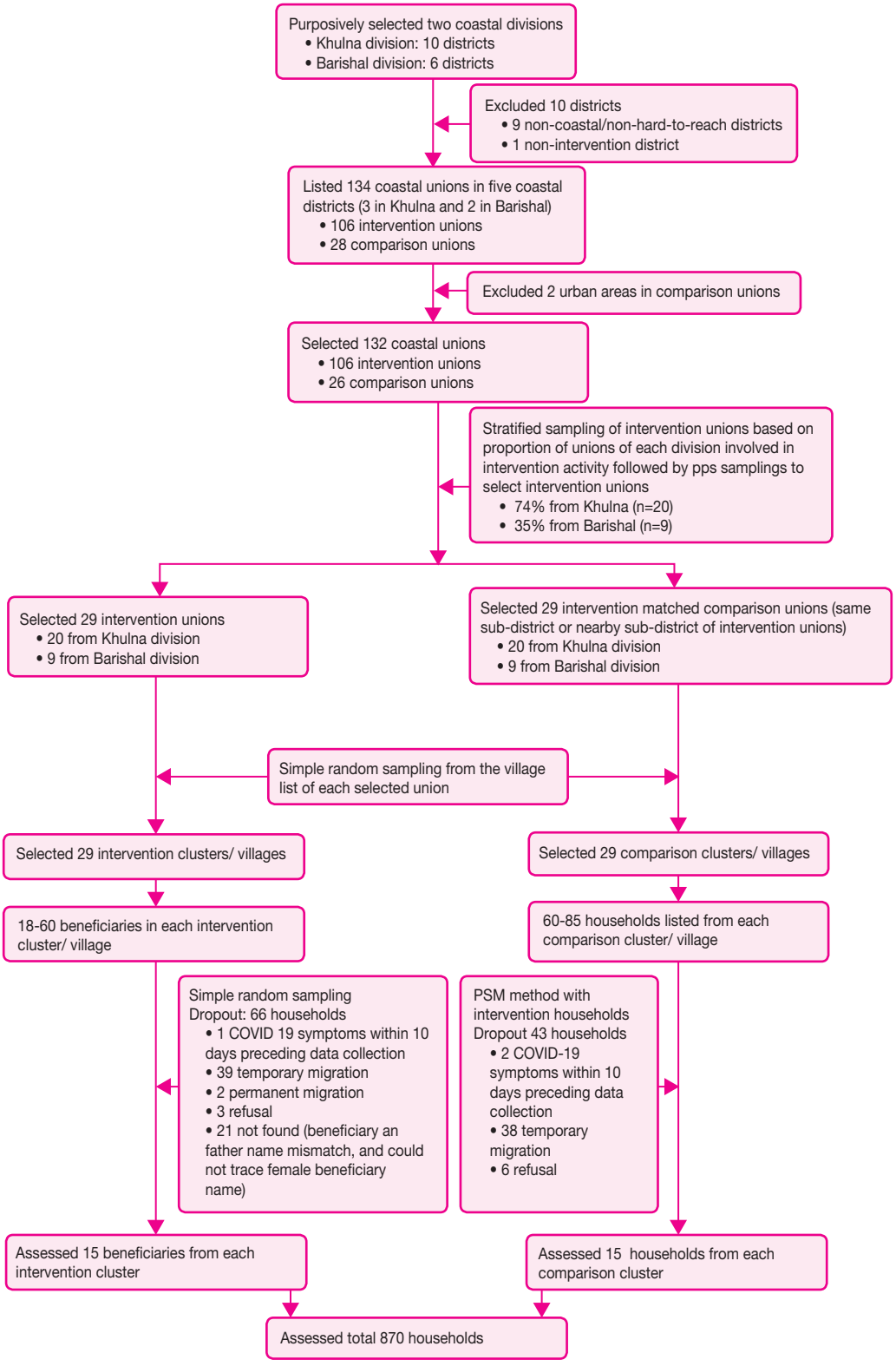


Table 2 Socio-demographic characteristics of the respondents and study households

Indicators	Intervention (N=435) % (n) or mean ± SD	Comparison (N=435) % (n) or mean ± SD	p-value
Respondent characteristics			
Respondent's status			
Main earning member of the household	3.5 (15)	2.8 (12)	0.558
Wife of the main earning member	84 (364)	84 (364)	1.000
Mother of the main earning member	9.7 (42)	11 (46)	0.653
Mean age of respondents (in years)	39 ±11.6	38 ±12.4	0.581
Sex of respondents (female)	98 (426)	99 (430)	0.282
Formal Education of respondents			
No formal education	9.9 (43)	15 (67)	0.014
1-5 years	32 (138)	35 (153)	0.282
6-10 years	48 (210)	41 (179)	0.035
>10 years	10 (44)	8.3 (36)	0.349
Occupation of the respondent (top 5)			
Homemaker	92 (400)	91 (398)	0.157
Skilled worker	1.8 (8)	1.8 (8)	1.000
Service holder	1.8 (8)	1.6 (7)	0.795
Traders/business occupation	1.6 (7)	1.4 (6)	0.780
Daily wage labor/boatman/shoe or Umbrella mechanic	0.5 (2)	2.1 (9)	0.034
Household characteristics			
Has an under-5 child	33 (144)	34 (149)	0.720
Sex of household head (male)	95 (411)	93 (406)	0.479
Mean age of the household head (in years)	48 ±11.6	46 ± 13.9	0.109
Formal Education of the main earning member			
No formal education	10 (45)	14 (60)	0.119
1-5 years	24 (105)	33 (142)	0.005

