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Can a specially designed information intervention around the WASH-agriculture linkages make any difference? Experimental evidence of behavioral changes and health impacts

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Acknowledgements

Abstract

This paper attempts to evaluate the effectiveness of the specially designed packages of water, sanitation and hygiene (WASH) interventions with '*student brigades*' (student teams tasked with maintaining hygiene in school) on household WASH behavior and practices in both a household and farm setting. In addition, household members' health and developmental productivity outcomes were also examined. A randomized control trial (RCT) involving student brigades (SBs) was carried out in six sub-districts (hotspots) characterized by comparatively poor WASH indicators. The specially designed WASH-agriculture treatment consisted of three interventions: (1) informing the households about the prior water testing results; (2) delivering hygiene messages with the help of posters; (3) equipping SB members with water quality test kits and asking them to test the water quality at different places and report their findings to their household. Employing the difference-in-difference (DID) multivariate regression technique, the analysis revealed that the BRAC WASH treatment performed well in terms of effecting behavioral changes and improving hygiene practices. In addition, the results suggested that informing households of their drinking water quality and conveying WASH-agriculture hygiene messages to them could have a significant incremental impact over the existing BRAC WASH treatment in changing household hygiene behavior and practices at home and on farms. This research provides evidence that students can act as agents of change in improving water quality, sanitation and health in a rural setting.

1. Introduction

The development interventions by the government of Bangladesh or other stakeholders, consisting mainly of non-governmental organizations (NGOs), have made enormous health advances in Bangladesh. The country now has the highest life expectancy, the lowest total fertility rate, and the lowest infant and under-five mortality rate among countries in south Asia, despite spending less on healthcare than several of their neighboring countries. However, Bangladesh still faces challenges in terms of water supply and sanitation (Engell and Lim, 2013), especially in achieving the Sustainable Development Goal (SDG) 6, which aims to ensure the availability and sustainable management of water and sanitation for all by 2030. Generally, poor water quality has a wide range of adverse health impacts (such as high mortality and morbidity rates, malnutrition and reduced life expectancy), and the resulting higher incidence of illness also brings about high economic costs (Srinivasan & Reddy, 2009). Every year in Bangladesh, 2.5 million under-five children are affected by diarrhea as a result of fecal matter coming into contact with food and water, which leads to 1.5 million child deaths (USAID, 2013). Van Derslice and Briscoe (1995) mentioned that improving water quality can only help reduce diarrhea risk of households living in good sanitary conditions. Although the development interventions have reduced diarrhea prevalence and therefore contributed to the reduction in child and infant deaths, diarrhea is still a major health problem in Bangladesh. A person can reduce their diarrhea risk by having access to clean water, sanitation and hygiene facilities, and also by practicing good hygiene. Although Bangladesh achieved its Millennium Development Goals (MDG) for 2015 in terms of access to improved water source, the question remains whether access to improved water source actually translates to the use of improved water. Poor personal hygiene may adversely affect water quality at the point of use (POU), effectively negating the benefits of having access to improved water sources. Further studies are needed to address the issue of poor water quality at the POU, especially the microbial quality of household drinking water. There is also a need to study how disseminating information on proper hygiene practices to households could help them improve their WASH behavior so as to achieve the desired health outcomes. Bangladesh's MDGs and SDGs concerning water and sanitation also did not adequately address water quality issues. There is a disconnection between the achievement of the MDGs and its effectiveness in producing the desired health outcomes. This presents an opportunity for an NGO such as BRAC to help realize the full benefits of access to improved water by providing basic WASH education to rural, peri-urban and urban households living in hotspot areas[1]. WASH education could alleviate health issues left unsolved by the slow progress in providing more households with improved sanitation facilities.

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[1] where the WASH achievements are reasonably poorer than the average rural and urban areas.

Economic literature has established that wealth is a key driver of the willingness-to-pay (WTP) to protect oneself from environmental and health hazards. However, a study investigating the effect of information on a community's demand on environmental quality in a suburb in Delhi, India, found that when given information, treatment households were not only more willing to pay for but also ready to spend more on water treatment methods (Jyotsna and Somanathan, 2008). This showed that information intervention can also be effective in increasing the demand for quality WASH technology. Further, public health literature emphasizes the role of WASH information and knowledge in improving household behavior and achieving health outcomes. Existing studies have tested the effectiveness of different WASH interventions, with either a single treatment arm or multiple treatment arms, that contributed to household-level behavioral and health outcomes (Waddington et al., 2009). However, there is a limited number of WASH interventions that address both at-home and on-farm hygiene issues. Anecdotal evidence suggests that farming households have higher a diarrhea risk than non-farming ones; the results of the water quality census conducted for this study (which will be discussed later) were able to confirm this observation. Our interaction with BRAC WASH practitioners also gave us the impression that educating a person on general hygiene is insufficient for changing their hygiene behavior at home and on farm to the extent of improving their health, nutrition and productivity outcomes. Thus, the WASH-agriculture treatment in this study also included information on hygiene practices that are applicable both at home and on farms. As mentioned earlier, having access to improved water sources does not necessarily mean safe POU drinking water quality. Poor personal hygiene at both the point of source (POS) and the POU might introduce fecal matter into drinking water, therefore contaminating the water and rendering it unsafe for drinking. In this study, apart from trained technical assistants collecting information on domestic water quality, treatment households were requested to participate in the water quality evaluation process at both the POU and POS. This was aimed at helping them understand their drinking water quality so that they can take the necessary measures to maintain safe drinking water. Another aspect of the field experiment is that students were asked to disseminate proper hygiene knowledge to their community as a form of information intervention. Many WASH initiatives in developing countries have effectively employed student participation as a strategy to change community hygiene behavior. Devaney et al. (1993) found that involving students in health interventions enhances the students' school achievement. Nutbeam et al. (1993) also found a positive correlation between unhealthy behavior and student underachievement as well as alienation in school. This underlines the importance of schools shifting towards more participatory forms of practice. Further, Jensen (2010) mentioned that action-competence is acquired through children's genuine participation in any intervention where they try to influence 'real life' as part of their education. However, there is a limited number of empirical and scientific studies assessing the role of students as agents of change and as

channels of conveying hygiene messages to their community. Involving student networks in implementing information treatments could potentially build community capacity and benefit the students, their household and their community. Therefore, we evaluated the effectiveness of our WASH-agriculture intervention package in 1) changing the at-home and on-farm WASH behavior of adult household members and 2) improving health outcomes for the household members. The participating student networks came from various secondary schools in six hotspot areas (sub-districts) in Bangladesh. These areas include not only those where BRAC WASH (NGO-led) activities were present but also those without BRAC WASH activities. This allowed us to estimate the incremental impact the WASH-agriculture treatment had over the existing BRAC WASH treatment or any other existing interventions run by the government or other NGO stakeholders.

This paper is organized as follows: Section 2 describes the study objectives and hypotheses. Section 3 gives a brief description of the study sites, the study and treatment design, sampling strategies, impact pathway and so on. Section 4 describes the analytical methods used in our impact analysis. Section 5 briefly discusses the baseline survey results; and the treatment impact on household WASH behaviors and practices, health, and developmental productivity. The final section summarizes and concludes the study.

2.   Study Objectives and Hypotheses

2.1 Study Objectives

Understanding how drinking water can be contaminated between the POS and the POU is crucial to improving household health and developmental outcomes. The objective of this study is to understand how to build community capacity in water and sanitation monitoring and how community WASH behavior can be improved. To address these objectives, we began with the assumption that giving a person more hygiene information can increase their demand on environment cleanliness, improve their WASH behavior and consequently improve their health outcomes. We evaluated the impact of our WASH-agriculture treatment on 1) at-home and on-farm WASH behavior of the treated household members and 2) health and developmental productivity outcomes for treated household members.

2.2 Study Hypotheses

We hypothesized that relative to the control group, individuals and households in the treatment groups will

- exhibit greater improvement in their WASH behavior, practice and knowledge (at home and on farms);

- show greater change in their attitude towards WASH-related technology, including their willingness to adopt WASH-related technology and the amount of money they are willing to invest in acquiring such technology;

- have drinking water with improved microbial quality;

- have lower diarrhea incidence;

- have improved under-five child anthropometrics;

- have lower cost of illness and fewer days of work/school absenteeism.

3. Study Methods

3.1 Selection of study sites

In Bangladesh, the average coverage of improved drinking water sources and sanitation facilities in rural and urban areas are nearly equal. Around 86% of the urban population and 84% of the rural population have access to improved drinking water sources, while 55% of both rural and urban populations have access to improved sanitation facilities (UNICEF and WHO, 2015). However, some advanced rural or peri-urban areas and marginal rural areas in Bangladesh have poorer-than-average WASH-related outcomes compared with their rural or urban counterparts. Such areas are considered hotspots. We used several indicators to select the hotspots for this study, such as improved water supply coverage, sanitation coverage, prevalence of water-related diseases (diarrhea), agro-ecological zone, BRAC WASH intervention areas, and the level of development (peri-urban/advanced rural or marginal rural). Information was obtained using various maps showing groundwater level, agro-ecological zones, flood- and drought-prone areas, and sites with high diarrhea prevalence. Other sources of information include the development level in different areas and a list of areas in Bangladesh with BRAC WASH interventions. After obtaining all these information, we selected six study sub-districts based on the criteria given in Table A:

Table A Overview of the criteria for selecting hotspots

Sl. No	District	Sub-district	Median Groundwater levels (m, msl)[1]	AEZs	Flood & drought prone area	Diarrhea prevalence[4]	Sanitation coverage (%)[5]	Level of development	BRAC WASH interventions
01	Naogaon	Atrai	12-16	5 & 3	Not flood prone & Severe drought prone	1(6-8%) & 2(<52%)	53	Advanced rural	Present
02	Tangail	Kalihati	8-12	8 & 9	Low river flooding & Slight drought prone	1(5-6%) & 2(62-69%)	48	Advanced rural	Present
03	Tangail	Mirzapur	8-12	8 & 9	Low river flooding & Slight drought prone	1(5-6%) & 2(62-69%)	--	Advanced rural	Absent
04	Jamalpur	Bakshiganj	14-20	8 & 9	Not flood prone & slightly to no drought area	1(>11%) & 2(62-69%)	41	Marginal rural	Present
05	Jamalpur	Melandaha	14-20	8 & 9	Not flood prone & slightly to no drought area	1(>11%) & 2(62-69%)	--	Marginal rural	Absent
06	Patuakhali	Bauphal	0-2	13	Moderate tidal surge & Slight drought area	1(8-11%) & 2(69-79%)	32	Marginal rural	Present

Note:

Median Groundwater Levels (m, msl1:m, msl) where m=meter and msl=mean sea level (Shamsudduha et al., 2009).

Diarrhea Prevalence4 (BBS/UNICEF MICS 2006): 1= % of children who had diarrhea in the two weeks prior to data collection, 2= % of children aged 0-59 months who had diarrhea and had received oral rehydration treatment with ORS

Annex 2-a gives a general picture of the socio-economic, health, sanitation and drinking water status at the study sites, while Annex 2-b shows agricultural practice at those sites. BRAC WASH interventions had been conducted in four of the sub-districts (Baufal, Atrai, Kalihati, Bakshiganj) in the past, whereas BRAC WASH interventions had never taken place in the two remaining sub-districts (Mirzapur, Melandaha). In all study areas, government- or NGO-led WASH interventions, if ever present, had operated on a very limited scale.

The locations of the study areas are shown in Fig 1. Although these advanced or marginal rural areas differ among themselves to some extent in terms of socio-economic status and agricultural practice, the selected hotspots are similar in terms of WASH status. The six selected study sub-districts were divided into three distinct groups:

a) BRAC WASH treatment group: BRAC WASH treatment has been ongoing in selected sub-districts of the country since between 2012-2013. The BRAC WASH treatment includes both

building infrastructure (e.g., latrine installation) and providing education (e.g., general hygiene messages). BRAC uses several platforms to conduct WASH education, such as door-to-door household visits, SBs, school management committees, village WASH committees and the organization of cluster meetings (BRAC, 2016). The same interventions and the same platforms were used across the different treatment areas.

b) WASH-agriculture Treatment group: This refers to areas receiving our specially designed WASH-agriculture treatment (to be elaborated in the following section) concurrently with the BRAC WASH treatment. The WASH-agriculture treatment was administered through SBs formed as part of a BRAC WASH program that focuses on hygiene promotion and education for students, training and orientation for teachers, school compound cleaning and disposal of solid waste, the provision of separate latrines for girls, and menstrual hygiene education. Shortly after BRAC had installed sanitation infrastructure in school compounds, the SBs were formed and subsequently trained to develop their capacities in proactively promoting proper hygiene in both their school and household. Each SB consists of 24 students with commendable grades selected from grades 6-9. They received a 30-day training along with their teachers. These student volunteers are tasked with educating their fellow students, and members of their households and community to promote hygienic behavior. Being a SB member enhances a student volunteer's reputation, and they are valued by others in their school as well as community. SBs also act as a catalyst for the student volunteers to develop their leadership skills.

c) Control group: Areas in this group received neither BRAC WASH treatment nor WASH-agriculture treatment. However, these areas may have received WASH intervention carried out by government departments or other stakeholders.