Indicators	Intervention (N=435) % (n) or mean ± SD	Comparison (N=435) % (n) or mean ± SD	p-value
6-10 years	48 (208)	38 (166)	0.004
>10 years	18 (77)	15 (67)	0.362
Occupation of the main earning member (Top five)			
Traders/business occupation	38 (163)	17 (74)	0.000
Daily wage labor/boatman/shoe or umbrella mechanic	14 (60)	26 (112)	0.000
Farmer/cultivator/homemaker	14 (62)	22 (95)	0.004
Service	13 (58)	16 (70)	0.251
Skilled worker/profession	15 (66)	11 (50)	0.111
Household size	4.7 ± 1.6	4.4 ± 1.7	0.052
Has a household member with disability (any type)	12 (54)	14 (60)	0.547
Socio-economic classification based on wealth index[1]			
Poorest	**14 (59)**	**26 (115)**	**0.000**
2nd	15 (67)	25 (107)	0.001
3rd	19 (83)	21 (91)	0.498
4th	23 (99)	17 (75)	0.042
Wealthiest	29 (127)	11 (47)	0.000
Average monthly income of the households in Bangladeshi Taka			
Poorest	**10,341 ± 5099**	**8,720 ± 4517**	**0.034**
2nd	12,052 ± 5830	10,421 ± 5322	0.060
3rd	16,584 ± 9268	12,549 ± 6024	0.001
4th	20,116 ± 10725	19,453 ± 10093	0.679
Wealthiest	32,909 ± 18210	28,723 ± 14567	0.159

3.2
NGO activities in the study areas

Among all the respondents, 92% (n=801) reported awareness of ongoing NGO activities in their communities. From intervention groups, higher proportion of respondents reported hearing about NGO activities in their community compared to the comparison groups (100% vs 85%; odds ratio (OR): 39.4; 95% CI: 9.79, 158.6). A significantly similar trend was found for both BRAC activities (98% vs 58%; OR: 30.3; 95% CI: 16.9, 54.2) and activities of other NGOs (87% vs 81%; OR: 1.63; 95% CI: 1.02, 2.6). Compared to the comparison households, the intervention household's involvement with WASH programs of any NGOs was 12 times higher (77% vs 21%; OR: 12.0; 95% CI: 6.84, 21.1), and involvement with BRAC WASH program was 91 times higher (75% vs 3.2%; OR: 91.05; 95% CI: 50.6, 163.96) (Table 3).

Table 3 NGO activities in the study areas and study households' involvement

Indicators	Intervention (N=435) % (n) or mean ± SD	Comparison (N=435) % (n) or mean ± SD	p-value[2]	OR / IRR (95% CI)[3]
Respondent heard about any NGO activity in their community	100 (433)	85 (368)	0.000	39.4 (9.79, 158.6)
Respondent knows about BRAC activity in their community	98 (425)	58 (254)	0.000	30.3 (16.9, 54.2)
Respondent heard about other NGO activity in their community	87 (380)	81 (352)	0.009	1.63 (1.02, 2.6)
Household members involved with WASH program activities of any NGO (financial/ technical support, attending meetings/ promotional activities)	77 (333)	21 (93)	0.000	12.0 (6.84, 21.1)
Household members involved with BRAC WASH program activities (financial/technical support, attended meetings/promotional activities)	75 (327)	3.2 (14)	0.000	91.1 (50.6, 163.9)
Household members involve with other NGO's WASH-related activities (financial/technical support, attended meetings/promotional activities)	21 (91)	15 (64)	0.017	1.5 (0.8, 2.85)
Household members involved with NGO's activities other than WASH (including other activities of BRAC)	54 (234)	50 (218)	0.278	1.2 (0.7, 1.8)

[1] Used principal component analysis (PCA) method using 29 household asset variables
[2] Two-sample t-test with equal variances
[3] Clustering effect adjusted by using Generalized Linear Models (GLM)

3.3
Received support from NGOs or government in building or repairing WASH facilities

Regarding receiving support from NGOs or others for building or repairing WASH facilities, in the intervention group, 1.42 times more households received financial or technical support from BRAC for constructing drinking water sources (36% vs 0%; OR: 1.42; 95% CI: 1.31, 1.54), 70.63 times for constructing latrines (25% vs 0.5%; OR: 75; 95% CI: 18.67, 301) compared to the comparison group. Conversely, the comparison group received more support from other NGOs or government compared to the intervention group in constructing and repairing WASH facilities in their households (Table 4).