One of our concerns when studying the control group was whether any WASH interventions not led by BRAC WASH were present in these areas. After careful investigation, we found various small-scale government-led WASH interventions in the six study sub-districts (hotspots). Nevertheless, this issue was carefully addressed in the protocol design, the survey and treatment implementation, and the data analyses.

AG-WATSAN Nexus Study Areas
in Bangladesh

Legend
☐ Non-study upazilas
▨ Study upazilas

Sl	Upazila	District
1	Atrai	Naogaon
2	Kalihati	Tangail
3	Mirzapur	Tangail
4	Bakshigonj	Jamalpur
5	Melandaha	Jamalpur
6	Bauphal	Patuakhali

Bay of Bengal

0   35   70   140
Kilometers

Cartography: Ratnajit Saha
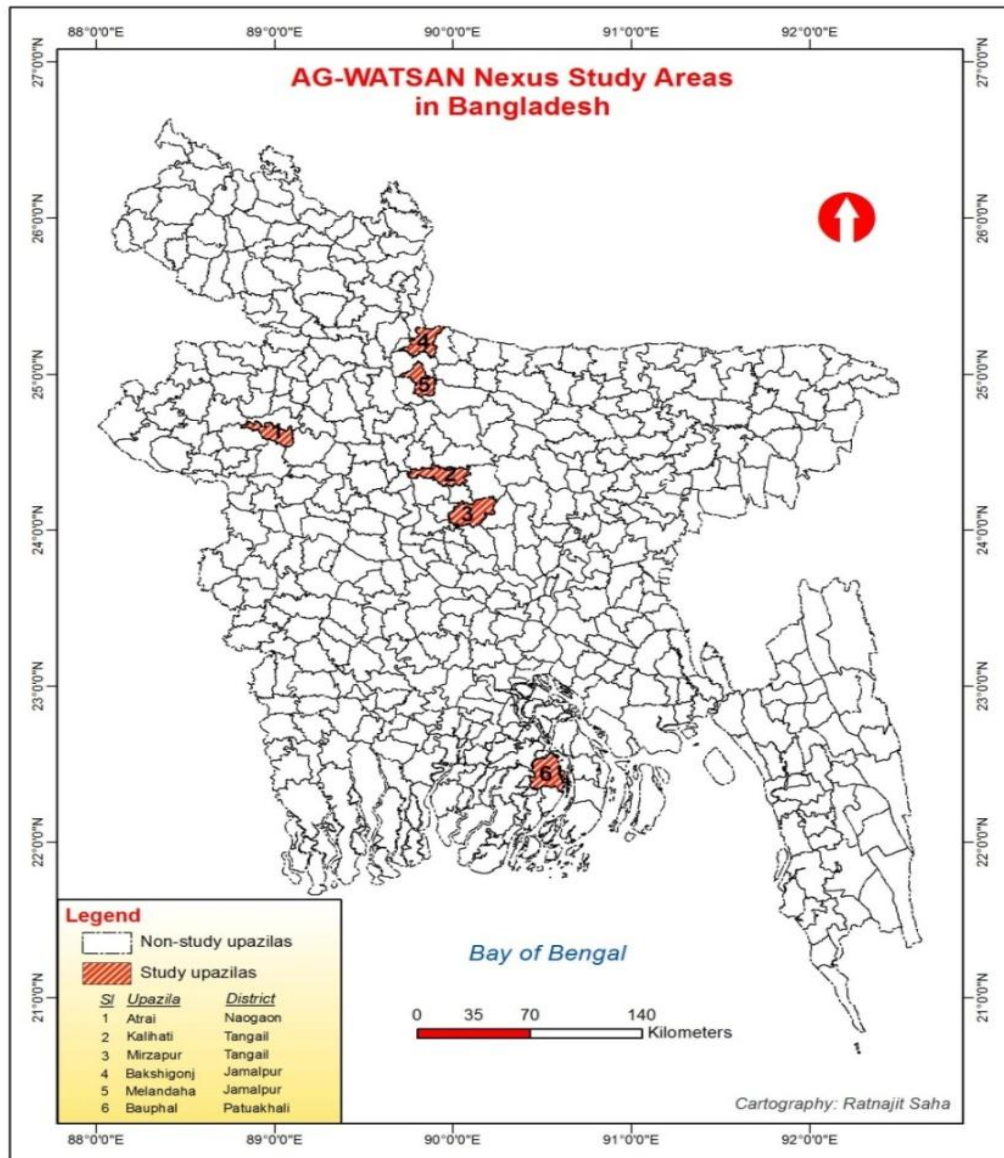
Figure 1 Map of WASH-agriculture Nexus study sites locations in Bangladesh

3.2 WASH-Agriculture Study Design and Sampling

The study took place between August 2014 and July 2015 and was divided into four stages:

A. Water quality testing and sample selection (August 2014)

Trained technical assistants performed the water quality census by testing the drinking water at the POU in every student's households (1,560 samples). They used inexpensive field-based hydrogen sulfide test kits provided by NGO Forum in Dhaka, Bangladesh, to determine the presence of *E. coli* in drinking water samples. In the presence of sulfur-reducing bacteria, the hydrogen sulfide in the test kit will be reduced to iron sulfide, which

8

causes the sample to have a black coloration. A detailed description of the test kit and the methodology used in this study can be found in Gupta et al. (2007). Based on the results of the POU water quality tests, eligible households were selected to form the study population. A sample of SB households (refers to households with a SB member) was selected for a more detailed investigation (see Fig. 2).

The water quality census showed that 72% of the households (1,094 households) had POU drinking water contaminated with fecal coliform (FC) bacteria. These households also had higher diarrhea prevalence than those whose drinking water was not contaminated with FC bacteria. Therefore, these 1,094 SB households were chosen to form the study population. In the next stage, a total of 648 SB households (slightly higher than the minimum sample size of 540 required for 3% LS and 95% CI) were randomly selected for the study. The number of households in the control and treatment (BRAC WASH and WASH-agriculture) groups was determined based on the presence of FC bacteria in their drinking water. The sampling design shown in Fig. 2 was applied to all three study groups.

I. BRAC WASH treatment: A total of 192 SB households were randomly selected from the study population of 407 households involving 24 schools (6 schools x 4 BRAC WASH sub-districts). These schools received only the BRAC WASH treatment.

II. WASH-agriculture treatment: A total of 227 households were selected to receive the WASH-agriculture treatment from the study population of 427 households involving 28 schools (7 schools x 4 BRAC WASH sub-districts). However, only 192 households received treatment in the end, while the rest of the households (15%) dropped out due to various reasons (to be discussed later). Additionally, to capture spillover effects, 106 households in this group were selected to form the sample group.

III. Control: Due to time constraints, a smaller number of households (126 households) were randomly selected from 260 households involving 14 schools in 2 sub-districts (7 schools x 2 sub-districts). These households received neither the BRAC WASH treatment nor the WASH-agriculture treatment but, as mentioned earlier, may have received WASH interventions carried out by government departments and other stakeholders. Since there were no BRAC SBs in these schools, households with students from grade 6-9 who had achieved commendable grades were randomly selected for this group instead.

6 Sub-districts were selected					
Atrai	**Kalihati**	Mirzapur	**Bauphal**	**Bakshigonj**	Melandaha

28 schools from WASH-agriculture treatment group and 24 schools from BRAC WASH treatment group were selected from four BRAC WASH treatment sub-districts (Atrai, Kalihati, Bakshigonj and Bauphal).
14 schools were selected from two Sub-districts (Mirzapur and Melandaha) as control.

24 SB members (or students, if school had no SB) were randomly selected from each school for water quality census

WASH-agriculture Treatment: BRAC WASH treatment + WASH-agriculture treatment 622 student brigades (SBs) HHs But 24*28=672	**BRAC WASH treatment: No WASH-agriculture treatment, only BRAC WASH treatment 555 student brigades (SBs) HHs But 24*24=576**	**Control: No WASH-agriculture Treatment, no BRAC WASH treatment 336 students HHs (24*14)**
427 cases of fecal contamination	407 cases of fecal contamination	260 cases of fecal contamination

Final samples size of 648 **(although only 540 our of 1,513 is required at 3% CI and 95% CL)** based on fecal contamination derived from water quality census: treatment –control follows proportionate random sampling

WASH-agriculture treatment: 224 SB households + 106 households to capture spillover effects	**BRAC WASH treatment: 192 SB households**	**Control: 126 students (households)**

Baseline measurement: (1) Household questionnaire (household demographic, availability and source of water, agriculture and irrigation, health), (2) village/school WASH committee questionnaire, (3) student questionnaire

WASH-agriculture treatment package

Letter containing prior water quality test results , agriculture hygiene messages through poster and repeated water quality tests

Endline measurement: (1) Household questionnaire (household demographic, availability and source of water, agriculture and irrigation, health), (2) village/school WASH committee questionnaire, (3) student questionnaire
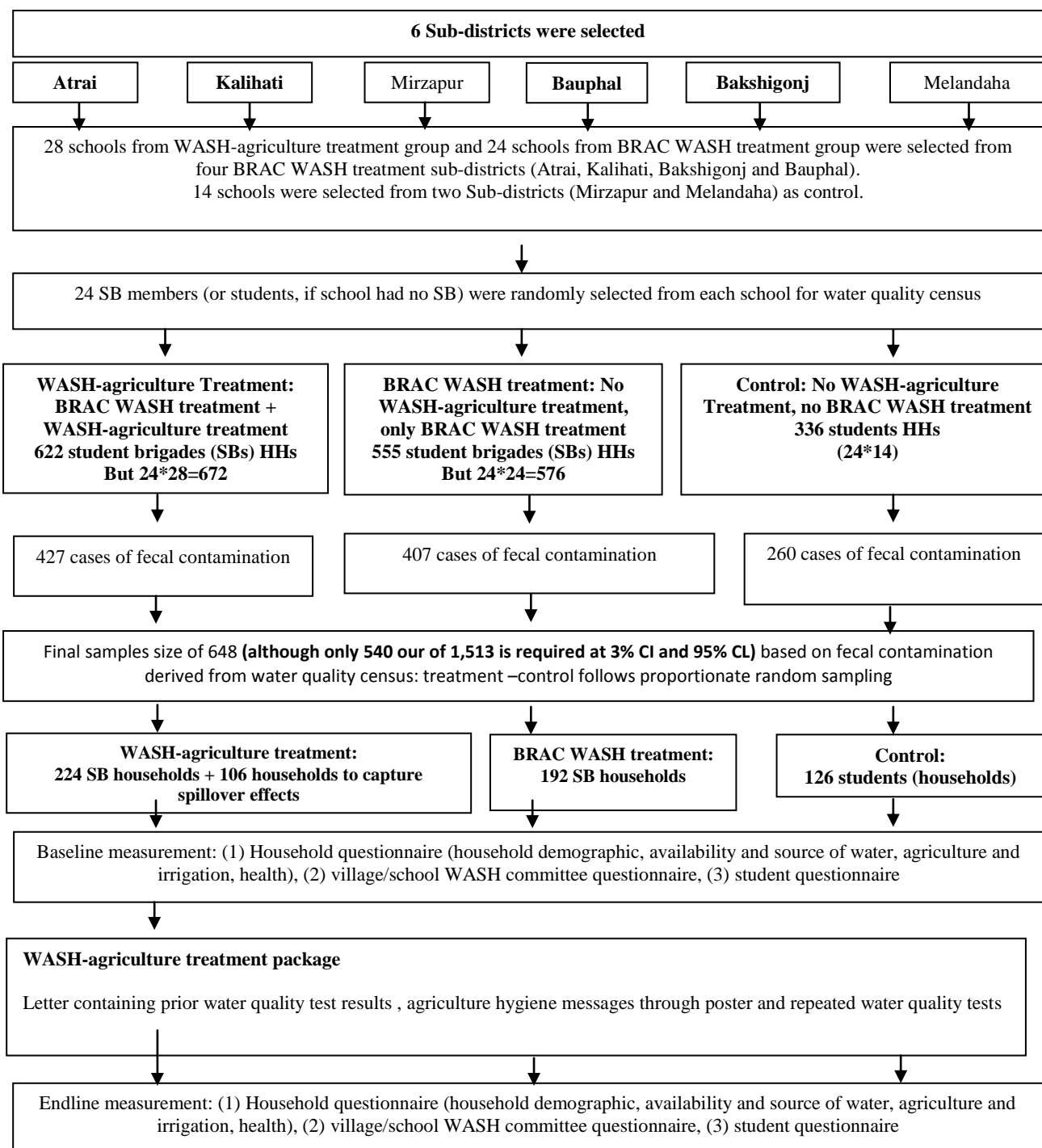
Figure 2 Detailed Sampling frame

Other information was also collected during the water quality census, including which WASH stakeholders were active in the sub-districts, locally available water filtration methods, and the cost of the water filtration methods.