Table 4 Association between social enterprise-based BRAC WASH program and received support in constructing or repairing WASH facilities by the study households

Indicators	Intervention (N=435) % (n)	Comparison (N=435) % (n)	OR (95% CI)	p-value
Proportion of households who received support from any NGO including BRAC for constructing the drinking water source	40 (138)	16 (53)	1.26 (1.1, 1.43)	0.001
Proportion of households who received support (financial/technical) from BRAC for constructing the drinking water source	36 (125)	0 (0)	1.42 (1.31, 1.54)	0.000
Proportion of households who received support (financial/technical) from other NGOs/government for constructing the drinking water source	3.8 (13)	16 (53)	0.21 (0.07, 0.68)	0.000
Proportion of households who received support from any NGO including BRAC for repairing the drinking water source	1 (1)	12 (25)	0.89 (0.81, 0.98)	0.019
Proportion of households who received support (financial/technical) from BRAC for repairing the drinking water source	0.7 (1)	0 (0)	1.01 (1, 1.02)	0.220
Proportion of households who received support (financial/technical) from other NGOs/government for repairing the drinking water source	0 (0)	12 (25)	0.88 (0.8, 0.98)	0.000
Proportion of HH Households received support from any NGO including BRAC for building latrine (financial/technical)	28 (120)	6.4 (23)	1.24 (1.15, 1.34)	0.000
Received support from BRAC for building latrine	25 (112)	0.5 (2)	75.07 (18.67, 301.9)	0.000
Other NGOs/government for building latrine	1.8 (8)	6.0 (26)	5.54 (3.06, 10.03)	0.000
BRAC for repairing improved latrine (financial/technical)	3.2 (14)	0.2 (1)	14.43 (1.76, 117.97)	0.013
Other NGOs/government for repairing latrine (financial/ technical)	0 (0)	0.2 (1)	1 (0.99, 1)	0.318

3.4
Access to basic drinking water sources

Picture 2 Different types of drinking water sources observed in study areas

Among 870 study households, 99% (n=858) had access to basic drinking water sources as defined by JMP, which were improved drinking water sources within 30 minutes travel distance, including queuing. In the study areas, the common improved drinking water sources within 30 minutes water collection time including queuing were deep tubewell or borehole with a depth of 250 feet or more (47%, n=412), rainwater (40%, n=344), bottled water (13%, n=110), pathogen treatment plant/pond sand filter (PSF) (11%, n=97), and shallow tubewell or borehole with a depth of less than 250 feet (5.98%, n=52).

In intervention and comparison villages had a similar type of water sources. The odds of owning a water source among the intervention households were 3.23 times higher than the odds among the comparison households (34% vs 11%; AOR: 3.23; 95% CI: 1.8, 5.82). In the BRAC intervention areas, 72% of households had a water source located within the compound premises, but in the comprion villages, only 53% of the households had water sources in the compound (AOR: 1.99; 95% CI: 1.05, 3.8) (Table 5).

Table 5 Association between BRAC WASH program in HtRAs and access to basic drinking water sources in the study areas

WASH indicators	Intervention (N=435) % (n)	Comparison (N=435) % (n)	Unadjusted OR (95% CI)[4]	p-value[5]	Adjusted OR (95% CI) [6]	p-value
Proportion of Households with access to drinking water sources						
Basic[7]	98 (426)	99 (432)	0.33 (0.08, 1.35)	0.081	0.34 (0.1, 1.59)	0.172
Limited[8]	2.1 (9)	0.2 (1)	9.17 (1.07, 78.43)	0.011	9.60 (1.1, 82.4)	0.039
Surface water[9]	0 (0)	0.5 (2)	0.157	-*	-*	-*
Common At least basic drinking water sources (top 5)						
Deep Tubewell / borehole (depth ≥250 feet)	48 (206)	48 (206)	1.03 (0.39, 2.72)	0.844	1 (0.37, 2.68)	0.999
Rainwater collection	43 (182)	38 (162)	1.24 (0.49, 3.18)	0.119	1.4 (0.53, 3.69)	0.491
Bottled water	17 (71)	9.0 (39)	2.02 (0.65, 6.23)	0.001	1.72 (0.55, 5.32)	0.348
Pathogen treatment plant (Pond Sand Filter)	3.8 (16)	19 (81)	0.17 (0.05, 0.54)	0.000	0.19 (0.06, 0.63)	0.006
Shallow Tubewell / borehole (depth <250 feet)	7.3 (31)	4.9 (21)	1.54 (0.35, 6.75)	0.138	1.84 (0.37, 9.07)	0.454
Ownership of drinking water source						
Target household	34 (147)	11 (46)	4.32 (2.45, 7.62)	0.000	3.23 (1.8, 5.82)	0.000
Shared ownership	8.1 (35)	21 (91)	0.33 (0.16, 0.67)	0.000	0.31 (0.14, 0.67)	0.003
Owned by others	25 (109)	31 (133)	0.76 (0.42, 1.38)	0.070	1.07 (0.6, 2.04)	0.844
Water vendor/ commercial	15 (64)	5.8 (25)	2.83 (0.67, 12.02)	0.000	2.55 (0.6, 10.66)	0.198
Community water source	14 (59)	18 (80)	0.7 (0.29, 1.67)	0.052	0.77 (0.3, 1.84)	0.553
Public water source	1.8 (8)	1.8 (8)	1 (0.13, 7.45)	1.000	0.92 (0.1, 6.31)	0.934