B. Baseline survey (December 2014 – January 2015)

A baseline survey was conducted among the selected sample households and students, and in their respective communities (the school WASH committee and village WASH committee) mainly to establish the similarity between the treatment and the control groups and highlight the salient WASH and agricultural hygiene issues.

C. WASH-agriculture intervention (March – May 2015)

The WASH-agriculture treatment implementation guidelines presented in Annex 5 were given to the teachers in charge of the SBs. Only SB members in the treatment group were given the technical knowledge related to the intervention. They were taught how to collect water samples from the POU and POS in their household and were instructed to collect water samples on three different times (March 2015 at the POU, April 2015 at the POS, and May 2015 at the POU). The SB members were also taught how to analyze the water samples at school using the test kits provided and how to communicate the results to their households. These repeated drinking water tests at the POU and POS were expected to help the SB households better understand their own drinking water quality and encourage them to take necessary measures to ensure safe drinking water quality. The teachers also distributed a letter containing the results of the initial water quality test and a poster displaying agriculture hygiene messages only to the SB members in the treatment group. Students in the control group were not given these items. The SB members were responsible for explaining the messages about agriculture hygiene conveyed by the poster to their household members. A copy of the letter and the poster are shown in Annex 3 and Annex 4 respectively.

D. Endline survey (June-July 2015 or 12 weeks after the WASH-agriculture treatment was given)

During the endline survey, the trained technical assistants collected and tested water samples from the POU of the selected sample households again. They also conducted a detailed survey among the households, students, school WASH committee and village WASH committee.

3.3 WASH-agriculture impact pathway

Figure 3 gives an overview of the WASH-agriculture treatment and impact pathway (Malek et al. 2015). The expected immediate output of improved hygiene awareness was increased demand on drinking water quality and WASH environment. This would consequently change household hygiene behavior and practice (such as improving hygiene index, increasing the amount of investment in and the willingness to pay for WASH-related technology, and

lowering medical expenditure caused by water borne diseases), which in turn would lead to better direct, or short-term, outcomes. For instance, the quality of water used for drinking, cooking and washing may be improved, and instances of fecal contamination of the drinking water at home and on farms may also be reduced because of improved WASH practice in both settings. These short-term outcomes would later translate into improved health (such as improved child anthropometrics) and higher developmental productivity by reducing incidence of waterborne diseases (such as diarrhea).
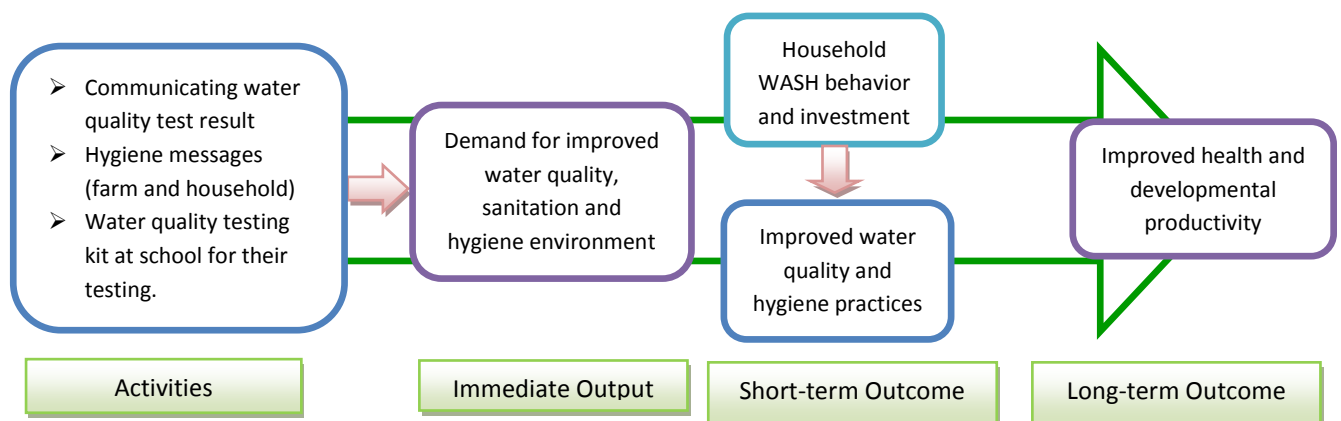
Figure 3 Impact pathway of WASH-agriculture intervention through the student brigades

3.4 Ethical Considerations

Interviews were only conducted after the participants had given their consent and ethical clearance was obtained from the appropriate authority. While the risk of creating an imbalance between the development path of the treatment and control groups cannot be completely ignored, we consider it minimal given that BRAC WASH may be scaling up the intervention program. The program would most likely be gradually expanded to cover households in the control areas after the completion of fieldwork related to this study. We hope that the beneficial effects of the interventions will motivate other organizations to replicate the interventions or include them in other WASH or development programs in the future.

4. Analytical Methods for Impact Analysis

The RCT method was used to assess the causal relationships between the interventions and the intended outcomes. We chose the RCT method to ensure that our impact analysis was both internally and externally valid. Our analysis was internally valid since it used valid comparison groups. External validity is the extent to which the evaluation results is representative of the general population. The following steps were carried out sequentially to evaluate the impact of the program: designing sampling frame, collecting baseline data, executing the intervention activities, performing endline surveys, and analyzing the data to estimate the average treatment effect (ATE) of the intervention. In this study, the treatment effect could be evaluated since most of the selected respondents complied with the assignments given to them as part of the treatment, especially those of three WASH-agriculture treatment components. Since an RCT evaluation design was adopted for WATSAN-agriculture treatment arm, the study subjects were randomly selected from the study population. The control and treatment groups should theoretically not have any significant differences between them in terms of baseline outcome variables and some baseline control variables (i.e., all three sample groups should be balanced). The balance between the control and treatment groups was checked by performing a Bonferroni multiple-comparison test (a t-test) and an F-test. After establishing the three sample groups were balanced and given that we had a valid estimate of the counterfactual, the impact (treatment effect) of the intervention could have been estimated by calculating the simple difference in outcomes of interest between the treated households and the counterfactual. However, Gertler et al. (2011) and Khandaker et al. (2010) recommended using the difference-in-difference (DID) technique, also known as the double difference technique, to check the robustness of the impact estimates. The DID multivariate regression model also allows household- and community-level fixed effects to be controlled for. Therefore, we estimated the following DID regression model for our empirical analyses:

$Outcome_{it}$ = β_1 + $\beta2WASH\_AgTreatment_i$ + β_3 BRAC_WASH Treatment$_i$ + β_4 time$_t$ + β_5 (BRAC_WASH Treatment * time)$_{it}$ + β_6 (WASH_Ag Treatment* time)$_{it}$ + ε_{it} .... (1)

Where, $Outcome_{it}$ = *Outcome of interest of household i at time t* (1= *endline* and 0 = *baseline*)

WASH_AgTreatment$_i$=

Dummy variable taking the value of 1 *if the observation (household) is in the WASH-agriculture + BRACWASH Treated group and* 0 *if otherwise. This variable captures possible differences between the* WASH_Ag Treatment *and* Control *groups prior to the intervention.*

BRAC_WASH Treatment$_i$=

Dummy variable taking the value of 1 *if the observation is in the BRAC-WASH Treated group and* 0 *if otherwise. This variable captures possible differences between the* BRAC_WASH Treatment *and* Control *groups prior to the intervention*

time$_t$=

Dummy variable taking the value of 1 *if the observation is from the endline and* 0 if *otherwise. This variable captures aggregate factors that would cause changes in the outcome even in the absence of intervention*

β_5 = *Treatment effect for those observations in the BRAC-WASH Treated group, that is, the DID estimate of BRAC_WASH Treatment*

β$_6$ = *Treatment effect for those observations in the WASH-agriculture Treated group, that is, the DID estimate of WASH_Ag Treatment*
β$_1$ = *Constant*, the *mean of outcome variables for Control group at the baseline.*

We estimated Eq. 1 for the entire sample population, hence β$_5$ represents the effect of the BRAC WASH treatment and β$_6$ represents the combined effect of the WASH-agriculture treatment and the BRAC WASH treatment. All of the impacts were estimated in relation to the control group, which received neither of the two interventions. The difference between β$_6$ and β$_5$ is the incremental impact the WASH-agriculture treatment had over BRAC WASH treatment. Although the treated households in both groups were not selected using the same randomization technique, β$_6$ and β$_5$ are comparable because our purpose was to compare the impacts of the two treatments by determining the impact WASH-agriculture treatment had on households receiving BRAC WASH treatment under the WASH-agriculture randomization structure. Further, the students involved in the WASH-agriculture treatment were either existing BRAC WASH SB members or students with comparable school achievements.

To ensure the robustness of the analyses, we also controlled for different baseline characteristics across the study groups, including some important confounding factors, such as weather-related variables (rainfall and temperature) and household exposure to government- departments (e.g. Public Health, Bangladesh Rural Development Board) and other stakeholders (e.g. *Korean Dip, Dishari*).

5. Results and Discussion

5.1 Baseline Survey Results

As mentioned earlier, there should be theoretically no significant difference between the three groups (the BRAC WASH treatment, WASH-agriculture and control group) in terms of baseline outcome variables of interest and major baseline characteristics because we adopted an RCT evaluation design. To determine whether there were any significant differences between the groups at baseline, a Bonferroni multiple-comparison test (a t-test) and an F-test were performed on key variables. We found that the baseline variables and baseline household characteristics were statistically similar between the three groups in most of the cases, which was in line with our expectation (Annex 6-a,b). More specifically, 9 out of 16 control variables reflected that the groups were balanced, while 19 out of 33 outcome variables indicated that the groups were balanced. There were only minor statistical differences in the other baseline variables (such as household size, the student's math score, average temperature, latitude, and household exposure to other WASH programs for control variables; and washing hands with soap or detergent before preparing and eating food, willingness to pay for water purification methods, and water hygiene index for outcome variables). We also adopted the DID multivariate regression technique to take into account the dissimilarities in these variables between the groups and to ensure the robustness of the analysis.

5.2 WASH-agriculture Treatment Acceptance and Attrition

A total of 227 SB households were randomly selected for the WASH-Agriculture treatment based on the baseline survey results. However, only 192 of the SB households received treatment in the end and the remaining households dropped out of the treatment due to various reasons, such as unavailability, vacation or change of residence. Treatment attrition was around 15%, while survey attrition was less than 1%. As shown in Table 1, exactly 50% of the treatment households reported that "*water testing result*" was the most important treatment form, followed by "*poster*" (42%) and then "*repeated water testing*" *(8%)*. About 55 % of the SB households were involved in the repeated water tests. About 41% of the households thought the water tests were necessary. During the endline survey, the enumerators found that 83.85% of the households were displaying the poster at home.

Table 1 Treatment household's acceptance of the WASH-agriculture treatment at the treatment areas

Acceptance: SB households that received the letter and poster and carried repeated water testing? (N=227)	192 (84.58%)
Which component of the treatment was the most important to the SB household? (N=192)	
1) Water testing result in the letter	96 (50.00%)
2) Agriculture hygiene messages/Poster	80 (41.67%)
3) Repeated water testing by children in the household	16 (8.33%)
Reason for performing repeated water testing (N=192)	
-Because it was necessary	78 (40.61%)
-Because they were asked to	107 (55.33%)
-Because it was free	7 (4.06%)
Enumerators observed poster display at home during endline data collection (N=192)	161 (83.85%)
Households members complied with the messages on the poster (N=192)	188 (97.92%)
Were those messages necessary for maintaining household cleanliness, safe drinking water and leading healthy life? (N=192)	192 (100.00%)

Table 2 The extent to which SB household members followed the agriculture hygiene messages on the poster according to the household head (N=192)

Agriculture hygiene messages	Did not follow	Followed somewhat	Followed quite well	Used to follow even before getting the poster
1. Carry safe drinking water in a covered clean jar/bottle to the crop field	40 (20.83%)	74 (38.54%)	58 (30.21%)	20 (10.42%)
2. Treat water using current standard practices and store treated water properly	83 (43.23%)	47 (24.48%)	50 (26.04%)	12 (6.25%)
3. Protect drinking water and food from wastes/latrine	6 (3.13%)	59 (30.73%)	66 (34.38%)	61 (31.77%)
4. Use hygienic latrine	25 (13.02%)	39 (20.31%)	79 (41.15%)	49 (25.52%)
5. Wash hands with soap/detergent after working on the farm, handling animals/wastes and defecating	14 (7.29%)	43 (22.4%)	67 (34.90%)	68 (35.42%)
6. Wash hands with soap/detergent before cooking and eating	3 (1.56%)	62(32.29%)	87 (45.31%)	40 (20.83%)

In addition, 97.92% of the households complied with the hygiene messages on the poster; all the households acknowledged that compliance with the hygiene messages was necessary for maintaining household cleanliness, ensuring safe drinking water and leading a healthy life. Table 2 shows the extent to which household members followed the six agricultural

hygiene messages on the poster according to their household head. All the messages conveyed by the poster are meant to ensure household cleanliness, safe drinking water and a healthy life. The idea of having improved health encouraged the households to adhere to the messages. Further, the students played a pivotal role in conveying the messages to their household members. Household members tended to respond more positively to the message of handwashing before preparing and eating food, and the use hygienic latrine than to the other hygiene messages. Household members appeared less likely to adhere to the message of proper water treatment and storage. The underlying reason for this was most likely the scarcity of the recommended treatment measures. Further, the farmers who work in crop fields usually did not carry drinking water to the field; therefore, only a low percentage of farmers followed this hygiene message.

5.3 Impact on Various Outcomes

We estimated both direct and indirect impacts of the interventions. In our analyses, the direct (or short-term) impacts encompass those that affected WASH behavior, WASH hygiene index, a household's willingness to pay for water purification equipment, WASH expenditure, and drinking water quality in terms of FC contamination. Other impacts were considered indirect (or long-term) and include those that affect diarrhea prevalence, anthropometric measures among under-five children, cost of illness caused by waterborne diseases and school absenteeism. The DID multivariate regression technique was used for estimating the impact of the interventions. All estimates are reported to show the impact of BRAC WASH treatment and WASH-agriculture treatment. Table 3 to Table 12 show the DID regression coefficients of BRAC WASH treatment*time (β_5) and WASH-agriculture*time (β_6). The coefficients measure the impacts of the existing BRAC WASH treatment and the specially designed WASH-agriculture treatment (administered alongside the BRAC WASH treatment) using the control group as reference. Further, the difference between β_5 and β_6 indicates the incremental impact the WASH-agriculture treatment had over the BRAC WASH treatment alone.

To ensure the robustness of the analyses, we controlled for different baseline characteristics, including some important confounding factors such as weather-related variables (rainfall and temperature) and household exposure to WASH interventions run by government departments (as shown in We also controlled for different baseline characteristics to ensure the robustness of the analyses (Table 12). These analyses were meant to help us understand the impact of the two treatments. In the following sub-sections, apart from statistically significant results, some statistically insignificant results will also be discussed because of their implication for policymaking.

5.3.1 Direct/short term impacts

1) Improvement in WASH behavior and practices at home and on farms

WASH-agriculture treatment households exhibited improved WASH behavior compared with both BRAC WASH treatment households and control households. They were more likely to store drinking water at home; and practice handwashing with soap or detergent after farming activities, handling animals or wastes, and defecating as well as before preparing and eating food. For example, the WASH-agriculture treatment households were 13.8 percentage points more likely to store drinking water at home than the control households, and the BRAC WASH treatment households were 11 percentage points more likely to do so. In terms of storing drinking water at home, the WASH-agriculture treatment households showed a 2.8 percentage point gain over the BRAC WASH treatment households. As the WASH-agriculture treatment was carried out alongside the BRAC WASH treatment, this 2.8 percentage point gain represents the incremental impact the WASH-agriculture treatment had over the BRAC WASH treatment in improving water storage practice at home and on farms. However, it should be noted that this behavioral practice showed a positive relationship with the baseline household characteristic 'household exposure to other WASH programs', which suggests the incremental impact of WASH-agriculture treatment may have been overestimated by about 1.9 percentage points. The WASH-agriculture treatment also had incremental impact on the handwashing practices mentioned above; the estimated incremental impact on handwashing with soap before preparing and eating food was robust to baseline household characteristics.

Table 3 Improvement in water, sanitation and hygiene behavior at home and on farms

VARIABLES	Carrying safe drinking water in a covered clean jar/bottle to the crop field		Water treatment using current standard practices and proper preservation of treated water		Storage of drinking Water at home		Protecting drinking water and food from wastes/latrine		Using hygienic latrine		Handwashing with soap/detergent after farming activities, handling animals/wastes and defecating		Handwashing with soap/detergent before preparing and eating food	
WASH_Ag Treatment	-0.0129 (0.0479)	0.0356 (0.0450)	0.00657 (0.0403)	-0.000135 (0.0469)	0 (0.0245)	0.0175 (0.0220)	-0.0504 (0.0415)	-0.0862* (0.0470)	0.0260 (0.0392)	0.0170 (0.0444)	0.0295 (0.0390)	0.0217 (0.0388)	-0.0998*** (0.0377)	-0.170*** (0.0457)
BRAC_WASH Treatment	0.0696 (0.0488)	0.0909** (0.0460)	0.0417 (0.0405)	0.0423 (0.0515)	-0 (0.0246)	0.0322 (0.0222)	0.0710* (0.0420)	0.124** (0.0519)	0.0859** (0.0394)	0.00696 (0.0488)	-0.00846 (0.0397)	-0.00858 (0.0397)	-0.137*** (0.0379)	-0.255*** (0.0502)
time	0.103** (0.0441)	3.249*** (0.378)	0.0273 (0.0371)	0.906* (0.474)	-0.238*** (0.0226)	-0.754*** (0.185)	0.0472 (0.0383)	1.805*** (0.477)	0.0157 (0.0362)	1.614*** (0.448)	0.0867** (0.0359)	-1.198*** (0.327)	0.109*** (0.0347)	1.237*** (0.462)
BRAC_WASH Treatment*time	0.0255 (0.0689)	0.0237 (0.0650)	0.0412 (0.0572)	-0.0159 (0.0776)	0.110*** (0.0348)	0.109*** (0.0313)	0.00670 (0.0594)	-0.0255 (0.0778)	0.0210 (0.0557)	0.0287 (0.0734)	0.0925* (0.0561)	0.0814 (0.0560)	0.118** (0.0535)	0.171** (0.0756)
WASH_AgTreatment*time	0.179*** (0.0677)	0.162** (0.0632)	0.0506 (0.0570)	0.00480 (0.0731)	0.138*** (0.0347)	0.118*** (0.0309)	0.131** (0.0587)	0.232*** (0.0729)	0.0675 (0.0555)	0.0981 (0.0691)	0.104* (0.0552)	0.0896 (0.0545)	0.172*** (0.0533)	0.238*** (0.0712)
Household Controls [Household exposure with other WASH programs]	No	Yes [0.06 (0.05)]	No	Yes [0.226*** (0.05)]	No	Yes [0.0615*** (0.0220)]	No	Yes [-0.0678 (0.0521)]	No	Yes [0.0769 (0.0492)]	No	Yes [0.0882** (0.0391)]	No	Yes [0.0280 (0.0507)]
Constant (Control)	0.372*** (0.0312)	7.710*** (1.284)	0.196*** (0.0263)	3.106** (1.449)	1*** (0.0160)	0.0917 (0.632)	0.689*** (0.0271)	2.409* (1.455)	0.724*** (0.0256)	8.877*** (1.372)	0.699*** (0.0254)	-1.232 (1.115)	0.757*** (0.0246)	5.066*** (1.413)
Observations	1,192	1,192	1,282	775	1,282	1,282	1,262	767	1,282	775	1,244	1,244	1,282	775
R-squared	0.039	0.185	0.009	0.071	0.115	0.314	0.020	0.156	0.013	0.204	0.041	0.086	0.071	0.149

Notes:

1) Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

2) The variable WASH_Ag Treatment captures possible differences between the WASH_Ag Treatment and Control groups prior to the intervention. WASH_Ag Treatment group refers to the group that received the WASH-agriculture treatment.

3) The variable BRAC_WASH Treatment captures possible differences between the BRAC_WASH Treatment and Control group prior to the intervention.

4) The variable time captures aggregate factors that cause changes in the outcome even without any intervention.

5) The variable WASH_AgTreatment*time shows the DID estimated impact of the WASH-Ag treatment, which include the BRAC WASH treatment.

6) The variable BRAC_WASH Treatment*time shows the DID estimated impact of the BRAC WASH treatment.

7) The variable Household Controls contains baseline household characteristics, such as household distance from school, household size, and household expenditure in the previous month. Along with all household control variables, 'household exposure to other WASH programs' is reported in the brackets.

8) Constant indicates the mean of the control group at baseline.

2) Household WASH hygiene index

Fifteen hygiene behaviors were used to calculate five hygiene indices (environmental, sanitary, water, food and personal) that constituted the overall WASH hygiene index, shown in the last column of Table 4. The indices were scored on a scale of one to three, with one representing '*worst*', two '*moderate*' and three '*best*'.

The results show that the BRAC WASH treatment had greater impact on the sanitary hygiene index and WASH hygiene index than the WASH-agriculture treatment (Table 4). Both were robust to household control variables, but the WASH hygiene index exhibited a negative relationship with the variable 'household exposure to other WASH programs', which did not suggest any over- or underestimation of the impacts on the WASH hygiene index. The WASH-agriculture treatment had incremental impact on the environmental hygiene index over the BRAC WASH treatment, but only after controlling for baseline household characteristics. In comparison, the WASH-agriculture treatment had greater impact on the personal hygiene index after considering the household controls, although the personal hygiene index also had a negative relationship with the variable 'household exposure to other WASH programs'. As with the WASH hygiene index, this did not suggest any over- or underestimation of the impacts on the personal hygiene index.

Even though the BRAC WASH treatment had greater impact on the sanitary hygiene index and the overall WASH hygiene index than the WASH-agriculture treatment (performed concurrently with the BRAC WASH treatment), this does not mean that the WASH-agriculture treatment caused household hygiene behavior to worsen. WASH-agriculture treatment was carried out in six sub-districts (hotspots) characterized by comparatively poor WASH indicators, and the two treatment groups consisted of households with slightly dissimilar baseline characteristics, which was why the DID regression technique was used for the analysis in the first place. The negative difference between the values of β_6 and β_5 (found in Eq. 1) implies that applying the WASH-agriculture treatment on top of the existing BRAC WASH treatment did not have as much impact as applying the BRAC WASH treatment alone. Nonetheless, households receiving the WASH-agriculture treatment still achieved better WASH outcomes than those in the control group.