WASH indicators	Intervention (N=435) % (n)	Comparison (N=435) % (n)	Unadjusted OR (95% CI)[4]	p-value[5]	Adjusted OR (95% CI) [6]	p-value
Owned by NGOs	2.8 (12)	11 (49)	0.22 (0.06, 0.85)	0.000	0.23 (0.1, 0.91)	0.037
Location of drinking water source						
Within compound premises	72 (312)	53 (230)	2.26 (1.2, 4.26)	0.000	1.99 (1.05, 3.8)	0.036
In others yard/ compound	24 (106)	37 (162)	0.54 (0.29, 1.00)	0.000	0.6 (0.3, 1.12)	0.111
In government/ community plot (union parishad, union center, mosque, and schools)	2.8 (12)	9.9 (43)	0.26 (0.1, 0.65)	0.000	0.32 (0.1, 0.83)	0.019
By water from NGOs/ vendors	1.2 (5)	0 (0)	1.01 (1, 1.03)	0.025	-*	-*

[4] Clustering effect adjusted by using Generalized Linear Models (GLM)

[5] Two-sample t-test with equal variances;

[6] Adjusted for household members involvement with other NGO's WASH-related activities (excluding BRAC), and involved with NGO's activities other than WASH (including other activities of BRAC), and wealth score

[7] SDG ladder for drinking water services: Basic drinking water services refer to an improved source, provided collection time is not more than 30 minutes for a roundtrip, including queuing.

[8] Drinking water from an improved source, for which collection time exceeds 30 minutes for a round trip, including queuing

[9] Drinking water directly from a river, dam, lake, pond, stream, canal or irrigation canal

Table 6 Association between BRAC WASH program in HtRAs and drinking water collection and household-level management practices

Indicators	Intervention % (n) or mean± SD	Comparison % (n) or mean±SD	OR / IRR (95% CI)[10]	p-value[11]	AOR (95% CI)[12]	p-value
Proportion of households who treat drinking water before use	18 (80)	24 (102)	0.74 (0.35, 1.55)	0.067	0.61 (0.3, 1.33)	0.216
Common methods used by the households for treating drinking water before use						
Boiling	19 (15)	15 (15)	1.34 (0.54, 3.33)	0.468	1.16 (0.4, 3.08)	0.765
Adding bleach/ chlorine/ solution/ Pur/ chlorine tablet	10 (8)	1 (1)	11.22 (1.34, 93.8)	0.005	11.3 (1, 129.34)	0.051
Adding fitkiri or potash alam	69 (55)	73 (74)	0.83 (0.38, 1.82)	0.578	1.17 (0.6, 2.49)	0.677
Using ceramic / bio-sand filter	23 (18)	22 (22)	1.06 (0.42, 2.64)	0.881	0.78 (0.3, 1.93)	0.597
Proportion of households store drinking water	92 (401)	95 (412)	0.66 (0.25, 1.73)	0.132	0.78 (0.3, 1.99)	0.605
Households store drinking water in a visibly clean and fully covered container	69 (299)	68 (295)	1.04 (0.64, 1.69)	0.771	0.94 (0.6, 1.55)	0.814
Households store drinking water in a visibly clean and fully covered container placed higher from the ground	55 (241)	51 (222)	1.19 (0.78, 1.82)	0.197	1.09 (0.7, 1.66)	0.704
Average duration of water storage (hours)	19 ± 41	34 ± 80	0.55[13] (0.34, 0.89)	0.001	0.6[14] (0.36, 0.99)	0.044

Indicators	Intervention % (n) or mean± SD	Comparison % (n) or mean±SD	OR / IRR (95% CI)[10]	p-value[11]	AOR (95% CI)[12]	p-value
Person who usually collects drinking water from the source						
Adult male	16 (71)	20 (88)	0.77 (0.37, 1.59)	0.136	0.73 (0.3, 1.55)	0.405
Adult female	92 (398)	89 (387)	1.33 (0.66, 2.69)	0.210	1.54 (0.8, 3.12)	0.235
10-18 years old male adolescent	2.1 (9)	2.5 (11)	0.81 (0.34, 1.97)	0.651	0.87 (0.4, 2.04)	0.751
10-18 years old female adolescent	2.1 (9)	1.2 (5)	1.82 (0.56, 5.92)	0.282	1.83 (0.4, 7.7)	0.409
<10 years old male children	0 (0)	0.2 (1)	0 (-0.01, 0)	0.318	-*	-*