Table 4 Impact on WASH hygiene indices

VARIABLES	Environmental hygiene index		Sanitary hygiene index		Water hygiene index		Food hygiene index		Personal hygiene index		Overall WASH hygiene index	
WASH_AgTreatment	-0.00391 (0.0685)	-0.0307 (0.0686)	0.0135 (0.0631)	0.0126 (0.0619)	-0.103 (0.0628)	-0.149** (0.0625)	0.0894 (0.0629)	-0.0597 (0.0755)	0.0101 (0.0661)	-0.101 (0.0780)	0.00610 (0.219)	-0.206 (0.214)
BRAC_WASH Treatment	0.0597 (0.0691)	0.0496 (0.0698)	-0.0199 (0.0637)	-0.0361 (0.0629)	-0.117* (0.0634)	-0.152** (0.0636)	0.114* (0.0635)	-0.0675 (0.0829)	0.0907 (0.0667)	-0.0208 (0.0857)	0.128 (0.221)	-0.0583 (0.218)
time	0.268*** (0.0630)	-0.860 (0.576)	-0.0881 (0.0580)	2.246*** (0.520)	0.142** (0.0578)	-1.006* (0.526)	0.184*** (0.0578)	-0.538 (0.762)	0.0536 (0.0608)	-0.939 (0.788)	0.559*** (0.201)	-0.344 (1.799)
BRAC_WASH Treatment*time	0.245** (0.0977)	0.234** (0.0983)	0.272*** (0.0901)	0.239*** (0.0887)	0.210** (0.0897)	0.184** (0.0897)	0.0539 (0.0898)	0.172 (0.125)	0.146 (0.0944)	0.255** (0.129)	0.927*** (0.312)	0.873*** (0.307)
WASH_AgTreatment*time	0.156 (0.0968)	0.160* (0.0963)	0.156* (0.0893)	0.165* (0.0868)	0.141 (0.0889)	0.141 (0.0878)	0.0308 (0.0890)	0.205* (0.117)	0.250*** (0.0935)	0.288** (0.121)	0.734** (0.309)	0.795*** (0.300)
Household Controls [Household exposure with other WASH programs]	No	Yes [-0.0883 (0.0683)]	No	Yes [-0.0750 (0.0616)]	No	Yes [-0.0309 (0.0623)]	No	Yes [-0.159* (0.0836)]	No	Yes [-0.194** (0.0864)]	No	Yes [-0.581*** (0.213)]
Constant (Control)	1.632*** (0.0445)	-2.233 (1.961)	2.123*** (0.0410)	5.528*** (1.769)	2.176*** (0.0409)	-0.207 (1.789)	2.172*** (0.0409)	1.007 (2.331)	2.142*** (0.0430)	0.977 (2.410)	10.25*** (0.142)	5.741 (6.121)
Observations	1,274	1,274	1,274	1,274	1,274	1,274	1,274	775	1,274	775	1,274	1,274
R-squared	0.081	0.113	0.014	0.089	0.038	0.083	0.033	0.097	0.032	0.086	0.068	0.140

Notes:

1) Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

2) The variable WASH_AgTreatment captures possible differences between the WASH_AgTreatment and Control groups prior to the intervention. WASH_AgTreatment group refers to the group that received the WASH-agriculture treatment.

3) The variable BRAC_WASH Treatment captures possible differences between the BRAC_WASH Treatment and Control group prior to the intervention.

4) The variable *time* captures aggregate factors that affect the outcome even without any intervention.

5) The variable WASH_AgTreatment*time shows the DID estimated impact of the WASH-Ag treatment, which includes the BRAC WASH treatment impact.

6) The variable BRAC_WASH Treatment*time shows the DID estimated impact of the BRAC WASH treatment.

7) The variable *Household Controls* contains baseline household characteristics, such as household distance from school, household size and household expenditure in the previous month. Along with all household control variables, '*household exposure to other WASH programs*' is reported in the brackets.

8) *Constant* shows the mean of the control group at baseline.

3) Impact on WASH expenditure and the willingness to use or pay for technology adoption and WASH expenditure

Table 5 shows the impact of the two treatments on a household's willingness to use[2] or pay for water purification methods. When compared with the WASH-agriculture treatment, the BRAC WASH treatment alone had a greater impact on a household's willingness to use or pay for six of the nine measures to ensure drinking water safety. These six measures are namely 'pumping and sand removal, 'cloth filter', 'boiling', 'water storage container', 'bottled water' and 'ceramic water filter'. The results were robust to household control variables. However, after controlling for baseline household characteristics, these results turn out to be slightly underestimated. Among them, the impact on 'cloth filtration' and 'ceramic water filter' were underestimated by the largest margins.

The WASH-agriculture treatment had incremental impacts on the measures 'chlorine tablet' and 'non-electric filter' over the BRAC WASH treatment. Controlling for baseline household characteristics revealed that the incremental impacts were slightly underestimated.

The WASH-agriculture treatment was initially estimated to have a larger impact on the variable 'sandstone filter' than the BRAC WASH treatment. However, after considering the household control variables, the BRAC WASH treatment turned out to have a larger impact on 'sandstone filter' instead. The results remained consistent even after taking into account household exposure to other WASH programs.

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[2] We use 'willingness to use' for water purification methods that do not require any monetary investment and 'willingness to pay' for water purification methods that requires some monetary investment.

Table 5 Willingness to use or pay for technology adoption

VARIABLES	Willingness to use or pay for water purification methods											
	Pump and sand removal (conventional method)		Cloth filter (conventional method)		Boiling		Chlorine tablet		Water storage container		Bottled water (factory made)	
WASH_AgTreatment	-0.228*** (0.0293)	-0.209*** (0.0290)	-0.236*** (0.0380)	-0.218*** (0.0431)	-0.219*** (0.0347)	-0.188*** (0.0340)	-0.154*** (0.0242)	-0.144*** (0.0242)	-0.193*** (0.0364)	-0.162*** (0.0339)	-0.106*** (0.0179)	-0.121*** (0.0246)
BRAC_WASH Treatment	-0.227*** (0.0295)	-0.205*** (0.0293)	-0.251*** (0.0382)	-0.232*** (0.0473)	-0.229*** (0.0348)	-0.196*** (0.0344)	-0.148*** (0.0243)	-0.141*** (0.0245)	-0.198*** (0.0365)	-0.160*** (0.0343)	-0.106*** (0.0179)	-0.120*** (0.0270)
time	-0.0682** (0.0270)	-0.383 (0.244)	-0.0868** (0.0350)	0.125 (0.435)	-0.0945*** (0.0320)	0.125 (0.286)	-0.126*** (0.0223)	-0.322 (0.204)	0.0675** (0.0335)	-1.074*** (0.285)	-0.0723*** (0.0165)	-0.0596 (0.248)
BRAC_WASH Treatment *time	0.152*** (0.0417)	0.152*** (0.0413)	0.218*** (0.0540)	0.276*** (0.0713)	0.220*** (0.0493)	0.230*** (0.0484)	0.167*** (0.0344)	0.168*** (0.0345)	0.291*** (0.0517)	0.300*** (0.0483)	0.109*** (0.0254)	0.126*** (0.0406)
WASH_AgTreatment*time	0.125*** (0.0415)	0.122*** (0.0407)	0.216*** (0.0537)	0.175*** (0.0671)	0.218*** (0.0490)	0.215*** (0.0477)	0.172*** (0.0342)	0.175*** (0.0340)	0.259*** (0.0514)	0.251*** (0.0476)	0.0978*** (0.0253)	0.0997*** (0.0382)
Household Controls [Household exposure with other WASH programs]	No	Yes [0.0848*** (0.0290)]	No	Yes [0.110** (0.0478)]	No	Yes [0.0724** (0.0340)]	No	Yes [0.0563** (0.0243)]	No	Yes [0.0307 (0.0339)]	No	Yes [0.0225 (0.0272)]
Constant (Control)	0.244*** (0.0191)	-2.648*** (0.832)	0.337*** (0.0248)	-2.630** (1.332)	0.283*** (0.0226)	-1.112 (0.977)	0.176*** (0.0158)	-0.705 (0.696)	0.210*** (0.0237)	-4.485*** (0.974)	0.107*** (0.0116)	-0.494 (0.759)
Observations	1,282	1,282	1,282	775	1,282	1,282	1,282	1,282	1,282	1,282	1,282	775
R-squared	0.072	0.128	0.046	0.227	0.046	0.116	0.044	0.078	0.114	0.258	0.039	0.094

Table 5 Willingness to use or pay for technology adoption (Continued)

VARIABLES	Willingness to use or pay for water purification methods					
	Ceramic water filter		Filter made of sand stone		Non-electric filter (factory made)	
WASH_AgTreatment	-0.124*** (0.0209)	-0.144*** (0.0269)	-0.167*** (0.0261)	-0.166*** (0.0308)	-0.0975*** (0.0236)	-0.0955*** (0.0237)
BRAC_WASH Treatment	-0.124*** (0.0210)	-0.152*** (0.0296)	-0.161*** (0.0263)	-0.185*** (0.0338)	-0.0815*** (0.0237)	-0.0840*** (0.0240)
time	-0.0760*** (0.0193)	-0.718*** (0.272)	-0.0759*** (0.0241)	-0.348 (0.311)	-0.0375* (0.0218)	0.00342 (0.199)
BRAC_WASH Treatment *time	0.123*** (0.0297)	0.158*** (0.0445)	0.128*** (0.0371)	0.181*** (0.0510)	0.111*** (0.0336)	0.118*** (0.0338)
WASH_AgTreatment*time	0.112*** (0.0295)	0.122*** (0.0419)	0.133*** (0.0370)	0.120** (0.0480)	0.136*** (0.0334)	0.149*** (0.0332)
Household Controls [Household exposure with other WASH programs]	No	Yes [0.0570* (0.0298)]	No	Yes [0.0915*** (0.0341)]	No	Yes [-0.0265 (0.0237)]
Constant (Control)	0.130*** (0.0136)	-2.383*** (0.832)	0.183*** (0.0170)	-1.411 (0.952)	0.103*** (0.0154)	-0.932 (0.681)
Observations	1,282	775	1,282	775	1,282	1,282
R-squared	0.038	0.112	0.043	0.131	0.023	0.053

Notes:
1) Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
2) The variable WASH_AgTreatment captures possible differences between the WASH_AgTreatment and Control groups prior to the intervention. WASH_AgTreatment group refers to the group that received the WASH-agriculture treatment.
3) The variable BRAC_WASH Treatment captures possible differences between the BRAC_WASH Treatment and Control group prior to the intervention.
4) The variable time captures aggregate factors that affect the outcome even without any intervention.
5) The variable WASH_AgTreatment*time shows the DID estimated impact of the WASH-Ag treatment, which include the BRAC WASH treatment impact.
6) The variable BRAC_WASH Treatment*time shows the DID estimated impact of the BRAC WASH treatment.
7) The variable Household Controls contains baseline household characteristics, such as household distance from school, household size, and household expenditure in the previous month. Along with all household control variables, 'household exposure to other WASH programs' is reported in the brackets.
8) Constant shows the mean of the control group at baseline.

The WASH-agriculture treatment did not have any significant incremental impact on household WASH expenditure over the BRAC WASH treatment (Table 6). However, after controlling for baseline household characteristics, the impact of the BRAC WASH treatment was greater than that of the WASH-agriculture treatment, but the resulting change in household WASH expenditure was insignificant.

Table 6 Impact on WASH expenditure

VARIABLES	WASH Expenditure (BDT)	
WASH_AgTreatment	-83.14** (38.82)	-86.32** (37.25)
BRAC_WASH Treatment	-44.04 (38.99)	-69.23* (37.67)
time	-108.4*** (35.78)	-380.4 (313.6)
BRAC_WASH Treatment*time	112.0** (55.14)	117.3** (53.07)
WASH_AgTreatment*time	112.6** (54.89)	117.2** (52.29)
Household Controls [Household exposure with other WASH programs]	No	Yes [26.54 (37.30)]
Constant (Control)	437.8*** (25.30)	2,851*** (1,071)
Observations	1,282	1,282
R-squared	0.009	0.120

Notes:
1) Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
2) The variable WASH_AgTreatment captures possible differences between the WASH_AgTreatment and Control groups prior to the intervention. WASH_AgTreatment group refers to the group that received the WASH-agriculture treatment.
3) The variable BRAC_WASH Treatment captures possible differences between the BRAC_WASH Treatment and Control group prior to the intervention.
4) The variable time captures aggregate factors that affect the outcome even without any intervention.
5) The variable WASH_AgTreatment*time shows the DID estimated impact of the WASH-Ag treatment, which include the BRAC WASH treatment impact.
6) The variable BRAC_WASH Treatment*time shows the DID estimated impact of the BRAC WASH treatment.
7) The variable Household Controls contains baseline household characteristics, such as household distance from school, household size, and household expenditure in the previous month. Along with all household control variables, 'household exposure to other WASH programs' is reported in the brackets.
8) Constant shows the mean of the control group at baseline.