3.5 Drinking water collection and managementat the household level

In the study areas, 21% (n=182) of the households reported treating drinking water before use and the proportion in the intervention group was 18% (n=80) and the comparison group was 24% (n=102) (AOR: 0.61; 95% CI: 0.30, 1.33). Common water treatment methods used by the households were by using fitkiri or potash alam (71%, n=129), using ceramic/bio-sand filter (22%, n=40), boiling (16%, n=30), and using bleach/chlorine solution/PUR/chlorine tablets (5%, n=9). Among the study households, 93% (n=813) reported storing drinking water and 57% (n=463) of those households' water storage container was visibly clean, fully covered, and placed higher from the ground. Households in the BRAC intervention area reported storing drinking water for a shorter duration compared to the households in the comparison areas (mean: 19 hours vs 34 hours) (adjusted mean difference: 0.60; 95% CI: 0.36, 0.99). According to the respondents, 90% (n=785) reported that adult female members of the households usually collect drinking water from the source (Table 6).

[10] Clustering effect adjusted by using Generalized Linear Models (GLM)

[11] Two-sample t-test with equal variances;

[12] Adjusted for household members involvement with other NGO's WASH-related activities (excluding BRAC), and involved with NGO's activities other than WASH (including other activities of BRAC), and wealth score

[13] Mean difference of average duration of water storage

[14] Adjusted mean difference of average duration of water storage

3.6
Access to basic and safely managed sanitation facilities

Picture 3 Different types of sanitation facilities observed in study areas

In coastal areas of Bangaldesh, 75% (n=656) of the study households had access to an improved latrine as defined by JMP. The households from the BRAC intervention villages were more likely to have an imporved latrine than those in the comparison villages (AOR: 1.6; 95% CI: 1.01, 2.52). Among all the study households, 49% (n=430) had access to a safely managed sanitation facility. BRAC intervention areas had more households with access to safely managed sanitation facility (58% vs 41%; AOR: 1.57; 95% CI: 1.00, 2.36), and an improved sanitation facility accessible to all age groups (82% vs 69%; AOR: 1.60; 95% CI: 1.01, 2.52) compared to the comparison areas. Significantly more intervention households had their toilet facility within the courtyard boundary (62% vs 46%; AOR: 1.49; 95% CI: 1.03, 2.17) compared to comparison group households (Table 6).

More households in the intervention areas had sanitation facilities located within the compound (62% vs 46%) compared to the comparison areas (AOR: 1.49; 95% CI: 1.03, 2.17). Regarding safe disposal practices of child feces, 77% of households from the intervention area reported disposing of child feces in the latrine, and the proportion was similar (75% in the comparison area (AOR: 1.05; 95% CI: 0.64, 1.71) (Table 7).

Table 7 Association between BRAC WASH program in HtRAs and access to different types of sanitation facilties among the study households

WASH indicators	Intervention (N=435) % (n)	Comparison (N=435) % (n)	p-value[15]	Unadjusted OR (95% CI)[16]	Adjusted OR (95% CI)[17]	p-value
Proportion of households with access to						
Improved sanitation facility[18]	82 (356)	69 (300)	0.000	2.03 (1.32, 3.12)	1.6 (1.01, 2.52)	0.044
Safely managed sanitation facility[19]	58 (251)	41 (179)	0.000	1.95 (1.3, 2.86)	1.57 (1, 2.36)	0.031
Basic sanitation facility[20]	17 (74)	17 (75)	0.074	0.98 (0.6, 1.55)	0.9 (0.6, 1.47)	0.672
Limited sanitation facility[21]	7.1 (31)	11 (46)	0.000	0.65 (0.3, 1.29)	0.91 (0.5, 1.83)	0.794
Unimproved sanitation facility[22]	18 (79)	31 (133)	0.000	0.5 (0.3, 0.78)	0.63 (0.4, 1.01)	0.054
Practice open defecation/no sanitation facility[23]	0 (0)	0.5 (2)	0.157	0 (0, 0)*	-*	-*
Improved sanitation facility accessible to all age groups	82 (356)	69 (300)	0.000	2.03 (1.32, 3.12)	1.60 (1.01, 2.52)	0.044
Improved sanitation facility within 20 meters of the household (Accessibility)	52 (227)	29 (124)	0.000	2.74 (1.84, 4.08)	2.07 (1.40, 3.06)	0.000
Improved sanitation facility accessible to all, including physically disabled members of the household	3.0 (13)	1.2 (5)	0.057	2.65 (0.83, 8.49)	1.52 (0.42, 5.51)	0.522

WASH indicators	Intervention (N=435) % (n)	Comparison (N=435) % (n)	p-value[15]	Unadjusted OR (95% CI)[16]	Adjusted OR (95% CI)[17]	p-value
Location of sanitation facility						
Attached or located within the compound	62 (270)	46 (199)	0.000	1.94 (1.33, 2.83)	1.49 (1.03, 2.17)	0.035
Outside the compound courtyard but within the compound boundary	33 (143)	41 (180)	0.009	0.69 (0.46, 1.04)	0.81 (0.55, 1.21)	0.314
Outside the compound boundary	2.8 (12)	8.3 (36)	0.000	0.31 (0.14, 0.70)	0.41 (0.18, 0.91)	0.029
Proportion of households practice safe disposal of child's feces (in the latrine) (N=474)	77 (183)	75 (177)	0.520	1.15 (0.72, 1.84)	1.05 (0.64, 1.71)	0.845

3.7 Access to handwashing facilities and hygiene practices

Thirty-nine percentage of (n=343) of the study households had access to a handwashing facility with soap and water available for handwashing. After adjusting for relevant co-variates, we found that households in the intervention area were more likely to have access to a basic handwashing facility compared to those from the comparison areas (AOR: 1.48; 95% CI: 1.00, 2.19).