4) Impact on microbial water quality

A microbial water quality test was conducted for every sample household before as well as after they received treatment (Table 7). At the baseline, the pre-intervention period, 100% of the households in our sample households had FC bacteria contamination in the drinking water. In the analysis, microbial water quality was represented as a binary variable, taking on the value one or zero depending whether FC bacteria were present in a household's drinking water. The WASH-agriculture treatment had a greater impact than the BRAC WASH treatment alone. Controlling for baseline household characteristics revealed that the impact of the WASH-agriculture treatment was underestimated, even though other WASH programs also had significant positive impact on household microbial water quality.

Table 7 Impact on microbial water quality (FC presence)

VARIABLES	Water Quality Result	
WASH_AgTreatment	0 (0.0288)	-0.00549 (0.0291)
BRAC_WASH Treatment	0 (0.0290)	-0.0108 (0.0294)
time	-0.186*** (0.0266)	-0.0751 (0.245)
BRAC_WASH Treatment*time	-0.0937** (0.0410)	-0.0831** (0.0415)
WASH_AgTreatment*time	-0.115*** (0.0408)	-0.109*** (0.0409)
Household Controls [Household exposure with other WASH programs]	No	Yes [-0.0609** (0.0291)]
Constant (Control)	1*** (0.0188)	1.760** (0.836)
Observations	1,280	1,280
R-squared	0.154	0.170

Notes:

1) Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

2) The variable WASH_AgTreatment captures possible differences between the WASH_AgTreatment and Control groups prior to the intervention. WASH_AgTreatment group refers to the group that received the WASH-agriculture treatment.

3) The variable BRAC_WASH Treatment captures possible differences between the BRAC_WASH Treatment and Control group prior to the intervention.

4) The variable time captures aggregate factors that affect the outcome even without any intervention.

5) The variable WASH_AgTreatment*time shows the DID estimated impact of the WASH-Ag treatment, which include the BRAC WASH treatment impact.

6) The variable BRAC_WASH Treatment*time shows the DID estimated impact of the BRAC WASH treatment.

7) The variable Household Controls contains baseline household characteristics, such as household distance from school, household size, and household expenditure in the previous month. Along with all household control variables, 'household exposure to other WASH programs' is reported in the brackets.

8) Constant shows the mean of the control group at baseline.

5.3.2 Indirect/long-term impacts

1) Impact on diarrhea prevalence

As reported in Table 8, the WASH-agriculture treatment largely had a positive, statistically significant impact on diarrhea prevalence. Compared with the control group, students and household members who received the WASH-agriculture treatment were around five percentage points less likely to suffer from diarrhea during the two weeks prior to the endline survey. The results were robust to household control variables. However, diarrhea prevalence among under-five children in the WASH-agriculture treatment group was significantly higher than in the control group. This may have been due to the very small sample size available, which is a result of the inadequate number of survey responses. The BRAC WASH treatment did not have any significant impact on the diarrhea prevalence in any of the three age categories (Table 8). Therefore, the WASH-Agriculture treatment may be

considered an improvement over the BRAC WASH treatment. It should be noted that FC bacteria are not the only cause of diarrhea and that the treatments may not have involved every measures for reducing diarrhea risk in humans.

Table 8 Impact on diarrhea prevalence of household members

VARIABLES	Diarrhea prevalence							
	Adults		Under-five children		Students		All household members	
WASH_AgTreatment	-0	-0.0379	0	-0.551	0.0104	0.0140	0.0104	0.0142
	(0.111)	(0.130)	(0.185)	(0.422)	(0.0133)	(0.0135)	(0.0136)	(0.0137)
BRAC_WASH Treatment	0.0313	0.0415	-0	-0.139	-0.0111	-0.00606	-0.0111	-0.00584
	(0.0935)	(0.118)	(0.185)	(0.339)	(0.0134)	(0.0137)	(0.0137)	(0.0139)
time	0.321***	-0.617	0.143	-2.354	0.0224*	-0.209*	0.0222*	-0.215*
	(0.0965)	(1.367)	(0.177)	(4.160)	(0.0126)	(0.113)	(0.0128)	(0.115)
BRAC_WASH Treatment*time	0.147	0.0381	0.190	0.350	-0.00462	-0.00739	0.000618	-0.00281
	(0.132)	(0.155)	(0.261)	(0.283)	(0.0192)	(0.0194)	(0.0195)	(0.0197)
WASH_AgTreatment*time	0.149	0.0682	0.190	0.938**	-0.0492***	-0.0490**	-0.0491**	-0.0493**
	(0.157)	(0.173)	(0.261)	(0.294)	(0.0190)	(0.0191)	(0.0193)	(0.0194)
Household Controls [Household exposure with other WASH programs]	No	Yes [-0.483** (0.213)]	No	Yes [0.854* (0.407)]	No	Yes [0.0290** (0.0135)]	No	Yes [0.0279** (0.0137)]
Constant (Control)	0	20.19	0	-45.21	0.0165*	-0.793**	0.0165*	-0.845**
	(0.0683)	(12.43)	(0.125)	(37.91)	(0.00878)	(0.383)	(0.00894)	(0.390)
Observations	154	138	38	25	1,195	1,195	1,200	1,200
R-squared	0.271	0.363	0.188	0.947	0.009	0.024	0.009	0.025

Notes:
1) Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
2) The variable WASH_AgTreatment captures possible differences between the WASH_AgTreatment and Control groups prior to the intervention. WASH_AgTreatment group refers to the group that received the WASH-agriculture treatment.
3) The variable BRAC_WASH Treatment captures possible differences between the BRAC_WASH Treatment and Control group prior to the intervention.
4) The variable time captures aggregate factors that affect the outcome even without any intervention.
5) The variable WASH_AgTreatment*time shows the DID estimated impact of the WASH-Ag treatment, which include the BRAC WASH treatment impact.
6) The variable BRAC_WASH Treatment*time shows the DID estimated impact of the BRAC WASH treatment.
7) The variable Household Controls contains baseline household characteristics, such as household distance from school, household size, and household expenditure in the previous month. Along with all household control variables, 'household exposure to other WASH programs' is reported in the brackets.
8) Constant shows the mean of the control group at baseline.

2) Impact on child health (anthropometrics)

Anthropometry is the measurement of body dimensions, such as weight and height, that reflect the nutritional status of an individual or a population group (Cogill, 2001). In this study, child anthropometrics[3] were classified into three categories: *wasting* (less weight for height), *stunting* (less height for age) and *underweight* (less weight for age). As shown in Table 9, neither the BRAC WASH treatment nor the WASH-agriculture treatment significantly improved child anthropometrics in the first regression. Even after controlling for baseline

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[3] World Health Organization (WHO) growth standard has been used for these estimations.

household characteristics, the treatments only had a few weakly significant impacts on child anthropometrics. Therefore, little conclusion can be drawn from the child anthropometric data. This is unsurprising as it takes a long time to observe detectable improvements in anthropometric measures and the time frame of this study was not long enough for such improvements to be observed, as is the case in other similar studies (Boisson et al., 2013; Brown et al., 2014; and Okyere et al., 2015). However, children in a BRAC WASH treatment household were slightly less likely to be stunted, and children in a WASH-agriculture treatment household had the highest likelihood of being stunted or underweight after the treatment. These findings are difficult to explain.

Table 9 Impact on Child anthropometrics

VARIABLES	The Child(ren) of the Household is/are Wasting		The Child(ren) of the Household is/are Stunting		The Child(ren) of the Household is/are Underweight	
WASH_AgTreatment	-0.0664 (0.0474)	-0.121** (0.0480)	0.0116 (0.0702)	0.0523 (0.0846)	-0.0197 (0.0717)	-0.0401 (0.0833)
BRAC_WASH Treatment	-0.0133 (0.0443)	-0.0484 (0.0444)	0.111* (0.0656)	0.167* (0.0858)	0.0341 (0.0670)	0.0885 (0.0844)
time	0.0208 (0.0400)	-0.410 (0.538)	0.0104 (0.0592)	-0.935 (1.025)	0.0521 (0.0605)	-1.732* (1.009)
BRAC_WASH Treatment*time	-0.0663 (0.0626)	-0.0600 (0.0626)	-0.132 (0.0927)	-0.229* (0.125)	-0.128 (0.0948)	0.0306 (0.123)
WASH_AgTreatment*time	-0.00197 (0.0670)	-0.0114 (0.0651)	0.141 (0.0993)	0.257** (0.123)	0.0423 (0.101)	0.226* (0.121)
Household Controls [Household exposure with other WASH programs]	No	Yes [-0.172*** (0.0465)]	No	Yes [-0.0835 (0.0872)]	No	Yes [-0.238*** (0.0858)]
Constant (Control)	0.104*** (0.0283)	8.278* (4.999)	0.177*** (0.0419)	-9.685 (10.91)	0.208*** (0.0428)	13.80 (10.74)
Observations	430	430	430	279	430	279
R-squared	0.014	0.108	0.022	0.134	0.009	0.140

Notes:
1) Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
2) The variable WASH_AgTreatment captures possible differences between the WASH_AgTreatment and Control groups prior to the intervention. WASH_AgTreatment group refers to the group that received the WASH-agriculture treatment.
3) The variable BRAC_WASH Treatment captures possible differences between the BRAC_WASH Treatment and Control group prior to the intervention.
4) The variable *time* captures aggregate factors that affect the outcome even without any intervention.
5) The variable WASH_AgTreatment*time shows the DID estimated impact of the WASH-Ag treatment, which include the BRAC WASH treatment impact.
6) The variable BRAC_WASH Treatment*time shows the DID estimated impact of the BRAC WASH treatment.
7) The variable *Household Controls* contains baseline household characteristics, such as household distance from school, household size, and household expenditure in the previous month. Along with all household control variables, '*household exposure to other WASH programs'* is reported in the brackets.
8) *Constant* shows the mean of the control group at baseline.

3) Impact on cost of illness

On average, BRAC WASH treatment households incurred a somewhat higher cost of illness than WASH-agriculture treatment households. At baseline, there were some significant differences in household expenditure on treating waterborne diseases between the three groups. A household in the control group spent an average of BDT 486.2 on treating waterborne diseases at baseline. After treatment, a BRAC WASH treatment household spent about BDT 243 more and a WASH-agriculture treatment household about BDT 209.5 more than a control household on average. Thus, the WASH-agriculture treatment had an incremental impact of BDT 33.5 over the BRAC WASH treatment. After considering household control variables, it was found that this decrease in the average expenditure was underestimated by about BDT 10.9. The higher average household expenditure on waterborne diseases in both the BRAC WASH treatment group and the WASH-agriculture treatment group may partly be attributed to higher levels of awareness among the treated households. Having a higher level of awareness of waterborne diseases may have motivated treated households to visit a certified doctor (likely one with an MBBS and charges a higher consultation fee) when they

felt unwell instead of using home remedies or seeking an uncertified village doctor for treatment at no or little cost.

Table 10 Impact on cost of illness for waterborne diseases

VARIABLES	Cost of illness (Expenditure on waterborne diseases in month prior to survey – in BDT)	
WASH_AgTreatment	-224.2** (88.21)	-268.9*** (87.91)
BRAC_WASH Treatment	-217.8** (85.26)	-280.3*** (85.97)
time	-456.9*** (61.92)	-2,333*** (580.9)
BRAC_WASH Treatment*time	243.0*** (92.34)	281.0*** (92.36)
WASH_AgTreatment*time	209.5** (95.01)	236.6** (94.19)
Household Controls [Household exposure with other WASH programs]	No	Yes [-31.26 (46.76)]
Constant (Control)	486.2*** (57.48)	-2,950* (1,678)
Observations	749	749
R-squared	0.095	0.139

Notes:
1) Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
2) The variable WASH_AgTreatment captures possible differences between the WASH_AgTreatment and Control groups prior to the intervention. WASH_AgTreatment group refers to the group that received the WASH-agriculture treatment.
3) The variable BRAC_WASH Treatment captures possible differences between the BRAC_WASH Treatment and Control group prior to the intervention.
4) The variable time captures aggregate factors that affect the outcome even without any intervention.
5) The variable WASH_AgTreatment*time shows the DID estimated impact of the WASH-Ag treatment, which include the BRAC WASH treatment impact.
6) The variable BRAC_WASH Treatment*time shows the DID estimated impact of the BRAC WASH treatment.
7) The variable Household Controls contains baseline household characteristics, such as household distance from school, household size, and household expenditure in the previous month. Along with all household control variables, 'household exposure to other WASH programs' is reported in the brackets.
8) Constant shows the mean of the control group at baseline.