[15] Two-sample t-test with equal variances;

[16] Clustering effect adjusted by using Generalized Linear Models (GLM)

[17] Adjusted for household members involvement with other NGO's WASH-related activities (excluding BRAC), and involved with NGO's activities other than WASH (including other activities of BRAC), and wealth score

[18] Improved facilities include flush/pour flush toilets connected to piped sewer systems, septic tanks or pit latrines; pit latrines with slabs (including ventilated pit latrines), and composting toilets

[19] Use of improved facilities which are not shared with other households and where excreta are safely disposed in situ or transported and treated off-site. We considered twin pit and septic tank toilet which are not shared with other households

[20] Use of improved facilities which are not shared with other households

[21] Use of improved facilities shared between two or more households

[22] Use of pit latrines without a slab or platform, hanging latrines or bucket latrines

[23] Disposal of human feces in fields, forests, bushes, open bodies of water, beaches and other open spaces or with solid waste

Regarding self-reported handwashing practices by the respondents, 91% (n=795) washed hands with soap and water after defecation, 47% (n=410) before eating, 9.9% (n=86) before preparing food, 9.0% (n=78) after handling child's and animal feces, 7.9% (n=69) after cleaning child's anus, and 3.0% (n=26) before feeding children. Prortion of respondents who reported washing hands with soap before eating food (51% vs 43%) or preparing food (14% vs 6%) was higher in the BRAC intervention villages compared to the comparison villages. When the enumerators observed the hands of the respondents and under-5 children, 24% (n=212) of respondent's hands and 21% (n=61) of under-5 children's hands were observed clean (Table 8).

Picture 4 Different types of handwashing facilities observed in study areas

Table 8 Association between BRAC WASH program in HtRAs and handwashing and hygiene facilities among the study households

Indicators	Intervention % (n) or mean±SD	Comparison % (n) or mean±SD	p-value[24]	OR / IRR (95% CI)[25]	Adjusted OR (95% CI)[26]	p-value
Households with access to a						
Basic[27] handwashing facility	49 (213)	30 (130)	0.000	2.25 (1.6, 3.26)	1.48 (1.00, 2.19)	0.052
Limited[28] handwashing facility	41 (180)	56 (245)	0.000	0.55 (0.4, 0.76)	0.77 (0.6, 1.06)	0.114
No handwashing facility[29]	9.7 (42)	14 (60)	0.058	0.67 (0.3, 1.44)	0.82 (0.4, 1.74)	0.602
Households with access to a handwashing facility within 6 feet from the main house, latrine, or cooking area with soap and water	32 (139)	17 (73)	0.000	2.33 (1.5, 3.62)	1.48 (0.92, 2.38)	0.106
Households with handwashing facilities that all age groups can access	91 (395)	87 (377)	0.054	1.52 (0.7, 3.3)	1.24 (0.6, 2.65)	0.574
Households with handwashing facility which can be accessed by all, including person with disability	5.6 (3)	8.3 (5)	0.566	0.65 (0.16, 2.64)	0.22 (0, 1.41)	0.110
The proportion of Respondents reported washing both hands with soap and water (self-reported)						
After defecation	92 (402)	90 (393)	0.278	1.3 (0.71, 2.4)	1.04 (0.5, 1.99)	0.916
Before eating	51 (222)	43 (188)	0.021	1.37 (1.04, 1.8)	1.26 (1, 1.68)	0.108
Before preparing food	14 (59)	6.2 (27)	0.000	2.37 (1.12, 5.02)	2.02 (0.9, 4.47)	0.083

Indicators	Intervention % (n) or mean±SD	Comparison % (n) or mean±SD	p-value[24]	OR / IRR (95% CI)[25]	Adjusted OR (95% CI)[26]	p-value
After handling child's and animal feces	7.8 (34)	10 (44)	0.236	0.75 (0.41, 1.4)	0.81 (0.4, 1.55)	0.529
After cleaning child's anus	7.1 (31)	8.7 (38)	0.380	0.8 (0.44, 1.45)	0.72 (0.4, 1.32)	0.287
Before feeding children	3.2 (14)	2.8 (12)	0.691	1.17 (0.56, 2.47)	0.9 (0.4, 1.99)	0.789
Youngest child (< 5 years old) in household hands appeared clean[30]	13 (31)	13 (30)	0.891	1.04 (0.54, 1.98)	0.76 (0.42, 1.37)	0.364
Respondents' hands appeared clean[31]	26 (112)	23 (100)	0.344	1.16 (0.68, 2)	0.88 (0.5, 1.51)	0.651

[24] Two-sample t-test with equal variances;

[25] Clustering effect adjusted by using Generalized Linear Models (GLM)

[26] Adjusted for HH's members involve with other NGO's WASH-related activities (excluding BRAC), and involved with NGO's activities other than WASH (including other activities of BRAC), and wealth score

[27] Availability of a handwashing facility with soap and water at home

[28] Availability of a handwashing facility lacking soap and/or water at home

[29] No handwashing facility at home

Table 9 Association between BRAC WASH program in HtRAs and access to climate resilient WASH infrastructures among the study households

WASH indicators	Intervention (N=435) % (n)	Comparison (N=435) % (n)	Unadjusted OR (95% CI)[32]	p-value[33]	Adjusted OR (95% CI)[34]	p-value
Proportion of households with primary drinking water source rainwater collection	43 (182)	38 (162)	1.24 (0.49, 3.18)	0.119	1.4 (0.53, 3.69)	0.491
Drinking water source constructed above the usual flood-line	48 (207)	40 (175)	1.35 (0.59, 3.07)	0.029	1.32 (0.6, 2.99)	0.506
Had safe drinking water post-disaster	60 (260)	64 (278)	0.84 (0.49, 1.44)	0.210	0.82 (0.5, 1.43)	0.493
Proportion of households with access to year-round drinking water from an at least basic drinking water source	68 (294)	66 (286)	1.09 (0.48, 2.48)	0.566	0.93 (0.4, 2.18)	0.876
Improved sanitation facility situated above the usual flood line	68 (294)	53 (231)	1.84 (1.21, 2.80)	0.000	1.47 (0.93, 2.31)	0.099

3.8 Climate-resilient WASH facilities

Among all the study households, 40% (n=344) collected rain water and used it as the primary drinking water source, 44% (382) household's tubewell's platforms were constructed above the usual flood line, 62% (n=538) households had access to a safe drinking water source during the post-disaster period, and 67% (n=580) had access to a year-round basic drinking water source. Proportion of housheolds who constructed drinking water source above flood line was higher in the BARC intervention areas (48% vs 40%); (AOR: 1.32; 95% CI: 0.6, 2.99). In the BRAC intervention areas, 68% of households constructed latrines above the usual flood line, whereas in the comparison villages, 53% of households constructed the latrines above the usual flood line (AOR: 1.47; 95% CI: 0.93, 2.31) (Table 9).

[26] No visible dirt over palms, finger pads and over/under finger nails

[26] No visible dirt over palms, finger pads and over/under finger nails

[26] Clustering effect adjusted by using Generalized Linear Models (GLM)

[26] Two-sample t-test with equal variances;

[26] Adjusted for household members involvement with other NGO's WASH-related activities (excluding BRAC), and involved with NGO's activities other than WASH (including other activities of BRAC), and wealth score

3.9
Self-reported infectious diseases

During the exploration of the health effect of the intervention among the study households, we found that 1.38% (n=28) of respondents reported diarrhea among any household members within 14 days preceding the data collection day. Only 2.13% (n=7) households reported diarrhea incidence among under-5 children within the same period.

After adjusting for the relevant co-variates, in intervention households 0.4% of respondents reported diarrhea among any household member compared to 1.0% in comparison households (AOR: 0.50, 95% CI: 0.14, 1.81). Regarding diarrhea incidence among under-5 children, in intervention households 1.2% respondents reported diarrhea preceeding 14 days compared to 3.1% in comparison groups (AOR: 0.53; 95% CI: 0.04, 6.5). A similar trend of intervention effects was observed in terms of acute respiratory tract infection among all household members (4.6% vs 6.7%; AOR: 0.72; 95% CI: 0.05, 1.14) and under-5 children (8.4% vs 12%; AOR: 0.90; 95% CI: 0.40, 1.88) (Table 10).

Table 10 Association between social enterprise-based BRAC WASH program and diarrhea and acute respiratory infections among residents of coastal areas (self-reported and within 14 days preceding data collection)

Health outcomes	Intervention (N=2025) % (n)	Comparison (N=1931) % (n)	Unadjusted OR (95% CI)[35]	p-value[36]	Adjusted OR (95% CI)[37]	p-value
Diarrhea incidence among any household members	0.4 (9)	1.0 (19)	0.45 (0.13, 1.52)	0.043	0.50 (0.14, 1.81)	0.290
Diarrhea incidence among under-5 children (N=329)	1.2 (2)	3.1 (5)	0.38 (0.04, 3.28)	0.237	0.53 (0.04, 6.5)	0.622
Acute respiratory tract infections among any household members	4.6 (93)	6.7 (133)	0.65 (0.42, 1.00)	0.002	0.72 (0.5, 1.14)	0.160
Acute respiratory tract infections among under-5 children (N=329)	8.4 (14)	12 (20)	0.65 (0.32, 1.30)	0.293	0.9 (0.4, 1.88)	0.787

[26] Clustering effect adjusted by using Generalized Linear Models (GLM)

[26] Two-sample t-test with equal variances;

[26] Adjusted for household members involvement with other NGO's WASH-related activities (excluding BRAC), and involved with NGO's activities other than WASH (including other activities of BRAC), and wealth score

CHAPTER

4

DISCUSSION

CHAPTER 4

DISCUSSION

After five years of implementation of a WASH program in the coastal areas of Bangladesh, there were positive impacts on access to WASH facilities. The households in the intervention areas had better access to basic sanitation, handwashing facilities with soap and water, and drinking water sources in the household premises or yard. The evaluation also showed that households in the intervention community had better climate resilient sanitation facilities as promoted by BRAC, but the intervention households were wealthier than the comparison households.