4) Impact on school absenteeism

Student absenteeism data was collected from the participating schools to measure the impact the treatments had on student developmental productivity. In this case, the students were asked if they had been absent from school in the two weeks before the survey. Both treatments had no significant impact on this variable (Table 11). After controlling for baseline household characteristics, we found that the WASH-agriculture treatment had no incremental impact on school absenteeism over the BRAC WASH treatment. However, students in a WASH-Agriculture treatment household were 15.7% less likely to be absent from school in the two weeks before the endline survey than those in the control group.

Table 11 Impact on school absenteeism

VARIABLES	Student Absenteeism	
WASH_AgTreatment	0.0969**	0.102**
	(0.0473)	(0.0515)
BRAC_WASH Treatment	0.0525	0.0689
	(0.0478)	(0.0529)
time	0.487***	1.306***
	(0.0400)	(0.391)
BRAC_WASH Treatment*time	0.0180	-0.0539
	(0.0629)	(0.0689)
WASH_AgTreatment*time	-0.0872	-0.157**
	(0.0620)	(0.0677)
Household Controls [Household exposure with other WASH programs]	No	Yes [-0.208* (0.110)]
Constant (Control)	1.365***	3.407***
	(0.0299)	(1.197)
Observations	1,000	837
R-squared	0.251	0.291

Notes*:*

1) Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

2) The variable WASH_AgTreatment captures possible differences between the WASH_AgTreatment and Control groups prior to the intervention. WASH_AgTreatment group refers to the group that received the WASH-agriculture treatment.

3) The variable BRAC_WASH Treatment captures possible differences between the BRAC_WASH Treatment and Control group prior to the intervention.

4) The variable *time* captures aggregate factors that affect the outcome even without any intervention.

5) The variable WASH_AgTreatment*time shows the DID estimated impact of the WASH-Ag treatment, which include the BRAC WASH treatment impact.

6) The variable BRAC_WASH Treatment*time shows the DID estimated impact of the BRAC WASH treatment.

7) The variable *Household Controls* contains baseline household characteristics, such as household distance from school, household size, and household expenditure in the previous month. Along with all household control variables, '*household exposure to other WASH programs'* is reported in the brackets.

8) *Constant* shows the mean of the control group at baseline.

6. Summary and conclusion

We conducted an RCT to examine the effectiveness of a specially designed package of WASH-agriculture interventions involving students in terms of its' impact on 1) the WASH behavior of household members both at home and on farms, and 2) the health and developmental outcomes for the students' household members. The WASH-agriculture treatment consisted of sending every treatment household a letter informing them of their drinking water quality, putting up posters with hygiene messages and requesting them to perform repeated water quality tests. Households selected for the study population had either BRAC SB members or students with similar qualities; the study involved 66 schools in 6 WASH hotspots (sub-districts) in Bangladesh. The control group in this study received neither the WASH-agriculture treatment nor the BRAC WASH treatment, but may have received other WASH interventions by government departments or other NGO stakeholders on a limited scale. The study design allowed us to estimate the differential impacts between 1) the BRAC WASH treatment group and the control group, 2) the WASH-agriculture treatment group and the control group, and 3) the WASH-agriculture treatment group and the BRAC WASH treatment group.

Initially, we performed POU water quality tests using inexpensive and user-friendly test kits for every household with students in the study areas (a total of 1,560 households). Households whose drinking water was contaminated with FC bacteria were selected for the study population (1,094 households). Then, a total of 648 households were randomly chosen for the entire study. The initial water quality census and baseline survey found that the interventions we suggested for this experiment were justified. The study groups were similar in most of the outcome and control variables at baseline. Out of those selected for the WASH-agriculture treatment, 84.58% received the WASH-agriculture treatment and the remaining households dropped out due to various reasons. The treatment attrition is around 15%, while the survey attrition is less than 1%.

We estimated both direct and indirect impacts of the interventions. The direct, or short-term, impacts encompass changes in household WASH behavior, WASH hygiene index, the willingness to use or pay for water purification methods, WASH expenditure and drinking water quality in terms of the presence of FC bacteria. Impacts that require more time to be observable were considered indirect impacts. These include changes in diarrhea prevalence, anthropometric measures in under-five children, developmental productivity (more specifically, cost of illness for waterborne diseases), and school absenteeism.

The DID multivariate regression technique was used to estimate the impact of the treatments for the households with slightly dissimilar baseline characteristics across the three groups. To ensure the robustness of the analyses, we controlled for different baseline characteristics, including an important confounding factor (i.e., a household's exposure to other WASH programs). These analyses helped us better understand the magnitude of the

impact of the two treatments. After controlling for baseline characteristics, over- or underestimations were generally small or negligible, indicating that the study results were robust.

In general, the WASH-agriculture treatment had an incremental impact over the BRAC WASH treatment, determined by calculating the difference between β_6 and β_5 in Eq. 1. Compared with the BRAC WASH treatment, the WASH-agriculture treatment was especially effective in improving the following: household WASH behavior and practices both at home and on farms, the willingness to use or pay for three of the nine water purification methods, WASH expenditure, and POU drinking water quality. However, the existing BRAC WASH treatment performed better than the WASH-agriculture treatment for some other indicators related to hygiene behavior and developmental productivity. The WASH-agriculture treatment had no significant incremental impact over the BRAC WASH treatment in terms of diarrhea prevalence, anthropometric measures in under-five children, and school absenteeism.

The fact that the BRAC WASH treatment had a greater impact on a few outcome variables than the WASH-agriculture treatment does not mean that the WASH-agriculture treatment caused household hygiene behavior to deteriorate. The DID regression results only indicate that the WASH-agriculture treatment did not surpass the level of impact the BRAC WASH treatment had by itself; households in the WASH-agriculture treatment group still had improved outcomes when compared with households in the control group. There was no evidence suggesting that the two treatments had any negative impact on household WASH outcomes.

During the endline survey, the treated households were asked to assess the effectiveness of three different components of the WASH-agriculture treatment. The households generally considered receiving previous water quality test results and the poster containing agriculture hygiene messages the two most important forms of intervention. Thus, the positive impact of the WASH-agriculture treatment can mainly be attributed to these two factors.

While the BRAC WASH treatment had been making good progress in improving household WASH behavior and practices, households that received the WASH-agriculture treatment showed some gains over those that received only the BRAC WASH treatment, especially in terms of their at-home and on-farm WASH behavior, and the microbial quality of their drinking water. The three-month observation period was too short for any potential health improvement among under-five children to be detectable. Improvement in diarrhea prevalence cannot be detected within a very short time. Further, diarrhea may also be caused by factors not addressed in the two treatments. However, BRAC WASH has contributed significantly to meeting the country's WASH goals through its various community- and business-oriented approaches (BRAC, 2015). Therefore, based on the study results, we recommend scaling up the BRAC WASH program to include hotspot areas with poor household WASH indicators. Additionally, involving students in the BRAC WASH program as agents of change and as a channel of conveying agriculture hygiene messages

could be an effective strategy for motivating households and communities to improve their WASH behavior and practices, especially at home and on farms. Further, the WASH-agriculture treatment could be scaled up through simple institutional or administrative arrangements that do not require high monetary investment on generating water quality information and poster implementation containing hygiene messages.

The suggested WASH-agriculture treatment represents an improvement over existing WASH treatments. The study found that conveying farm-related hygiene messages to households and informing them of their drinking water quality could be useful in improving household hygiene behavior. Even though the WASH-agriculture treatment was implemented through SB members, the impact could also be attributed to the efforts of their household members and community. This shows that our study contributed to building the capacity of the treatment households and communities in monitoring their own WASH environment through water quality testing. Our study findings are relevant for researchers, policymakers and program implementers in the WASH sector of not only Bangladesh but also other developing countries.

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Annex

Annex 1. Prevalence of diarrhea in the hotspot areas in Bangladesh (1 if yes) : Results from logit regression

Diarrhea	Coef.	Std. Err.	P-values
Income	0.000	0.000	0.958
Agri_work (1 if yes)	**0.460**	**0.211**	**0.029**
ChildU5 (1 if yes)	-0.263	0.202	0.193
Latrine_imprvd (1 if yes)	0.007	0.211	0.972
Soap/ash use for hand wash (1 if yes)	**-0.663**	**0.206**	**0.001**
Advanced areas (1 if yes)	-0.030	0.190	0.874
Impvd_toilet (1 if yes)	-0.424	0.389	0.276
Ss2 (1 if control)	**0.600**	**0.251**	**0.017**
Ss3 (1 if treatment)	-0.004	0.255	0.986
Inc2	**-0.533**	**0.256**	**0.038**
inc3	-0.167	0.298	0.574
inc4	-0.121	0.464	0.795
_cons	-0.031	0.814	0.970
		Number of obs	648
		LR chi2(12)	43.33
		Prob> chi2	0

Annex 2-a. Socio-economics, health, sanitation and drinking water sources at study sites in Bangladesh

Indicators	National rural	Peri-urban/ advanced rural areas				Marginal rural areas			
		Kalihati	Atrai	Mirzapur	Avg	Bauphal	Bakshiganj	Melandaha	Avg
People under poverty line (%)	35	28	30	25	27	41	49	47	45
Child mortality rate (000)	66	99	42	56	66	65	67	96	76
% of population using improved sanitary facilities	42	58	72	67	66	21	39	57	39
% of population using improved water sources	96	100	97	100	99	100	95	100	98

Source: HIES (2010) and District series of Yearbook of Agricultural Statistics 2010 (BBS)

Annex 2-b. Agricultural practices at study sites in Bangladesh

	National	Peri-urban/ advanced rural areas				Marginal rural areas			
		Kalihati	**Atrai**	**Mirzapur**	**Avg**	**Bauphal**	**Bakshiganj**	**Melandaha**	**Avg**
Irrigation	62.19	77.65	76.89	75.74	76.76	0.55	77.90	91.54	56.66
Cropping intensity	173	193	182.22	184	186.41	181	190	195	188.67
MV Adoption	80.23	91.81	84.39	96.82	91.00	22.32	97.85	94.87	71.68

Source: District series of Yearbook of Agricultural Statistics 2010

Note: Though differences between those peri-urban and marginal areas in terms of socio-economic and agricultural practices exist, there are similarities among those areas in terms of prevalence of diarrhea- all areas have high diarrhea prevalence rate.

Annex 3. Letter treatment

……March 2015

Name and Address…………………………

Dear Madam/Sir,

Greetings.

Probably you can recall that we took drinking water sample to test the water quality from your home during the survey conducted in August 2014. Thank you for your cooperation. Unfortunately, we found the sample of your household fecal contaminated (pathogen). But we are not very sure whether this contamination might make you sick.

You may wish to take the following preventive measures:
1. You may please get your water at point of use (POU) tested again through your kid to confirm whether the water is still contaminated. The water testing kit is kept at your kids' school and your kid is already taught about how to use it. You may also like to test the water at source of your household at second time and thirdly at point of source. You will get maximum three times to get the water sample to be tested from your kids' school at free of cost within next 12 weeks.
2. If your drinking water is still contaminated, we recommend you to take actions that could make it clean prior to drinking. We also suggest you to maintain cleanliness regarding farm activities both at home and at farm fields. We request you to set the posters at your dwelling wall and follow the agriculture hygiene messages given at the poster-your kids are also taught about these messages at the school.

We will appreciate your cooperation to follow these guidelines to make your environment clean.

With warm regards,

……………………..

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Phone:
Cell:
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Annex 4. WASH-agriculture hygiene poster

Annex 5. Treatment implementation guidelines for Research Assistants and School Teachers

1st Stage (7th-12th March, 2015)

7th March, Send the researchers to their designated sub-districts and speak to the sub-district WASH program officers regarding the next day's preparations and content of the training.

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8th March: Training on water quality testing for bacteria in water and awareness and knowledge through poster to be given to the school teachers in charge of the student brigades in schools which are covered by the WASH offices and to 3-4 WASH program POs in the designated sub-districts.