Access to at least basic sanitation in the intervention areas in coastal Bangladesh was 75%, which is better than the national average of 64% for rural areas [14]. BRAC intervention areas had more households with access to safely managed sanitation facilities and within the courtyard suggesting better sanitation access. More households in the intervention area reported being involved in WASH program activities and receiving monetary support, suggesting that better access to basic sanitation could be the result of the support provided by BRAC. Findings from previous studies indicate that households with access to microfinance for sanitation are more likely to adopt improved sanitation than those without [40-43]. Microfinance is considered to enable poor households to invest in sanitation by allowing them to pay for sanitation in small amounts over a longer period [44]. However, there was a limited effect of the intervention on safe child feces disposal practices. This may suggest that focused attention is needed to improve child feces disposal [45]. Future intervention should consider ways to improve child feces disposal by making sure the facilities are child-friendly.

More than 98% of the households had access to a basic water source, which is similar to the national average [14]. Households in the intervention areas had better access to water as more households in the intervention households had drinking water sources on the household premises or in the yard compared to the comparison households. The location of the water source is important as it makes the collection of drinking water easier. This is also reflected in the fact that the intervention households store drinking water for shorter durations than the comparison households. Better access to a water source can be explained by the support provided by BRAC in building safe drinking water sources in the intervention areas.

In the BRAC intervention areas, the proportion of households with access to handwashing facilities with soap was 49%, which is much lower than the national average of 71% for rural areas [14]; due to water scarcity in the coastal areas. The households in the intervention villages had better handwashing opportunities than the comparison areas, even after controlling for wealth. It is possible that better access to water as supported by

BRAC enabled households to have better handwashing facilities. The presence of handwashing facilities is a good proxy for handwashing practices, as recognized in previous studies [46]. Although the intervention areas had better access to handwashing facilities, more effort is needed to close the gap in access to handwashing facilities. The intervention household reported better handwashing practice, but the difference in practice was not statistically significant. Future interventions should consider how to support households to increase access to handwashing and better handwashing practice.

In this study area prevalence of diarrhea and acute respiratory infection was very low. This may reflect a good effort by the government and NGOs working in the study areas. Although the BRAC intervention areas had a lower prevalence of reported diarrhea and respiratory infection than the comparison group, the difference in prevalence between the two groups was not statistically significant. So the low prevalence of diarrhea and respiratory infection cannot be attributed to BRAC intervention with confidence. This could mean that the intervention was effective in improving access. But from this study we do not know if habits among the residents of coastal Bangladesh was also chnaged. To change habits, targeted behavior change communication intervention developed using the latest behavior change communication science may be needed. It is also possible that the study had limited power to detect a difference in health as the health outcome was a secondary objective of the evaluation. So the samle size for this study was not calculated, considering diarrhea or respiratory infection as a primary outcome. In addition, we did not collect longitudinal data on health to capture seasonal variation for diarrhea and respiratory infection. Future evaluation of similar programs could consider using surveillance systems to collect health data.

The study had important limitations that could affect our interpretation of our findings. We do not have any baseline data. So we cannot estimate the effect of the intervention over time. However, we did include a geographically matched control group to assess the impact of BRAC WASH program. We matched the geographical location in addition to matching household characteristics using propensity score matching. None the less the intervention was not controlled by the program, so some of the households in the comparison group also received financial support. But the overall support in the intervention area was higher. The health data was collected at one-time point and was reported. Given the COVID 19 situation, we had to conduct the evaluation in a short time so the health data was collected just to get some indication of the health status. We also could not collect observed data regarding WASH practices due to a lack of time and resources. However, these findings give us important insight regarding the effectiveness of the BARC intervention in coastal areas of Bangladesh. Future large-scale intervention should consider including rigorous monitoring and evaluation plan in the over project planning.

CHAPTER

5

CONCLUSION

CHAPTER 5

CONCLUSION

Our study findings suggest that financial support alone may help with access to sanitation facilities. Nonetheless, the findings indicate a positive impact of the intervention on access to water, sanitation and hygiene facilities among residents of coastal communities in Bangladesh. Future evaluation should use randomized controlled community trials to reduce the study design bias and measure the effect of microfinance-based interventions on access to WASH facilities and health. Future programs should consider ongoing process evaluation to understand the intervention delivery. Future intervention should consider the promotion of WASH behavior as part of the program as access alone cannot ensure sustained practices and better health outcomes.

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