At the same time, the teachers will be notified to choose 8 student brigades from their respective schools and inform them about the procedures as well. During the training day, the teachers will be given the materials for water testing, list of students, letter to the parents of the respective chosen students, register copies, sample bottles, vial, marker, poster and a sheet of paper where names of respective teachers, their mobile number and signature will be included.

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9th March: The teachers will make the selected student brigades aware of the water testing and poster and inform them to bring water from their households in the supplied sample collection bottle the next day. For collection of water they should be told with emphasis that "Water should be brought from the point of use (Pitcher/Jug) from which they drink water." It should be stated that after the student brigades hand over their bottles to the teachers, the teachers should mark each bottle with their individual household ID number. Side by side the student brigades will be explained about the letter to their parents and the poster. By paying visits to a few schools, it will be observed if the designated teachers are explaining properly to the selected student brigades regarding the required procedure.

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10th March: The student brigades will hand over their bottles to their designated teachers to test bacteria in water. The teachers will mark each bottle with the respective household ID number and then using the vial will proceed with the water testing for each household. Water will be kept in the vial for 48 hours for testing purpose. For safety purpose it is wise to keep the vials with the head teacher of each respective school. The researchers will visit the schools for some time.

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11th March: The research assistants of each designated sub-districts will go around school to school for observation purpose with the support of the WASH officers. They will observe if the schools are storing the water appropriately and also notice if there has been any change in the color of the water. With the view to make the water quality testing for bacteria in water successful, 48 hours must be given to avail appropriate results.

12th March: After completion of 48 hours, the research assistants should visit the designated schools of the respective sub-districts again and observe and assert the change in color of the water in the vial. At the same time attention must be given to the teachers in keeping record of the change in the color of the water in their register copy.

2nd Stage: (11th-13th April, 2015)

The respective teachers will wash and properly clean the bottles with soap/detergent and inform the students to bring water from the point of source of their drinking water (tube-well/pipe). The water quality testing should be completed by 13th April as per the steps of stage 1 and the results should be recorded in the registered copy.

3rd Stage: (11th-13th May, 2015)

The students will bring water from point of use (Pitcher/Jug) of their drinking water and test properly just like before and by 13th May 2015 complete the whole procedure of water quality testing.

The register copies will be collected by the end of the 3rd stage water quality testing.

With regards to any query please contact Ikhtiar Mohammad, Staff Researcher, at the mobile number 01670211214.

Annex 6-a. Balance checking of Baseline characteristics (Control Variables)

Baseline Characteristics	(1) Control Mean (SD)	(2) WASH-agriculture Treatment Mean (SD)	(3) WASH-agriculture Treatment Diff (P-value)	(4) BRAC WASH Treatment Mean (SD)	(5) BRAC WASH Treatment Diff (P-value)	(6) F-test F-stat	(7) F-test P-value	(8) Sample Size (N)
Household Head Characteristics								
Male	0.94 (0.24)	0.93 (0.26)	0.01 (1)	0.97 (0.17)	-0.03 (0.68)	1.73	0.18	648
Years of Schooling	5.48 (7.49)	5.41 (7.26)	0.07 (1)	5.38 (7.18)	0.10 (1)	0.91	0.40	648
Household Characteristics								
Expenditure in last one month (BDT)	95,565 (48,342.72)	83,942.06 (51,895.55)	11,622.9 (0.21)	93,316.16 (80,163.09)	2,248.84 (1)	2.34	0.10	648
Household Distance from School (Km)	0.79 (0.54)	1.15 (1.08)	-0.35 (0.001)	0.92 (0.73)	-0.13 (0.62)	8.31	0.0003	648
Household family size	5.81 (2.01)	5.34 (1.96)	0.47 (0.07)	5.74 (2.06)	0.07 (1)	3.81	0.02	648
Number of Children under five years of age	0.6 (0.63)	0.42 (0.62)	0.17 (0.03)	0.57 (0.64)	0.03 (1)	0.40	0.67	228
Farm Size (decimal)	98.99 (75.93)	137.87 (152.10)	-38.88 (0.15)	142.25 (189.79)	-43.26 (0.14)	2.39	0.09	435
School Characteristics								
Drinking water purification facility in the school	0 (0)	0.07 (0.26)	-0.07 (1)	0.17 (0.38)	-0.17 (0.27)	1.60	0.21	66
Separate latrines for men and women	1 (0)	0.96 (0.19)	0.04 (1)	0.96 (0.20)	0.04 (1)	0.27	0.76	66
Student Characteristics								
Students perceived their health as "very good"	0.86 (0.36)	0.96 (0.19)	-0.11 (0.35)	1 (0)	-0.14 (0.13)	0.88	0.42	648
Math Score of Students - Term 3/Final (2014) in GPA	3.27 (1.26)	3.6 (1.18)	-0.33 (0.03)	4.03 (0.88)	-0.76 (0.00)	14.55	0.00	648
Weather Characteristics								
Average temperature (Degree Celsius)	18.4 (0.34)	18.68 (1.00)	-0.28 (0.01)	18.68 (1.00)	-0.28 (0.02)	4.8	0.01	648
Average Rainfall (Millimeter)	0.24 (0.24)	0.27 (0.20)	-0.03 (0.45)	0.27 (0.20)	-0.03 (0.53)	1.18	0.31	648
Location Characteristics								
Latitude (degree decimal)	24.57 (0.45)	24.19 (1.12)	0.38 (0.001)	24.16 (1.03)	0.41 (0.001)	7.90	0.00	648
longitude (degree decimal)	89.94 (0.14)	89.82 (0.57)	0.11 (1)	89.68 (2.23)	0.25 (0.25)	1.57	0.21	648
Household exposure with other WASH program	0.21 (0.41)	0.07 (0.26)	0.14 (0)	0.08 (0.27)	0.13 (0)	21.54	0.00	1296

Annex 6-b. Balance checking of Baseline characteristics (Outcome Variables)

Baseline Outcome Variables	(1) Control Mean (SD)	(2) WASH-agriculture Treatment Mean (SD)	(3) WASH-agriculture Treatment Diff (P-value)	(4) BRAC WASH Treatment Mean (SD)	(5) BRAC WASH Treatment Diff (P-value)	(6) F-test F-stat	(7) F-test P-value	(8) Sample Size (N)
Presence of Fecal Coliform Bacteria	1 (0)	1 (0)	0 (.)	1 (0)	0 (.)	.	.	648
Water, Sanitation and Hygiene Behavior								
Carrying safe drinking water in a covered clean jar/bottle to the crop field	0.34 (0.48)	0.38 (0.49)	-0.04 (1)	0.44 (0.50)	-0.10 (0.23)	10.48	0.23	596
Treating water by current standard practices and preserve treated water	0.22 (0.41)	0.19 (0.39)	0.02 (1)	0.24 (0.43)	-0.02 (1)	0.62	0.54	641
Stocking Drinking Water in the House	1 (0)	1 (0)	0 (.)	1 (0)	0 (.)	0	.	641
Protecting drinking water and food from wastes/latrine	0.71 (0.46)	0.65 (0.48)	0.06 (0.69)	0.76 (0.43)	-0.05 (1)	30.28	0.04	631
Using hygienic latrine	0.71 (0.45)	0.74 (0.44)	-0.03 (1)	0.81 (0.39)	-0.10 (0.15)	20.25	0.11	641
Washing hands with soap/detergent after farming , handling animals/wastes and defecation	0.71 (0.45)	0.71 (0.45)	0.00 (1)	0.69 (0.46)	0.02 (1)	0.36	0.70	622
Washing hands with soap/detergent before cooking and eating	0.88 (0.33)	0.65 (0.48)	0.23 (0)	0.62 (0.49)	0.26 (0)	50.47	0.004	641
Diarrhea Prevalence								
All Households	0.02 (0.13)	0.02 (0.15)	-0.01 (1)	0.01 (0.07)	0.01 (1)	10.30	0.22	610
Adult Households	0 (0)	0 (0)	0 (1)	0.03 (0.18)	-0.03 (1)	0.70	0.50	77
Students	0.02 (0.13)	0.02 (0.15)	-0.01 (1)	0.01 (0.07)	0.01 (1)	10.30	0.27	609
Children of less than five years of age	0 (0)	0 (0)	0 (.)	0 (0)	0 (.)	.	.	15
Treated water to make it safer to drink	0.02 (0.15)	0.03 (0.17)	-0.01 (1)	0.03 (0.17)	-0.01 (1)	0.38	0.68	641

Annex 6-b. Balance checking of Baseline characteristics (Outcome Variables) - Continued

Baseline Outcome Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Willingness to Pay for Water Purification Methods								
Pump and remove sand(Conventional methods)	0.50 (0.50)	0.01 (0.11)	0.49 (0.00)	0.02 (0.13)	0.49 (0.00)	470.62	0.00	641
Filter with cloth (Conventional method)	0.58 (0.50)	0.11 (0.31)	0.47 (0.00)	0.08 (0.28)	0.49 (0.00)	320.92	0.00	641
Boiling	0.53 (0.50)	0.06 (0.24)	0.47 (0.00)	0.05 (0.22)	0.48 (0.00)	34.00	0.00	641
Use chlorine tablet	0.34 (0.48)	0.02 (0.14)	0.32 (0.00)	0.03 (0.16)	0.32 (0.00)	240.52	0.00	641
Store water in the container for a while	0.42 (0.50)	0.02 (0.12)	0.41 (0.00)	0.01 (0.10)	0.41 (0.00)	390.62	0.00	641
Bottled water (Factory made)	0.22 (0.41)	0.003 (0.06)	0.21 (0.00)	0 (0)	0.22 (0.00)	220.57	0.00	641
Ceramic water filter	0.27 (0.45)	0.003 (0.06)	0.27 (0.00)	0.01 (0.07)	0.27 (0.00)	240.28	0.00	641
Filter made of sand stone	0.37 (0.48)	0.02 (0.13)	0.35 (0.00)	0.02 (0.14)	0.35 (0.00)	290.22	0.00	641
Non-electric filter (factory made)	0.20 (0.40)	0.01 (0.10)	0.19 (0.00)	0.02 (0.14)	0.18 (0.00)	14.02	0.00	641
Hygiene and Health Related Expenditure								
WASH Expenditure	4360.75 (2760.67)	3880.25 (5560.70)	480.50 (1)	390.34 (450.39)	460.41 (1)	10.67	0.19	641
Medical Expenditure	540.92 (1670.25)	650.52 (4610.35)	-10.60 (1)	480.93 (1630.52)	50.98 (1)	0.68	0.51	641
WASH-Hygiene Index								
Environment-Hygiene Index	10.71 (0.73)	10.59 (0.77)	0.12 (0.40)	10.68 (0.78)	0.03 (1)	0.37	0.69	641
Sanitation-Hygiene Index	20.22 (0.62)	20.10 (0.70)	0.12 (0.27)	20.11 (0.71)	0.11 (0.46)	0.06	0.94	641
Water-Hygiene Index	20.25 (0.63)	2.09 (0.70)	0.16 (0.08)	2.05 (0.74)	0.20 (0.04)	20.39	0.09	641
Food-Hygiene Index	20.18 (0.77)	20.21 (0.71)	-0.03 (1)	20.27 (0.76)	-0.09 (0.81)	10.53	0.22	641
Personal-Hygiene Index	20.14 (0.67)	20.15 (0.75)	-0.003 (1)	20.24 (0.78)	-0.10 (0.70)	10.29	0.28	641
Total WASH-Hygiene Index	10.52 (20.45)	10.15 (20.51)	0.37 (0.50)	10.36 (20.70)	0.15 (1)	0.17	0.85	641
Anthropometric Measurement of Children of Less than Five Years								
Wasting	0.1 (0.30)	0.07 (0.25)	0.03 (1)	0.09 (0.29)	0.01 (1)	1.01	0.37	215
Stunting	0.12 (0.32)	0.22 (0.42)	-0.11 (0.34)	0.29 (0.46)	-0.17 (0.06)	10.56	0.21	215
Underweight	0.17 (0.38)	0.22 (0.42)	-0.06 (1)	0.24 (0.43)	-0.08 (0.91)	0.27	0.77	215
Student absenteeism	10.33 (0.47)	10.43 (0.50)	-0.10 (0.30)	10.42 (0.50)	-0.09 (0.57)	1280.84	0.00	604